(19) DANMARK

(10) DK/EP 2645039 T3

(12) Oversættelse af europæisk patentskrift

Patent- og Varemærkestyrelsen

(51) Int.Cl.: *F 28 F 3/04 (2006.01)* *F 28 D 9/00 (2006.01)* *F 28 F 3/12 (2006.01)*

(45) Oversættelsen bekendtgjort den: **2018-03-26**

(80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2017-12-27**

(86) Europæisk ansøgning nr.: **12162657.6**

(86) Europæisk indleveringsdag: **2012-03-30**

(87) Den europæiske ansøgnings publiceringsdag: **2013-10-02**

(84) Designerede stater: **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 MK MT NL NO PL PT RO RS SE SI SK SM TR**

(73) Patenthaver: **Heatex AB, Tommarpsvägen 46, 231 65 Trelleborg, Sverige**

(72) Opfinder: **Nilsson, Karl-Henrik, Domherrevägen 3, 227 31 Lund, Sverige**
Nilsson, Fredrik, Folkparksvägen 4 L, 227 30 Lund, Sverige

(74) Fuldmægtig i Danmark: **Patrade A/S, Ceresbyen 75, 8000 Århus C, Danmark**

(54) Benævnelse: **Varmevekslerplade**

(56) Fremdragne publikationer:
GB-A- 818 603
GB-A- 1 007 879
US-A- 4 389 857
US-A- 5 335 414
US-A1- 2003 093 900
US-A1- 2005 077 637

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 pre-heating. 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] US 2003/0093900 discloses one kind of heat exchanger comprising plates provided with flanges used for maintaining the distance between adjacent plates. The flanges are arranged along the peripheral edges of the plates.

[0004] Another 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 not only maintain the distance between adjacent plates constant but also 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.

[0005] Further, GB-818,603 discloses a plate heat exchanger comprising plates provided with a number of fin parts. The fin parts are welded onto both sides of each plate such that the space between adjacent plates is completely filled with fin parts. US2005/077637 further discloses a plate heat exchanger with protrusions and depressions present on each side of each heat exchanger plate. However, there are problems with these kinds of solutions. The spacers/fins are welded onto the plates, which leads to a separate and hence time consuming manufacturing step. Further, welding at the corrugation bends 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. These kinds of configurations also limit the direction of the flow of fluid to the direction of the corrugations.

Summary of the invention

[0006] 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 heat exchanger plate 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 heat exchanger 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 heat exchanger plate in the same direction as the second set of edges, the first spacers are formed as protrusions on the first side and as depressions on the second side of the heat exchanger plate and the second spacers are formed as protrusions on the second side and as depressions on the first side of the heat exchanger plate, each adjacent set of rows of first spacers form a channel extending across the first side of the heat exchanger 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 heat exchanger plate in the same direction as the second set of edges, the channels being suitable for flow of fluid, characterized in that the heat exchanger plate further comprises a number of corrugations extending parallel to said second spacers and surrounding said first and second spacers, said corrugations ending adjacent to the periphery of each spacer, wherein said corrugations form protrusions on said first side and depressions on said second side of said heat exchanger plate. The use of a heat exchanger plate having this kind of spacers is beneficial not only in that it is simple to manufacture the heat exchanger 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 heat exchanger plate which the user can assemble without worrying about how to correctly fit the plates. The use of corrugations stiffens the heat exchanger 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. 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.

[0007] 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.

[0008] 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 heat exchanger 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

[0009] 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 heat exchanger plate according to the present invention.

Figure 2 shows a side view of an embodiment of the heat exchanger 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 heat exchanger plate according to figure 1.

Detailed description

[0010] Figure 1 shows the top side of a heat exchanger 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 heat exchanger plate the second side 5. The heat exchanger 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 heat exchanger 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.

[0011] The heat exchanger 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 heat exchanger plate such that no further, separate manufacturing step is needed. The heat exchanger plate 1 could also be manufactured by other methods such as electromagnetic forming, rubber pad forming, or hydroforming.

[0012] 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 heat exchanger 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 heat exchanger plate in the same direction as the second set of edges 3. The columns themselves are also placed equidistantly from each other.

[0013] All spacers 6 on the heat exchanger 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 heat exchanger plate and a depression on the other side of the heat exchanger 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 heat exchanger plate and as depressions on the second side 5 of the heat exchanger plate. The second spacers 6b, which are arranged in columns, are formed as depressions on the first side 4 of the heat exchanger plate and as protrusions on the second side 5 of the heat exchanger plate. The protrusions and depressions extend in a direction which is perpendicular to that of the plane of the heat exchanger 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.

[0014] In the plane of the heat exchanger 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.

[0015] 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.

[0016] As a result, both the first and the second sides 2, 3 of the heat exchanger 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.

[0017] 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 heat exchanger 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 heat exchanger 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 heat exchanger plate to the opposite edge 3, 2, in line with common practice for heat exchangers.

[0018] As mentioned above, the first and second spacers 6 are arranged such that they form rows and columns, respectively, on the heat exchanger 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.

[0019] 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 heat exchanger plate may have two or three adjacent second spacers 6b. The first spacers 6a arranged along the edges 2, 3 of the heat exchanger 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 heat exchanger 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.

[0020] 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 heat exchanger plate and which also extend perpendicularly to the edge which they are adjacent to.

[0021] The heat exchanger 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 heat exchanger 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 heat exchanger 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 heat exchanger 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 heat exchanger plate. Further, the corrugations could form both protrusions and depressions on both sides of the heat exchanger plate, i.e. such that the zigzag pattern is

centred as seen in a cross-sectional side view of the heat exchanger plate.

[0022] The above mentioned heat exchanger 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).

[0023] The arrangement of the spacers 6 on the heat exchanger 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 heat exchanger 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 heat exchanger 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 heat exchanger plate 1, the heat exchanger plates 1 are stacked such that every pair of adjacent heat exchanger plates 1 has contact through the protruding spacers 6, i.e. the protrusions on the bottom side of the upper heat exchanger plate of the pair rests upon the corresponding protrusions on the top side of the lower heat exchanger plate of the pair.

[0024] 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 heat exchanger 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.

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US20030093900A **[0003]**
- US4183403A **[0004]**
- GB818603A **[0005]**
- US2005077637A **[0005]**

Patentkrav

1. Varmevekslerplade (1), omfattende
- en rektangulær plade med et første sæt modstående periferikanter (2) og et andet sæt modstående periferikanter (3), en første side (4) og en anden side (5), og
- en flerhed af afstandsstykker (6), hvori
- et antal første afstandsstykker (6a) er arrangeret i et antal rækker, der strækker sig hen over varmevekslerpladen (1) i samme retning som det første sæt kanter (2), og
- et antal andre afstandsstykker (6b) er arrangeret i et antal søjler, der strækker sig hen over varmevekslerpladen (1) i samme retning som det andet sæt kanter (3),
- hvor de første afstandsstykker (6a) er dannet som fremspring på den første side (4) og som fordybninger på den anden side (5) af varmevekslerpladen (1), og de andre afstandsstykker (6b) er dannet som fremspring på den anden side (5) og som som fordybninger på den første side (4) af varmevekslerpladen (1),
- hvor hvert tilstødende sæt rækker af første afstandsstykker (6a) danner en kanal (7), der strækker sig hen over den første side (4) af varmevekslerpladen (1) i samme retning som det første sæt kanter (2), og
- hvert tilstødende sæt søjler af andre afstandsstykker (6b) danner en kanal (7), der strækker sig hen over den anden side (5) af varmevekslerpladen (1) i samme retning som det andet sæt kanter (3),
hvilke kanaler (7) er egnet til strømning af et fluid, **kendetegnet ved, at** varmevekslerpladen (1) yderligere omfatter et antal korrugeringer (8), der strækker sig parallelt med de andre afstandsstykker (6b) og omgiver det første og andre afstandsstykker (6), hvilke korrugeringer (8) ender tilstødende periferien af hvert afstandsstykke (6), hvori korrugeringerne (8) danner fremspring på den første side (4) og fordybninger på den anden side (5) af varmevekslerpladen (1).

2. Varmevekslerplade (1) ifølge krav 1, hvori afstandsstykkerne (6) har aflang form, og hvor de første afstandsstykker (6a) strækker sig langsgående i samme retning som det første sæt kanter (2), og de andre afstandsstykker (6b) strækker sig langsgående i samme retning som det andet sæt kanter (3).

3. Varmevekslerplade (1) ifølge krav 2, hvori de første og andre afstandsstykker (6) er arrangeret sådan, at mindst en ende af hvert første afstandsstykke (6a) ender ved midten eller enden af mindst et andet afstandsstykke (6b), og mindst

en ende af hvert andet afstandsstykke (6b) ender ved midten eller enden af mindst et første afstandsstykke (6a).

4. Pladevarmeveksler omfattende mindst to varmevekslerplader (1) ifølge krav 1 – 3 stablet ovenpå hinanden, hvori hver anden varmevekslerplade (1) er drejet 90° i forhold til den/de tilstødende varmevekslerplade(r) (1).

DRAWINGS

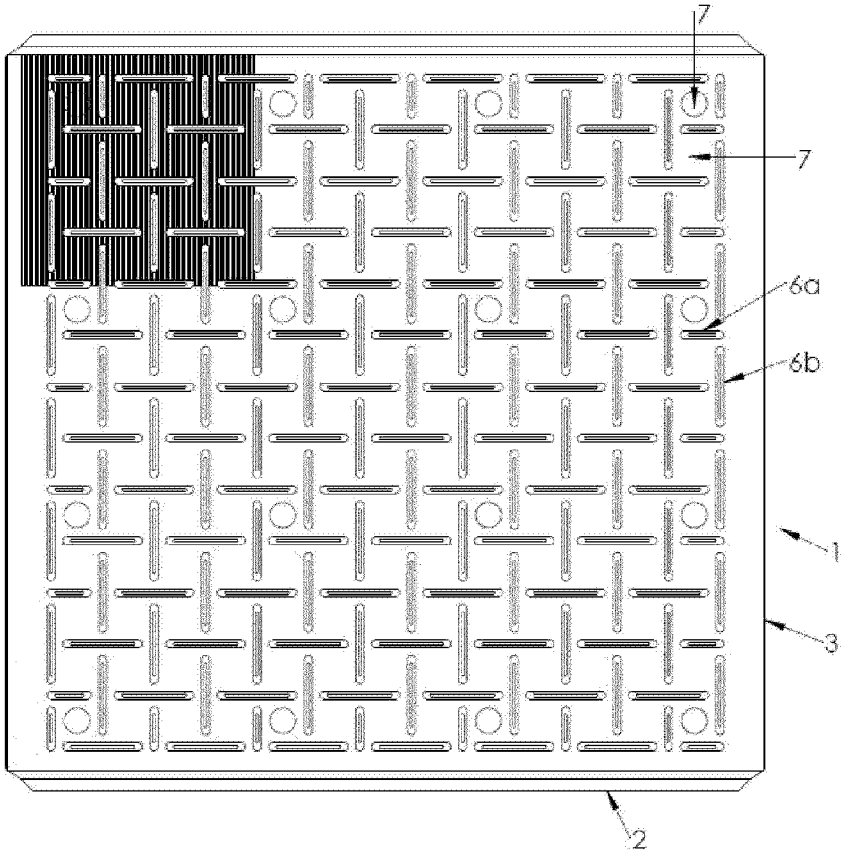

Fig. 1

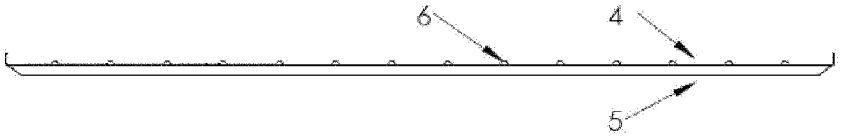

Fig. 2

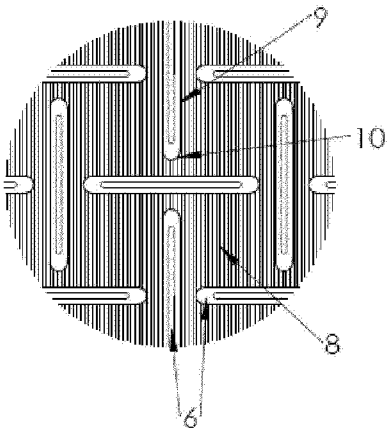

Fig. 3

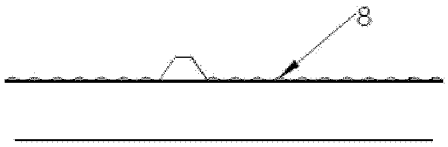

Fig. 4