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(54) **HEAT EXCHANGER AND PARTING PLATE THEREOF**

(57) A parting plate (10) for a heat exchanger, comprising a frame (20) and a main body (24) arranged within the frame (20) and connected to the frame (20) so as to define, between the frame (20) and the main body (24), ports including a first inlet port (12), a first outlet port (14), a second inlet port (16) and a second outlet port (18), wherein the frame forms lobes (28) around the ports and a width (W) of the frame (20) from one of the lobes (282) to an adjacent lobe (288) is substantially constant.

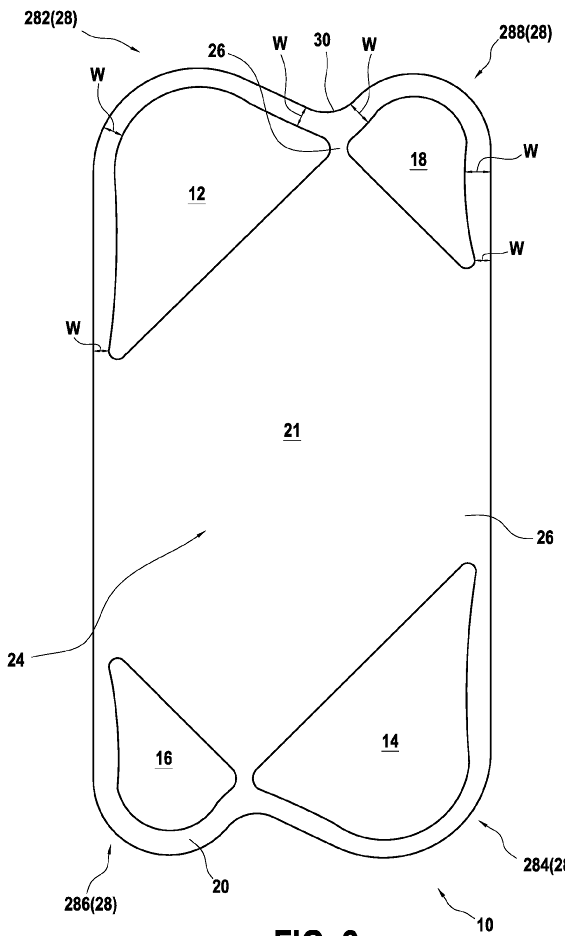

FIG. 2

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Description

TECHNICAL FIELD

[0001] The present disclosure relates to heat exchangers, and more particularly to a parting plate for a heat exchanger. Such a parting plate may be used to separate two fluids flowing in the heat exchanger for the transfer of heat from one fluid to another.

TECHNOLOGICAL BACKGROUND

[0002] Throughout the years, many different heat exchanger designs have been developed to meet different needs. In particular, some heat exchangers comprise first layers, in which a first fluid is to flow, and second layers, in which a second fluid is to flow, stacked in turn. Consecutive first and second layers are separated by a so-called parting plate, which provides structural support for the heat exchanger and prevent the fluids from mixing.

[0003] In such heat exchangers, the layers and parting plates must be assembled in a leak-tight manner. This requirement becomes crucial when the fluids are pressurized, in particular for efficiency reasons. One possible method for assembling the layers and parting plates together is welding, in particular brazing.

[0004] In this context, there is room for improvement as regards the assembling of heat exchangers.

SUMMARY

[0005] In this respect, the present disclosure relates to a parting plate for a heat exchanger, comprising a frame and a main body arranged within the frame and connected to the frame so as to define, between the frame and the main body, ports including a first inlet port, a first outlet port, a second inlet port and a second outlet port, wherein the frame forms lobes around the ports and a width of the frame from one of the lobes to an adjacent lobe is substantially constant.

[0006] The parting plate may be a part having the general shape of a plate.

[0007] In order to efficiently separate the first fluid from the second fluid as mentioned above, the parting plate, in particular the main body, may be devoid of any opening other than the aforementioned ports. For instance, the main body may be solid.

[0008] The lobes may be convex portions of the frame. The frame may comprise a succession of the lobes and areas of connection with the main body.

[0009] A segment of the frame from one of the lobes to an adjacent lobe is a segment of the frame which starts at a point where the frame surrounds said one of the lobes and continuously extends to a point where the frame surrounds said adjacent lobe, namely a lobe adjacent to the one of the lobes. The width of that segment is substantially constant, e.g. the width varies by at most 35% from a reference value.

[0010] Thanks to the width of frame from one of the lobes to an adjacent lobe being substantially constant, this segment of the frame facilitates assembling the parting plate with other layers of the heat exchanger by brazing or diffusion bonding. In addition, stresses within this segment of the frame are well distributed and reduced. As a consequence, the frame can be more homogenously attached to an adjacent layer, thus improving the mechanical properties of the heat exchanger as well as the leaktightness.

[0011] Optionally, the frame is concave between the one of the lobes and the adjacent lobe. The concavity of this segment is oriented towards the outside of the frame.

[0012] Optionally, end faces of the frame in a thickness direction of the parting plate are planar. This further facilitates assembling, in particular brazing or diffusion bonding.

[0013] The present disclosure is further directed to a heat exchanger comprising a plurality of stacked parting plates as described above, and, between consecutive ones of the parting plates, alternately, at least one first channel extending from the first inlet port to the first outlet port and at least one second channel extending from the second inlet port to the second outlet port. Thanks to the above described features of the parting plate, the heat exchanger has enhanced mechanical properties and leaktightness.

[0014] Optionally, the first inlet port and the first outlet port are provided on opposite sides of the main body.

[0015] Optionally, the second inlet port and the second outlet port are provided on opposite sides of the main body.

[0016] Optionally, the respective parting plates are brazed or diffusion bonded to one another.

[0017] Besides the features already mentioned, the disclosed heat exchanger may comprise at least one of the following features, taken alone or in technically possible combinations:

- the heat exchanger comprises first edge bars extending on either sides of the at least one first channel to prevent communication between the at least one first channel and the second ports, and the at least one first channel opens out onto a first rectilinear portion of one of the first ports, and at least one of the first edge bars extends up to the rectilinear portion;
- the at least one first channel opens out onto the first rectilinear portion in a direction substantially orthogonal to the rectilinear portion;
- the first edge bars are substantially parallel to the at least one first channel;
- an end portion of the at least one of the first edge bars supports a rounded corner of said one of the first ports;
- the at least one of the first edge bar overlaps a projection of the one of the first ports orthogonal to the first rectilinear portion;

- the at least one of the first edge bar is flush with one of the second ports;
- an edge of the one of the first ports adjacent the first rectilinear portion is tangent to the first rectilinear portion;
- the at least one first channel and/or the first edge bars are assembled to the parting plate by brazing;
- the at least one first channel is formed by a corrugated plate;
- the heat exchanger further comprises second edge bars extending on either sides of the at least one second channel to prevent communication between the at least one second channel and the first ports;
- the at least one second channel opens out onto a second rectilinear portion of one of the second ports, and at least one of the second edge bars extends up to the second rectilinear portion;
- the at least one of the first edge bars and the at least one of the second edge bars are superimposed with each other, on either side of a junction between the frame and the main body;
- the at least one of the first edge bars and the at least one of the second edge bars are substantially orthogonal to each other.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The invention and advantages thereof will be better understood upon reading the detailed description which follows, of embodiments given as non-limiting examples. This description refers to the appended drawings, wherein:

- Fig. 1 is a schematic exploded view of a heat exchanger according to an embodiment;
- Fig. 2 is a top view of a parting plate according to an embodiment;
- Fig. 3 is a top view of first channels and first edge bars according to an embodiment;
- Fig. 4 is a top view of second channels and second edge bars according to an embodiment.

DETAILED DESCRIPTION OF EMBODIMENTS

[0019] A heat exchanger 100 according to an embodiment is described with reference to Figs. 1-4. The heat exchanger 100 enables heat transfer between a first fluid and a second fluid. As shown in Fig. 1, which is an exploded view of the heat exchanger 100, the heat exchanger 100 comprises at least one parting plate 10 having two first ports and two second ports, namely a first inlet port 12, a first outlet port 14, a second inlet port 16 and a second outlet port 18. The parting plate 10 prevents the fluids from mixing: specifically, the first fluid is configured to flow through the first inlet port 12, circulate on a first face 21 of the parting plate 10, and exit through the first outlet port 14. Likewise, the second fluid is configured to flow through the second inlet port 16, circulate on a second face 22 of the parting plate 10, opposite the first face 21, and exit through the second outlet port 16. Heat exchange takes place by convection of the fluids along the parting plate 10.

[0020] As shown in Fig. 1, the heat exchanger 100 may have a layered structure. Besides the parting plate 10, the heat exchanger 100 may comprise at least one first plate 31 and at least one second plate 32. The first plate 31 and the second plate 32 may be stacked in an alternate manner, with a parting plate 10 being provided between each first plate 31 and each second plate 32 adjacent thereto. In other words, a minimum stacking may comprise, in order, one first plate 31, one parting plate 10 and one second plate 32, as shown in the top portion of Fig. 1. However, for sizing purposes, it may be desired to add further layers, in which case a further subset comprising, in order, a parting plate 10, a first plate 31, a parting plate 10 and a second plate 32, may be stacked next to the minimum stacking, N times as shown in the bottom portion of Fig. 1 (N being zero or a non-zero positive integer).

[0021] In this example, each one of the first and second plates 31, 32 is provided with first and second ports 12, 14, 16, 18 respectively in fluid communication with the first and second ports 12, 14, 16, 18 of the adjacent parting plates 10.

[0022] The resulting stack may be flanked by end plates, for instance an open end plate 33 and a closed end plate 34. The end plates may be made of one or several elements. The open end plate 33 is provided with first and second ports 12, 14, 16, 18 respectively in fluid communication with the first and second ports 12, 14, 16, 18 of the adjacent parting plate 10. Conversely, the closed end plate 34 is solid and forms a closed bottom 12a, 14a, 16a, 18a for the first and second ports 12, 14, 16, 18 of the stack. In this way, when entering the heat exchanger 100 through the first inlet port 12, the first fluid must cross one of the first plates 31 in order to access the first outlet port 14. The same applies, mutatis mutandis, to the second fluid.

[0023] In a variant, instead of the open end plate 33 and the closed end plate 34, the heat exchanger could include a first end plate having a first inlet port 12 and a first outlet port 14 and a closed bottom 16a, 18a for the second inlet port 16 and the second outlet port 18 of the stack, and a second end plate having a second inlet port 16 and a second outlet port 18 and a closed bottom 12a, 14a for the first inlet port 12 and the first outlet port 14 of the stack. Further arrangements are possible, as long as the fluids do not mix with each other and flow along the parting plate 10 in order to exchange heat with each other.

[0024] Ports of the end plates 33, 34 may have a different shape than the shape of the ports of the parting plate 10 in order to interface with systems external to the heat exchanger 100.

[0025] For instance, the first fluid may be a gaz. For instance, the second fluid may be a gaz. The first fluid may flow at a pressure less than the second fluid; for this reason, the first ports 12, 14 may be bigger than the second ports 16, 18. Of course, the opposite situation is envisaged as well.

[0026] The components of the heat exchanger 100 may be metallic, e.g. made of stainless steel or nickel-based alloys.

[0027] A parting plate 10 according to an embodiment is described in more details with reference to Fig. 2.

[0028] The parting plate 10 comprises a frame 20 and a main body 24. The frame 20 may be formed by a rim forming a closed contour. The main body 24 is arranged within the frame 20 and connected to the frame 20 so as to define, between the frame 20 and the main body 24, the aforementioned first inlet port 12, first outlet port 14, second inlet port 16 and second outlet port 18.

[0029] In this embodiment, in order to maximize heat exchange between the fluids and the main body 24, the first inlet port 12 and the first outlet port 14 are provided on opposite sides of the main body 24. Likewise but independently, the second inlet port 16 and the second outlet port 18 are provided on opposite sides of the main body 24. The main body 24 forms a main heat transfer area of the parting plate 10.

[0030] The main body 24 is connected to the frame 20 at one or more localized junctions 26. Between two consecutive junctions 26, the space between the frame 20 and the main body 24 defines one of the ports.

[0031] More generally, the frame 24 forms lobes 28 (respectively 282, 284, 286, 288) around the ports. The lobes 28 project from the main body 24 and may have a rounded shape.

[0032] In this embodiment, a width W of the frame 20 from one of the lobes 28 to an adjacent lobe 28 is substantially constant. Specifically, Fig. 2 shows that the width W of the frame 20 does not vary by more than 35% from a reference value, from the lobe 282 including the first inlet port 12 to an adjacent lobe, here the lobe 288 including the second outlet port 18. The width W is measured as the smallest dimension of the frame 20 in the plane in which the lobe 28 protrudes from the main body 24.

[0033] Besides, the frame 20 is concave between the lobe 282 and the adjacent lobe 288. Thus, the frame 20 forms a concave portion 30 where the frame 20 gets inwards with respect to the lobes 28 and closer to the main body 24. The concave portion 30 helps keeping a substantially constant width W while ensuring a good junction with the main body 24.

[0034] As illustrated in Fig. 2, at least one of the first inlet port 12, the first outlet port 14, the second inlet port 16 and the second outlet port 18 of the parting plate 10 has a substantially triangular shape, with three main sides and corners (here rounded corners) in-between. However, other port shapes are contemplated, in particular polygonal-like port shapes.

[0035] A first plate 31 according to an embodiment is now described in more details with reference to Fig. 3.

[0036] The first plate 31 comprises a frame 20 similar to the frame 20 of the parting plate 10. When the first plate 31 is stacked next to a parting plate 10, the respective frames 20 of the first plate 31 and the parting plate 10 superimpose in order to form a continuous wall for the heat exchanger 100.

[0037] As described above, the first plate 31 has ports 12, 14, 16, 18 corresponding to the respective ports 12, 14, 16, 18 of the parting plate 10. In particular, like the frame 20, the ports of the first plate 31 superimpose to the ports of the parting plate 10: they may be identical in shape.

[0038] In the first plate 31, the second inlet port 16 and the second outlet port 18 are each isolated by a first edge bar 35. Specifically, the first edge bar 35 extends between two distant portions of the frame 20. Thus, each of the second inlet port 16 and the second outlet port 18 is defined between the frame 20, and more particularly a lobe 28 thereof, and a first edge bar 35.

[0039] The first edge bar 35 may be formed integrally with the frame 20 of the first plate 31.

[0040] The first edge bar 35 may be flush with the corresponding second port 16, 18, so that the respective second ports 16, 18 of the first plate 31 and of the parting plate 10 are identical in shape, as mentioned above. Conversely, in the first plate 31, the first inlet port 12 and the first outlet port 14 are in fluid communication with one another. This enables the first fluid to flow from the first inlet port 12 to the first outlet port 14 across the first plate 31. As illustrated, the first fluid may flow between the two first edge bars 35. In other words, the first edge bars 35 form, between them, a first channel 37 extending from one of the first ports (here the first inlet port 12) to another one of the first ports (here the first outlet port 14) on a first face 21 of the main body 24. In addition, as described above, the first edge bars 35 extend on either sides of the first channel 37 to prevent communication between the first channel 37 and the second ports 16, 18.

[0041] In order to enhance heat exchange, the first plate 31 may be provided with a plurality of first channels 37, as illustrated. In this embodiment, a plurality of fins 39 extend from the first inlet port 12 to the first outlet port 14. A first channel 37 is defined between two consecutive fins 39. In an embodiment, the first channels 37 may be formed by a corrugated plate. The corrugated plate may form, in cross-section, the fins 39.

[0042] The first edge bars 35 may be substantially parallel to the first channels 37. Specifically, the first channels 37 may extend between the first ports 12, 14 in a piecewise linear manner. For instance, the first channels 37 comprise an inlet segment 37a, an intermediate segment 37b and an outlet segment 37c, communicating with each other in this order. The inlet segment 37a extends substantially parallel to the first edge bar 35 adjacent thereto (in this case, the first edge bar 35 adjacent to the second outlet port 18). The intermediate segment 37b is angled with respect to the inlet segment 37a. The intermediate segment 37b may extend substantially parallel to portions of the frame 20 adjacent thereto. Finally, the outlet segment 37c is angled with respect to the intermediate segment 37b. The outlet segment 37c extends substantially parallel to the first edge bar 35 adjacent thereto (in this case, the first edge bar 35 adjacent to the second inlet port 16).

[0043] As the first edge bars 35 are parallel to each other, the inlet segment 37a and the outlet segment 37c may be parallel to each other too.

[0044] As regards the direction of a first channels 37, it should be noted that the first channels 37 may be rectilinear or not. In the example of Fig. 3, the first channels 37, specifically the inlet segment 37a, mainly extend along a direction D which is rectilinear. Optionally, the first channels 37 may undulate about the direction D. The direction D is a direction with respect to which the undulations have a zero average.

[0045] As mentioned above, at least one of the first ports has a rectilinear portion. In the following, the case of the first inlet port 12 will be detailed, but the present description applies mutatis mutandis to the first outlet port 14, in this example. In other embodiments, the first outlet port 14 may be different.

[0046] The first inlet port 12 has a rectilinear portion 42 onto which the first channels 37, in particular the inlet segment 37a, open. The first channels, in particular the inlet segment 37a, may extend up to the rectilinear portion 42, as illustrated. Besides, the first edge bar 35 is designed to extend up to the first rectilinear portion 42. As shown in Fig. 3, the first edge bar 35 extends towards the first channels 37 enough to reach the first rectilinear portion 42 of the first inlet port 12.

[0047] For instance, an end portion of the first edge bars 35 may support a rounded corner 44 of the first inlet port 12. The end portion of the first edge bar 35 may be provided such that the rounded corner 44 is fully surrounded, either by the frame 20, the junction 26 or the first edge bar 35.

[0048] Besides, let us consider a projection of the first inlet port 12 orthogonal to the first rectilinear portion 42. As depicted in Fig. 3, the projection extends between point A and point B. In this embodiment, the first edge bar 35 overlaps the projection of the first inlet port 12 orthogonal to the first rectilinear portion 42.

[0049] Besides, an edge 43 of the first inlet port 12 adjacent to the first rectilinear portion 42 is tangent to the first rectilinear portion 42. Here, the edge 43 is the edge of the rounded corner 44, which starts tangent to the first rectilinear portion and progressively turns in order to define a rounded corner 44 for the first inlet port 12.

[0050] The first channels 37 may open out onto the first rectilinear portion 42 in a direction substantially orthogonal to the first rectilinear portion 42. In other words, the above-defined direction D is orthogonal to the first rectilinear portion 42. In view of the above description, the first edge bar 35 may be orthogonal to the first rectilinear portion 42.

[0051] Figure 4 illustrates a top view of the second plate 32. In this embodiment, the second plate 32 is identical, mutatis mutandis, to the first plate 31, except for the following aspects. However, in general, the second plate 32 could differ more broadly from the first plate 31.

[0052] In the second plate 32, the first inlet port 12 and the first outlet port 14 are each isolated by a second edge bar 36, which may be flush with these ports, respectively. Conversely, the second inlet port 16 and the second outlet port 18 are in fluid communication with one another.

[0053] The second plate 32 defines at least one second channel 38 extending from the second inlet port 16 to the second outlet port 18 on a second face 22 of the main body 24, the second edge bars 36 extending on either sides of the second channels 38 to prevent communication between the second channels 38 and the first ports 12, 14.

[0054] Like the first channels 37, the second channels 38 may extend between the second ports 12, 14 in a piecewise linear manner. Specifically, the second channels 38 comprise an inlet segment 38a, an intermediate segment 38b and an outlet segment 38c, communicating with each other in this order. The inlet segment 38a extends substantially parallel to the second edge bar 36 adjacent thereto (in this case, the second edge bar 36 adjacent to the first outlet port 14). The intermediate segment 38b is angled with respect to the inlet segment 38a. The intermediate segment 38b may extend substantially parallel to portions of the frame 20 adjacent thereto. Finally, the outlet segment 38c is angled with respect to the intermediate segment 38b. The outlet segment 38c extends substantially parallel to the second edge bar 36 adjacent thereto (in this case, the second edge bar 36 adjacent to the first inlet port 12).

[0055] Thus, in the intermediate region of the channels, the first channels 37 and the second channels 38 may define a counter flow of the first fluid and the second fluid in the intermediate segments 37b, 38b. Besides, in the inlet and outlet region of the channels, the first channels 37 and the second channels 38 may define cross flow of the first fluid and the second fluid in the inlet segments 37a, 38a and the outlet segments 37c, 38c.

[0056] As mentioned above, the second channels 38 open out onto a second rectilinear portion 46 of the second inlet port, and at least one of the second edge bars 36 extends up to the second rectilinear portion 46.

[0057] In view of the above description, in the present embodiment, the first edge bar 35 and the second edge bar 36 are superimposed with each other, on either side of a junction between the frame 20 and the main body 24. For instance, Fig. 4 illustrates, in phantom, the position of a first edge bar 35 when the first plate 31 and the second plate 32 are stacked on either sides of a parting plate 10. The hatched portion illustrates an area where the first edge bar 35 and the second edge bar 36 overlap. This area is further superimposed with the junction portion 26 of the parting plate 10. Therefore, the first edge bars 35 and the second edge bars 36 provide strong support for the parting plate 10.

[0058] Besides, the first edge bar 35 and the second edge bar 36 may be substantially orthogonal to each other, as best shown in Fig. 4. This facilitates orthogonality of the first channels 37 and/or second channels 38 with the first rectilinear portions 42 and/or second rectilinear portion 46, respectively.

[0059] Back to Fig. 1, the parting plate 10, the first plate 31 and the second plate 32 may be stacked as described above.

[0060] In order to facilitate stacking, the end faces of the frame 20 of the parting plate 10, but also optionally of the first plate 31 and the second plate 32, may be planar in a thickness direction of the parting plate. That is, each end face of the frame 20 may be included in a single plane, this plane being preferably transverse to the stacking direction of the plates. Besides, in order to assemble these plates together, a variety of techniques may be used, including welding, brazing (such as MIG-MAG brazing) or diffusion bonding. These techniques are known per se in the art. Thus, in an example, the first channels 37 (e.g. the fins 39) or the first edge bars 35 may be assembled to the parting plate 10 by brazing. The same may apply to the second plate 32.

[0061] The above described features may apply to a wide variety of heat exchangers, including so-called gasket plate heat exchangers, in which adjacent plates are separated by a gasket, or so-called plate-fin heat exchangers, where no gasket is provided and the plates and fins (e.g. the above mentioned corrugated plate) are directly assembled to one another. Although the present disclosure refers to specific exemplary embodiments, modifications may be provided to these examples without departing from the general scope of the invention as defined by the claims.

[0062] For instance, although described with reference to a first plate 31 and a second plate 32 respectively, the first and second channels, the first and second edge bars and the like may be formed otherwise and/or do not need to be in a plate form, as long as the two fluids are separated by a parting plate.

[0063] Instead of the particular structure of channels described above, the heat exchanger 100 may comprise, more generally, a plurality of stacked parting plates 10, and, between consecutive ones of the parting plates 10, alternately, at least one first channel 37 extending from the first inlet port 12 to the first outlet port 14 and at least one second channel 38 extending from the second inlet port 16 to the second outlet port 18. In case only the parting plates 10 are provided, with integrated edge bars and channels as the case may be, the respective parting plates 10 may be directly assembled to one another, e. g. by welding, brazing or diffusion bonding.

[0064] More generally, individual characteristics of the different illustrated/mentioned embodiments may be combined in additional embodiments.

[0065] Besides, although the provision of the first edge bar extending up to the first rectilinear portion has been described in a context in which the frame forms lobes around the ports and a width of the frame from one of the lobes to an adjacent lobe is substantially constant, it should be understood that these aspects are independent. That is, the first edge bar could extend up to the first rectilinear portion even if the frame had a different shape or thickness. Likewise, the width of the frame could be as defined earlier even if the first edge bar was arranged in a different manner, or even if the first port had no rectilinear portion at all. The same applies to the other ports or edge bars, as the case may be. Therefore, the description and the drawings should be considered in an illustrative rather than in a restrictive sense.

Claims

1. A parting plate (10) for a heat exchanger (100), comprising a frame (20) and a main body (24) arranged within the frame (20) and connected to the frame (20) so as to define, between the frame (20) and the main body (24), ports including a first inlet port (12), a first outlet port (14), a second inlet port (16) and a second outlet port (18), wherein the frame forms lobes (28) around the ports and a width (W) of the frame (20) from one of the lobes (282) to an adjacent lobe (288) is substantially constant.

2. The parting plate of claim 1, wherein said width (W) varies by at most 35% from a reference value.

3. The parting plate of claim 1 or 2, wherein the frame (20) is concave between the one of the lobes (282) and the adjacent lobe (288).

4. The parting plate of any one of claims 1 to 3, wherein end faces of the frame (20) in a thickness direction of the parting plate (10) are planar.

5. A heat exchanger (100) comprising a plurality of stacked parting plates (10) as claimed in any one of claims 1 to 4, and, between consecutive ones of the parting plates (10), alternately, at least one first channel (37) extending from the first inlet port (12) to the first outlet port (14) and at least one second channel (38) extending from the second inlet port (16) to the second outlet port (18).

6. The heat exchanger of claim 5, wherein the first inlet port (12) and the first outlet port (14) are provided on opposite sides of the main body (24), and/or wherein the second inlet port (16) and the second outlet port (18) are provided on opposite sides of the main body (24).

7. The heat exchanger of claim 5 or 6, wherein the respective parting plates (10) are brazed or diffusion bonded to one another.

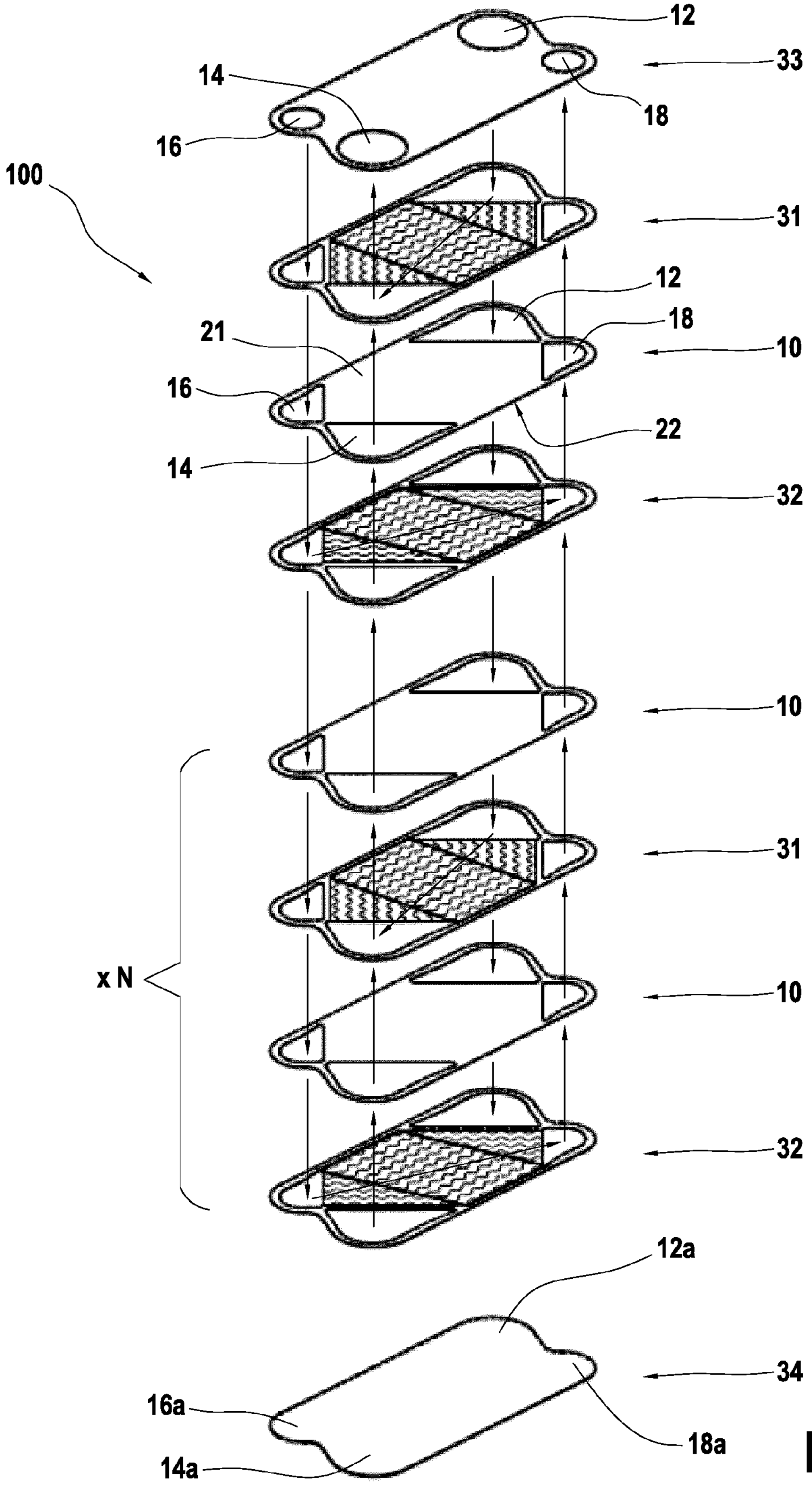
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FIG. 1

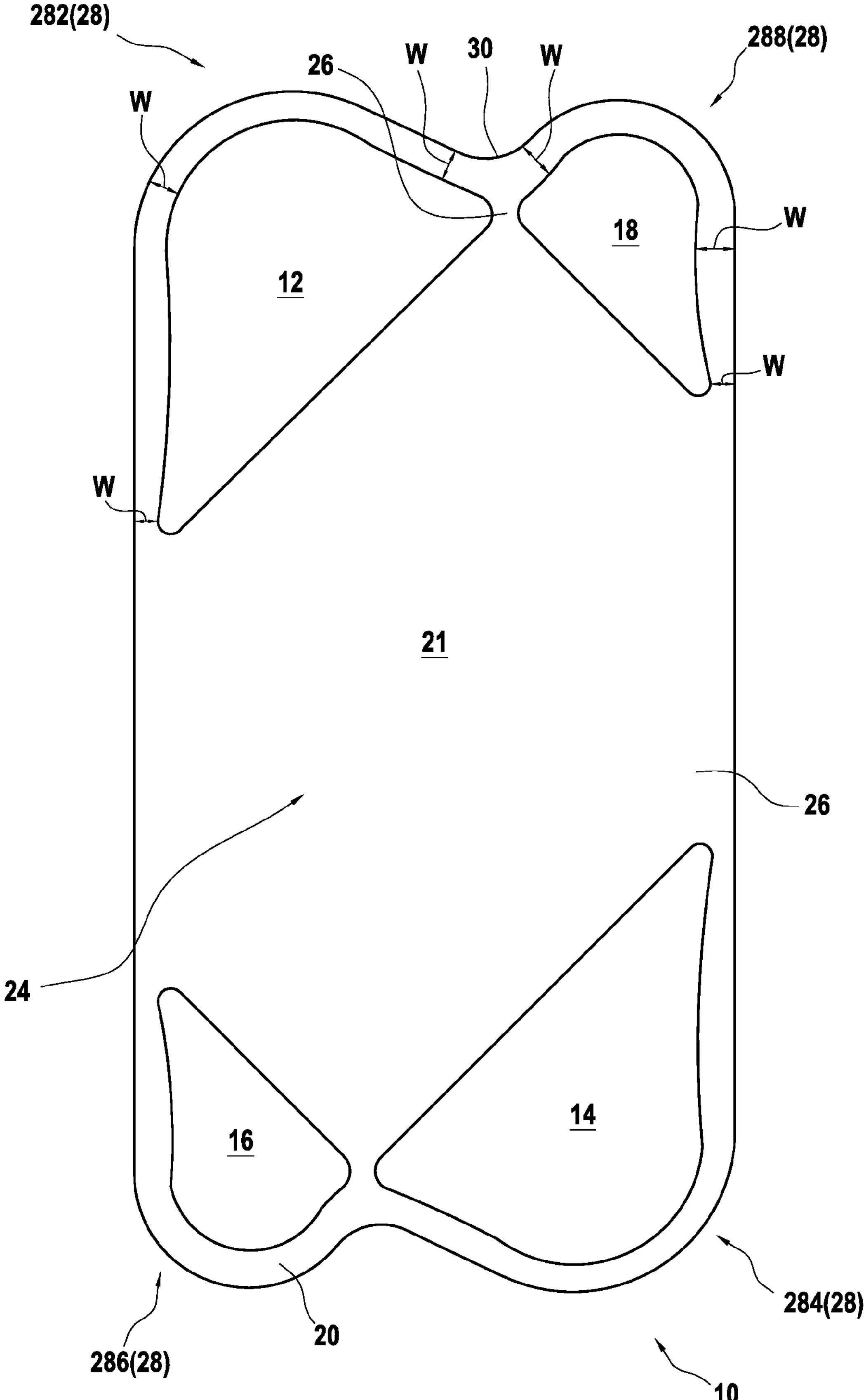

FIG. 2

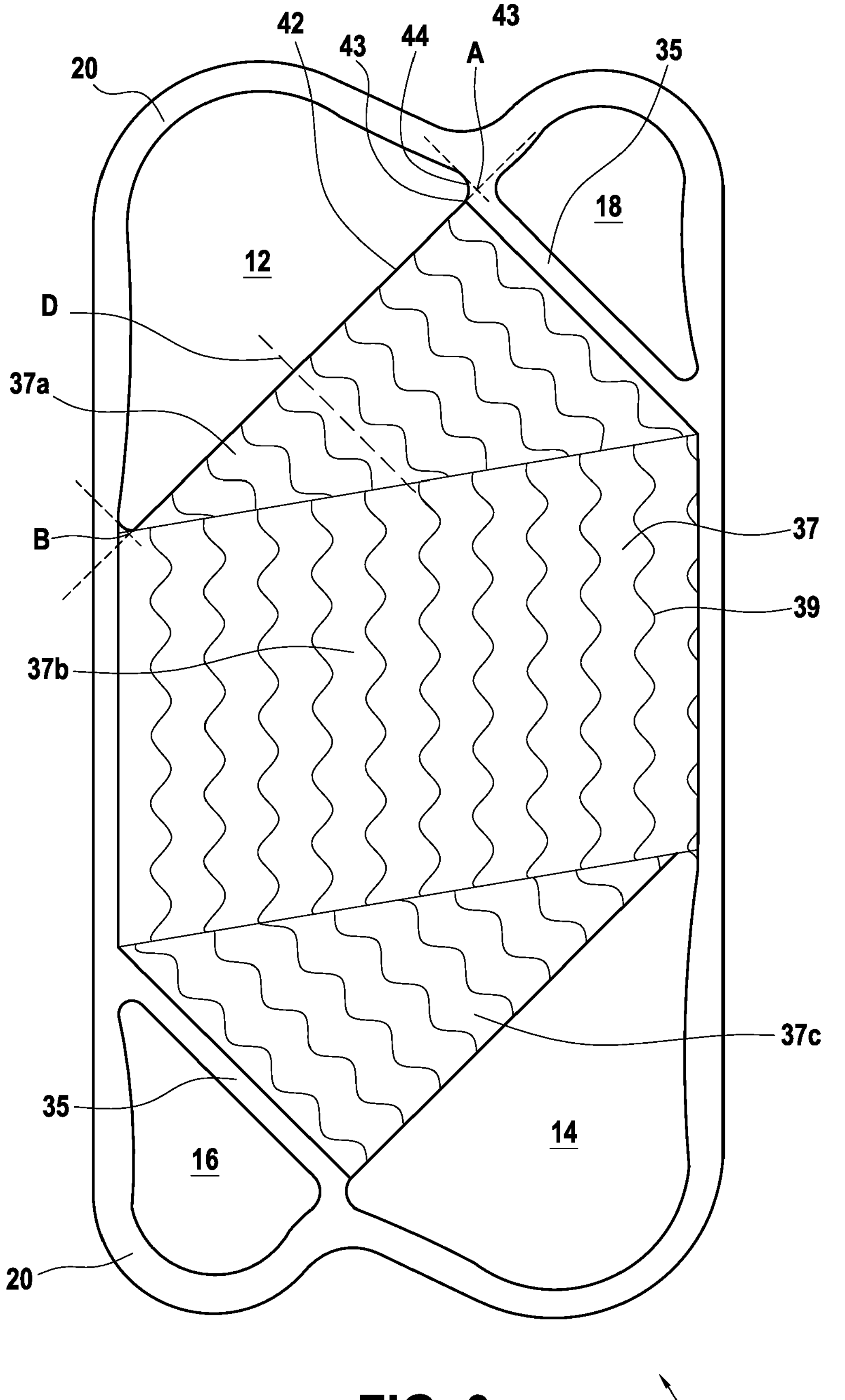

FIG. 3

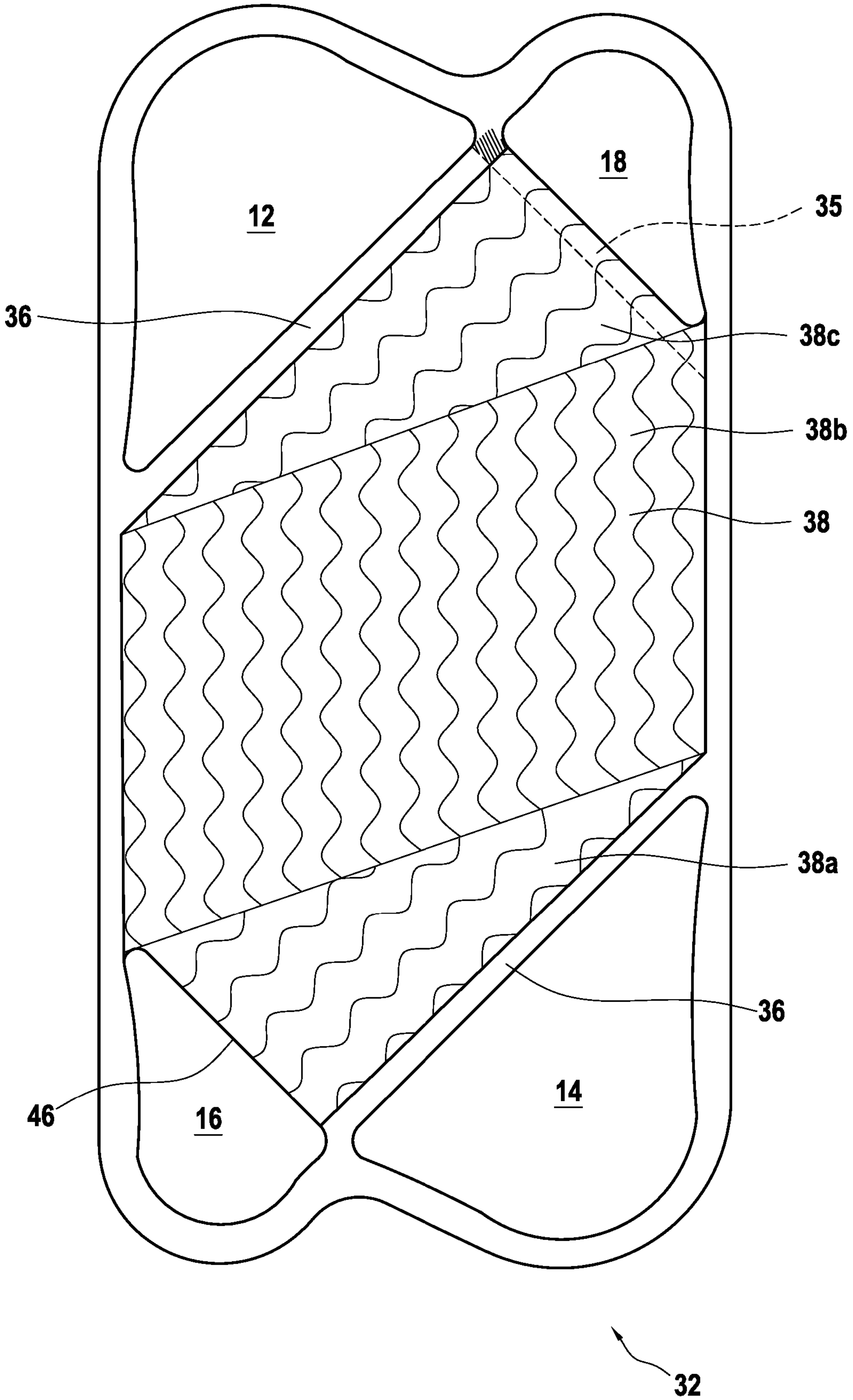

FIG. 4

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European Patent Office
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EUROPEAN SEARCH REPORT

Application Number
EP 22 19 6565

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2006/151147 A1 (SYMONDS KEITH [GB]) 13 July 2006 (2006-07-13) * figures 11-15 * -----	1-7	INV. F28D9/00 F28F3/02
X	US 2020/284521 A1 (GADALLA HANI AHMED [US] ET AL) 10 September 2020 (2020-09-10) * figure 1 * -----	1-7	
X	US 2018/045469 A1 (POLLARD BERWYN [GB]) 15 February 2018 (2018-02-15) * figures 1,2 * -----	1-7	
X	US 9 417 016 B2 (SCOTT DAVID RUSSELL [GB]; HS MARSTON AEROSPACE LTD [GB]) 16 August 2016 (2016-08-16) * figures 1,2 * -----	1,2,4-7	
A	US 10 619 936 B2 (HAMILTON SUNDSTRAND CORP [US]) 14 April 2020 (2020-04-14) * the whole document * -----	1-7	

TECHNICAL FIELDS SEARCHED (IPC)

F28D
F28F

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	7 March 2023	Vassoille, Bruno

CATEGORY OF CITED DOCUMENTS

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