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(54) Plate for heat exchanger

(57) The present invention relates to a plate (1) for a heat exchanger comprising a rectangular plate having a first set of opposing circumferential edges (2) and a second set of opposing circumferential edges (3), a first side (4), a second side (5), and a plurality of spacers (6). A number of first spacers (6a) are arranged in a number of rows extending across the plate in the same direction as the first set of edges (2), and a number of second spacers (6b) are arranged in a number of columns extending across the plate in the same direction as the second set of edges (3). The first spacers (6a) are formed as protrusions on the first side (4) of the plate and the second spacers (6b) are formed as protrusions on the second side (5) of the plate. Each adjacent set of rows of first spacers (6a) form a channel (7) extending across the first side (4) of the plate in the same direction as the first set of edges (2), and each adjacent set of columns of second spacers (6b) form a channel (7) extending across the second side (5) of the plate in the same direction as the second set of edges (3). The channels (7) are suitable for flow of fluid. The present invention further relates to a plate heat exchanger comprising said plates (1).

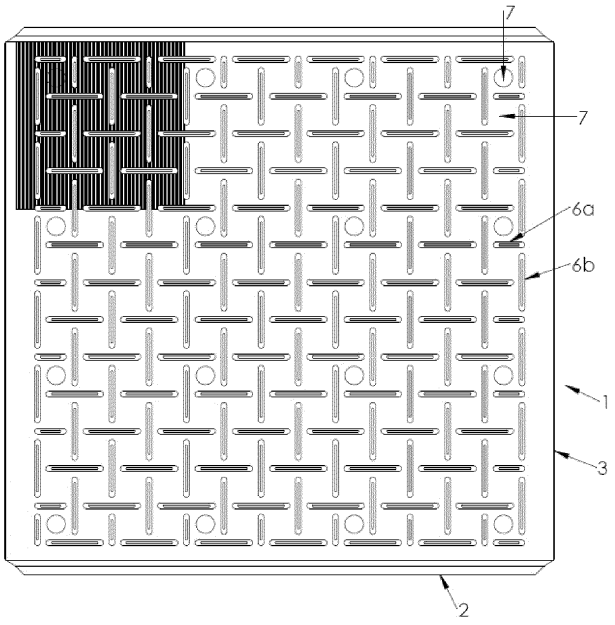

Fig. 1

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Description

Field of the invention

[0001] The present invention relates to a plate for a heat exchanger comprising a rectangular plate having a first set of opposing circumferential edges and a second set of opposing circumferential edges, a first side, and a second side, and a plurality of spacers.

Background of the invention

[0002] Plate heat exchangers are used for transfer of heat between fluids in applications such as energy recovery in ventilation systems, electronic cooling, and preheating. The plates of the heat exchanger need to have a certain configuration in order to be efficient, which includes maintaining a distance between adjacent plates.

[0003] One kind of plate heat exchanger is shown in US- 4, 183, 403. This document discloses a heat exchanger comprising corrugated plates provided with a number of different spacers in order to maintain the distance between adjacent plates constant and to strengthen the bends of the corrugated plates. One kind of spacers extends along the peripheral edges of the plates. Another kind of spacers is arranged at the bends of the corrugations, and extend longitudinally along these bends.

[0004] However, there are problems with this kind of solution. The spacers are welded onto the corrugated plates, which leads to a separate and hence time consuming manufacturing step. Further, some welding is done at the corrugation bends which in itself poses a further problem during manufacturing. Also, the use of longitudinally extending spacers prevents the plates from being stacked in a more space efficient manner when the plates are separated, i.e. not fitted into the heat exchanger. This kind of configuration also limits the direction of the flow of fluid to the direction of the corrugations.

Summary of the invention

[0005] It is an object of the present invention to mitigate the above problems, and to provide a plate for a heat exchanger which significantly improves the efficiency of the heat exchanger, while still being relatively simple to manufacture. According to a first aspect of the present invention, these objects are achieved by a plate for a heat exchanger comprising a rectangular plate having a first set of opposing circumferential edges and a second set of opposing circumferential edges, a first side, and a second side, and a plurality of spacers, wherein a number of first spacers are arranged in a number of rows extending across the plate in the same direction as the first set of edges, and a number of second spacers are arranged in a number of columns extending across the plate in the same direction as the second set of edges, the first spacers are formed as protrusions on the first side of the plate and the second spacers are formed as protrusions on the second side of the plate, each adjacent set of rows of first spacers form a channel extending across the first side of the plate in the same direction as the first set of edges, and each adjacent set of columns of second spacers form a channel extending across the second side of the plate in the same direction as the second set of edges, the channels being suitable for flow of fluid.

[0006] The use of a plate having this kind of spacers is beneficial not only in that it is simple to manufacture the plate and its spacers in one piece, e.g. by pressing, but also in that the plates can be space efficiently stacked on top of each other when not in use. Also, the configuration of the spacers leads to two perpendicular channels for the flow of fluid which is to be used during the heat exchange. This configuration also gives the two perpendicular flows of fluid the same cross sectional area and geometrical separation, i.e. the two flows are identical with regard to the fluidics, which results in a symmetrical plate which the user can assemble without worrying about how to correctly fit the plates.

[0007] The spacers may have an oblong shape, and the first spacers may extend longitudinally in the same direction as the first set of edges and the second spacers may extend longitudinally in the same direction as the second set of edges. This is advantageous in creating relatively tight channels for fluid, which extend in different directions.

[0008] In one embodiment, the first and second spacers are arranged such that at least one end of each first spacer terminates at the centre or end of at least one second spacer, and at least one end of each second spacer terminates at the centre or end of at least one first spacer. The use of such a pattern facilitates the creation of separate, perpendicular channels and also the stapling of the plates when used in the heat exchanger.

[0009] In yet another embodiment, the plate further comprises a number of corrugations extending parallel to the second spacers and surrounding the first and second spacers, the corrugations ending adjacent to the periphery of each spacer, wherein the corrugations form protrusions on the first side and depressions on the second side of the plate. The use of corrugations stiffens the plate such that the distance between the spacers may be increased and hence the number of spacers reduced. The corrugations are also beneficial in that they increase the heat transferring surface of the plates, and lead to an earlier induction of turbulence as compared to a smooth plate. Turbulence increases the efficiency of the heat exchanger by facilitating the highest possible heat transfer in combination with the lowest possible pressure loss.

[0010] According to a second aspect of the present invention, these objects are achieved by a plate heat exchanger comprising at least two of the above mentioned plates being stacked on top of each other, wherein every other plate is rotated 90° relative to the adjacent plate(s). This facilitates stacking of the plates while maintaining a distance between them since every pair of adjacent

plates may have contact through the protruding spacers, i.e. the protrusions on the first side of one plate of the pair rests upon the corresponding protrusions on the second side of the other plate of the pair.

Brief description of the drawings

[0011] This and other aspects of the present invention will now be described in more detail, with reference to the appended drawings showing a currently preferred embodiment of the invention.

Figure 1 shows a top view of an embodiment of the plate according to the present invention.
Figure 2 shows a side view of an embodiment of the plate according to figure 1.
Figure 3 shows an enlarged portion of the top view according to figure 1.
Figure 4 shows a partial cross-sectional view of the plate according to figure 1.

Detailed description

[0012] Figure 1 shows the top side of a plate 1 for use in a heat exchanger. This top side is also referred to as the first side 4, making the bottom side of the plate the second side 5. The plate 1 has an essentially rectangular shape, it being understood that rectangular also includes a quadratic shape. The rectangular plate has four circumferential edges 2, 3, where each pair of two opposing edges are parallel. The plate 1 is preferably made of aluminium, stainless steel, or plastics material, but could also be made of any other suitable metal or highly heat conductive material.

[0013] The plate 1 is provided with a plurality of spacers 6, which are pressed into the plate using common pressing technology. I.e., the spacers 6 are integral with the plate such that no further, separate manufacturing step is needed. The plate 1 could also be manufactured by other methods such as electromagnetic forming, rubber pad forming, or hydroforming.

[0014] A number of spacers 6, approximately half the total amount of spacers which are referred to as the first spacers 6a, are arranged essentially equidistantly in a number of rows which extend across the plate in the same direction as the first set of edges 2. The rows themselves are also placed equidistantly from each other. The remainder of the spacers 6, consequently also approximately half the total amount of spacers and which are referred to as the second spacers 6b, is arranged essentially equidistantly in a number of columns which extend across the plate in the same direction as the second set of edges 3. The columns themselves are also placed equidistantly from each other.

[0015] All spacers 6 on the plate have essentially the same shape, except for their length. What is considered to be the length will be described in more detail further below. As shown in figure 2, each spacer 6 is formed as a protrusion, or more exactly a protrusion on one side of the plate and a depression on the other side of the plate. In the described embodiment, the first spacers 6a, which are arranged in rows, are formed as protrusions on the first side 4 of the plate and as depressions on the second side 5 of the plate. The second spacers 6b, which are arranged in columns, are formed as depressions on the first side 4 of the plate and as protrusions on the second side 5 of the plate. The protrusions and depressions extend in a direction which is perpendicular to that of the plane of the plate, i.e. in the stacking direction of a heat exchanger. In a preferred embodiment, the protrusions/depressions have the shape of a truncated cone as seen in the perpendicular direction, but they could e.g. also have the shape of a pointed triangle or a soft shape such as a sinusoidal wave.

[0016] In the plane of the plate, the spacers 6 have an oblong shape, essentially that of an elongated approximate oval or an elongated approximate rectangle having opposing rounded ends. The spacer has two first opposing sides 9 which extend in parallel, and two second opposing sides 10 which connect the first sides 9. The second opposing sides 10 are arched or semi-circular, the centre of such a theoretical circle shape being at the interior of the spacer 6 such that the arc or circle is rounded outwards.

[0017] The spacers 6 are arranged in the rows or columns, respectively, such that they extend longitudinally along the row or column. I.e., the first spacers 6a extend longitudinally in the same direction as the first set of edges 2 and the second spacers 6b extend longitudinally in the same direction as the second set of edges 3.

[0018] As a result, both the first and the second sides 2, 3 of the plate 1 are provided with protrusions and depressions, the protrusions on one side being arranged at a 90° angle to the depressions on the same side, and the opposite. I.e., the spacers in the rows and the spacers in the columns are arranged at a 90° angle to each other.

[0019] Every two adjacent rows or columns, comprising protrusions, form a channel 7. Adjacent rows form a channel 7 which extends across the first side 4 of the plate in the same direction as the first set of edges 2 while adjacent columns form a channel 7 which extends across the second side 5 of the plate in the same direction as the second set of edges 3. These channels 7 are used for transmitting a flow of fluid from one edge 2, 3 of the plate to the opposite edge 3, 2, in line with common practice for heat exchangers.

[0020] As mentioned above, the first and second spacers 6 are arranged such that they form rows and columns, respectively, on the plate 1. These rows and columns are however arranged mutually such that the individual spacers 6 do not come in contact with each other. More exactly, the first and second spacers 6 are arranged such that at least one end of each first spacer 6a terminates at the centre or end of at least one second spacer 6b, and at least one end of each second spacer 6b terminates at the centre or end of at least one first spacer 6a.

[0021] In other words, the first spacers 6a and the second spacers 6b are arranged such that they alternate in both the direction of the first set of edges 2 and the direction of the second set of edges 3. Every first spacer 6a is has two, three or four adjacent second spacers 6b. The first spacers 6a arranged at the very corners of the plate may have two or three adjacent second spacers 6b. The first spacers 6a arranged along the edges 2, 3 of the plate have three adjacent second spacers 6b. The remaining first spacers 6a have four adjacent second spacers 6b. As previously mentioned, the first spacer 6a extends longitudinally in the same direction as the first set of edges 2 and the second spacers 6b extend longitudinally in the same direction as the second set of edges 3. Hence, the spacers 6 together form a pattern on the plate which can be described as a somewhat offset square pattern, as an H-pattern or, maybe most correctly as a number of T's arranged on top of each other in columns, where every other column is offset in the direction of the second set of edges 3 such that every first spacer 6a has two, three, or four adjacent second spacers 6b.

[0022] The majority of the spacers 6 have the same length. However, a number of spacers 6 are shorter, preferably about half the length. This applies mainly, preferably only, to the spacers 6 which are located closest to the edges 2, 3 of the plate and which also extend perpendicularly to the edge which they are adjacent to.

[0023] The plate 1 is further provided with a number of corrugations 8, as shown in figures 3 and 4. The corrugations 8 preferably extend in parallel lines in parallel with the second spacers 6b. However, they could also be angled in relation to the spacers 6, e.g. by 45°, in the plane of the plate. The corrugations 8 surround the first and second spacers 6 and end adjacent to the periphery of each spacer 6 such that they cover preferably all the plate surface located between the spacers 6. In a preferred embodiment, the corrugations 8 form protrusions on the first side 4 and depressions on the second side 5 of said plate 1. The corrugations 8 have an essentially triangular shape or V-shape such that they form a zigzag pattern when studying a cross-sectional side view of the plate. Further, the corrugations could form both protrusions and depressions on both sides of the plate, i.e. such that the zigzag pattern is centred as seen in a cross-sectional side view of the plate.

[0024] The above mentioned plates 1 are intended for use in a plate heat exchanger, wherein they are stacked on top of each other in essentially the same way as in a conventional plate heat exchanger. The plates are stacked such that every other plate is rotated 90° relative to the adjacent plate(s).

[0025] The arrangement of the spacers 6 on the plate is rotationally but oppositely symmetrical. By *rotationally symmetrical* is meant that the same visual pattern of spacers 6 is maintained no matter if the plate is rotated 90°, 180°, or 270° or not at all. By *oppositely* is meant that, even though the visual pattern is the same, the spacers 6 come to protrude in the opposite direction as the plate is rotated, i.e. a protrusion at 0° is exchanged for a depression at 90°, a protrusion once again at 180°, and a depression at 270°. Due to this configuration of spacers 6 in combination with the rotation of every other plate 1, the plates 1 are stacked such that every pair of adjacent plates 1 has contact through the protruding spacers 6, i.e. the protrusions on the bottom side of the upper plate of the pair rests upon the corresponding protrusions on the top side of the lower plate of the pair.

[0026] The person skilled in the art realizes that the present invention by no means is limited to the preferred embodiments described above. On the contrary, many modifications and variations are possible within the scope of the appended claims. For example, the plate could be manufactured in any suitable manner and by any suitable material. Also, the spacers could have any suitable shape in all three dimensions.

Claims

1. A plate (1) for a heat exchanger comprising
a rectangular plate having a first set of opposing circumferential edges (2) and a second set of opposing circumferential edges (3), a first side (4), and a second side (5), and
a plurality of spacers (6), wherein
a number of first spacers (6a) are arranged in a number of rows extending across said plate (1) in the same direction as the first set of edges (2), and
a number of second spacers (6b) are arranged in a number of columns extending across said plate (1) in the same direction as the second set of edges (3),
said first spacers (6a) are formed as protrusions on said first side (4) of said plate (1) and said second spacers (6b) are formed as protrusions on said second side (5) of said plate (1),
each adjacent set of rows of first spacers (6a) form a channel (7) extending across said first side (4) of said plate (1) in the same direction as the first set of edges (2), and
each adjacent set of columns of second spacers (6b) form a channel (7) extending across said second side (5) of said plate (1) in the same direction as the second set of edges (3),
said channels (7) being suitable for flow of fluid.

2. A plate (1) according to claim 1, wherein said spacers (6) have an oblong shape, and said first spacers (6a) extend longitudinally in the same direction as the first set of edges (2) and said second spacers (6b) extend longitudinally in the same direction as the second set of edges (3).

3. A plate (1) according to claim 2, wherein said first and second spacers (6) are arranged such that at least one end of each first spacer (6a) terminates at the centre or end of at least one second spacer (6b),

and at least one end of each second spacer (6b) terminates at the centre or end of at least one first spacer (6a).

4. A plate (1) according to any of claims 1-3, further comprising a number of corrugations (8) extending parallel to said second spacers (6b) and surrounding said first and second spacers (6), said corrugations (8) ending adjacent to the periphery of each spacer (6), wherein said corrugations (8) form protrusions on said first side (4) and depressions on said second side (5) of said plate (1).

5. A plate heat exchanger comprising at least two plates (1) according to claims 1-4 being stacked on top of each other, wherein every other plate (1) is rotated 90° relative to the adjacent plate(s) (1).

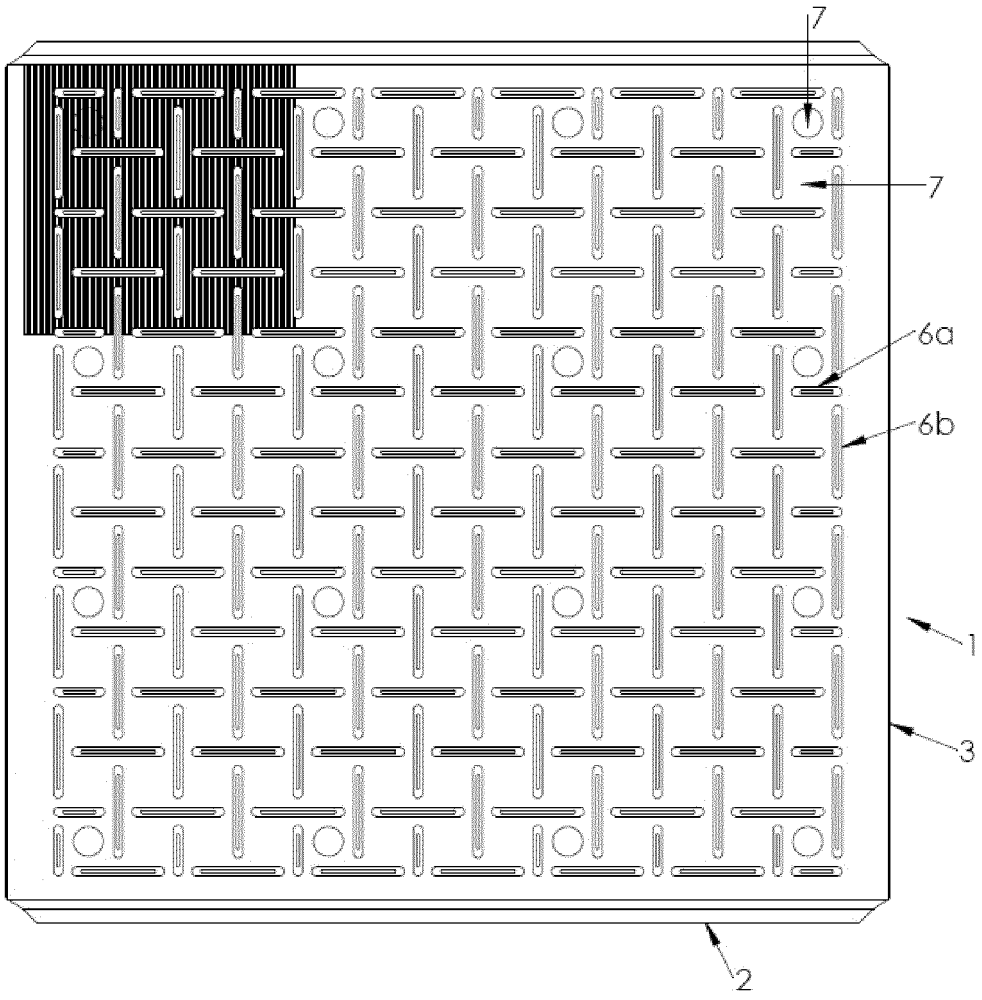

Fig. 1

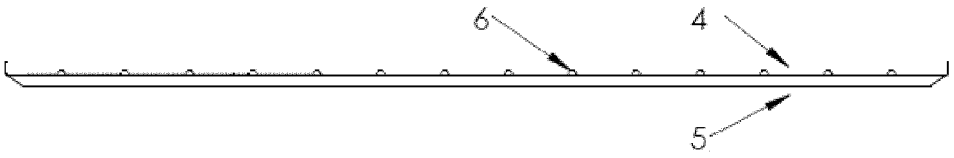

Fig. 2

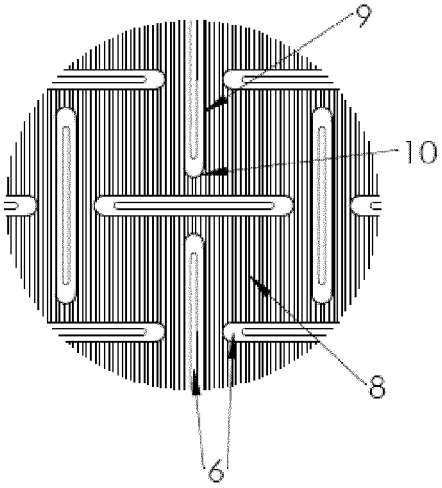

Fig. 3

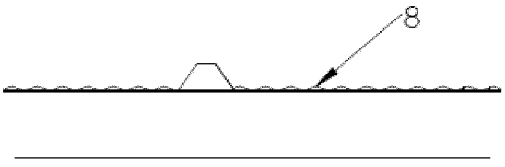

Fig. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 12 16 2657

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	19 September 2012	Delval, Stéphane

CATEGORY OF CITED DOCUMENTS

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