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(54) **Plate heat exchanger**

Plattenwärmeaustauscher

Échangeur thermique à plaque

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Description

TECHNICAL FIELD

[0001] The invention relates to a plate heat exchanger comprising a first frame plate, a second frame plate, a first number of side walls and a stack of heat transfer plates each having a center portion and a peripheral portion encircling the center portion. The heat transfer plates are arranged in pairs between the first and second frame plates and essentially parallel thereto. A first flow path for a first fluid is formed between the heat transfer plates of the pairs and a second flow path for a second fluid is formed between the pairs of heat transfer plates. The side walls extend between the first and second frame plates and enclose the stack of heat transfer plates. A first side wall of the side walls, having an inside surface facing the stack of heat transfer plates, is provided with a through hole for draining of a substance from an inside to an outside of the plate heat exchanger. The substance originates from one of the first and second fluids.

BACKGROUND ART

[0002] Today several different types of plate heat exchangers exist, which 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 plates. This certain type of plate heat exchanger is often 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.

[0003] A block-type heat exchanger typically has fluid inlets and fluid outlets arranged on the side panels while baffles are attached to the stack of heat transfer plates for directing fluids back and forth through channels formed between heat transfer plates in the stack of heat transfer plates.

[0004] Since the stack of heat transfer plates is surrounded by the top head, the bottom head and the four side panels, the heat exchanger may withstand high pressure levels in comparison with many other types of plate heat exchangers. Still, the block-type heat exchanger is compact, it has good heat transfer properties and may withstand hard usage without breaking.

[0005] The stack of heat transfer plates is sometimes referred to as a plate pack and has a special, block-like design that is characteristic for block-type heat exchangers. The stack of heat transfer plates is often all-welded and no gaskets are needed between heat transfer plates for proper sealing of flow channels that are formed between the plates. This makes a block-type heat exchanger suitable for operation with a wide range of aggressive fluids, at high temperatures and at high pressures.

[0006] A block-type heat exchanger can be adapted for use as a condenser in which a fluid containing condensable matter is cooled whereby a condensate and a residual fluid are formed. One such condenser as defined in the preamble of claim 1, is described in applicant's patent application US 2008/0196871. It has a lower wall comprising an outlet for draining the condensate to the outside of the plate heat exchanger.

SUMMARY

[0007] An object of the present invention is to provide a plate heat exchanger with an improved capability of draining a fluid from the inside to the outside of the plate heat exchanger as compared to prior art. The basic concept of the invention is provide one of the side walls of the plate heat exchanger with a design that facilitates fluid drainage, i.e. a design that makes the fluid to be drained spontaneously flow towards a draining outlet of the side wall. The plate heat exchanger for achieving the object above is defined in the appended claims and discussed below.

[0008] A plate heat exchanger according to the present invention comprises a first frame plate, a second frame plate, a first number of side walls and a stack of heat transfer plates each having a center portion and a peripheral portion encircling the center portion. The heat transfer plates are arranged in pairs between the first and second frame plates and essentially parallel thereto. A first flow path for a first fluid is formed between the heat transfer plates of the pairs and a second flow path for a second fluid is formed between the pairs of heat transfer plates. The side walls extend between the first and second frame plates and enclose the stack of heat transfer plates. A first side wall of the side walls, having an inside surface facing the stack of heat transfer plates, is provided with a through hole for draining of a substance from an inside to an outside of the plate heat exchanger. The substance originates from one of the first and second fluids. The plate heat exchanger is **characterized in that** at least a first portion of the inside surface of the first side wall is sloping towards the hole for facilitating the draining of the substance. The plate heat exchanger is further characterized in that the first side wall comprises an inner portion and an outer portion, which are separately formed. The inner portion comprises an inner surface and an outer surface, which inner surface is comprised in the inside surface of the first side wall, and the outer portion comprises an inner surface arranged to engage with the outer surface of the inner portion.

[0009] In a block-type heat exchanger as initially described, the first and second frame plates correspond to the top and bottom head, respectively, while the side walls correspond to the side panels.

[0010] Between the heat transfer plates, throughout the stack, channels are formed. The channels form flow paths; every second channel is comprised in the first flow path and the rest of the channels is comprised in the second flow path.

[0011] Heat is transferred between the first and second fluids inside the plate heat exchanger whereby a substance is formed from one of the first and second fluids. This substance can exit the plate heat exchanger through the hole of the first side wall.

[0012] In that the inside surface of the first side wall at least partly is sloping towards the draining hole, the substance is spontaneously fed towards the hole and drained, by gravity, when the plate heat exchanger is essentially horizontally arranged with the first side wall facing the ground.

[0013] Since the first side wall is formed in two pieces, i.e. the inner and outer portions, its field of application is widened in that the characteristics of the inner portion may differ from the characteristics of the outer portion.

[0014] As an example, the inner portion and the outer portion of the first side wall may be made of different materials. This may be advantageous in connection with heat exchanger applications where the first fluid and/or the second fluid and/or the substance formed are corrosive or destructive and only should be in contact with relatively resistant materials. Then, the inner portion may be of a more resistant material than the outside portion. This is economically beneficial in that more resistant materials often are more expensive than less resistant materials. If the first side wall instead was formed in one piece, the complete first side wall would have to be made of a more resistant material which would be relatively costly.

[0015] The outer portion of the first side wall may comprise a recess arranged to receive the inner portion of the first side wall. This design facilitates a correct positioning of the inner portion of the first side wall in the plate heat exchanger.

[0016] The plate heat exchanger may be such that the inner surface of the outer portion and the outer surface of the inner portion of the first side wall are essentially plane. This design enables use of a conventional side panel (possibly machined) as the outer portion and a specifically designed lining as the inner portion, which side panel and lining engage to form the first side wall of the inventive plate heat exchanger.

[0017] The inside surface of the first side wall may comprise a second number of inclined planes sloping towards the hole and adjoining each other along essentially straight lines extending from the hole. Such a design is advantageous in that it is relatively straightforward and hygienic.

[0018] The plate heat exchanger according to the present invention may be adapted for use as a condenser. Then, said one of the first and second fluids contains matter condensable into the substance and the other one is a cooling agent. Then, the substance drained from the plate heat exchanger through the hole of the first side wall is a condensate.

[0019] The plate heat exchanger may comprise a stack in which the heat transfer plates of each pair are permanently joined to each other by two opposing edge plate joints between the peripheral portions of the heat transfer plates of the pair. Additionally or alternatively, each two of the pairs of heat transfer plates may be permanently joined to each other by two opposing edge pair joints between the peripheral portions of the two adjacent heat transfer plates of the different pairs. As compared to a stack of heat transfer plates separated by gaskets, a stack of permanently joined heat transfer plates can be used in connection with higher pressures and higher temperatures, and also in applications involving aggressive media that would destroy the gaskets.

[0020] The above discussed joints can be made by welding. Welded joints are relatively strong. Different welding techniques, such as laser welding and TIG welding, can be used for the different types of joints.

[0021] The plate heat exchanger may be constructed so that the first flow path and the second flow path are essentially transverse in relation to each other.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] The invention will now be described in more detail with reference to the appended schematic drawings, in which

Fig. 1 is an exploded view of a block-type heat exchanger comprising four side walls and a stack of heat transfer plates,
Fig. 2a is a plan view of a part of the stack of heat transfer plates,
Fig. 2b is a cross-sectional view along section A-A of Fig. 2a,
Fig. 2c is a cross-sectional view along section B-B of Fig. 2a,
Fig. 3a is a plan view of a first side wall of the side walls,
Fig. 3b is a cross-sectional view along section A-A of Fig. 3a,
Fig. 3c is a cross-sectional view along section B-B of Fig. 3a,
Fig. 4a is a plan view of an inner portion of the first side wall,
Fig. 4b is a cross-sectional view along section A-A of Fig. 4a,
Fig. 4c is a cross-sectional view along section B-B of Fig. 4a,
Fig. 5a is a plan view of an alternative first side wall,
Fig. 5b is a cross-sectional view along section A-A of Fig. 5a, and
Fig. 5c is a cross-sectional view along section B-B of Fig. 5a.

DETAILED DESCRIPTION

[0023] With reference to Fig. 1 a plate heat exchanger 2 of a block-type is shown. The plate heat exchanger 2 comprises a first frame plate 4, a second frame plate 6 and four side walls 8, 10, 12 and 14 that are bolted together with four corner girders 16 to form a parallelepiped shaped enclosure of the assembled plate heat exchanger 2. In operation, the heat exchanger 2 is arranged to be horizontally positioned such that the side wall 10 is facing the ground and is arranged essentially parallel thereto. Each of the side walls 8, 10, 12 and 14 is composed of an outer portion 8a, 10a, 12a and 14a, respectively, and an inner portion, of which only two, denoted 10b and 12b, can be seen in Fig. 1. The outer portions are each formed of a conventional side panel, i.e. a relatively thick plate of carbon steel. The inner portions each consists of a panel lining of a material that can be chosen after the specific application of the plate heat exchanger 2, more particularly the fluids to be handled by the plate heat exchanger, as will be further discussed below. A stack 18 of aligned essentially rectangular heat transfer plates 20 and two rectangular end plates 22 (of which only one can be seen in Fig. 1) are arranged within the enclosure. The end plates 22 are aligned with the heat transfer plates 20 and arranged at a respective end of the stack 18. Conventional baffles 24 (of which only two can be seen in Fig. 1) are connected to two opposite sides of the stack 18 of heat transfer plates 20. The side walls, heat transfer plates and baffles will be further discussed below.

[0024] Four side linings 26 arranged to face a respective one of the corner girders 16 are arranged at a respective one of the corners of the stack 18. Further, four top linings 28 are arranged to extend between the side linings 26 and between one of the end plates 22 and a respective one of the side walls 8, 10, 12 and 14. Similarly, four bottom linings 30 (of which only two can be seen in Fig. 1) are arranged to extend between the side linings 26 and between the other one of the end plates 22 and a respective one of the side walls 8, 10, 12 and 14. Gaskets (not shown) are provided so as to seal the four spaces defined by the side walls and the linings to make the plate heat exchanger leak proof. Further, the side wall 8 comprises an inlet 32 and an outlet 34 for a first fluid while the side wall 14 has an inlet 36 and the side wall 10 has an outlet 38 for a second fluid.

[0025] The heat transfer plates 20 are all essentially similar and they are arranged in pairs in the stack 18. A pair of heat transfer plates will herein after also be denoted a cassette. Figs. 2a-c illustrate two adjacent cassettes of the stack. As apparent from Figs. 1 and 2a, each of the heat transfer plates has a center portion 40 and a peripheral portion 42 encircling the center portion. The limit between the center and the peripheral portion has been illustrated with a broken line in the figures. The center portion 40 is pressed with a pattern of ridges 44, valleys 46 and grooves 48, as is illustrated in Figs. 2a-c. The peripheral portion 42 comprises a first edge portion 42a, a second edge portion 42b, a third edge portion 42c and a fourth edge portion 42d. Seen from the figure plane of Fig. 2a, the two opposite first and third edge potions 42a and 42c are folded upwards while the two opposite second and fourth edge portions 42b and 42d are folded downwards.

[0026] As mentioned above, and also apparent from the figures, the heat transfer plates are arranged in pairs or cassettes throughout the stack, the number of cassettes being variable in dependence upon the specific application of the plate heat exchanger. Every second heat transfer plate of the stack, hereinafter indicated with"’", is turned, in relation to the rest of the heat transfer plates, hereinafter indicated with " ’’ ", ..., 180° around an axis X which is parallel to a plane of the first and second frame plates 4 and 6, respectively, i.e. the figure plane of Fig. 2a. Further, the stack of heat transfer plates is all-welded. Thereby, in a cassette thus comprising two heat transfer plates 20’ and 20", the second edge portions 42b’ and 42b" of the heat transfer plates are permanently joined along a welded first edge plate joint 50 while the fourth edge portions 42d’ and 42d" of the heat transfer plates are permanently joined along an opposite welded second edge plate joint 52. Further, throughout the stack, the heat transfer plate 20’ of one cassette is permanently joined to the heat transfer plate 20" of an adjacent cassette along a welded first edge pair joint 54 between the third edge portion 42c’ of the heat transfer plate 20’ and the first edge portion 42a" of the heat transfer plate 20" and an opposite welded second edge pair joint 56 between the first edge portion 42a’ of the heat transfer plate 20’ and the third edge portion 42c" of the heat transfer plate 20".

[0027] As apparent from Figs. 2b-c, the plate heat exchanger is so designed that support areas 58 exist between the center portions of the heat transfer plates 20’ and 20" of each of the cassettes. More particularly, the heat transfer plates of a cassette are welded together in these support areas. However, no support areas exist between the center portions of two adjacent heat transfer plates of different cassettes.

[0028] There are a first flow path F1 for a first fluid and a second flow path F2 for a second fluid through the plate heat exchanger 2. The first flow path F1 extends through the inlet 32 of the side wall 8, through the cassettes and through the outlet 34 of the side wall 8. The baffles 24 guide the flow of the first fluid back and forth through the stack 18, as illustrated by the arrows in Fig. 1. Because of the support areas 58 inside the cassettes, the passability through the cassettes is limited, and the first flow path F1 is referred to as an obstructed-flow path. The second flow path F2 extends through the inlet 36 of the side wall 14, between the cassettes and through the outlet 38 of the side wall 10, as illustrated by the arrows in Fig. 1. Since there are no support areas between the center portions of two different cassettes, the passability between the cassettes is unlimited, and the second flow path F2 is referred to as a free-flow path. As apparent from the figures, the first and second flow paths are essentially transverse in relation to each other. The linings 26 seal the corners of the stack 24, which ensures that the two different flow paths F1 and F2 are separated.

[0029] The stack of heat transfer plates is not described in detail herein but in European Patent Application No. 11161423.6, filed on April 7, 2011, and European Patent Application No. 12163320.0 , filed on April 5, 2012, both in the name of Alfa Laval Corporate AB, which applications are incorporated in their entirety herein by this reference.

[0030] The plate heat exchanger 2 is adapted for use as a condenser. Accordingly, the first fluid is a cooling agent while the second fluid is a gas containing matter condensable into a substance. The first and second fluid enters the plate heat exchanger 2 through the inlets 32 and 36, respectively, and flows through the stack of heat transfer plates. Then, the second fluid is cooled by the first fluid whereby a condensate in the form of said substance and a residual gas is formed. Following the first flow path F1, the stack of heat transfer plates is passed through four times. More particularly, the stack of heat transfer plates is divided into four parts through which the first fluid passes in order. When the first fluid exits the fourth and last part of the stack 18, i.e. the part to the left of the left visible baffle 24 of Fig. 1, it flows towards the outlet 34 of the side wall 8 to be fed out of the plate heat exchanger 2. In other words, the outlet 34 is in direct flow communication only with the last part of the stack. On the contrary, following the second flow path F2, the stack is passed through only once. When the condensate and the residual gas exit the stack 18, they flow towards the outlet 38 of the side wall 10 to be fed out of, or drained from, the plate heat exchanger 2. In other words, the outlet 38 is in direct flow communication with the complete stack.

[0031] As discussed above, each of the side walls 8, 10, 12 and 14 is composed of an outer portion in the form of a side panel and an inner portion in the form of a panel lining. Each of the inlets and outlets, 32, 36 and 34, 38, respectively, of the side walls naturally comprises a hole extending through the side wall to feed the first fluid, the second fluid, the residual gas or/and the condensate into and out of the plate heat exchanger. In the figures, only the hole through the side wall 10 is visible and this is denoted 60. The panel linings of the side walls 8, 12 and 14 are each formed as a relatively thin plate of uniform thickness and of a material suitable for the specific application of the plate heat exchanger. The plate is provided with a number of holes corresponding to the total number of inlets and outlets, i.e. holes, of the side wall. The panel linings of the side walls 8, 12 and 14 are attached to the respective side panel in dependence upon the application of the plate heat exchanger. As an example, if the plate heat exchanger is to be used with a pressure along the second flow path F2 that is lower than a pressure outside the plate heat exchanger, the panel lining of the side wall 14 may have to be attached to the corresponding side panel in order not to be sucked towards the stack 18.

[0032] The side wall 10, which is shown in more detail in Figs. 3a-c, is different from the other side walls 8, 12 and 14. Just like the other side walls, the side wall 10 has an inside surface 62, which comprises an inner surface 64 of the panel lining 10b. However, the panel lining 10b, which is shown in more detail in Figs. 4a-c, is not constructed in the same way as the panel linings of the other side walls.

[0033] The panel lining 10b comprises a hole 60', and the side panel 10a comprises a hole 60", forming part of the hole 60 of the side panel 10. The hole 60, and thus the holes 60' and 60", is arranged essentially in a center of the side wall 10, the panel lining 10b and side panel 10a, respectively. The inner surface 64 of the panel lining 10b comprises a rectangular first portion or center portion 64a and a second portion or peripheral portion 64b. The center portion 64a comprises four planes 66 which are inclined towards the hole 60' and joined along four straight lines 68, each line 68 extending from the hole 60' towards a respective outer corner of the center portion 64a. The peripheral portion 64b is formed like a plane frame encircling the center portion 64a and it is adapted to engage with one of the above mentioned (not shown) gaskets.

[0034] An outer surface 70 of the panel lining 10b is essentially flat and arranged to engage with an inner surface 72 of the side panel 10a, which is also essentially flat. More particularly, the inner surface 72 of the side panel 10a forms a bottom of a recess 73 for receiving the panel lining 10b. The recess 73 is surrounded by edge portions 75, in turn provided with apertures 77 for engagement with the corner girders 16, as previously mentioned. The side panels of the side walls 8, 12 and 14 have a similar design.

[0035] As apparent from Figs. 3b-c and Figs. 4b-4c, the panel lining 10b has a varying thickness; close to the edges, the panel lining is relatively thick, as compared to the panel linings of the other side walls 8, 12 and 14, and close to the hole 60' the panel lining is thinner. For the panel lining 10b to fit into the recess 73 of the side panel 10a, the recess 73 is deeper than the recesses of the side walls 8, 12 and 14. Further, as compared to the panel linings of the side walls 8, 12 and 14, the panel lining 10b is relatively heavy. Therefore, in many applications, even applications where the plate heat exchanger is to be used with a pressure along the second flow path F2 that is lower than a pressure outside the plate heat exchanger, it will not be necessary to attach the panel lining 10b to the side wall 10 to avoid that the panel lining is sucked towards the stack 18.

[0036] Returning to the discussion about the use of the plate heat exchanger 2 as a condenser, the second fluid is transformed into a condensate and a residual gas inside the stack. Due to gravity and the horizontal arrangement of the plate heat exchanger 2 as is shown in Fig. 1, the condensate spontaneously flows towards the side wall 10. Since the outlet 38 of the side wall 10 is in flow communication with the stack all across its length, some of the condensate, that is condensate flowing out from a center part of the stack of heat transfer plates, will hit the panel lining 10b relatively close to the hole 60' and the outlet 38 while some of the condensate , that is condensate flowing out from end portions of the stack of heat transfer plates, will hit the panel lining 10b relatively far from the hole 60' and the outlet 38. If the inside surface of the side wall 10 had been flat, proper draining of the condensate from the inside to the outside of the plate heat exchanger 2 could be difficult to achieve. More particularly, there would be a risk of condensate flowing out from the plate stack far from the hole 60' remaining inside the plate heat exchanger. This is highly undesired for some plate heat exchanger applications, such as pharmaceutical applications. By instead designing the inside surface of the side wall 10 sloping, as described above, complete draining of the condensate from the plate heat exchanger is facilitated.

[0037] Figs. 5a-c illustrate an alternative side wall 74 that can replace the above described side wall 10 in an alternative embodiment of the plate heat exchanger according to the present invention. The side wall 74 is not composed of an outer and an inner portion but formed in one single piece. Thus, the side wall 74 is simply composed of a specially designed side panel. It is provided with a centrally arranged hole 76 which is comprised in an outlet, similar to the above described outlet 38, for draining the condensate and the residual gas from the plate heat exchanger. Further, an inside surface 78 of the side wall 74 comprises a rectangular first portion or center portion 78a and a second portion or peripheral portion 78b. The center portion 78a is designed in a similar way as the center portion 64a of the inner surface 64 of the panel lining 10b described above. Thus, the center portion 78a comprises planes 80 which are inclined towards the hole 76 and joined along four straight lines 82, each line 82 extending from the hole 76 towards a respective outer corner of the center portion 78a. The peripheral portion 78b encircles the center portion 78a and is designed like a corresponding peripheral portion of a conventional side panel, i.e. it comprises edge portions 84 provided with apertures 86 for engagement with the corner girders 16, as previously mentioned.

[0038] Thus, the side wall 10 and the side wall 74 are constructed differently but are provided with the same drainage facilitating feature. Regarding the side wall 10, the drainage facilitating feature results from a uniquely formed panel lining that is arranged on the inside of a side panel. Regarding the side wall 74, the drainage facilitating feature results from a unique design of the side panel itself. A two-portion side wall like the side wall 10 is advantageous in that it is very flexible since the panel lining can be exchanged and adapted to the specific plate heat exchanger application. Further, it is economical in that it may comprise a conventional side panel. Another advantage with the two-portion side wall is that the one of the portions can be made of one material while the other portion is made of another material. As an example, if the plate heat exchanger is to be used in an application involving aggressive fluids and/or products resulting from the fluids, the elements of the plate heat exchanger that come into contact with the aggressive fluids or products should be made of a resistant material. Such resistant materials are often much more expensive than carbon steel, which is a common material of side panels. In such case, the inner portion of the side wall can be made of the resistant expensive material while the outer portion is made of less expensive, less resistant material. Naturally, this is economically very beneficial. However, if the side wall instead had been of a single-piece type, the entire side panel would have to be made of the resistant, expensive material.

[0039] The above described embodiments of the present invention should only be seen as examples. A person skilled in the art realizes that the embodiments discussed can be varied and combined in a number of ways without deviating from the inventive conception.

[0040] As an example, the above describe plate heat exchanger or condenser is of a "one-pass" type which means that the stack of heat transfer plates is passed only once when following the flow path of the fluid containing the condensable matter. Further, in such a "one-pass" condenser, the outlet of the condensate and the outlet of the residual fluid is the same and this outlet is arranged on the opposite side wall of the plate heat exchanger as compared to the inlet of the fluid containing the condensable matter. Naturally, the present invention is equally usable in connection with a plate heat exchanger or condenser of "multi-pass" type, like the one described in US 2008/0196871, the document mentioned by way of introduction, which document is incorporated in its entirety herein by this reference. In such a "multi-pass" condenser, the stack of heat transfer plates is passed more than once when following the flow path of the fluid containing the condensable matter. Further, in such a "multi-pass" condenser, the outlet of the condensate may be separate from the outlet of the residual fluid and the outlet of the residual fluid may be arranged, together with inlet of the fluid containing the condensable matter, on the opposite side wall of the plate heat exchanger as compared to the outlet of the condensate.

[0041] As another example, the invention could be used in connection with other types of heat exchangers than all-welded, block-type plate heat exchangers, for example gasketed plate heat exchangers.

[0042] Further, the drainage facilitating feature of the above described side walls results from four planes inclined towards the drainage hole of the side walls. Naturally, a side wall could be formed in many other ways to achieve this feature. As an example, the inside surface of the side wall could comprise more or less than four planes, it could be bowl-shaped or it could comprise different patterns of grooves, all leading to the hole or some of them leading to the hole and others leading to other grooves.

[0043] Also, the above described drainage holes run essentially centrally through the corresponding side walls. Naturally, the hole could be positioned essentially anywhere on the side wall, such as close to an edge thereof.

[0044] Further, in the above described plate heat exchanger, the free-flow path passes between the cassettes while the obstructed-flow path passes through the cassettes. Naturally, it is conceivable to reconstruct the heat transfer plates to have it the opposite way.

[0045] Additionally, other techniques for achieving the above described permanent joints than welding are of course possible. One example is brazing.

[0046] As used above, the term "pair" refers to the heat transfer plates of one cassette. However, "pair" could also be used as a term for two adjacent heat transfer plates forming part of two adjacent but different cassettes.

[0047] The heat transfer plates of the stack above are all essentially similar but they have two different orientations. Naturally, the heat transfer plates of the stack could instead be of different, alternately arranged, types.

[0048] Finally, the above described plate heat exchanger or condenser comprises one obstructed-flow path and one free-flow path. A free-flow path is desired in some plate heat exchanger applications, such as applications with high hygienic demands since a free-flow path is relatively easy to clean, or applications involving fluids containing fibers and solids since a free-flow path is associated with a relatively low risk of plugging. Naturally, the present invention is equally usable in connection with plate heat exchangers comprising no free-flow path.

[0049] It should be stressed that a description of details not relevant to the present invention has been omitted and that the figures are just schematic and not drawn according to scale. It should also be said that some of the figures have been more simplified than others. Therefore, some components may be illustrated in one figure but left out on another figure.

Claims

1. A plate heat exchanger (2) comprising a first frame plate (4), a second frame plate (6), a first number of side walls (8, 10, 12, 14) and a stack (18) of heat transfer plates (20) each having a center portion (40) and a peripheral portion (42) encircling the center portion, the heat transfer plates being arranged in pairs between the first and second frame plates and essentially parallel thereto, a first flow path (F1) for a first fluid being formed between the heat transfer plates of the pairs and a second flow path (F2) for a second fluid being formed between the pairs of heat transfer plates, the side walls extending between the first and second frame plates and enclosing the stack of heat transfer plates, a first side wall (10, 74) of the side walls, having an inside surface (62, 78) facing the stack of heat transfer plates, being provided with a through hole (60, 76) for draining of a substance from an inside to an outside of the plate heat exchanger, said substance originating from one of the first and second fluids, **characterized in that**
   at least a first portion (64a,78a) of the inside surface of the first side wall is sloping towards the hole for facilitating the draining of the substance, and
   the first side wall (10) comprises an inner portion (10b) and an outer portion (10a), which are separately formed, the inner portion comprising an inner surface (64) and an outer surface (70), which inner surface is comprised in the inside surface (62) of the first side wall, and the outer portion comprising an inner surface (72) arranged to engage with the outer surface of the inner portion.

2. A plate heat exchanger (2) according to claim 1, wherein the inner portion (10b) and the outer portion (10a) of the first side wall (10) are made of different materials.

3. A plate heat exchanger (2) according to any of the preceding claims, wherein the outer portion (10a) of the first side wall (10) comprises a recess (73) arranged to receive the inner portion (10b) of the first side wall (10).

4. A plate heat exchanger (2) according to any of the preceding claims, wherein the inner surface (72) of the outer portion (10a) and the outer surface (70) of the inner portion (10b) of the first side wall (10) are essentially plane.

5. A plate heat exchanger (2) according to any of the preceding claims, wherein the inside surface (62, 78) of the first side wall (10, 74) comprises a second number of inclined planes (66, 80) sloping towards the hole (60, 76) and adjoining each other along essentially straight lines (68, 82) extending from the hole.

6. A plate heat exchanger (2) according to any of the preceding claims, adapted for use as a condenser, wherein said one of the first and second fluids contains matter condensable into the substance and the other one is a cooling agent and the flow path of said one of the first and second fluids is in flow communication with the hole (60, 76) of the first side wall (10, 74).

7. A plate heat exchanger (2) according to any one of the preceding claims, wherein the heat transfer plates (20', 20") of each pair are permanently joined to each other by two opposing edge plate joints (50, 52) between the peripheral portions (42) of the heat transfer plates of the pair.

8. A plate heat exchanger (2) according to any of the preceding claims, wherein each two of the pairs of heat transfer plates (20) are permanently joined to each other by two opposing edge pair joints (54, 56) between the peripheral portions (42) of the two ad-

jacent heat transfer plates (20', 20") of the different pairs.

9. A plate heat exchanger (2) according to any of claims 7-8, wherein the joints (50, 52, 54, 56) are made by welding.

10. A plate heat exchanger (2) according to any of the preceding claims, wherein the first flow path (F1) and the second flow path (F2) are essentially transverse in relation to each other.

Patentansprüche

1. Plattenwärmeaustauscher (2), der eine erste Rahmenplatte (4), eine zweite Rahmenplatte (6), eine erste Anzahl von Seitenwänden (8, 10, 12, 14) und einen Stapel (18) von Wärmeübertragungsplatten (20), die jeweils einen Mittenabschnitt (40) und einen Umfangsabschnitt (42), der den Mittelabschnitt umgibt, haben, umfasst, wobei die Wärmeübertragungsplatten in Paaren zwischen der ersten und der zweiten Rahmenplatte und im Wesentlichen parallel zu denselben angeordnet sind, wobei eine erste Strömungsbahn (F1) für ein erstes Fluid zwischen den Wärmeübertragungsplatten der Paare geformt ist und eine zweite Strömungsbahn (F2) für ein zweites Fluid zwischen den Paaren von Wärmeübertragungsplatten geformt ist, wobei sich die Seitenwände zwischen der ersten und der zweiten Rahmenplatte erstrecken und den Stapel von Wärmeübertragungsplatten umschließen, wobei eine erste Seitenwand (10, 74) der Seitenwände eine Innenfläche (62, 78), die zu dem Stapel von Wärmeübertragungsplatten zeigt, hat, wobei sie mit einem Durchgangsloch (60, 76) zum Ablassen einer Substanz aus einem Inneren zu einem Äußeren des Plattenwärmeaustauschers versehen ist, wobei die Substanz aus einem von dem ersten und dem zweiten Fluid stammt, **dadurch gekennzeichnet, dass**
wenigstens ein erster Abschnitt (64a, 78a) der Innenfläche der ersten Seitenwand zu dem Loch hin abfällt, um das Ablassen der Substanz zu erleichtern, und
die erste Seitenwand (10) einen inneren Abschnitt (10b) und einen äußeren Abschnitt (10a), die gesondert geformt sind, umfasst, wobei der innere Abschnitt eine Innenfläche (64) und eine Außenfläche (70) umfasst, wobei die Innenfläche in der Innenfläche (62) der ersten Seitenwand eingeschlossen ist und der äußere Abschnitt eine Innenfläche (72) umfasst, die dafür angeordnet ist, mit der Außenfläche des inneren Abschnitts ineinanderzugreifen.

2. Plattenwärmeaustauscher (2) nach Anspruch 1, wobei der innere Abschnitt (10b) und der äußere Abschnitt (10a) der ersten Seitenwand (10) aus unterschiedlichen Werkstoffen hergestellt sind.

3. Plattenwärmeaustauscher (2) nach einem der vorhergehenden Ansprüche, wobei der äußere Abschnitt (10a) der ersten Seitenwand (10) eine Aussparung (73) umfasst, die dafür angeordnet ist, den inneren Abschnitt (10b) der ersten Seitenwand (10) aufzunehmen.

4. Plattenwärmeaustauscher (2) nach einem der vorhergehenden Ansprüche, wobei die Innenfläche (72) des äußeren Abschnitts (10a) und die Außenfläche (70) des inneren Abschnitts (10b) der ersten Seitenwand (10) im Wesentlichen eben sind.

5. Plattenwärmeaustauscher (2) nach einem der vorhergehenden Ansprüche, wobei die Innenfläche (62, 78) der ersten Seitenwand (10, 74) eine zweite Anzahl von geneigten Ebenen (66, 80) umfasst, die zu dem Loch (60, 76) hin abfallen und entlang im Wesentlichen gerader Linien (68, 82), die sich von dem Loch aus erstrecken, nebeneinander liegen.

6. Plattenwärmeaustauscher (2) nach einem der vorhergehenden Ansprüche, eingerichtet zur Verwendung als ein Kondensator, wobei das eine von dem ersten und dem zweiten Fluid einen Stoff enthält, der in die Substanz kondensieren kann, und das andere ein Kühlmittel ist und die Strömungsbahn des einen von dem ersten und dem zweiten Fluid ist Strömungsverbindung mit dem Loch (60, 76) der ersten Seitenwand (10, 74) steht.

7. Plattenwärmeaustauscher (2) nach einem der vorhergehenden Ansprüche, wobei die Wärmeübertragungsplatten (20', 20") jedes Paares dauerhaft durch zwei gegenüberliegende Kantenplattenverbindungen (50, 52) zwischen den Umfangsabschnitten (42) der Wärmeübertragungsplatten des Paares miteinander verbunden sind.

8. Plattenwärmeaustauscher (2) nach einem der vorhergehenden Ansprüche, wobei jeweils zwei der Paare von Wärmeübertragungsplatten (20) dauerhaft durch zwei gegenüberliegende Kantenpaarverbindungen (54, 56) zwischen den Umfangsabschnitten (42) der zwei benachbarten Wärmeübertragungsplatten (20', 20") der unterschiedlichen Paare miteinander verbunden sind.

9. Plattenwärmeaustauscher (2) nach einem der Ansprüche 7 bis 8, wobei die Verbindungen (50, 52, 54, 56) durch Schweißen hergestellt sind.

10. Plattenwärmeaustauscher (2) nach einem der vorhergehenden Ansprüche, wobei die erste Strömungsbahn (F1) und die zweite Strömungsbahn (F2) im Verhältnis zueinander im Wesentlichen quer gerichtet sind.

Revendications

1. Echangeur thermique à plaques (2), comprenant une première plaque de cadre (4), une deuxième plaque de cadre (6), un premier nombre de parois latérales (8, 10, 12, 14) et une pile (18) de plaques de transfert de chaleur (20), comportant chacune une partie centrale (40) et une partie périphérique (42) encerclant la partie centrale, les plaques de transfert de chaleur étant agencées par paires entre les première et deuxième plaques de cadre et y étant essentiellement parallèles, une première trajectoire d'écoulement (F1) pour un premier fluide étant formée entre les plaques de transfert de chaleur des paires, et une deuxième trajectoire d'écoulement (F2) pour un deuxième fluide étant formée entre les paires de plaques de transfert de chaleur, les parois latérales s'étendant entre les première et deuxième plaques de cadre et renfermant la pile de plaques de transfert de chaleur, une première paroi latérale (10, 74) des parois latérales comportant une surface intérieure (62, 78) faisant face à la pile de plaques de transfert de chaleur, comportant un trou de passage (60, 76) pour drainer une substance d'une partie interne vers une partie externe de l'échangeur thermique à plaques, ladite substance provenant de l'un des premier et deuxième fluides, **caractérisé en ce que**
au moins une première partie (64a, 78a) de la surface intérieure de la première paroi latérale est inclinée vers le trou pour faciliter le drainage de la substance ; et
la première paroi latérale (10) comporte une partie interne (10b) et une partie externe (10a), formées séparément, la partie interne comprenant une surface interne (64) et une surface externe (70), ladite surface interne étant comprise dans la surface intérieure (62) de la première paroi latérale, et la partie externe comprenant une surface interne (72) agencée de sorte à s'engager dans la surface externe de la partie interne.

2. Echangeur thermique à plaques (2) selon la revendication 1, dans lequel la partie interne (10b) et la partie externe (10a) de la première paroi latérale (10) sont composées de matériaux différents.

3. Echangeur thermique à plaques (2) selon l'une quelconque des revendications précédentes, dans lequel la partie externe (10a) de la première paroi latérale (10) comprend un évidement (73), destiné à recevoir la partie interne (10b) de la première paroi latérale (10).

4. Echangeur thermique à plaques (2) selon l'une quelconque des revendications précédentes, dans lequel la surface interne (72) de la partie externe (10a) et la surface externe (70) de la partie interne (10b) de la première paroi latérale (10) sont essentiellement planes.

5. Echangeur thermique à plaques (2) selon l'une quelconque des revendications précédentes, dans lequel la surface intérieure (62, 78) de la première paroi latérale (10, 74) comprend un deuxième nombre de plans inclinés (66, 80), inclinés vers le trou (60, 76) et se rejoignant l'un l'autre le long de lignes essentiellement droites (68, 82) s'étendant à partir du trou.

6. Echangeur thermique à plaques (2) selon l'une quelconque des revendications précédentes, adapté pour servir de condenseur, dans lequel ledit un fluide des premier et deuxième fluides contient des matières pouvant être condensées en la substance, l'autre fluide étant un agent de refroidissement, et la trajectoire d'écoulement dudit un fluide des premier et deuxième fluides étant en communication d'écoulement avec le trou (60, 76) de la première paroi latérale (10, 74).

7. Echangeur thermique à plaques (2) selon l'une quelconque des revendications précédentes, dans lequel les plaques de transfert de chaleur (20', 20") de chaque paire sont reliées de manière permanente l'une à l'autre par deux joints de plaques de bordure opposées (50, 52) entre les parties périphériques (42) des plaques de transfert de chaleur de la paire.

8. Echangeur thermique à plaques (2) selon l'une quelconque des revendications précédentes, dans lequel toutes les deux paires des paires de plaques de transfert de chaleur (20) sont reliées de manière permanente l'une à l'autre par deux joints de paires de bordure opposées (54, 56) entre les parties périphériques (42) des deux plaques de transfert de chaleur adjacentes (20', 20") des différentes paires.

9. Echangeur thermique à plaques (2) selon l'une quelconque des revendications 7 à 8, dans lequel les joints (50, 52, 54, 56) sont formés par soudure.

10. Echangeur thermique à plaques (2) selon l'une quelconque des revendications précédentes, dans lequel la première trajectoire d'écoulement (F1) et la deuxième trajectoire d'écoulement (F2) sont essentiellement transversales l'une à l'autre.

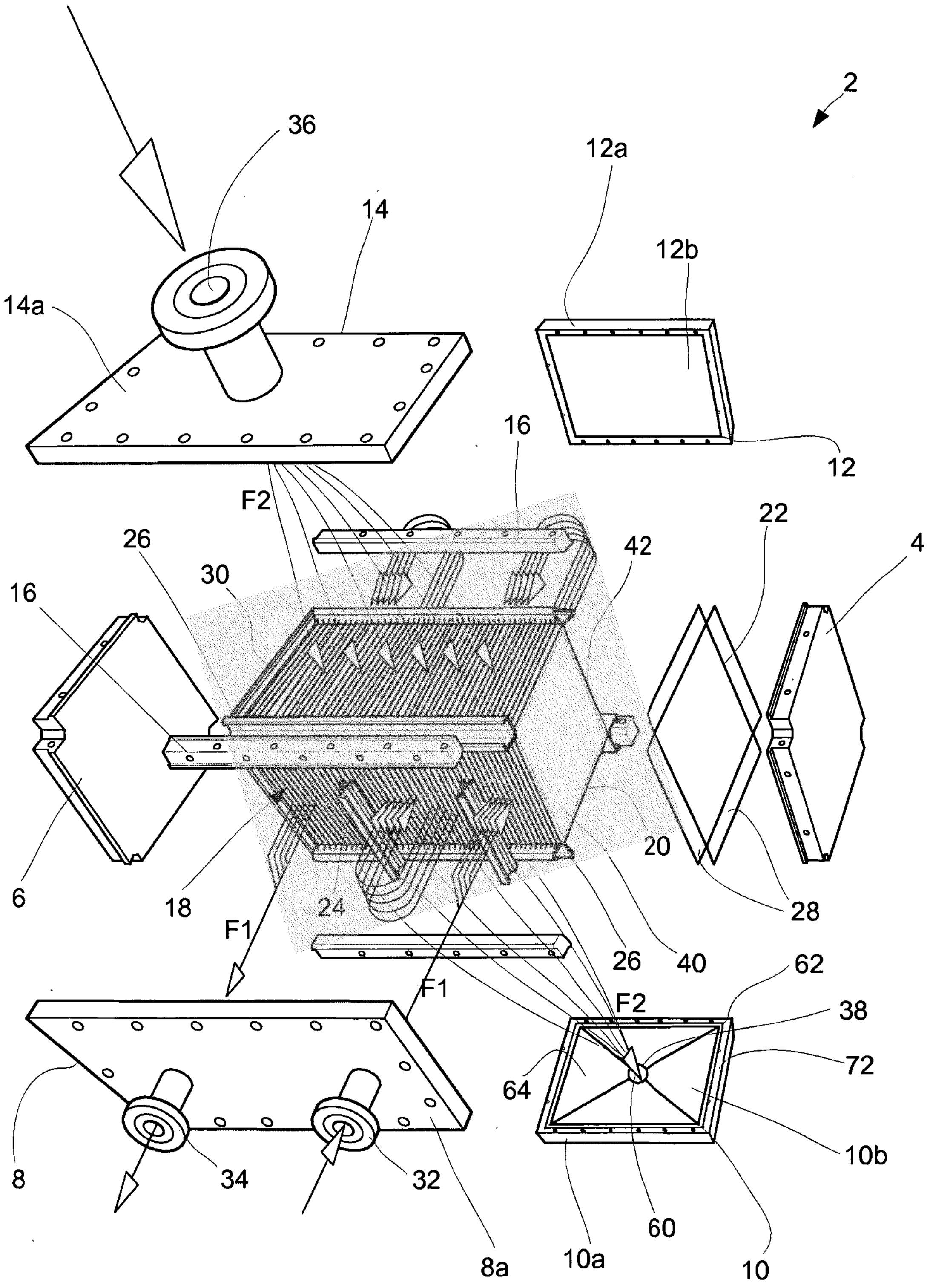

2
36
12a
14
12b
14a
16
12
F2
22
26
42
4
30
16
6
18
20
24
28
F1
26
40
62
F1
F2
38
72
64
8
34
32
10b
60
8a
10a
10

Fig. 1

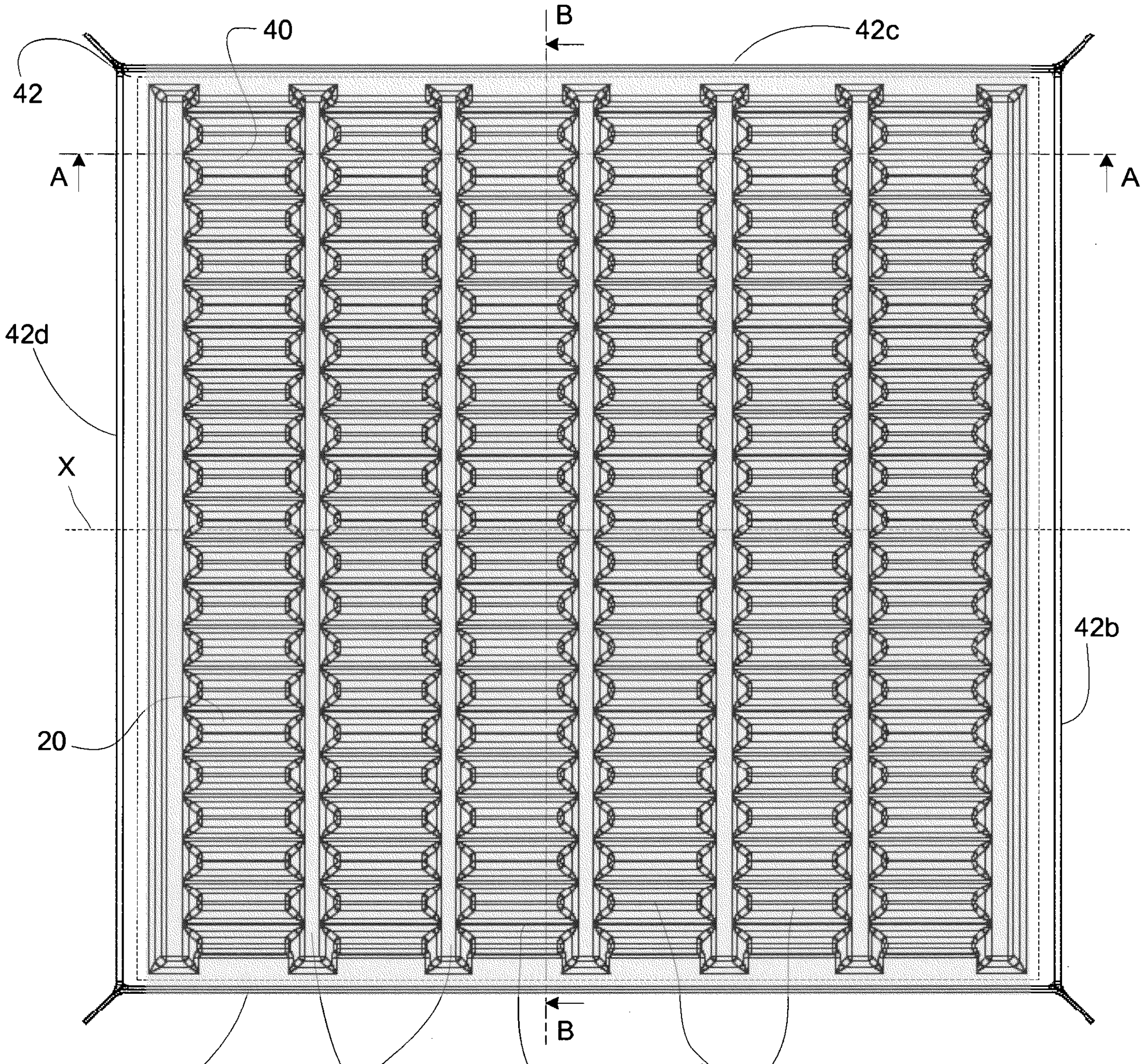


Fig. 2a

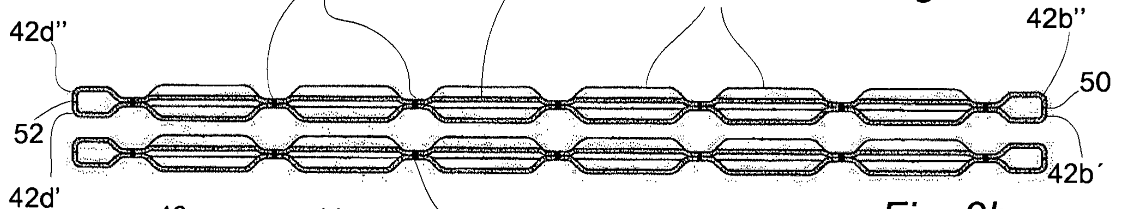


Fig. 2b

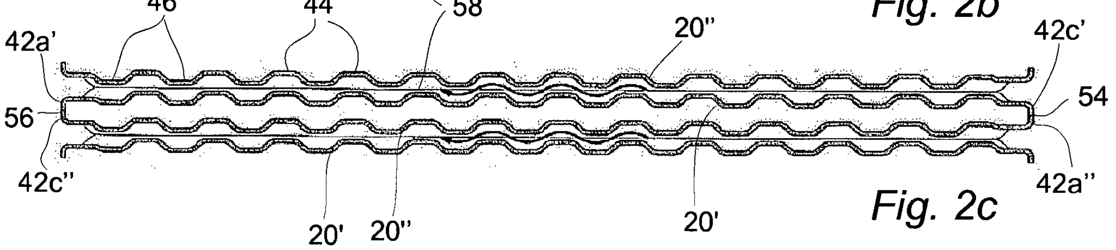


Fig. 2c

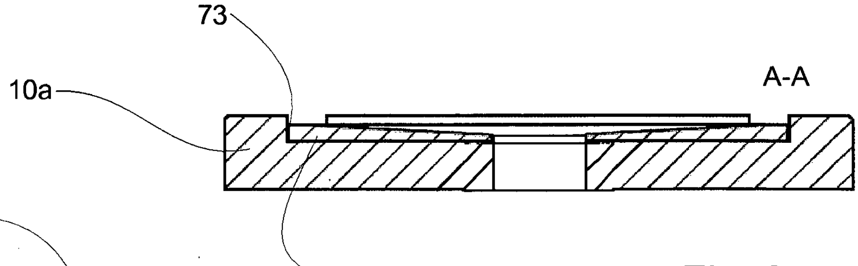


Fig. 3c

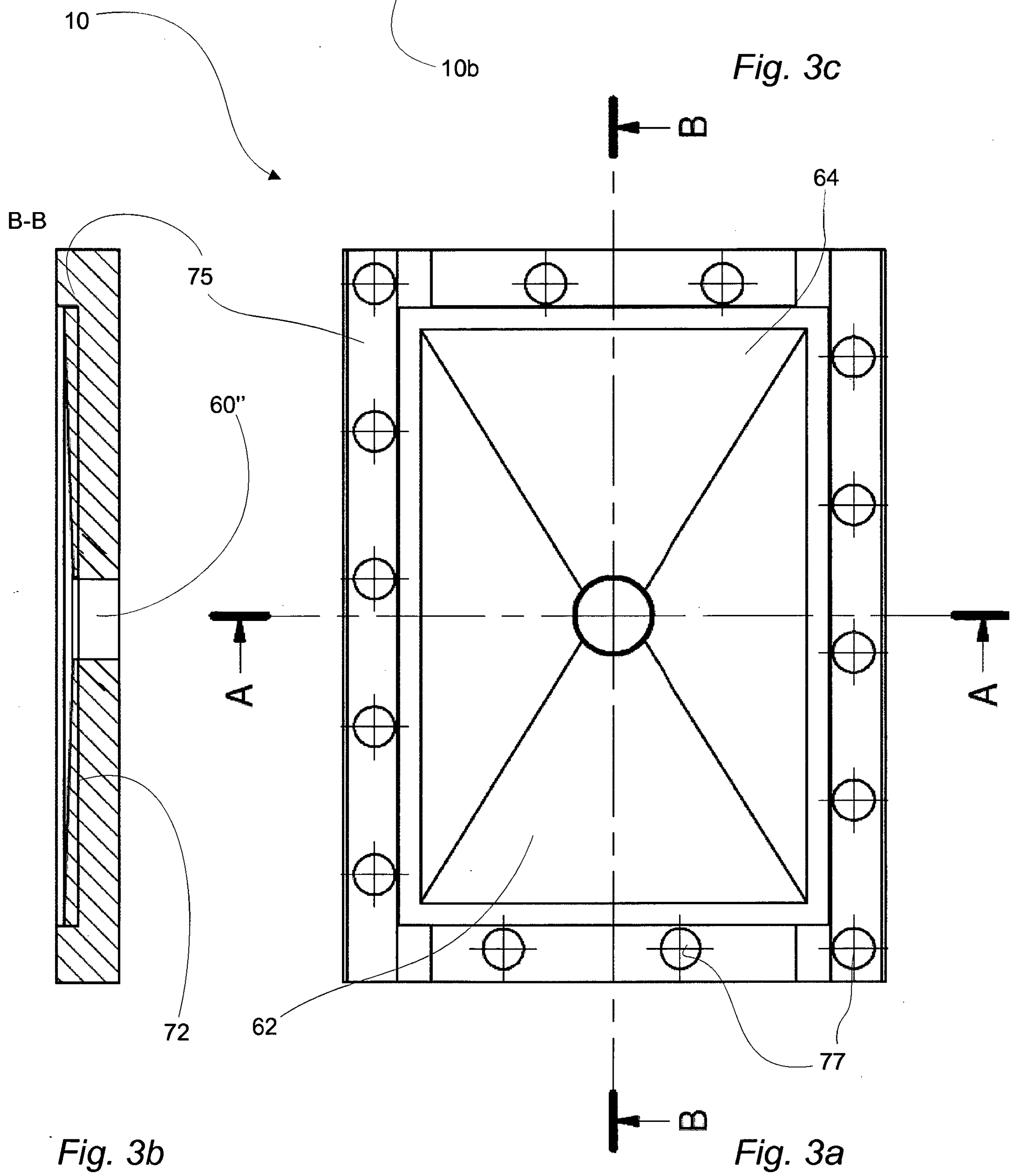


Fig. 3b

Fig. 3a

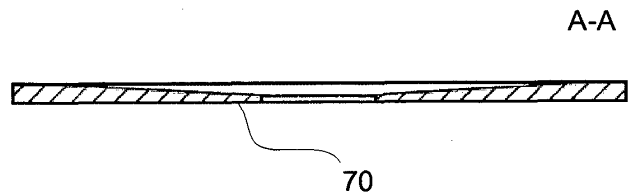


Fig. 4c

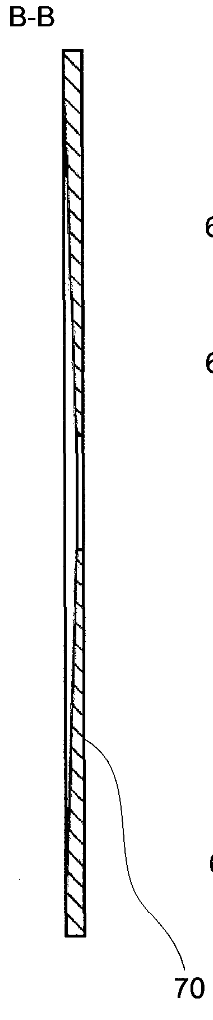


Fig. 4b

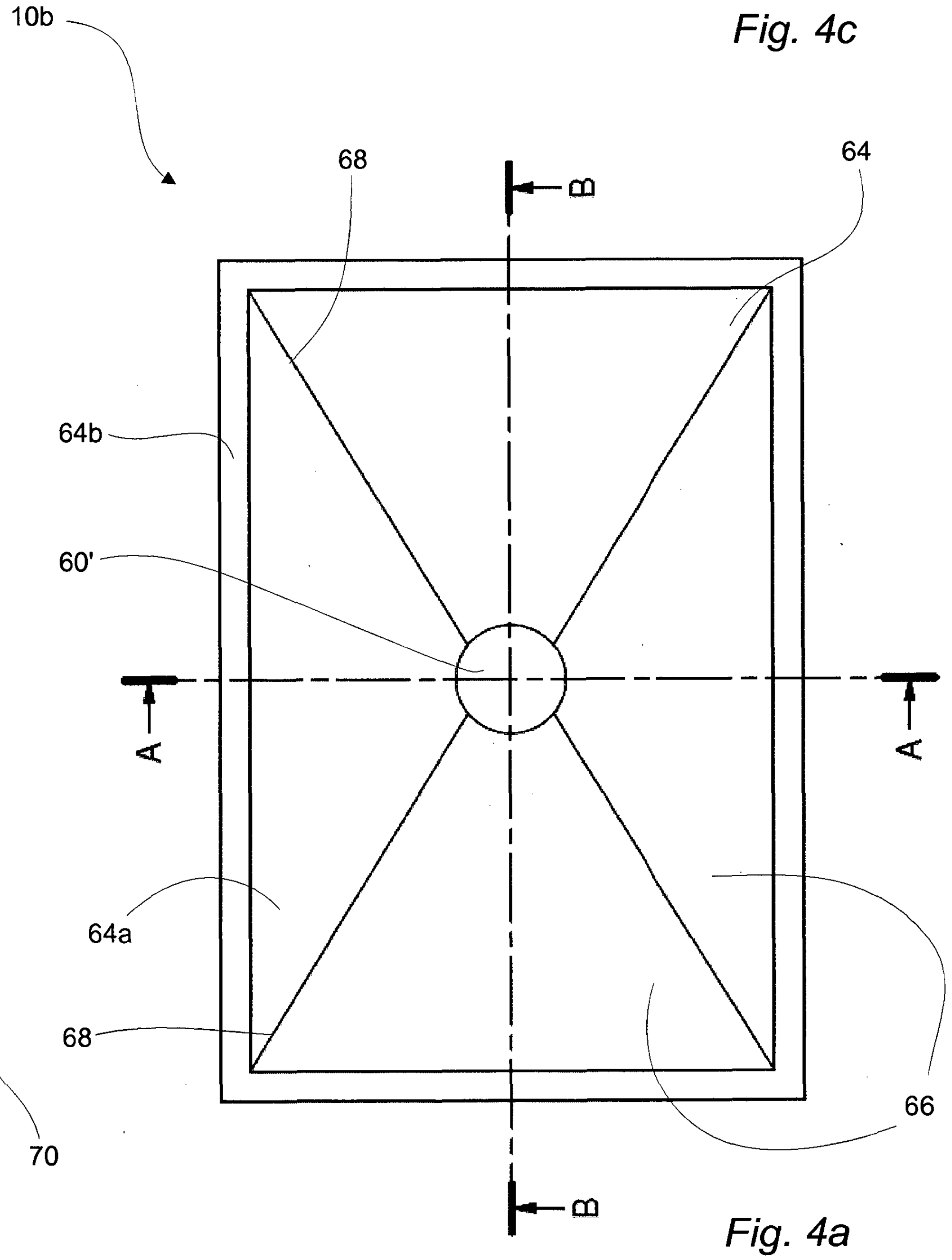


Fig. 4a

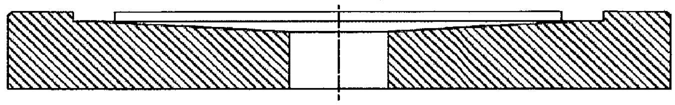
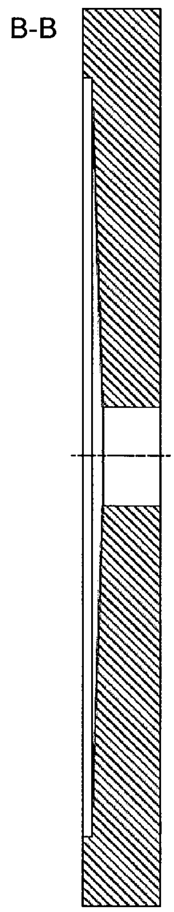


Fig. 5c



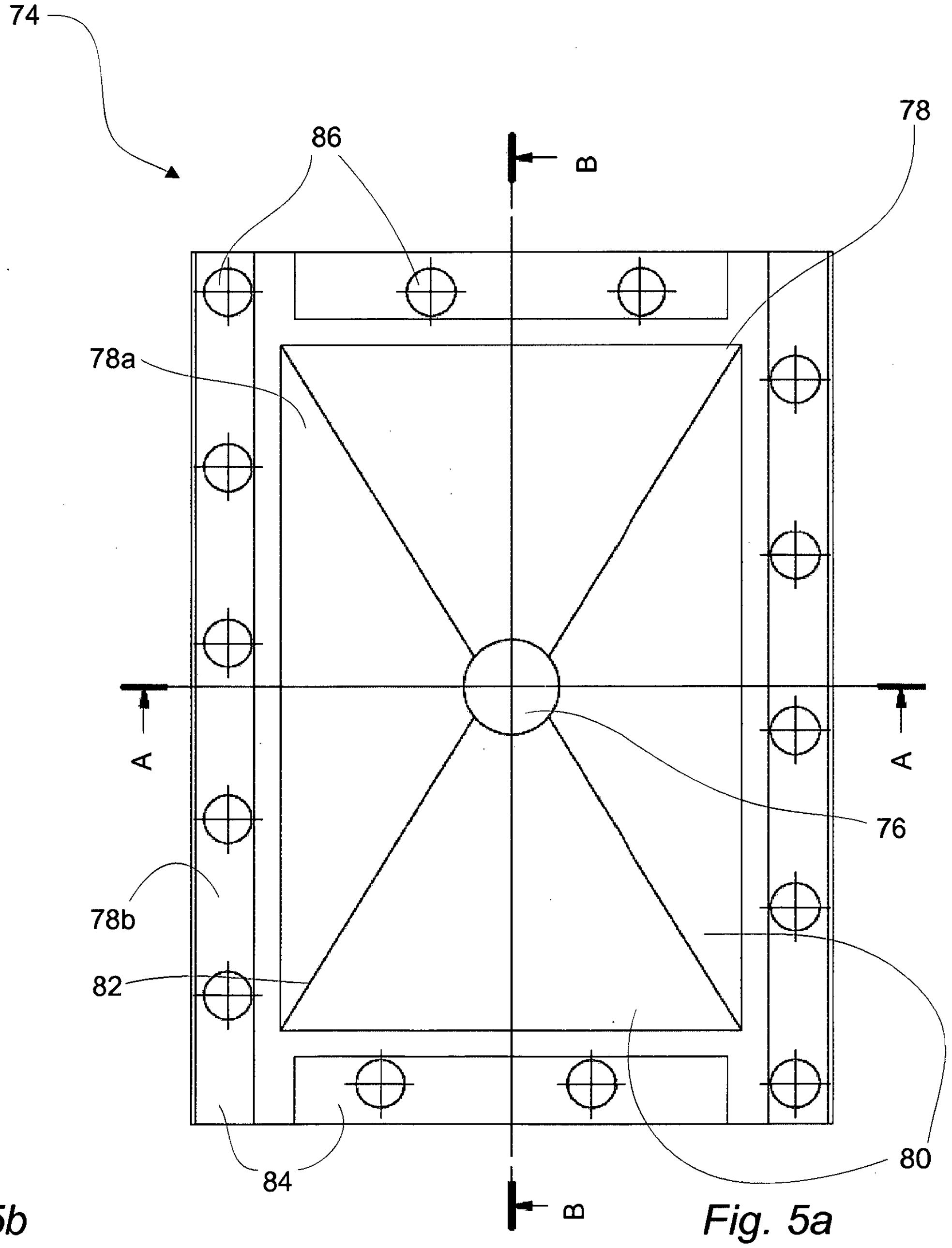


Fig. 5b

Fig. 5a

REFERENCES CITED IN THE DESCRIPTION

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