



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
26.12.2018 Bulletin 2018/52

(51) Int Cl.:
F28F 9/00 (2006.01) F28D 9/00 (2006.01)

(21) Application number: **17176750.2**

(22) Date of filing: **20.06.2017**

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

• **Alfa Laval Vicarb SAS**
38120 Fontanil-Cornillon (FR)

(72) Inventor: **FERNANDEZ, Jean-Noël**
69630 Chaponost (FR)

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

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

(54) **PLATE HEAT EXCHANGER**

(57) The present invention relates to a plate heat exchanger (100) comprising a top head (104), a bottom head (106), four side panels (108a, 108b, 108c, 108d), and four corner girders (110a, 110b, 110c, 110d) bolted together to form a sealed enclosure (102) for housing a pack of heat exchanging plates. At least one of the side panels (108a, 108b, 108c, 108d) is divided into at least

two separate plates (112a, 112b, 112c, 112d, 112e) arranged one after another along a longitudinal direction (L). The least two separate plates (112a, 112b, 112c, 112d, 112e) include a first separate plate (112e) being adapted to be bolted to the top head (104) and a second separate plate (112a) being adapted to be bolted to the bottom head (106).

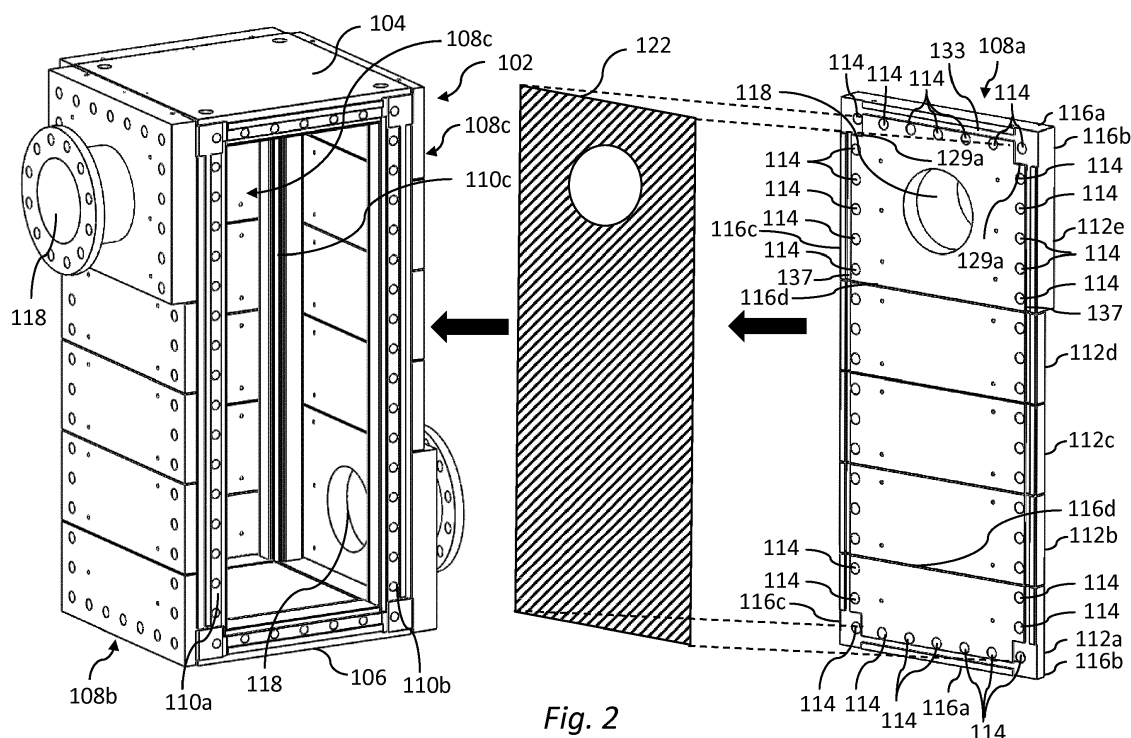


Fig. 2

Description

Technical Field

[0001] The present disclosure relates to a plate heat exchanger comprising a top head, a bottom head, four side panels, and four corner girders, wherein the side panels and the corner girders extend along a longitudinal direction from the bottom head to the top head. Each side panel is associated with two corner girders, wherein the top head, the bottom head, the four side panels and the four corner girders are bolted together to form a sealed enclosure for housing a pack of heat exchanging plates.

Technical Background

[0002] Today several different types of plate heat exchangers exist and are employed in various applications depending on their type. One certain type of plate heat exchanger is assembled by bolting a top head, a bottom head and four side panels to a set of corner girders to form a box-like enclosure around a stack of heat transfer or heat exchanging plates. This certain type of plate heat exchanger is referred to as a block-type heat exchanger. One example of a commercially available block-type heat exchanger is the heat exchanger offered by Alfa Laval AB under the product name Compabloc. Other block-type plate heat exchangers are disclosed in patent documents EP 165179 and EP 639258.

[0003] In the block-type plate heat exchanger fluid paths for two heat exchange fluids are formed between the heat transfer plates in the stack of heat transfer plates, in order to transfer heat between the two heat exchange fluids.

[0004] Block-type heat exchangers are commonly used in applications where the heat exchange fluids or one of the heat exchange fluids are provided at a high pressure, such as up to 40 bars. Moreover, the block-type heat exchangers are commonly used where relatively speaking large heat exchangers are desired. As an example, a side panel of a typical block-type heat exchanger may be several meters tall and several meters wide. The high pressure in combination with the size demands a high strength box-like enclosure to withstand the forces originating from the pressure of the heat transfer fluids. Also for smaller size block-type heat exchangers a high strength box-like enclosure is commonly needed.

[0005] The box-like enclosure, i.e. the parts forming the enclosure, of a block-type heat exchanger is commonly made of metal, such as steel. The use of a metal case providing a sufficient mechanical strength brings about that the box-like enclosure commonly requires a significant amount of material in order to be fabricated, thus becoming heavy and costly in order to provide a required mechanical strength.

[0006] Also handling and transportation of the respective parts of the box-like enclosure become troublesome

as the parts increase in size and thus weight. In other words, those problems become more pronounced for large size block-type heat exchangers having a large enclosure.

[0007] Problems associated with high material consumption and high weight becomes especially pronounced when the sides panels are provided with machinings or details, such as feed troughs, which reduce the overall strength of the side panel concerned, as the thickness of the side panels typically have to be increased in order to compensate for the reduction in strength introduced by the machinings or details.

[0008] Hence, there is a need for an improved plate heat exchanger.

Summary

[0009] It is an object of the present disclosure to provide an improvement of the above techniques and prior art. In particular, it is an object to provide a plate heat exchanger comprising a sealed enclosure for housing a pack of heat exchanging plates which is easier and less costly to fabricate and handle while exhibiting a desired mechanical strength.

[0010] To solve these objects a plate heat exchanger is provided. The plate heat exchanger comprising a top head, a bottom head, four side panels, and four corner girders, wherein the side panels and the corner girders extend along a longitudinal direction from the bottom head to the top head, wherein each side panel is associated with two corner girders, wherein the top head, the bottom head, the four side panels and the four corner girders are bolted together to form a sealed enclosure for housing a pack of heat exchanging plates, wherein at least one of the side panels is divided into at least two separate plates arranged one after another along the longitudinal direction, wherein the at least two separate plates include a first separate plate being adapted to be bolted to the top head and a second separate plate being adapted to be bolted to the bottom head.

[0011] The plate heat exchanger is advantageous in that at least one of the side panels forming part of the sealed enclosure for housing the pack of heat exchanging plates is divided into at least two separate plates arranged one after another along the longitudinal direction. By dividing at least one of the side panels into at least two separate plates arranged one after another, the handling of the at least two separate plates may become significantly simplified as compared to handling a side panel formed of a single part. Particularly, in case of relatively speaking large side panels, the handling of separate plates may significantly lower the requirements on the equipment required during for instance transportation, installation and maintenance as each of the separate plates are smaller and lighter as compared to a side panel being formed in a single piece.

[0012] Further, by dividing at least one of the side panels into at least two separate plates arranged one after

another, the mechanical properties of the respective separate plates may be tailored to suit specific needs of a particular installation. As an example, one separate plate may be made thicker and thus stronger as compared to another separate plate or plates. It is thus possible to reduce material consumption, since the thickness of the respective separate plates may be chosen based on the forces a particular separate plate is subjected to. Further, separate plates not exhibiting weakening structures or details such as openings may be made thinner as compared to separate plates not exhibiting weakening structures or details, which allows for a reduced material consumption.

[0013] Furthermore, by dividing at least one of the side panels into at least two separate plates arranged one after another, a modular system for forming the sealed enclosure for housing the pack of heat exchanging plates may be provided. In other words, the respective side panels of the sealed enclosure may be formed of a plurality of standard modules in form of separate plates having a standard height or standard heights. The modular system may include separate plates for instance including an opening or similar and flat separate plates without any opening or similar. If specific heights of the side panels, other than those that may be formed or achieved by available standard sized separate plates are needed, a single plate of a specific height may easily be formed to complement the standard sized separate plates so as to achieve any height of the side panels. The modular system may thus facilitate the fabrication of the sealed enclosure and reduce the fabrication cost.

[0014] Further, different separate plates may be made of different materials depending on different requirements or needs.

[0015] The plate heat exchanger may further comprise a lining covering an internal surface area of the divided side panel thereby providing a closed internal surface area of the side panel being divided into two or more separate plates arranged one after another along the longitudinal direction. By providing a lining covering an internal surface area of the divided side panel, a closed internal surface area of the side panel being divided into two or more separate plates arranged one after another along the longitudinal direction may be achieved. The lining may thus seal the surface of the divided side panel thereby making the divided side panel liquid or fluid tight, such that leakage of heat exchange fluids or heat transfer mediums may be counteracted. Moreover, the lining may be provided in form of a material capable of withstand e. g. corrosive heat exchange mediums or excessive heat, thereby increasing the lifetime of the divided side panel while increasing security. It should be noted that within the context of the application the term "internal surface" may refer to any surface area of the side panel facing the interior of the plate heat exchanger and not necessarily the complete surface area of the side panel concerned.

[0016] The first separate plate may be provided with

an opening extending through the plate for providing a channel for a flow of heat transfer medium through the first plate, and/or the second separate plate may be provided with an opening extending through the plate for providing a channel for a flow of heat transfer medium through the second plate. By providing an opening extending through the first and or second plate, a flow of heat transfer medium through the first and or second plate may be realized.

[0017] The first separate plate may be provided with bolt holes along first, second and third edges and may be adapted to be bolted to the top head along a first edge and may adapted to be bolted to two associated corner girders along second and third edges of the first separate plate, wherein a fourth edge of the first separate plate may be free from bolt holes, and wherein the second separate plate may be provided with bolt holes along first, second and third edges and may be adapted to be bolted to the bottom head along a first edge and may be adapted to be bolted to the two associated corner girders along second and third edges of the second separate plate, wherein a fourth edge of the second separate plate may be free from bolt holes. By providing bolt holes along first, second and third edges of the first separate plate and the second separate plate, the respective plates may be bolted to the corner girders and top respective bottom head without requiring any additional details for forming the sealed enclosure for housing the pack of heat exchanging plates. Hence, no additional girders, reinforcing elements or similar may be required. Moreover, the mounting of the first separate plate and the second separate plate may be facilitated as a limited number of bolts may be used.

[0018] At least one of the side panels may be divided into at least three separate plate modules arranged one after another along the longitudinal direction, which is advantageous in that a limited number of separate plate types may be used to form a large number of different types or heights of side panels. Further, the mechanical properties of the respective separate plate modules may vary so as to account for different requirements, such as different mechanical strengths or openings to give a few examples.

[0019] A third separate plate module, arranged between the first and the second plate modules in the longitudinal direction, may be adapted to be bolted to two associated corner girders without being bolted to the top head or bottom head, which is advantageous in that no additional details for forming the sealed enclosure for housing the pack of heat exchanging plates may be required. In other words, the third separate plate module may only be bolted to the two associated corner girders. Moreover, the mounting of the of the mounting of the third separate plate module may be facilitated as a limited number of bolts may be used.

[0020] At a first side a separate plate being provided with a channel for a flow of heat transfer medium through the plate may have a first thickness and wherein at the

first side a separate plate not being provided with a channel for a flow of heat transfer medium through the plate may have a second thickness, wherein the first thickness may be greater than the second thickness, which is advantageous in that the reduced strength owing from the channel of flow may be compensated for in an efficient manner. In other words, the separate plate being provided with a channel for a flow of heat transfer medium through the plate may be made thicker so as to account for the channel for a flow without having to change or alter the separate plate not being provided with a channel for a flow. This arrangement may result in a reduced material consumption and hence a reduced cost while still maintaining a desired mechanical strength of the side panel.

[0021] The first thickness may be at least 110%, preferably at least 120% of the second thickness.

[0022] At least the side panel or side panels being provided with an opening extending through the respective side panel for providing a channel for a flow of heat transfer medium through the side panel, may be divided into two or more separate plates arranged one after another along the longitudinal direction, which is advantageous in that material consumption of the side panel may be reduced while maintaining a desired mechanical strength of the side panel.

[0023] Each of the two corner girders associated with the divided side panel may be provided with a longitudinally extending notch, wherein the notch, as seen in a cross-section across the longitudinal direction, may be positioned at a corner formed by a surface facing the side panel and a surface facing the other corner girder, wherein the notch extends along the longitudinal direction from an interface between the top head and the corner girder to an interface between the bottom head and the corner girder, wherein the longitudinally extending notch together with the separate plates of the side panel form a groove extending along the longitudinal direction, the groove being configured to receive and clamp an edge portion of the lining, which is advantageous in that the lining may be clamped between the corner girders and the side panel while mounting the side panel to the corner girders. Moreover, the notch may act as a mechanical stop and abut the side panel when mounting the side panel to the corner girders. By this abutment between the side panel and the corner girders the risk of over-compressing the lining may be reduced as the final distance between the side panel and the corner girders may be determined by the demoulding of the notch. The height of the notch may thus for instance be slightly lower than an initial thickness of the lining, so as to compress the lining slightly during mounting. The height of the notch may be different and may for instance account for the thickness of a gasket which may be provided between the lining and the corner girders.

[0024] The top head may, on an edge surface facing the divided side panel, be provided with a notch extending in a transverse direction along the edge surface, wherein

the notch, as seen in a cross-section across the transverse direction, is positioned at a corner formed by the edge surface and an internally facing major surface of the top head, wherein the notch extends from an interface between the first separate plate and a first of the two associated corner girders and an interface between the first separate plate and a second one of the two associated corner girders, wherein the notch extending in a transverse direction together with the first separate plate forms a groove extending along the transverse direction, the groove being configured to receive and clamp an edge portion of the lining, which is advantageous in that the lining may be clamped between the top head and the side panel while mounting the side panel to the top head. Moreover, the notch may act as a mechanical stop and abut the side panel when mounting the side panel to the top head. By this abutment between the side panel and the top head the risk of over-compressing the lining may be reduced as the final distance between the side panel and the top may be determined by the demoulding of the notch. The height of the notch may thus for instance be slightly lower than an initial thickness of the lining, so as to compress the lining slightly during mounting. The height of the notch may be different and may for instance account for the thickness of a gasket which may be provided between the lining and the top head.

[0025] The bottom head may, on an edge surface facing the divided side panel, be provided with a notch extending in a transverse direction along the edge surface, wherein the notch, as seen in a cross-section across the transverse direction, is positioned at a corner formed by the edge surface and an internally facing major surface of the bottom head, wherein the notch extends from an interface between the second separate plate and a first of the two associated corner girders and an interface between the second separate plate and a second one of the two associated corner girders, wherein the notch extending in a transverse direction together with the second separate plate forms a groove extending along the transverse direction, the groove being configured to receive and clamp an edge portion of the lining, which is advantageous in that the lining may be clamped between the bottom head and the side panel while mounting the side panel to the bottom head. Moreover, the notch may act as a mechanical stop and abut the side panel when mounting the side panel to the bottom head. By this abutment between the side panel and the bottom head the risk of over-compressing the lining may be reduced as the final distance between the side panel and the top may be determined by the demoulding of the notch. The height of the notch may thus for instance be slightly lower than an initial thickness of the lining, so as to compress the lining slightly during mounting. The height of the notch may be different and may for instance account for the thickness of a gasket which may be provided between the lining and the top head.

[0026] The lining may have a thickness between 2 and 15 mm, preferably between 5 and 15 mm, more preferred

between 8 and 12 mm, and preferably comprise stainless steel or titanium. By providing a lining having a thickness between 2 and 15 mm, the lining may efficiently withstand the pressure of the fluids in the plate heat exchanger. Moreover, by providing a relatively speaking thick lining, the lining may withstand irregularities, slots or gaps that may be present for instance at the interface between two separate plates. In other words, the fit between two adjacent separate plates need not be perfect as relatively speaking small gaps may be acceptable. A relatively speaking thick lining may also mitigate the need for fixing adjacent separate plates to each other e.g. by using fasteners such as bolts or keyed surfaces interacting with each other.

[0027] Each of the two corner girders associated with the divided side panel may be provided with a first, transversely protruding, shoulder portion adapted to interact with the first separate plate and a second, transversely protruding, shoulder portion adapted to interact with the second separate plate, wherein the first shoulder portion comprises a first abutment surface having an extension in a direction transverse to the longitudinal direction and facing the second shoulder portion, wherein the second shoulder portion comprises a second abutment surface having an extension in a direction transverse to the longitudinal direction and facing the first shoulder portion, wherein the first separate plate may comprise two abutment surfaces, each having an extension in a direction transverse to the longitudinal direction and facing away from the second separate plate, the two abutment surfaces being configured to interact with the respective first abutment surface of the two associated corner girders, and wherein the second separate plate may comprise two abutment surfaces, each having an extension in a direction transverse to the longitudinal direction and facing away from the first separate plate, the two abutment surfaces being configured to interact with the respective second abutment surface of the two associated corner girders. By this arrangement, forces acting to separate the top head from the bottom head along the longitudinal direction may be transferred through the corner girders via the abutment surfaces present on the corner girders, the first separate plate and the second separate plate respectively. In other words, the top head may become locked with respect to the bottom head in the longitudinal direction by the abutment surfaces present on the corner girders, the first separate plate and the second separate plate respectively while forces acting to separate the top head from the bottom head will be transferred via the first separate plate, the corner girders and the second separate plate by means of the interaction between the abutment surfaces. In this way, the top head will be counteracted from being separated from the bottom head in the longitudinal direction.

[0028] Hence, forces may be transferred from the top head to the bottom head or vice versa allowing for that the side panels of the plate heat exchanger may be formed as separate plates, since the side panels need

not transfer forces acting to separate the top head from the bottom head. Hence, the side panels may be made as a plurality of separate plates, where the separate plates need not interact with each other, while providing a mechanically strong sealed enclosure for housing a pack of heat exchanging plates.

[0029] The first abutment surface of the first shoulder portion, the second abutment surface of the second shoulder portion, the two abutment surfaces of the first separate plate and the two abutment surfaces of the second separate plate may be planar in cross section and have respective normal directions being parallel to the longitudinal direction, which is advantageous in that an efficient interaction between the abutment surfaces may be provided using a simple shape of the abutment surfaces. In other words, forces may efficiently be transferred via the abutment surfaces.

[0030] It is noted that the invention relates to all possible combinations of features recited in the claims.

Brief Description of the Drawings

[0031] Embodiments of the invention will now be described, by way of example, with reference to the accompanying schematic drawings, in which

Fig. 1 is a schematic perspective view of a block-type plate heat exchanger having side panels divided into separate plates arranged one after another, Fig. 2 is a schematic perspective view of the sealed enclosure of the block-type plate heat exchanger of Fig. 1, Fig. 3 is an enlarged view of a bottom portion of the sealed enclosure of Fig. 2, and Fig. 4 is an enlarged view of a top portion sealed enclosure of Fig. 2, with the side panels removed and the top head opened up.

Detailed description

[0032] The present inventive concept will now be described more fully hereinafter with reference to the accompanying drawings, in which a preferred embodiment of the present inventive concept is shown. This inventive concept may, however, be embodied in many different forms and should not be construed as limited to the embodiment set forth herein; rather, the embodiment is provided for thoroughness and completeness, and fully convey the scope of the inventive concept to the skilled person.

[0033] Referring now to the drawings and to Fig. 1 in particular, there is conceptually depicted a plate heat exchanger 100. The plate heat exchanger 100 is a block-type heat exchanger. The plate heat exchanger 100 includes a sealed enclosure 102 for housing a pack of heat exchanging plates, not shown.

[0034] The sealed enclosure 102 for housing a pack of heat exchanging plates will now be described in greater

detail with reference to Fig. 1, 2, 3 and 4. The sealed enclosure 102 of the plate heat exchanger 100 includes a top head 104, a bottom head 106, four side panels 108a, 108b, 108c 108d, and four corner girders 110a, 110b, 110c, 110d. The side panels 108a, 108b, 108c 108d and the corner girders 110a, 110b, 110c, 110d extend along a longitudinal direction L from the bottom head 106 to the top head 104.

[0035] Each side panel 108a, 108b, 108c 108d is associated with two corner girders 110a, 110b, 110c, 110d. As an example, side panel 108a is associated with the two corner girders 110a and 110b, whereas side panel 108c is associated with the two corner girders 110b and 110c. The top head 104, the bottom head 106, the four side panels 108a, 108b, 108c 108d and the four corner girders 110a, 110b, 110c, 110d are bolted together to form the sealed enclosure 102.

[0036] According to the present inventive concept, at least one of the side panels 108a, 108b, 108c 108d is divided into at least two separate plates arranged one after another along the longitudinal direction L. In the depicted enclosure 102 of Fig. 2, each of the side panels 108a, 108b, 108c 108d are divided into five separate plates or plate modules. Side panel 108a is divided into separate plates 112a, 112b, 112c, 112d, 112e arranged one after another along the longitudinal direction L so as to form the side panel 108a. The uppermost or first separate plate 112e is adapted to be bolted to the top head 104 and lowermost or second separate plate 112a is adapted to be bolted to the bottom head 106.

[0037] In the depicted embodiment, the side panels 108a, 108b, 108c 108d are depicted as being divided into five separate plates 112a, 112b, 112c, 112d, 112e. However, the side panels 108a, 108b, 108c 108d may be divided into any number of separate plates. Not all side panels 108a, 108b, 108c 108d need to be divided into the same number of separate plates. Further not all side panels 108a, 108b, 108c 108d need to be divided at all, meaning that one, two or three of the side panels 108a, 108b, 108c 108d may be formed as a single panel formed of a single part or plate.

[0038] For instance, the side panel 108a may be divided into two separate plates arranged one after another, where uppermost separate plate is adapted to be bolted to the top head 104 and lowermost separate plate is adapted to be bolted to the bottom head 106. At the same time the other side panels 108b, 108c 108d may be divided into any number of separate plates as discussed above.

[0039] As a further example, the side panel 108a may be divided into three separate plates arranged one after another, where uppermost separate plate is adapted to be bolted to the top head 104 and lowermost separate plate is adapted to be bolted to the bottom head 106.

[0040] One, two, three or four of the side panels 108a, 108b, 108c 108d may be divided into any number of separate plates, including two, three, four, five, six, seven and ten to give a few non limiting examples.

[0041] The uppermost separate plate 112e of side panel 108a is in the depicted embodiment provided with bolt holes 114 along first, second and third edges 116a, 116b, 116c and is adapted to be bolted to the top head 104 along a first edge 116a and adapted to be bolted to two associated corner girders 110a, 110b along second and third edges 116b, 116c of the uppermost separate plate 112e. The fourth edge 116d of the uppermost separate 112e plate is free from bolt holes.

[0042] Similarly, the lowermost separate plate 112a is provided with bolt holes 114 along first, second and third edges 116a, 116b, 116c and is adapted to be bolted to the bottom head 106 along a first edge 116a and adapted to be bolted to the two associated corner girders 110a, 110b along second and third edges 116b, 116c of the lowermost separate plate 112a. The fourth edge 116d of the lowermost separate plate 112a is free from bolt holes.

[0043] Other arrangements than bolts introduced in the bolt holes 114 may be used for mounting the separate plates 112e, 112a. Rivets or pins may for example be used. The bolt holes 114 are thus optional and may be omitted.

[0044] As already mentioned above, at least one of the side panels 108a, 108b, 108c 108d may be divided into at least three separate plates or plate modules 112a, 112b, 112c, 112d, 112e arranged one after another along the longitudinal direction L.

[0045] Side panel 108a is depicted as being divided into five separate plates 112a, 112b, 112c, 112d, 112e. The separate plates 112b, 112c, 112d are arranged between the uppermost and the lowermost plate modules 112a, 112b in the longitudinal direction L in the depicted embodiment. The separate plates 112b, 112c, 112d are adapted to be bolted to the two associated corner girders 110a, 110b without being bolted to the top head 104 or bottom head 106. In other words, the separate plates 112b, 112c, 112d may only bolted to the corner girders 110a, 110b.

[0046] As seen in Fig. 1 and 2 the uppermost separate plate 112e of the side panel 108a may be provided with an opening 118. The opening 118 may extend through the plate 112e, thereby providing a channel for a flow of heat transfer medium through the plate 112e. In Fig 2. the opening 118 is depicted as being provided with a flange 120 on the outside of the enclosure 102. The flange may be used to connect the heat exchanger 100 to e.g. a pipe for feeding a flow of heat transfer medium through the plate 112e and into the heat exchanger 100. The opening 118 may correspondingly be used to allow heat transfer medium to leave the heat exchanger 100 through the plate 112e.

[0047] As is evident from Fig. 1 and 2, more openings 118 may be provided on the respective side panels 108a, 108b, 108c 108d. For instance, the lowermost separate plate of side panel 108c is provided with an opening 118 extending through the plate for providing a channel for a flow of heat transfer medium through the plate. Any number of openings may be provided in any locations of

the enclosure 102.

[0048] According to the present inventive concept, at least the side panel or side panels 108a, 108b, 108c 108d being provided with an opening 118 extending through the respective side panel 108a, 108b, 108c 108d for providing a channel for a flow of heat transfer medium through the side panel 108a, 108b, 108c 108d, may be divided into two or more separate plates 112a, 112b, 112c, 112d, 112e arranged one after another along the longitudinal direction L.

[0049] As is depicted in Fig. 1 and 2, the uppermost separate plate 112e of side panel 108a being provided with a channel for a flow of heat transfer medium through the plate 112e may have a first thickness, while the separate plates 112a, 112b, 112c, 112d not being provided with a channel for a flow of heat transfer medium through the plates 112a, 112b, 112c, 112d may have a second thickness. The first thickness, i.e. the thickness of the separate plate 112e is depicted as being greater than the second thickness, i.e. the thickness of the separate plates 112a, 112b, 112c, 112d. Separate plate 112e may be of greater thickness than separate plates 112a, 112b, 112c, 112d, so as to compensate for the reduced strength introduced by the opening 118 provided through the plate 112e.

[0050] As an example, the first thickness may be at least 110%, preferably at least 120% of the second thickness. Other relations between the first and second thickness may of course be used. Moreover, when more than two separate plates 112a, 112b, 112c, 112d, 112e are used, more different thicknesses may be used. Each separate plate separate plates 112a, 112b, 112c, 112d, 112e may for instance have a specific thickness. The thickness may also vary within a separate plate 112a, 112b, 112c, 112d, 112e. For instance, a single separate plate 112a, 112b, 112c, 112d, 112e may be made thicker at locations where material stresses are greater than in other locations.

[0051] Further, different effective thicknesses of the separate plates 112a, 112b, 112c, 112d, 112e may as an alternative be realized by stacking elements forming the separate plates 112a, 112b, 112c, 112d, 112e on top of each other. It is for example possible to double the thickness by stacking to elements of a certain thickness on top of each other so as to form a separate plate 112a, 112b, 112c, 112d, 112e. More elements such as three, four, five or ten may be stacked on top of each other so as to form a separate plate 112a, 112b, 112c, 112d, 112e, to give a few non limiting examples.

[0052] As an alternative, the separate plates 112a, 112b, 112c, 112d, 112e may be made stronger by being provided by impressions, corrugations or similar stiffening the separate plates 112a, 112b, 112c, 112d, 112e concerned.

[0053] By dividing the side panels 108a, 108b, 108c 108d into separate plates 112a, 112b, 112c, 112d, 112e arranged one after another as described above, a modular system for forming the sealed enclosure 102 may

be provided. More specifically, the respective side panels 112a, 112b, 112c, 112d, 112e of the sealed enclosure 102 may be formed of a plurality of standard modules 112a, 112b, 112c, 112d, 112e having standard heights.

5 The modular system may include separate plates 112e including an opening 118 flat separate plates 112a, 112b, 112c, 112d without any opening. If specific heights of the side panels 108a, 108b, 108c 108d, other than those that may be formed by available standard sized separate plates 112a, 112b, 112c, 112d, 112e are needed, a single plate, not shown, of a specific height may easily be formed to complement the standard sized separate plates 112a, 112b, 112c, 112d, 112e so as to achieve any height of the side panels 108a, 108b, 108c 108d.
10 The modular system may thus facilitate the fabrication of the sealed enclosure 102.

[0054] As is depicted in Fig. 2, a lining 122 may be provided at an inside of the side panel 108a, i.e. at side of the side panel 108a facing the interior of the enclosure 102. The lining 122 is shown separately from the side panel 108a in order to clearly illustrate how the lining is provided with respect to the side panel 108a and the rest of the enclosure 102. The depicted lining 122 covers the internal surface area of the divided side panel 108a thereby providing a closed internal surface area of the side panel 108a. The lining 122 covers the internal surface of the side panel 108a in the sense that the internal surface of the side panel 108a otherwise being exposed to the interior of the enclosure 102 is covered. In other words, the entire internal surface of the side panel 108a is typically not covered by the lining. However, the lining 122 may as an alternative cover the entire internal surface of the side panel 108a. The lining 122 may thus provide a closed internal surface area of the side panel 108a in the sense that the divided side panel 108a is made fluid tight. Should the lining 122 not be present, the side panel may risk leaking fluid medium for instance at an interface between the separate plates 112a, 112b, 112c, 112d, 112e. The lining 122 typically has a thickness between 2 and 15 mm, such as between 5 and 15 mm, so as to be able to handle the pressure which it is subjected to. In the depicted embodiment, the lining 122 is typically 10 mm and preferably between 8 and 12 mm. Further, the lining 122, typically comprises a material selected from the group consisting of: stainless steel, titanium and Hastelloy™. By selecting different material for the lining 122, the material of the interior of the heat exchanger being exposed to the heat transfer fluids may be tailored. The lining 122 is typically made of a metal material or a metal comprising material. In this way, the same type of separate plates 112a, 112b, 112c, 112d, 112e may be used with linings of different materials so as to account for example corrosive heat transfer fluids or excessive heat.

[0055] It is to be noted that the other side panels 108b, 108c, 108d of the depicted enclosure 102 are typically also provided by a corresponding lining, not shown. The lining of the other side panels 108b, 108c, 108d is hence omitted in Fig. 2 in order to make Fig. 2 more clear. On

the other hand, if one or some of the side panels 108a, 108b, 108c, 108d are not divided into separate plates 112a, 112b, 112c, 112d, 112e, the lining may be omitted at the non-divided side panel or side panels. The lining 122 may even be omitted at the divided side panel or side panels. The lining 122 is thus optional and may be omitted.

[0056] The depicted lining 122 of the side panel 108a is clamped between the side panel 108a and the two associated corner girders 110a, 110b, the top head 104 and the bottom head 106 respectively. The clamping of the lining 122 will be described in more detail below with reference to Figs. 2, 3 and 4.

[0057] Each of the two depicted corner girders 110a, 110b associated with the divided side panel 108a is provided with a longitudinally extending notch 123. The notch 123, as seen in a cross-section across the longitudinal direction L, is positioned at a corner of the two corner girders 110a, 110b formed by the surface of the respective corner girder 110a, 110b facing the side panel 108a and the surface of the respective corner girder 110a, 110b facing the other corner girder 110a, 110b. The notch 123 extends along the longitudinal direction L from an interface between the top head 104 and the corner girder 110a, 110b to an interface between the bottom head 106 and the corner girder 110a, 110b. In other words, the notch 123 extends along the entire length of the two corner girders 110a, 110b associated with the divided side panel 108a. The longitudinally extending notch 123 together with the separate plates 112a, 112b, 112c, 112d, 112e of the side panel 108a forms a groove when the separate plates 112a, 112b, 112c, 112d, 112e of the side panel 108a are mounted to the two corner girders 110a, 110b. Hence, the groove so formed at each of the two corner girders 110a, 110b extends along the longitudinal direction L of the heat exchanger 100 and enclosure 102. The groove is configured to receive and clamp an edge portion of the lining 122 in the sense that the lining 122 is clamped or pressed between the corner girders 110a, 110b and the separate plates 112a, 112b, 112c, 112d, 112e of the side panel 108a, such that the lining 122 is fixed with respect to the corner girders 110a, 110b and the separate plates 112a, 112b, 112c, 112d, 112e of the side panel 108a. The notch 123 is optional and may be omitted.

[0058] Similarly, the bottom head 106 is in the depicted embodiment, on an edge surface facing the divided side panel 108a, provided with a notch 124 extending in a transverse direction along the edge surface. The notch 124, as seen in a cross-section across the transverse direction, is positioned at a corner formed by the edge surface and an internally facing major surface of the bottom head 106. The notch 124 extends from an interface between the lowermost separate plate 112a and a first 110a of the two associated corner girders 110a, 110b and an interface between the lowermost separate plate 112a and a second one 110b of the two associated corner girders 110a, 110b. In other words, the notch 124 extends

along the entire upper edge of the bottom head 106. The notch 124 forms together with the lowermost separate plate 112a a groove when the plate 112a is mounted to the bottom head 106 and the two corner girders 110a, 110b. The groove so formed extends along the transverse direction and is configured to receive and clamp an edge portion of the lining 122 in the sense that the lining 122 is clamped or pressed between the bottom head 106 and the separate plate 112a of the side panel 108a, such that the lining 122 is fixed with respect to the bottom head 106 and the separate plate 112a of the side panel 108a. The notch 124 is optional and may be omitted.

[0059] A corresponding notch 125 is provided at the top head 104 in the depicted embodiment. The notch 125 forms a together with the uppermost separate plate 112e a corresponding groove when the plate 112e is mounted to the top head 104 and the two corner girders 110a, 110b. The groove so formed extends along the transverse direction and is configured to receive and clamp an edge portion of the lining 122 in the sense that the lining 122 is clamped or pressed between the top head 104 and the separate plate 112e of the side panel 108a, such that the lining 122 is fixed with respect to the top head 104 and the separate plate 112e of the side panel 108a. The notch 125 is optional and may be omitted.

[0060] Hence, the lining 122 may be fixed to the side panel 108a and the enclosure by the respective grooves formed by the respective notches 123, 124, 125, when the separate plates 112a, 112b, 112c, 112d, 112e of the side panel 108a are mounted to the two corner girders 110a, 110b, the top head 104 and the bottom head 106. The lining 122 may thus form a fluid tight joint between the separate plates 112a, 112b, 112c, 112d, 112e of the side panel 108a, the two corner girders 110a, 110b, the top head 104 and the bottom head 106.

[0061] It is to be understood that corresponding arrangements for clamping or fixing liners to the other side panels 108b, 108c, 108d may be made. This will not be discussed any further to avoid undue repetition.

[0062] A gasket, not shown, may be provided in the respective grooves formed by the respective notches 123, 124, 125.

[0063] In the following it will be described in greater detail how the enclosure 102 is formed of the top head 104, the bottom head 106, the four side panels 108a, 108b, 108c, 108d and the four corner girders 110a, 110b, 110c, 110d, and how the respective parts are designed such that the enclosure 102 exhibits a desired mechanical strength to e.g. withstand the pressure of the heat exchanging fluids.

[0064] The formation of the enclosure will be described with reference to Figs. 2, 3 and 4 and it will be discussed how the side panel 108a with the separate plates 112a, 112b, 112c, 112d, 112e is mounted or fixed to the two corner girders 110a, 110b, the top head 104 and the bottom head 106 so as to form part of the enclosure 102. It is to be understood that corresponding arrangements for mounting the other side panels 108b, 108c, 108d to the

corner girders 110a, 110b, 110c, 110d, the top head 104 and the bottom head 106 of the depicted embodiment may be made. This will however not be discussed any further to avoid undue repetition.

[0065] Each of the two corner girders 110a, 110b of the depicted embodiment associated with the divided side panel 108a is provided with a first, transversely protruding, shoulder portion 128. The first shoulder portion 128 of the respective two corner girders 110a, 110b is adapted to interact with the uppermost or first separate plate 112e of the divided side panel 108a.

[0066] Further, each of the two corner girders 110a, 110b of the depicted embodiment associated with the divided side panel 108a is provided with a second, transversely protruding, shoulder portion 130. The second shoulder portion 130 of the respective two corner girders 110a, 110b is adapted to interact with the second or lowermost separate plate 112a of the divided side panel 108a.

[0067] The first shoulder portion 128 includes a first abutment surface 128a. The first abutment surface 128a extends in a direction transverse to the longitudinal direction L and faces the second shoulder portion 130. In other words, the first abutment surface 128a faces downwards in Fig. 4.

[0068] The second shoulder portion 130 includes a second abutment surface 130a. The second abutment surface 130a extends in a direction transverse to the longitudinal direction L and faces the first shoulder portion 128. In other words, the second abutment surface 130a faces upwards in Fig. 3.

[0069] The uppermost separate plate 112e of the depicted embodiment comprises two abutment surfaces 129a, as depicted in Fig. 2. Each of the two abutment surfaces 129a extends in a direction transverse to the longitudinal direction L and faces away from the uppermost separate plate 112e. The two abutment surfaces 129a are configured to interact with the respective first abutment surface 128a of the two associated corner girders 110a, 110b. The respective first abutment surface 128a of the two associated corner girders 110a, 110b will thus contact the two abutment surfaces 129a of the uppermost separate plate 112e when the uppermost separate plate 112e is mounted to the two associated corner girders 110a, 110b. This arrangement will consequently counteract movement of the uppermost separate plate 112e in an upward direction along the longitudinal direction L when the uppermost separate plate 112e is pushed upwards along the longitudinal direction L owing from e.g. pressure in the enclosure 102. The interaction between the abutment surfaces 128a, 129a will consequently result in a mechanical stress along the two corner girders 110a, 110b associated with the divided side panel 108a.

[0070] Correspondingly, the lowermost separate plate 112a of the depicted embodiment comprises two abutment surfaces 131 a, as depicted in Fig. 3. Each of the two abutment surfaces 131 a extends in a direction transverse to the longitudinal direction L and faces away from

the lowermost separate plate 112a. The two abutment surfaces 131 a are configured to interact with the respective second abutment surface 130a of the two associated corner girders 110a, 110b. The respective second abutment surface 130a of the two associated corner girders 110a, 110b will thus contact the two abutment surfaces 131 a of the lowermost separate plate 112a when the lowermost separate plate 112a is mounted to the two associated corner girders 110a, 110b. This arrangement will consequently correspondingly counteract movement of the lowermost separate plate 112a in a downward direction along the longitudinal direction L when the lowermost separate plate 112a is pushed downwards along the longitudinal direction L owing from e.g. pressure in the enclosure 102. The interaction between the abutment surfaces 130a, 131 a will consequently result in a mechanical stress of the two corner girders 110a, 110b associated with the divided side panel 108a.

[0071] The first abutment surface 128a of the first shoulder portion 128 and the second abutment surface 130a of the second shoulder portion 130 are in the depicted embodiment planar in cross section. Further, the abutment surfaces 128a, 130a both have normal directions being parallel to the longitudinal direction L. The normal direction of abutment surfaces 128a points downwards in Fig. 4, whereas the normal direction of abutment surfaces 130a points upwards in Fig. 3.

[0072] The two abutment surfaces 129a of the uppermost or first separate plate 112e and the two abutment surfaces 131 a of the lowermost or second separate plate 112a are in the depicted embodiment planar in cross section, like the abutment surfaces 128a, 130a of the two corner girders 110a, 110b. Further, the abutment surfaces 129a, 131 a both have normal directions being parallel to the longitudinal direction L. The normal direction of abutment surfaces 129a points downwards in Fig. 2, whereas the normal direction of abutment surfaces 131 a points upwards in Fig. 3.

[0073] By providing planar abutment surfaces 128a, 129a, 130a, 131 a an efficient interaction of transfer of forces may be realized between the respective abutment surfaces 128a, 129a, 130a, 131 a. It is however to be noted that inclined, wavy, keyed or toothed abutment surfaces may be used to give a few non-limiting examples. In other words, any type of abutment surfaces may be used as long as the abutment surfaces are capable of interacting so as to transfer forces between them.

[0074] As an alternative, each of the two corner girders 110a, 110b associated with the divided side panel 108a may be provided with first and second, shoulder portions in form of internal surfaces of a recess or cut, not shown, provided on each of the two corner girders 110a, 110b. In other words, the abutment surfaces of the two corner girders 110a, 110b may be provided as internal surfaces of a recess or cut provided on each of the two corner girders 110a, 110b. When the abutment surfaces of the two corner girders 110a, 110b are provided as internal surfaces of a recess or cut provided on each of the two

corner girders 110a, 110b, the abutment surfaces of the uppermost separate plate 112e and the lowermost separate plate 112a may advantageously be provided as external surfaces of a respective protrusion, not shown, provided on each of the uppermost separate plate 112e and the lowermost separate plate 112a. The external surface of the respective protrusion may thus interact with the internal surface of the respective recesses so as to transfer forces. Consequently, this arrangement of the abutment surfaces, also allows for efficient transfer of forces although being slightly differently crafted.

[0075] As a further example, each of the two corner girders 110a, 110b associated with the divided side panel 108a may be provided with first and second, shoulder portions in form of internal surfaces of a respective recess, not shown, provided on each of the two corner girders 110a, 110b. In other words, the abutment surfaces of the two corner girders 110a, 110b may be provided as internal surfaces of a recess or groove provided on each of the two corner girders 110a, 110b. When the abutment surfaces of the two corner girders 110a, 110b are provided as an internal surface of a respective recess provided on each of the two corner girders 110a, 110b, the abutment surfaces of the uppermost separate plate 112e and the lowermost separate plate 112a may advantageously be provided as an external surface of a respective key or tongue, not shown, arranged in a recess or groove, not shown, provided on each of the uppermost separate plate 112e and the lowermost separate plate 112a. In other words, the two corner girders 110a, 110b, the uppermost separate plate 112e and the lowermost separate plate 112a may be provided with transversal grooves or recesses in which a key or tongue may be provided. Also this alternative arrangement of the abutment surfaces, allows for efficient transfer of forces although being slightly differently crafted.

[0076] As depicted in Fig. 4, the top head 104 may be provided with an elongated protrusion 132 extending in a direction transverse to the longitudinal direction L. The depicted elongated protrusion 132 faces the uppermost or first separate plate 112e. The uppermost separate plate 112e may be provided with a corresponding groove 133 as depicted in Fig. 2. The depicted groove 133 is formed so as to interact with the elongated protrusion 132. The interaction between the elongated protrusion 132 and the groove 133 will, thus counteract movement of the plate 112e in the longitudinal direction L. The enclosure 102 will thus become stronger, and at the same time mounting of the plate 112e will be facilitated as the plate 112e will be counteracted from moving during mounting, e.g. when being bolted to the top head 104 and the two corner girders 110a, 110b.

[0077] As depicted in Fig. 3, the bottom head 106 may be provided with an elongated protrusion 134 extending in a direction transverse to the longitudinal direction L. The depicted elongated protrusion 134 faces the lowermost or second separate plate 112a. The lowermost separate plate 112a may be provided with a corresponding

groove 135 as depicted in Fig. 3. The groove 135 is formed so as to interact with the elongated protrusion 134. The interaction between the elongated protrusion 134 and the groove 135 will, thus counteract movement of the plate 112a in the longitudinal direction L. The enclosure 102 may thus become stronger, and at the same time mounting of the plate 112a may be facilitated as the plate 112a may be counteracted from moving during mounting, e.g. when being bolted to the top head 104 and the two corner girders 110a, 110b.

[0078] Further, as depicted in Figs. 3 and 4, each of the two corner girders 110a, 110b associated with the divided side panel 108a may be provided with an elongated protrusion 136. The depicted protrusions 136 extends in the longitudinal direction L and faces the uppermost separate plate 112e and the lowermost separate plate 112a. The uppermost or first separate plate 112e and the lowermost or second separate plate 112a may be provided with corresponding grooves 137. The grooves 137 of the plates 112a, 112e may be arranged to interact with the elongated protrusion 136 of each of the two corner girders 110a, 110b. Also the separate plates 112b, 112c, 112d, may be provided with corresponding grooves 137. The depicted grooves 137 of the plates 112b, 112c, 112d may also be arranged to interact with the elongated protrusion 136 of each of the two corner girders 110a, 110b. The enclosure 102 may thus become stronger, and at the same time mounting of the separate plates 112a, 112b, 112c, 112d, 112e may be facilitated as the plates 112a, 112b, 112c, 112d, 112e may be counteracted from moving during mounting, e.g. when being bolted to the top head 104, the bottom head 106 and the two corner girders 110a, 110b.

[0079] Each of the two corner girders 110a, 110b associated with the divided side panel 108a may be provided with, at a first end facing the top head 104, a first protrusion 140 extending towards the top head 104 as depicted in Fig. 4. The first depicted protrusion 140 is provided at an inner corner of the first end of the two corner girders 110a, 110b. The top head 104 may be provided with, at respective outer corners facing the respective first ends of the girders 110a, 110b, a first protrusion 142 extending towards the first end of the respective girder 110a, 110b. The respective first protrusions 140 of each of the two associated corner girders 110a, 110b may be configured to interact with the respective first protrusions 142 of the top head. By this arrangement, movement of the corner girders 110a, 110b in an outward direction may be counteracted. The enclosure 102 may thus be made stronger and capable of handling higher pressures.

[0080] Correspondingly, each of the two corner girders 110a, 110b associated with the divided side panel 108a may be provided with, at a second end facing the bottom head 106, a second protrusion, not shown, extending towards the bottom head 106. The second protrusion may then correspondingly be provided at an inner corner of the second end of the two corner girders 110a, 110b.

The bottom head 106 may then advantageously be provided with, at respective outer corners facing the respective second ends of the girders 110a, 110b, a second protrusion, not shown, extending towards the second end of the respective girder 110a, 110b. The respective second protrusions of each of the two associated corner girders 110a, 110b may thus correspondingly be configured to interact with the respective second protrusions of the bottom head 106. The enclosure 102 may thus be made stronger and capable of handling higher pressures.

[0081] The person skilled in the art realizes that the present inventive concept by no means is limited to the preferred embodiment described above. On the contrary, many modifications and variations are possible within the scope of the appended claims.

[0082] Additionally, variations to the disclosed embodiments can be understood and effected by the skilled person in practicing the claimed inventive concept, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

Claims

1. Plate heat exchanger (100) comprising a top head (104), a bottom head (106), four side panels (108a, 108b, 108c, 108d), and four corner girders (110a, 110b, 110c, 110d), wherein the side panels (108a, 108b, 108c, 108d) and the corner girders (110a, 110b, 110c, 110d) extend along a longitudinal direction (L) from the bottom head (106) to the top head (104), wherein each side panel (108a, 108b, 108c, 108d) is associated with two corner girders (110a, 110b, 110c, 110d), wherein the top head (104), the bottom head (106), the four side panels (108a, 108b, 108c, 108d) and the four corner girders (110a, 110b, 110c, 110d) are bolted together to form a sealed enclosure (102) for housing a pack of heat exchanging plates,
characterised in
that at least one of the side panels (108a, 108b, 108c, 108d) is divided into at least two separate plates (112a, 112b, 112c, 112d, 112e) arranged one after another along the longitudinal direction (L), wherein the at least two separate plates (112a, 112b, 112c, 112d, 112e) include a first separate plate (112e) being adapted to be bolted to the top head (104) and a second separate plate (112a) being adapted to be bolted to the bottom head (106).
2. Plate heat exchanger (100) according to claim 1, further comprises a lining (122) covering an internal surface area of the divided side panel (108a) thereby

providing a closed internal surface area of the side panel (108a) being divided into two or more separate plates (112a, 112b, 112c, 112d, 112e) arranged one after another along the longitudinal direction (L).

3. Plate heat exchanger (100) according to claim 1 or 2, wherein the first separate plate (112e) is provided with an opening (118) extending through the plate (112e) for providing a channel for a flow of heat transfer medium through the first plate (112e), and/or wherein the second separate plate (112a) is provided with an opening extending through the plate (112a) for providing a channel for a flow of heat transfer medium through the second plate (112a).
4. Plate heat exchanger (100) according to any one of the previous claims, wherein the first separate plate (112e) is provided with bolt holes (114) along first, second and third edges (116a, 116b, 116c) and is adapted to be bolted to the top head (104) along a first edge (116a) and adapted to be bolted to two associated corner girders (110a, 110b) along second and third edges (116b, 116c) of the first separate plate (112e), wherein a fourth edge (116d) of the first separate plate (112e) is free from bolt holes, and wherein the second separate plate (112a) is provided with bolt holes (114) along first, second and third edges (116a, 116b, 116c) and is adapted to be bolted to the bottom head (106) along a first edge (116a) and adapted to be bolted to the two associated corner girders (110a, 110b) along second and third edges (116b, 116c) of the second separate plate (112a), wherein a fourth edge (116d) of the second separate plate (112a) is free from bolt holes.
5. Plate heat exchanger (100) according to any one of the previous claims, wherein at least one of the side panels (108a) is divided into at least three separate plate modules (112a, 112b, 112c, 112d, 112e) arranged one after another along the longitudinal direction (L).
6. Plate heat exchanger (100) according to claim 5, wherein a third separate plate module (112b, 112c, 112d), arranged between the first and the second plate modules (112e, 112a) in the longitudinal direction (L), is adapted to be bolted to two associated corner girders (110a, 110b) without being bolted to the top head (104) or bottom head (106).
7. Plate heat exchanger (100) according to any one of the previous claims, wherein at a first side a separate plate (112e) being provided with a channel for a flow of heat transfer medium through the plate (112e) has a first thickness and wherein at the first side a separate plate (112a, 112b, 112c, 112d) not being provided with a channel for a flow of heat transfer medium through the plate (112a, 112b, 112c, 112d) has

a second thickness, wherein the first thickness is greater than the second thickness.

8. Plate heat exchanger (100) according to claim 7, wherein the first thickness is at least 110%, preferably at least 120% of the second thickness. 5
9. Plate heat exchanger (100) according to any one of claims 3-8, wherein at least the side panel (108a) or side panels (108a, 108b, 108c) being provided with an opening (118) extending through the respective side panel (108a, 108b, 108c) for providing a channel for a flow of heat transfer medium through the side panel (108a, 108b, 108c), is divided into two or more separate plates (112a, 112b, 112c, 112d, 112e) arranged one after another along the longitudinal direction (L). 10
10. Plate heat exchanger (100) according to any one of claims 2-9, wherein each of the two corner girders (110a, 110b) associated with the divided side panel (108a) is provided with a longitudinally extending notch (123), wherein the notch (123), as seen in a cross-section across the longitudinal direction (L), is positioned at a corner formed by a surface facing the side panel (108a) and a surface facing the other corner girder (110a, 110b), wherein the notch (123) extends along the longitudinal direction from an interface between the top head (104) and the corner girder (110a, 110b) to an interface between the bottom head (106) and the corner girder (110a, 110b), wherein the longitudinally extending notch (123) together with the separate plates (112a, 112b, 112c, 112d, 112e) of the side panel (108a) form a groove extending along the longitudinal direction (L), the groove being configured to receive and clamp an edge portion of the lining (122). 20
11. Plate heat exchanger (100) according to any one of claims 2-10, wherein the top head (104) is, on an edge surface facing the divided side panel (108a), provided with a notch (125) extending in a transverse direction along the edge surface, wherein the notch (125), as seen in a cross-section across the transverse direction, is positioned at a corner formed by the edge surface and an internally facing major surface of the top head (104), wherein the notch (125) extends from an interface between the first separate plate (112e) and a first of the two associated corner girders (110a, 110b) and an interface between the first separate plate (112e) and a second one of the two associated corner girders (110a, 110b), wherein the notch (125) extending in a transverse direction together with the first separate plate (112e) forms a groove extending along the transverse direction, the groove being configured to receive and clamp an edge portion of the 40

lining (122).

12. Plate heat exchanger (100) according to any one of claims 2-11, wherein the bottom head (106) is, on an edge surface facing the divided side panel (108a), provided with a notch (124) extending in a transverse direction along the edge surface, wherein the notch (124), as seen in a cross-section across the transverse direction, is positioned at a corner formed by the edge surface and an internally facing major surface of the bottom head (106), wherein the notch (124) extends from an interface between the second separate plate (112a) and a first of the two associated corner girders (110a, 110b) and an interface between the second separate plate (112a) and a second one of the two associated corner girders (110a, 110b), wherein the notch (124) extending in a transverse direction together with the second separate plate (112a) forms a groove extending along the transverse direction, the groove being configured to receive and clamp an edge portion of the lining (122). 5
13. Plate heat exchanger (100) according to any one of claims 2-12, wherein the lining (122) has a thickness between 2 and 15 mm, preferably between 5 and 15 mm, more preferred between 8 and 12 mm, and preferably comprise stainless steel or titanium. 25
14. Plate heat exchanger (100) according to any one of the previous claims, wherein each of the two corner girders (110a, 110b) associated with the divided side panel (108a) is provided with a first, transversely protruding, shoulder portion (128) adapted to interact with the first separate plate (112e) and a second, transversely protruding, shoulder portion (130) adapted to interact with the second separate plate (112a), wherein the first shoulder portion (128) comprises a first abutment surface (128a) having an extension in a direction transverse to the longitudinal direction and facing the second shoulder portion (130), wherein the second shoulder portion (130) comprises a second abutment surface (130a) having an extension in a direction transverse to the longitudinal direction (L) and facing the first shoulder portion (128), wherein the first separate plate (112e) comprises two abutment surfaces (129a), each having an extension in a direction transverse to the longitudinal direction (L) and facing away from the second separate plate (112a), the two abutment surfaces (129a) being configured to interact with the respective first abutment surface (128a) of the two associated corner girders (110a, 110b), and wherein the second separate plate (112a) comprises two abutment surfaces (131 a), each having an extension in a direction transverse to the longitudinal 30

direction (L) and facing away from the first separate plate (112e), the two abutment surfaces (131 a) being configured to interact with the respective second abutment surface (130a) of the two associated corner girders (110a, 110b).

5

15. Plate heat exchanger (100) according to claim 14, wherein the first abutment surface (128a) of the first shoulder portion (128), the second abutment surface (130a) of the second shoulder portion (130), the two abutment surfaces (129a) of the first separate plate (112e) and the two abutment surfaces (131 a) of the second separate plate (112a) are planar in cross section and have respective normal directions being parallel to the longitudinal direction (L).

10

15

20

25

30

35

40

45

50

55

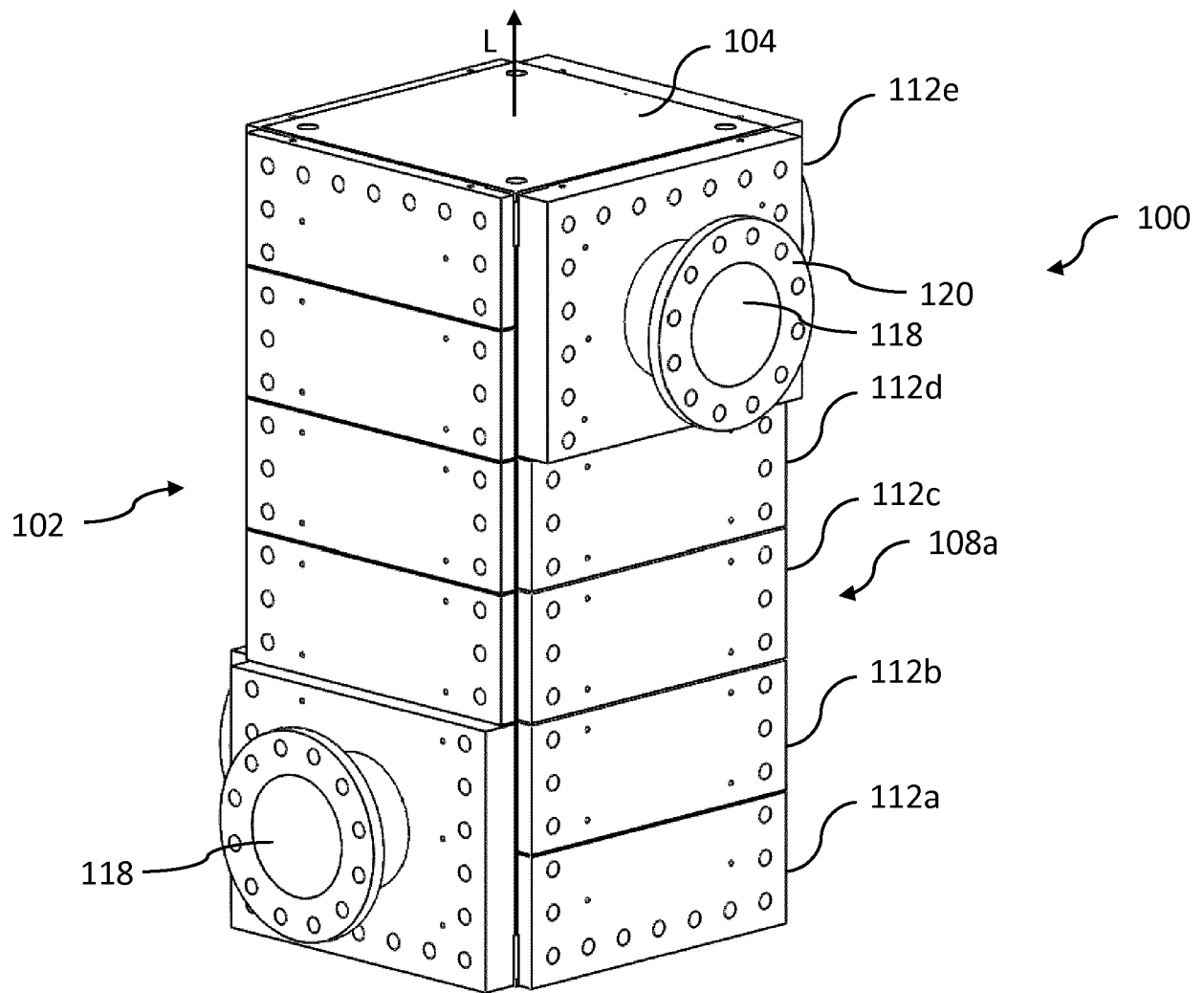
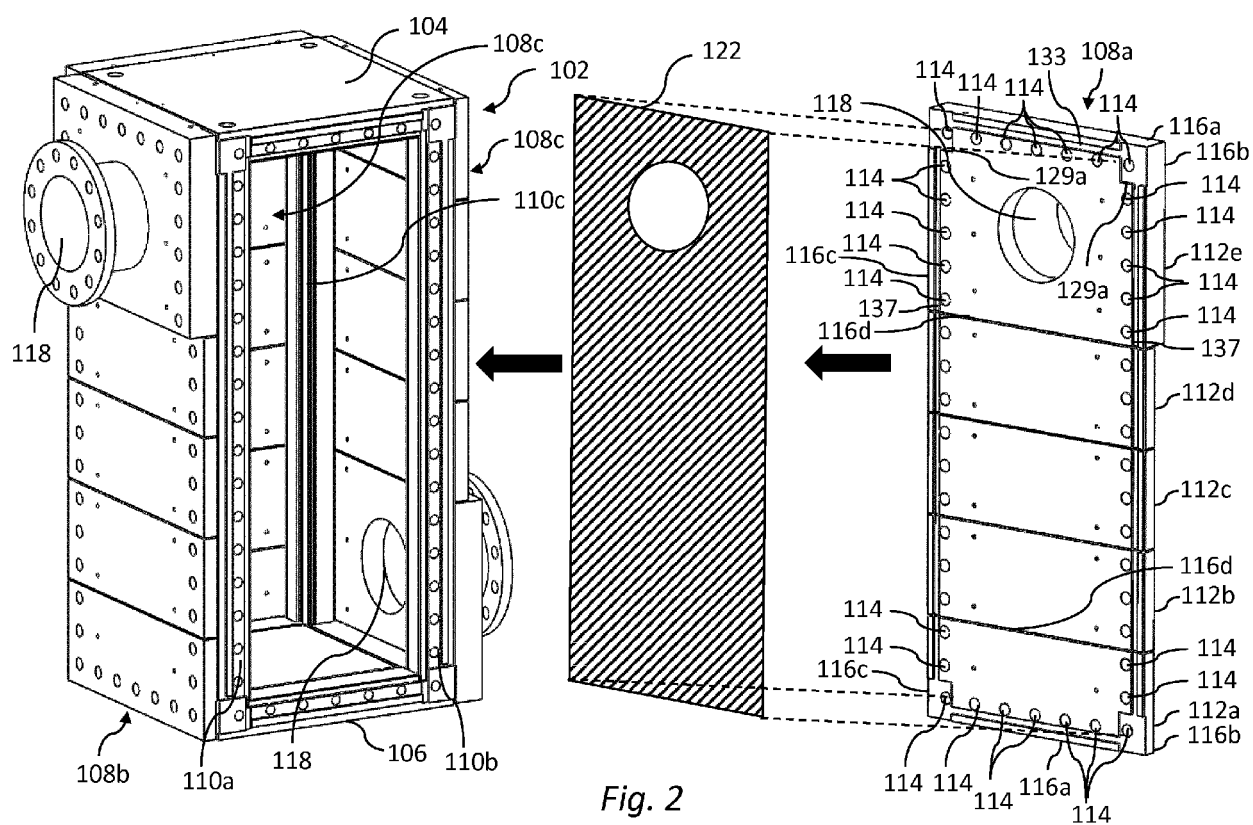


Fig. 1



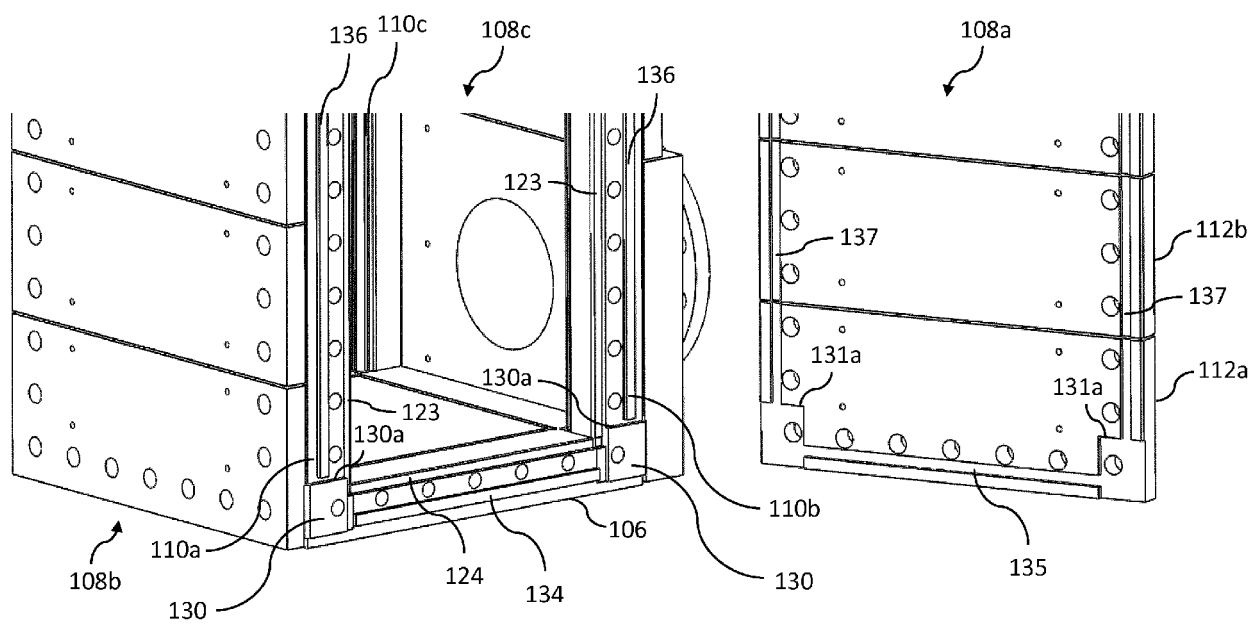


Fig. 3

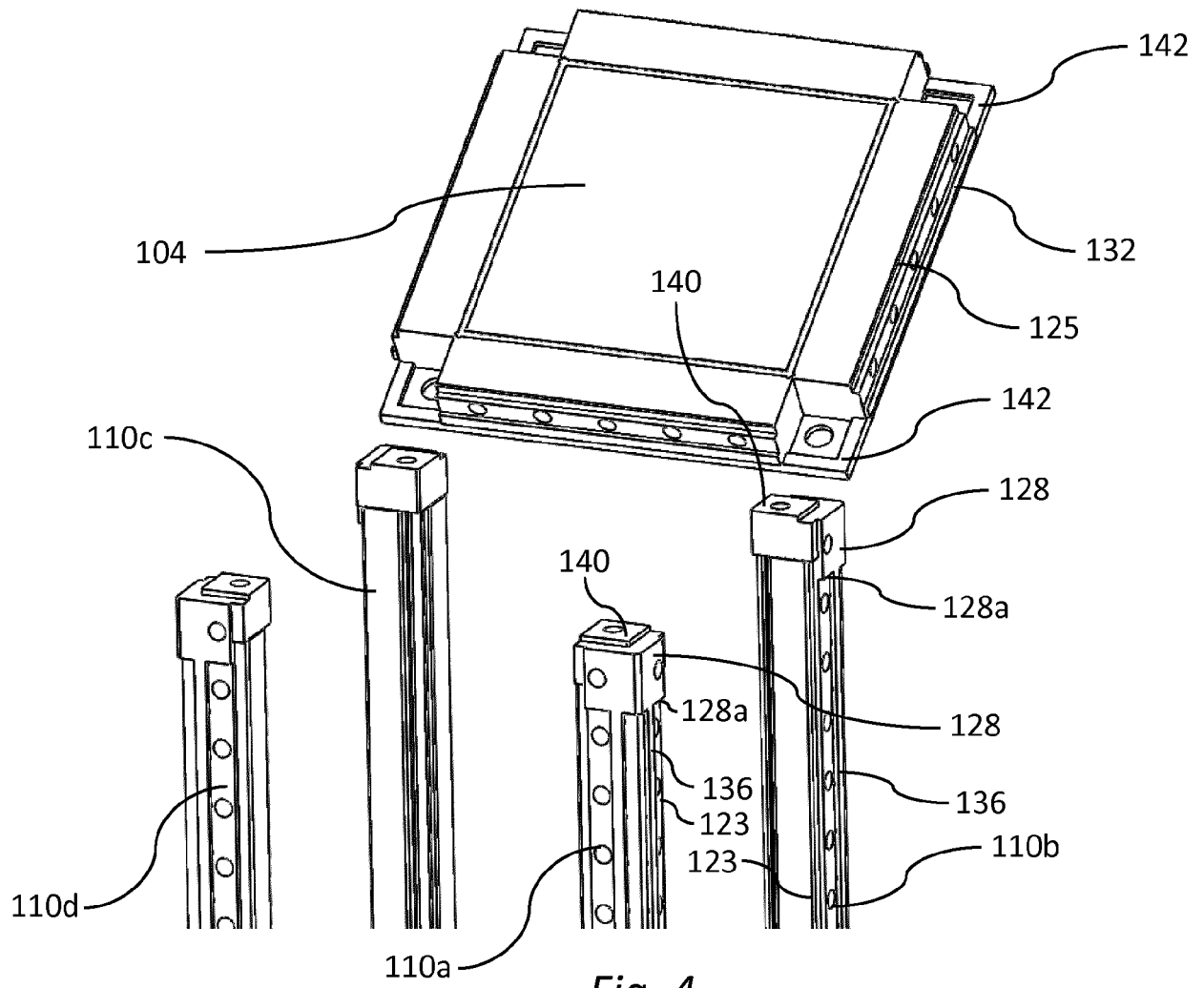


Fig. 4



EUROPEAN SEARCH REPORT

Application Number
EP 17 17 6750

5

10

15

20

25

30

35

40

45

50

55

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	EP 2 672 215 A1 (ALFA LAVAL CORP AB [SE]) 11 December 2013 (2013-12-11) * figure 1 * * paragraph [0017] * * paragraph [0024] *	1-15	INV. F28F9/00 F28D9/00
Y	DE 10 2006 058096 A1 (MODINE MFG CO [US]) 12 June 2008 (2008-06-12) * figure 3 *	1-15	
A	US 2012/000633 A1 (MALUGANI GERARD [FR] ET AL) 5 January 2012 (2012-01-05) * abstract; figures *	1-15	
A	DE 10 2010 046864 A1 (GEA ECOFLEX GMBH [DE]) 29 March 2012 (2012-03-29) * abstract; figures *	1-15	
A	US 2015/136371 A1 (NYANDER ANDERS [SE] ET AL) 21 May 2015 (2015-05-21) * abstract; figures *	1-15	
A	DE 20 2015 106833 U1 (FUNKE WÄRMEAUSTAUSCHER APPBAU GMBH [DE]) 16 March 2017 (2017-03-16) * abstract; figures *	1-15	TECHNICAL FIELDS SEARCHED (IPC) F28F F28D
A	US 2017/023311 A1 (URBANSKI NICHOLAS F [US]) 26 January 2017 (2017-01-26) * abstract; figures *	1-15	
A	US 2006/201660 A1 (WATANABE TARO [JP]) 14 September 2006 (2006-09-14) * abstract; figures *	1-15	
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 1 November 2017	Examiner Fernandez Ambres, A
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 17 17 6750

5

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

01-11-2017

10

15

20

25

30

35

40

45

50

55

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 2672215 A1	11-12-2013	CN 104350353 A	11-02-2015
		DK 2672215 T3	08-12-2014
		EP 2672215 A1	11-12-2013
		KR 20150006013 A	15-01-2015
		US 2015096718 A1	09-04-2015
		WO 2013182370 A1	12-12-2013

DE 102006058096 A1	12-06-2008	NONE	

US 2012000633 A1	05-01-2012	CA 2746977 A1	08-07-2010
		CN 102282437 A	14-12-2011
		EP 2376860 A1	19-10-2011
		ES 2583633 T3	21-09-2016
		FR 2939879 A1	18-06-2010
		HU E029704 T2	28-03-2017
		PL 2376860 T3	30-12-2016
		PT 2376860 T	27-07-2016
		US 2012000633 A1	05-01-2012
		WO 2010076477 A1	08-07-2010
		ZA 201104815 B	26-09-2012

DE 102010046864 A1	29-03-2012	DE 102010046864 A1	29-03-2012
		WO 2012041287 A2	05-04-2012

US 2015136371 A1	21-05-2015	AU 2013270820 A1	22-01-2015
		CN 103512419 A	15-01-2014
		CN 203881198 U	15-10-2014
		EP 2672214 A1	11-12-2013
		EP 2856057 A1	08-04-2015
		JP 2015518955 A	06-07-2015
		JP 2017096624 A	01-06-2017
		KR 20150017368 A	16-02-2015
		TW 201413209 A	01-04-2014
		US 2015136371 A1	21-05-2015
		WO 2013182427 A1	12-12-2013

DE 202015106833 U1	16-03-2017	NONE	

US 2017023311 A1	26-01-2017	US 2017023311 A1	26-01-2017
		WO 2017019141 A1	02-02-2017

US 2006201660 A1	14-09-2006	CN 1831460 A	13-09-2006
		JP 4666142 B2	06-04-2011
		JP 2006250373 A	21-09-2006
		KR 20060096949 A	13-09-2006
		TW 200638017 A	01-11-2006

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

01-11-2017

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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

- EP 165179 A [0002]
- EP 639258 A [0002]