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(54) HEAT EXCHANGER MODULE

(57) A heat exchanger module (100) comprising at least one first layer (10) for a first fluid and at least one second layer (20) for a second fluid, wherein the first layer (10) and the second layer (20) are separated by a parting plate (30), the first layer (10) comprising a first wall (12) meandering between opposite sides (31, 32) of the first layer (10) in order to define first channels (14), the second layer (20) comprising a second wall (22) meandering between opposite sides (31, 32) of the second layer (20) in order to define second channels (24), wherein a pitch (p1) of the first wall is less than a pitch (p2) of the second wall, a thickness (e1) of the first wall is less than a thickness (e2) of the second wall, and a ratio of the pitch (p1) to a height (h1) of the first wall is less than a ratio of the pitch (p2) to a height (h2) of the second wall.

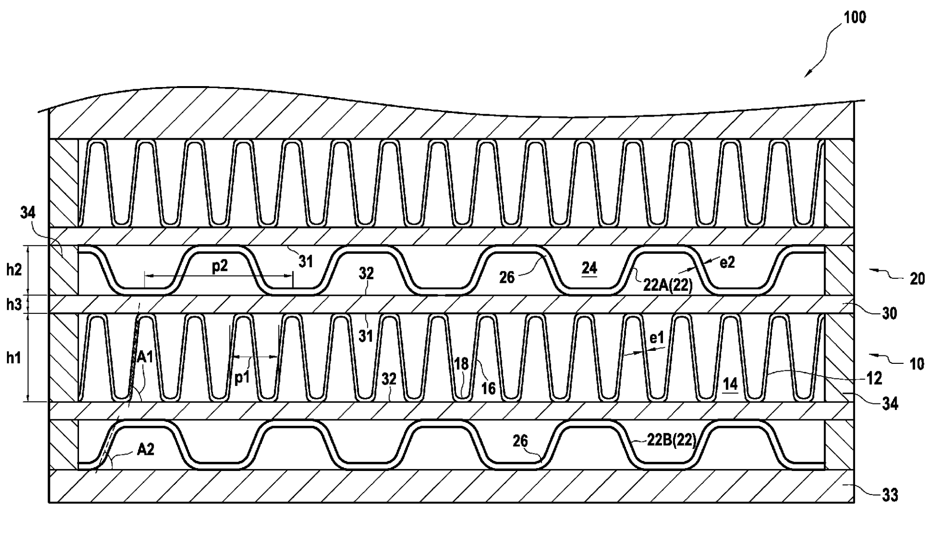

FIG. 1

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Description

TECHNICAL FIELD

[0001] The present disclosure relates to the technical field of heat exchangers, and more particularly to a heat exchanger module and a method for manufacturing a heat exchanger module.

TECHNOLOGICAL BACKGROUND

[0002] Good efficiency of heat exchangers is defined by, among other things, an effective transfer area. The fluids flowing through the heat exchanger should be exposed to as much material as possible to effectively transfer their heat to the structure of the heat exchanger, and eventually to the other fluid.

[0003] However, this principle may be difficult to apply in practice, because it should take account of the nature of the fluids and the other constraints which the heat exchanger is subjected to, such as its mechanical properties.

[0004] Thus, there is a need for a new type of heat exchanger module and manufacturing method.

SUMMARY

[0005] In this respect, the present disclosure relates to a heat exchanger module comprising at least one first layer for a first fluid to flow therein between a first inlet and a first outlet, and at least one second layer for a second fluid to flow therein between a second inlet and a second outlet, wherein the at least one first layer and the at least one second layer are separated by a parting plate, the first layer comprising a first wall meandering between opposite sides of the first layer in order to define first channels extending between the first inlet and the first outlet, the second layer comprising a second wall meandering between opposite sides of the second layer in order to define second channels extending between the second inlet and the second outlet, wherein a pitch of the first wall is less than a pitch of the second wall, a thickness of the first wall is less than a thickness of the second wall, and a ratio of the pitch to a height of the first wall is less than a ratio of the pitch to a height of the second wall.

[0006] The heat exchanger module comprises one or more first layer and one or more second layer. As used herein, for conciseness and unless the context indicates otherwise, "a", "an", and "the" are intended to refer to "at least one" or "each" and to include plural forms as well. In addition, an element (e.g. layer, wall, channels, etc.) mentioned without "first" or "second" may indicate either one or both of the first element and the second element. Likewise, although one parting plate has been defined, the heat exchanger module may comprise a plurality of parting plates each separating two consecutive layers of the heat exchanger module. Conversely, each one of the first layer and the second layer may be defined between two parting plates, except possibly for the end layers. The facing surfaces of the two parting plates may define the opposite sides of a layer, between which the first wall and second wall meander respectively.

[0007] In meandering, the wall may create a plurality of junctions between the opposite sides of the layer, these junctions partitioning the layer in channels. That is, the wall may successively and repeatedly go from one of the opposite sides of a layer to the other, while advancing in another direction. The wall may meander in a plane transverse to the channels. The wall may meander in a periodical manner.

[0008] The pitch of the wall is defined as the distance between a point where the wall reaches one of the opposite sides of the layer and a corresponding point where the wall next reaches the same side of the layer. The pitch may be constant. If the wall meanders periodically, the pitch of the wall corresponds to a period of the wall.

[0009] The thickness of the wall is defined as the smallest dimension of the wall. The thickness is generally measured transversely to the wall. The thickness may be constant, otherwise an average thickness may be considered.

[0010] The height of the wall is defined as the height along which the meandering wall extends, i.e. the distance between the two opposite sides of the layer. The height may be constant, otherwise an average height may be considered.

[0011] When discussing parameters, the terms "great", "small" and the like should be understood as relative to each other, even if they are used alone. For instance, the small pitch of the first wall refers to the pitch of the first wall being relatively small as compared to the pitch of the second wall.

[0012] Thanks to the small thickness, the small pitch and the small pitch-to-height ratio of the first wall, the first layer comprises a great density of channels, which promotes heat exchange, especially when the fluid flowing in the first channel is gaseous, e.g. air. In addition, the small pitch-to-height ratio of the first wall makes up for its small thickness in terms of mechanical resistance of the heat exchanger module.

[0013] Optionally, the first wall, the second wall and the parting plate are assembled by diffusion bonding. As known per se in the art, diffusion bonding is an assembling technical based on the principle of solid-state diffusion. Diffusion bonding is typically carried out under high temperature and pressure conditions. Thanks to the above-defined structure, the heat exchanger module is able to withstand the pressure applied during diffusion bonding. In addition, diffusion bonding is a technique which does not require an additional weld material, as opposed to other welding techniques such as brazing. Therefore, diffusion bonding the first wall, the second wall and the parting plate ensures that the heat exchanger module does not comprise any brazing weld in the layers, which may be attacked by potentially corrosive fluids flowing therein, e.g. molten salts. Optionally, the parting plate, the first wall and the second wall are metallic. This encompasses metals as well as alloys and metallic composites.

[0014] Optionally, a thickness of the parting plate is greater than or equal to the thickness of the second wall. The thickness, or height, of the parting plate, is the smallest dimension of the parting plate and corresponds to the distance between a first layer and a second layer adjacent to and on either sides of the parting plate. Thus, the parting plate contributes to the mechanical strength of the heat exchanger module while homogenizing the heat transfer between the first layer and the second layer. In other embodiments, the thickness of the parting plate may be less than the thickness of the second wall.

[0015] Optionally, the height of the first wall is greater than the height of the second wall. In other embodiments, the height of the first wall may be less than or equal to the height of the second wall.

[0016] Optionally, a ratio of the height of the first wall to the thickness of the first wall is greater than or equal to 8, preferably 10, preferably 12. The meanders of the first wall may be obtained by folding the first wall. Optionally, a ratio of the height of the second wall to the thickness of the second wall is less than or equal to 8, preferably to 6, preferably 5, preferably 4. The meanders of the second wall may be obtained by pressing the second wall.

[0017] Optionally, a ratio of the pitch of the first wall to the height of the first wall is less than or equal to 2, preferably 1, preferably 0.6.

[0018] Optionally, a ratio of the pitch of the second wall to the height of the second wall is greater than or equal to 2, preferably 2.2, preferably 2.4. Optionally, a ratio of the pitch of the second wall to the pitch of the first wall is greater than 2, preferably 3, preferably 4, preferably 6.

[0019] Optionally, the pitch of the first wall lies in the range 0.5 to 3 millimeters (mm), preferably 1 to 2 mm.

[0020] Optionally, the pitch of the second wall lies in the range 3 to 10 mm, preferably 4 to 8 mm.

[0021] Optionally, the height of the first wall lies in the range 2 to 15 mm, preferably 2 to 5 mm.

[0022] Optionally, the height of the second wall lies in the range 1 to 10 mm, preferably 1.5 to 4 mm, preferably 2 to 3 mm.

[0023] Optionally, the thickness of the first wall lies in the range 0.05 to 0.5 mm, preferably 0.10 to 0.30 mm.

[0024] Optionally, the thickness of the second wall lies in the range 0.2 to 1.2 mm, preferably 0.30 to 0.50 mm.

[0025] Optionally, the thickness of the parting plate lies in the range 0.4 to 1 mm, preferably 0.50 to 0.70 mm.

[0026] Optionally, between opposite sides of the first layer, the first wall has a maximum angle greater than or equal to 70° with the opposite sides. That is, a portion of the first wall joining one opposite side to the other makes an angle with each one of the opposite sides. This angle reaches a maximum, which is at least 70°. The maximum angle may be greater than 80°, and may even reach 90°, in which case the first wall has portions perpendicular to the opposite sides of the first layer.

[0027] Optionally, between opposite sides of the second layer, the second wall has a maximum angle less than 70° with the opposite sides. More generally, the maximum angle of the second wall is less than the maximum angle of the first wall.

[0028] Optionally, the heat exchanger module comprises a plurality of the second layers, wherein the meandering second wall of one of the second layers and the meandering second wall of an adjacent one of the second layers are in opposite phase. In other words, the meandering second wall of one of the second layers is offset by a half-pitch relative to the meandering second wall of an adjacent one of the second layers. Thus, a valley of the second wall of one of the second layers is register with a peak of the second wall of the adjacent second layer, and vice versa. This ensures a good transmission of pressure applied to the heat exchanger module from one second layer to another, and limits deformation of the layers and the parting plate.

[0029] Optionally, the first channels and the second channels define counter flows. Alternatively, the first channels and the second channels could define parallel flows, or yet cross flows.

[0030] Optionally, the heat exchanger module comprises at least one side strut separating two adjacent parting plates at an end of the first layer and/or second layer, the at least one side strut supporting the two adjacent parting plates relative to each other. The side strut may close the corresponding layer in one direction. For instance, the side strut may extend between two opposite sides of the corresponding layer, and extend from an inlet to an outlet of the layer. The side strut, besides providing fluid containment in a layer, contributes to the mechanical strength of the heat exchanger module.

[0031] The present disclosure is further directed to a method for manufacturing the heat exchanger module as described above, the method comprising:

- providing a first wall and folding the first wall so as to make it meander and define first channels extending between a first inlet and a first outlet;
- providing a second wall and pressing the second wall so as to make it meander and define second channels extending between a second inlet and a second outlet, wherein a pitch of the first wall is less than a pitch of the second wall, a thickness of the first wall is less than a thickness of the second wall, and a ratio of the pitch to a height of the first wall is less than a ratio of the pitch to a height of the second wall;
- providing a parting plate between the first wall and the second wall;
- assembling the first wall, the second wall and the parting plate, whereby the first wall defines a first layer for a first fluid to flow therein between the first inlet and the first outlet, and the second wall defines second layer for a second fluid to flow therein be-

tween the second inlet and the second outlet.

[0032] The resulting heat exchanger module may have any of the above-described features, and the manufacturing method may be modified accordingly.

[0033] In particular, in the manufacturing method, the assembling optionally comprises diffusion bonding the first wall, the second wall and the parting plate.

BRIEF DESCRIPTION OF THE DRAWINGS

[0034] 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 cross-sectional view of a heat exchanger module according to an embodiment.

DETAILED DESCRIPTION OF EMBODIMENTS

[0035] A heat exchanger module 100 according to an embodiment is described in reference to Fig. 1, which shows a cross-section thereof. Although illustrating the main aspects of the present disclosure, Fig. 1 is not to scale.

[0036] A stacking direction or a height direction is a vertical direction in Fig. 1. A width direction is perpendicular to the stacking direction and corresponds, here, to a horizontal direction in Fig. 1. A length direction is a main direction in which at least one the fluids is to flow in the heat exchanger module 100 and corresponds, in this example, to a direction perpendicular to the stacking direction and the width direction. Here, the length direction is orthogonal to the plane of Fig. 1.

[0037] The heat exchanger module 100 comprises a plurality of layers stacked on one another, including at least one first layer 10 and at least one second layer 20. The first layer 10 has a first inlet and a first outlet located respectively in front of and behind the plane of Fig. 1, and is configured to receive the flow of a first fluid, e.g. a gas such as air. Likewise, the second layer 20 has a second inlet and a second outlet located respectively in front of and behind the plane of Fig. 1 in case of a parallel-flow heat exchanger, or respectively behind and in front of the plane of Fig. 1 in case of a counter-flow heat exchanger. The second layer is configured to receive the flow of a second fluid, e.g. a liquid such as molten salts.

[0038] The first layer 10 and the second layer 20 are separated by a parting plate 30. The parting plate 30 extends over the whole first layer 10 and second layer 20 in order to prevent the fluids of the first layer 10 and the second layer 20 from mixing.

[0039] First layers 10 and second layers 20 are stacked alternately, with parting plates 30 in-between. A desired number of first layers 10, parting plates 30 and second layers 20 may be stacked onto one another in order to obtain a heat exchanger module 100 with a desired flow capacity. At the end of the stack, end plates 33 may be provided. The end plates 33 may be similar in construction to the parting plates 30, but may be thicker in order to provide a strong casing for the heat exchanger module 100. Thus, each layer 10, 20 is closed, in the stacking direction, by a parting plate 30. In the width direction, each layer 10, 20 may be closed by respective side struts 34. That is, the side struts separate two adjacent parting plates 30 at the ends of the first layer 10 and the second layer 20, respectively. The side struts 34 support the two adjacent parting plates 30 relative to each other.

[0040] The side struts 34 may take the form of solid bars, which mainly extend in the length direction. The side struts 34 may be at least as thick as the parting plate 30.

[0041] In the length direction, the layers 10, 20 are not closed but open onto the respective inlets and outlets, as detailed above.

[0042] In this embodiment, the first layer 10 is provided with a channel structure to facilitate circulation of the first fluid and to enhance heat transfer. Specifically, the first layer 10 comprises a first wall 12 meandering between opposite sides 31, 32 of the first layer 10 in order to define first channels 14 extending between the first inlet and the first outlet.

[0043] Here, the opposite sides 31, 32 of the first layer 10 are formed by facing surfaces of the respective parting plates 30 adjacent to the first layer 10.

[0044] The first wall 12 may be a metallic wall. In this example, the meanders of the first wall 12 form a plurality of fins 16, which may be substantially rectilinear and/or oblique as shown in the cross-section of Fig. 1. In this example, the fins 16 make an angle with the opposite sides 31, 32. Here, the angle is substantially constant (e.g. constant besides edge effects) but in general, and this angle may vary. The angle reaches a maximum angle A1. The maximum angle A1 may be greater than or equal to 70°.

[0045] The fins 16 join each other at plateau portions 18 alternately in contact with each one of the opposite sides 31, 32 of the first layer 10. The space between two consecutive ones of the fins 16 and the opposite sides 31, 32 forms one of the above-mentioned first channels 14.

[0046] The first wall 12 has a height h1, a thickness e1 and a pitch p1. The height h1 corresponds to the distance between the opposite sides 31, 32 of the first layer 10. In this embodiment, the first wall 12 meanders periodically, such that the pitch p1 corresponds to a period of the first wall 12.

[0047] The first wall 12 may be formed, starting from a substantially planar sheet, by folding so as to make it meander. That is, the first wall 12 may be folded a plurality of times, e.g. one fold at a time on a continuous production line, to form the fins 16 and the plateau portions 18. In order to carry out the folding process, the height h1 should be relatively large with respect to the thickness e1. In other words, a ratio of the height h1 of the first wall 12 to the thickness e1 of the first wall 12, namely h1/e1, may be greater than or equal to 8, preferably 10, preferably 12. Besides, a ratio of the pitch p1 of the first wall 12 to the height h1 of the first wall 12, namely p1/h1, may be less than or equal to 2, preferably 1, preferably 0.6. Folding enables to achieve a great density of the fins 16 within the first layer 10.

[0048] In this embodiment, the second layer 20 is provided with a channel structure to facilitate circulation of the second fluid and to enhance heat transfer. Specifically, the second layer 20 comprises a second wall 22 meandering between opposite sides 31, 32 of the second layer 20 in order to define second channels 24 extending between the second inlet and the second outlet.

[0049] Like for the first layer 10, the opposite sides 31, 32 of the second layer 20 are formed by facing surfaces of the respective parting plates 30 adjacent to the second layer 20.

[0050] The second wall 22 may be a metallic wall. In this example, the meanders of the second wall 22 form a plurality of corrugations 26. Each corrugation 26 is in contact with one of the opposite sides 31, 32 and closed by the other one of the opposite sides 31, 32. The space between a corrugation 26 and the closing one of the opposite sides 31, 32 forms one of the above-mentioned second channels 24.

[0051] In this example, the portion of the second wall 22, going from one of the opposite sides 31, 32 to the other, makes an angle with the opposite sides 31, 32. Here, the angle is substantially constant (e.g. constant besides edge effects) but in general, and this angle may vary. The angle reaches a maximum angle A2. The maximum angle A2 may be less than 70°.

[0052] The second wall 22 has a height h2, a thickness e2 and a pitch p2. The height h2 corresponds to the distance between the opposite sides 31, 32 of the second layer 20. In this embodiment, the second wall 22 meanders periodically, such that the pitch p2 corresponds to a period of the second wall 22.

[0053] The second wall 22 may be formed, starting from a substantially planar sheet, by pressing so as to make it meander. That is, the second wall 22 may be inserted into a press and pressed by a stamping die, to force the sheet to take the form of the die. An appropriate shape of the die enables to obtain the corrugations 26. In order to carry out the pressing process, the height h2 should be relatively small with respect to the thickness e1, to prevent the sheet material from tearing apart. In other words, a ratio of the height h2 of the second wall 22 to the thickness e2 of the second wall 22, namely h2/e2, may be less than or equal to 8, preferably to 6, preferably 5, preferably 4. Besides, a ratio of the pitch p2 of the second wall 22 to the height h2 of the second wall 22, namely p2/h2, may be greater than or equal to 2, preferably 2.2, preferably 2.4. Pressing enables to achieve a small density of the corrugations 26, with a great thickness e2, within the second layer 10.

[0054] The parameters of the first wall 12 and the second wall 22 are such that a pitch p1 of the first wall 12 is less than a pitch p2 of the second wall 22 (p1<p2). Besides, a thickness e1 of the first wall 12 is less than a thickness e2 of the second wall 22 (e1<e2). Besides, a ratio of the pitch p1 to the height h1 of the first wall 12 is less than a ratio of the pitch p2 to the height h2 of the second wall 22 (p1/h1<p2/h2).

[0055] Thus, the first wall 12 and the second 22 are adapted to be manufactured by folding and pressing, respectively. The first wall 12 offers a surface suitable for efficient heat exchange with the first fluid, e.g. air, whereas the second wall 22 offers a surface suitable for efficient heat exchanger with the second fluid, e.g. molten salts. Besides, a relatively dense structure (governed by the height h1 and pitch p1) for the first wall 12 makes up for the small thickness e1, whereas the great thickness e2 of the second wall allows for a less dense structure, hence different height h2 and pitch p2 values.

[0056] The parting plate 30 may have a thickness h3 greater than the thickness e2 of the second wall 22 (h3>e2). In other embodiments, the thickness h3 of the parting plate 30 may be equal to or less than the thickness e2 of the second wall 22.

[0057] For instance, a ratio of the pitch p2 of the second wall 22 to the pitch p1 of the first wall 12, namely p2/p1, is greater than 2, preferably 3, preferably 4, preferably 6.

[0058] In this embodiment, the height, pitch and thickness parameters may have the following values.

[0059] The pitch p1 of the first wall 12 lies in the range 0.5 to 3 mm, preferably 1 to 2 mm.

[0060] The pitch p2 of the second wall 22 lies in the range 3 to 10 mm, preferably 4 to 8 mm.

[0061] The height h1 of the first wall 12 lies in the range 2 to 15 mm, preferably 2 to 5 mm.

[0062] The height h2 of the second wall 22 lies in the range 1 to 10 mm, preferably 1.5 to 4 mm, preferably 2 to 3 mm.

[0063] The thickness e1 of the first wall 12 lies in the range 0.05 to 0.5 mm, preferably 0.10 to 0.30 mm.

[0064] The thickness of the second wall 22 lies in the range 0.2 to 1.2 mm, preferably 0.30 to 0.50 mm.

[0065] Transverse to the plane of Fig. 1, namely in the length direction, the first wall 12 and/or the second wall 22 may be rectilinear, oblique, wavy, etc. as desired.

[0066] Once provided, the first walls 10, the second walls 20 and the parting plates 30, and if applicable the end plates 33 and side struts 34, may be assembled to form the heat exchanger module 100. In an embodiment, the assembling comprises diffusion bonding these components together. Namely, after stacking, heat and pressure are applied to trigger solid-state diffusion between the components in contact with one another.

[0067] In order to further enhance the mechanical strength of the heat exchanger module 100, especially during the diffusion bonding, the second wall 22A of one of the second layers 20 and the second wall 22B of an adjacent one of the second layers 20 may be in opposite phase. As shown in Fig. 1, the corrugations 26 of the second wall 22A are upside down relative to the facing corrugations 26 of the second wall 22B, at a given position in the width direction. This ensures that the force exerted by the second wall 22A onto the adjacent parting plate 30, after being transmitted to the first wall 10 and the subsequent parting plate 30, is duly supported by the second wall 22B of the adjacent second layer 20. 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. In particular, individual characteristics of the different illustrated/mentioned embodiments may be combined in additional embodiments. Therefore, the description and the drawings should be considered in an illustrative rather than in a restrictive sense.

Claims

1. A heat exchanger module (100) comprising at least one first layer (10) for a first fluid to flow therein between a first inlet and a first outlet, and at least one second layer (20) for a second fluid to flow therein between a second inlet and a second outlet, wherein the at least one first layer (10) and the at least one second layer (20) are separated by a parting plate (30), the first layer (10) comprising a first wall (12) meandering between opposite sides (31, 32) of the first layer (10) in order to define first channels (14) extending between the first inlet and the first outlet, the second layer (20) comprising a second wall (22) meandering between opposite sides (31, 32) of the second layer (20) in order to define second channels (24) extending between the second inlet and the second outlet, wherein a pitch (p1) of the first wall is less than a pitch (p2) of the second wall, a thickness (e1) of the first wall is less than a thickness (e2) of the second wall, and a ratio of the pitch (p1) to a height (h1) of the first wall is less than a ratio of the pitch (p2) to a height (h2) of the second wall.

2. The heat exchanger module of claim 1, wherein the first wall (12), the second wall (22) and the parting plate (30) are assembled by diffusion bonding.

3. The heat exchanger module of claim 1 or 2, wherein the height (h1) of the first wall is greater than the height (h2) of the second wall.

4. The heat exchanger module of any one of claims 1 to 3, wherein a ratio of the height (h1) of the first wall to the thickness (e1) of the first wall is greater than or equal to 8; and/or wherein a ratio of the height (h2) of the second wall to the thickness (e2) of the second wall is less than or equal to 8.

5. The heat exchanger module of any one of claims 1 to 4, wherein a ratio of the pitch (p1) of the first wall to the height (h1) of the first wall is less than or equal to 2; and/or wherein a ratio of the pitch (p2) of the second wall to the height (h2) of the second wall is greater than or equal to 2.

6. The heat exchanger module of any one of claims 1 to 5, wherein a ratio of the pitch (p2) of the second wall to the pitch (p1) of the first wall is greater than 2.

7. The heat exchanger module of any one of claims 1 to 6, wherein:

- the pitch (p1) of the first wall lies in the range 0.5 to 3 mm; and/or
- the pitch (p2) of the second wall lies in the range 3 to 10 mm; and/or
- the height (h1) of the first wall lies in the range 2 to 15 mm; and/or
- the height (h2) of the second wall lies in the range 1 to 10 mm; and/or
- the thickness (e1) of the first wall lies in the range 0.05 to 0.5 mm, preferably 0.10 to 0.30 mm; and/or
- the thickness (e2) of the second wall lies in the range 0.2 to 1.2 mm, preferably 0.30 to 0.50 mm.

8. The heat exchanger module of any one of claims 1 to 7, wherein between opposite sides (31, 32) of the first layer (10), the first wall (12) has a maximum angle (A1) greater than or equal to 70° with the opposite sides (31, 32); and/or wherein between opposite sides (31, 32) of the second layer (20), the second wall (22) has a maximum angle (A2) less than 70° with the opposite sides (31, 32).

9. The heat exchanger module of any one of claims 1 to 8, comprising a plurality of the second layers (20), wherein the meandering second wall (22A) of one of the second layers and the meandering second wall (22B) of an adjacent one of the second layers are in opposite phase.

10. The heat exchanger module of any one of claims 1 to 9, wherein the first channels (14) and the second channels (24) define counter flows.

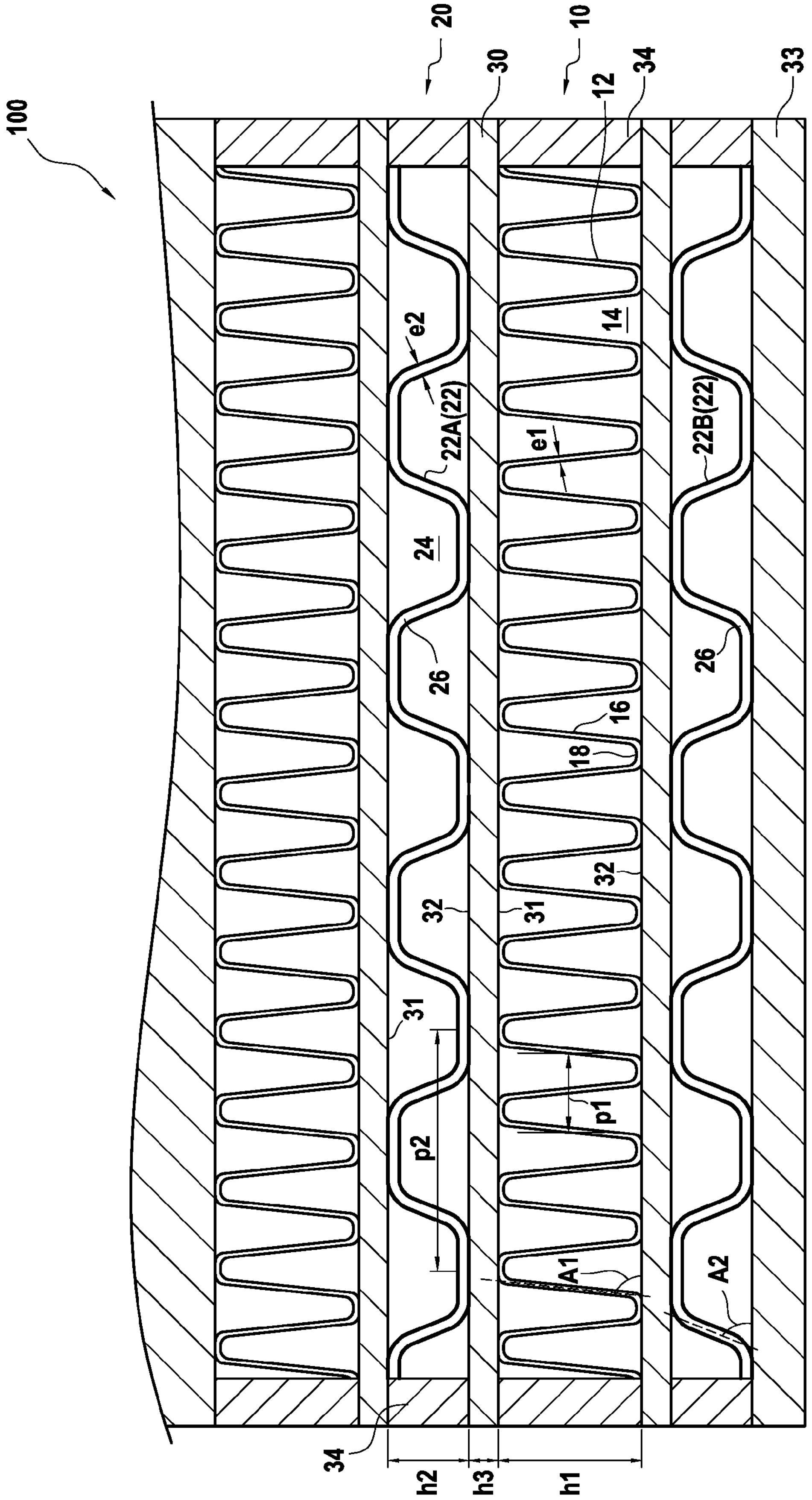
11. The heat exchanger module of any one of claims 1 to 10, comprising at least one side strut (34) separating two adjacent parting plates (30) at an end of the first layer (10) and/or second layer (20), the at least one side strut (34) supporting the two adjacent parting plates (30) relative to each other.

12. A method for manufacturing the heat exchanger module (100) of any one of claims 1 to 11, the method comprising:

- providing a first wall (12) and folding the first

wall (12) so as to make it meander and define first channels (14) extending between a first inlet and a first outlet;
- providing a second wall (22) and pressing the second wall (22) so as to make it meander and define second channels (24) extending between a second inlet and a second outlet, wherein a pitch (p1) of the first wall is less than a pitch (p2) of the second wall, a thickness (e1) of the first wall is less than a thickness (e2) of the second wall, and a ratio of the pitch (p1) to a height (h1) of the first wall is less than a ratio of the pitch (p2) to a height (h2) of the second wall;
- providing a parting plate (30) between the first wall (12) and the second wall (22);
- assembling the first wall (12), the second wall (22) and the parting plate (30), whereby the first wall (12) defines a first layer (10) for a first fluid to flow therein between the first inlet and the first outlet, and the second wall (22) defines second layer (20) for a second fluid to flow therein between the second inlet and the second outlet.

13. The method of claim 12, wherein the assembling comprises diffusion bonding the first wall (12), the second wall (22) and the parting plate (30).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e1
22B(22)
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A2
h2
h3
h1

FIG. 1

Europäisches Patentamt
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EUROPEAN SEARCH REPORT

Application Number
EP 22 19 6549

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 2021/341186 A1 (SUN FAMING [JP] ET AL) 4 November 2021 (2021-11-04) * figures 5, 7 * -----	1-13	INV. F28F3/02 F28D9/00
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The present search report has been drawn up for all claims

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Place of search	Date of completion of the search	Examiner
Munich	24 February 2023	Vassoille, Bruno

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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