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(54) GASKET ARRANGEMENT AND PLATE ARRANGEMENT FOR A PLATE HEAT EXCHANGER

(57) The present invention relates to a gasket arrangement (300, 300a) for a plate heat exchanger (2). An inner segment (350) is adapted to at least partially circumscribe a port hole (114) of a heat exchanger plate (100). An outer segment (310) is adapted to at least partially circumscribe the inner segment (350) to define a permeation space (130) between the inner segment (350) and the outer segment (310). An external segment (320, 320a) defining an evacuation space (150, 150a) is adapted to be arranged at least partially outside a footprint area of the heat exchanger plate (100). A channel (330) is adapted to fluidly connect the permeation space (130) and the evacuation space (150, 150a) by extending between an outlet opening (312) through the outer segment (310) and an inlet opening (322) through the external segment (320). A plate arrangement (400) comprising a gasket arrangement (300, 300a) and a heat exchanger plate (100) is also disclosed.

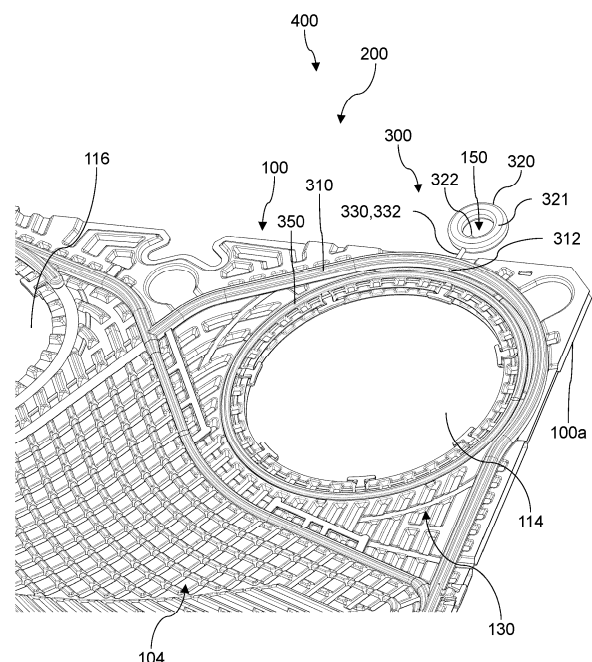


Fig.5

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Description

Technical Field

[0001] The invention relates to the field of plate heat exchangers. More particularly, it is related to a gasket arrangement for a plate heat exchanger and to a plate arrangement for a plate heat exchanger comprising such a gasket arrangement.

Background Art

[0002] Plate heat exchangers, PHEs, are used in numerous applications where heat is to be transferred from one fluid to another or vice versa. A typical plate heat exchanger includes two end plates between which a plurality of heat exchanger plates or heat transfer plates are arranged in a stacked configuration so as to form a plate stack or plate pack. Generally, a number of heat exchanger plates and gaskets are stacked in an alternating fashion. In this way first plate interspaces and second plate interspaces are alternately formed between the heat exchanger plates. The first plate interspaces and the second plate interspaces are typically separated from each other and are designed to receive a respective fluid between which fluids heat is to be exchanged. Thus, the first plate interspaces and the second plate interspaces form channels for the respective fluids. Further, respective inlet and outlet ports are typically provided to the first plate interspaces and to the second plate interspaces. The inlet and outlet ports are typically formed by aligned portholes extending through the plate stack.

[0003] In a common type of PHE gaskets are used between each heat exchanger plate to seal the fluids from each other and to define fluid channels for the respective fluids. Such PHEs are generally referred to as gasketed PHEs.

[0004] In another type of common PHE two adjoining heat exchanger plates are welded to each other to form what is generally referred to as a heat exchanger cassette or simply a cassette. The cassettes are in turn stacked with gaskets in between. Such PHEs are generally referred to as semi-welded PHEs. Thus, in semi-welded PHEs, the plate interspaces formed between the heat exchanger plates making up a cassette are sealed off by a weld, whereas the plate interspaces formed between the cassettes are sealed off by gaskets. In other words, a semi-welded PHE includes a combination of welded plate interspaces (welded fluid channels) and gasketed plate interspaces (gasketed fluid channels). However, in semi-welded PHEs, the fluid attributable to the welded plate interspaces of the cassettes is typically sealed off by a ring gasket around the inlet port and a ring gasket around the outlet port in between the cassettes. Thus, even if a fluid is fed through welded plate interspaces it is still sealed off by two gaskets for each cassette.

[0005] Some fluids used in heat exchangers are cap-

able of permeating gaskets meaning that although a generally speaking tight gasket is in place, the fluid will still permeate through the material of the gasket and escape e.g. to the ambient. Although a semi-welded PHE may significantly reduce the permeation through gaskets owing to the welded plate interspaces or channels, problems related to permeation through the ring gaskets can still be outspoken. For instance, in ammonia applications problems related to permeation through the ring gaskets of a semi-welded PHE can lead to work environment problems and health issues since ammonia for instance has a pungent smell. Problems related to permeation through gaskets are for natural reasons more pronounced in gasketed PHEs. Given the problems associated with fluids permeating the gaskets of a PHEs, it desirable to handle permeated fluid in a safe way where the permeated fluid for instance is ventilated away in a controlled manner.

[0006] To this end, it has been suggested to surround relevant gaskets by another gasket to capture the permeated fluid between the gaskets. It has further been suggested to provide the heat exchanger plates or cassettes with an opening located between the gaskets to be able to lead away the permeated fluid in a safe way via the opening.

[0007] Although such solutions have proved efficient when it comes to handling permeated fluid, such as ammonia, the provision of an opening through the heat exchanger plates or cassettes can result in several drawbacks. For instance, the provision of an opening through the heat exchange plates or cassettes results in that additional gaskets for surrounding the opening have to be used between the heat exchanger plates or cassettes. Another drawback resides in that the heat exchanger plates and correspondingly the cassettes may become weaker owing from the presence of the additional opening. Moreover, the flow of the fluid may be disturbed e.g. with an increased pressure drop and lowered efficiency as a result. Further, the heat exchanger plates of a cassette may typically have to be provided with an additional weld for welding the heat exchanger plates to each other around the opening with increases the work needed to fabricate the cassettes.

[0008] Hence, there is room for improvement when it comes to handling fluid permeated through gaskets of a PHE.

Summary

[0009] With the above in mind, it is an objective of the present invention to provide an improved gasket arrangement for a plate heat exchanger as well as plate arrangement including a gasket arrangement.

[0010] Another objective is to provide such a gasket arrangement which is capable of evacuating permeated fluid in a safe way.

[0011] Another objective is to provide such a gasket arrangement which is capable of evacuating permeated

fluid while not negatively affecting the flow of the fluids between which heat is to be exchanged.

[0012] Another objective is to provide such a gasket arrangement which is capable of evacuating permeated fluid without the need for any dedicated ventilation or evacuation hole through an associated plate or cassette.

[0013] Another objective is to provide such a gasket arrangement which is capable of evacuating permeated fluid without the need for any additional manufacturing steps of an associated plate or cassette.

[0014] Another objective is to provide such a gasket arrangement which is capable of evacuating permeated fluid without the need for any modification of an associated plate or cassette.

[0015] Another objective is to provide such a gasket arrangement which is capable of evacuating permeated fluid when used in combination with a standard heat exchanger plate or cassette.

[0016] Another objective is to provide such a gasket arrangement which is more cost-effective.

[0017] To achieve at least one of the above objects and also other objects that will be evident from the following description, a gasket arrangement for a plate heat exchanger, having the features defined in claim 1, is provided according to the present inventive concept. A plate arrangement for a plate heat exchanger including a gasket arrangement is provided according to claim 15.

[0018] More specifically, according to a first aspect, there is provided gasket arrangement for a plate heat exchanger comprising:

an inner segment adapted to be arranged on a first side of a heat exchanger plate and to at least partially circumscribe a port hole of the heat exchanger plate, an outer segment adapted to be arranged on the first side of the heat exchanger plate and to at least partially circumscribe the inner segment to define a permeation space between the inner segment and the outer segment,

an external segment defining an evacuation space adapted to be arranged at least partially outside a footprint area of the heat exchanger plate, and a channel adapted to fluidly connect the permeation space and the evacuation space by extending between an outlet opening through the outer segment and an inlet opening through the external segment.

[0019] Hereby an improved gasket arrangement for a plate heat exchanger is provided.

[0020] The gasket arrangement is designed for, and hence suitable to be used with gasketed PHEs and semi-welded PHEs.

[0021] The present invention is based on the realization that by providing a gasket arrangement which includes an external segment defining an evacuation space which is adapted to be arranged at least partially outside a footprint area of a heat exchanger plate, fluid having permeated through the inner segment of the

gasket arrangement may be evacuated and consequently led away without the need for any dedicated ventilation or evacuation hole through the plate or cassette with which the gasket arrangement is used. Moreover, the fluid having permeated through the inner segment of the gasket arrangement may be evacuated in a safe way while not affecting the performance of the PHE in which the gasket arrangement is used.

[0022] More particularly, by the gasket arrangement comprising an inner segment which is adapted to be arranged on a first side of a heat exchanger plate and to at least partially circumscribe a port hole of the heat exchanger plate, and an outer segment which is adapted to be arranged on the first side of the heat exchanger plate and to at least partially circumscribe the inner segment, the gasket arrangement may define a permeation space between the inner segment and the outer segment. Thus, in practice, the gasket arrangement may define a permeation space between the inner segment and the outer segment when arranged on a first side of a heat exchanger plate. In this regard, it is to be understood that the permeation space so formed will be open in a normal direction of the first side of the heat exchanger plate unless arranged in a stack of heat exchanger plates or a stack of cassettes. However, when the gasket arrangement and an associated heat exchanger plate are arranged in a stack of heat exchanger plates a gasketed or sealed permeation space will in practice be formed along the first surface of the associated heat exchanger plate between the inner segment and the outer segment of the gasket arrangement.

[0023] In this way, fluid which has permeated through the inner segment may be captured in permeation space and consequently prevented or counteracted from escaping the permeation space by the outer segment. So captured permeated fluid may in turn leave the permeation space and enter into the evacuation space defined by the external segment via the channel, since the channel is adapted to fluidly connect the permeation space and the evacuation space by extending between an outlet opening through the outer segment and an inlet opening through the external segment. In other words, the channel will fluidly connect the permeation space and the evacuation space when the gasket arrangement is used in a PHE. In this way, the channel may lead or convey fluid which has permeated through the inner segment to the evacuation space of the external segment.

[0024] Further, by the external segment defining an evacuation space which is adapted to be arranged at least partially outside a footprint area of the heat exchanger plate, fluid which has permeated through the inner segment may be evacuated and consequently lead away outside of the footprint area of an associated heat exchanger plate, or in case of a semi-welded PHE, outside of the footprint of an associated cassette.

[0025] It should be noted that within the context of this application the term "inner segment" may mean any type of gasket segment, sealing or similar which is adapted to

be arranged on a surface of a heat exchanger plate and to at least partially circumscribe a port hole thereof. The inner segment may comprise more than one part. Thus, the inner segment may in practice be adapted to circumscribe a port hole so as to seal of the port hole from the remaining surface of the heat exchanger plate. In other words, the inner segment may typically be adapted to prevent fluid from escaping a porthole channel formed by a plurality of aligned port holes of a stack of heat exchanger plates. In practice, the inner segment may be a ring shaped port hole gasket.

[0026] It should be noted that within the context of this application the term "outer segment" may mean any type of gasket segment, sealing or similar which is adapted to be arranged on a surface of a heat exchanger plate and to at least partially circumscribe the inner segment. The outer segment may comprise more than one part. As an example, the outer segment may comprise a first part and a separate second part. The outer segment may in practice be adapted to circumscribe the inner segment so as to form a permeation space therebetween. In other words, the outer segment may typically be adapted to prevent fluid having permeated through the inner segment from escaping the permeation space.

[0027] It should be noted that within the context of this application the term "external segment" may mean any type of gasket segment, sealing, member, pipe or similar which defines an evacuation space. It is to be understood that the so defined evacuation space may typically be open in both normal directions of the first side of an associated heat exchanger plate. In this way, the evacuation space of the external segment may fluidly connect to a corresponding evacuation space of an external segment of an adjoining gasket arrangement. Thus, the external segment may constitute a portion of a joint evacuation space for a plurality of stacked heat exchanger plates or cassettes. Such joint evacuation space may be defined by a single or integrally formed member of which the external segments constitutes a portion.

[0028] It should be noted that within the context of this application the term "channel" may mean any type element which is capable of fluidly connecting an outlet opening through the outer segment and an inlet opening through the external segment.

[0029] The channel may comprise a pipe element extending between the outlet opening of the outer segment and the inlet opening of the external segment. By the channel comprising a pipe element extending between the outlet opening of the outer segment and the inlet opening of the external segment, the channel may efficiently fluidly connect the permeation space and the evacuation space. In practice, the channel may be formed of a pipe element extending between the outlet opening of the outer segment and the inlet opening of the external segment. However, the channel may comprise two or more pipe elements connected in series.

[0030] The pipe element may be formed from a material being different from a material of the outer segment and

from a material of the external segment. In this way, the pipe element may be formed of a material suitable for fluidly connecting the permeation space and the evacuation space, whereas the outer segment and the external segment may be formed of a material or materials having different properties. As an example, the outer segment may be formed of a material suitable for providing a fluid tight seal when in abutment with a heat exchanger plate or cassette. As an example, the external segment may be formed of a material suitable for providing a fluid tight seal when in abutment with a corresponding external segment of an adjoining gasket arrangement.

[0031] The pipe element may be formed of a plastic material, a metal material or a glass material to give a few non-limiting examples.

[0032] The pipe element may be molded into the material of the outer segment and into the material of the external segment. By the pipe element being molded into the material of the outer segment and into the material of the external segment, a fluid tight connection between the permeation space and the evacuation space may be established via the pipe element. Moreover, the material of the outer segment may form a fluid tight connection at the interface between the outer segment and the pipe element. Correspondingly, the material of the external segment may form a fluid tight connection at the interface between the outer segment and the pipe element.

[0033] The external segment may comprise a loop portion for at least partially defining the evacuation space. By the external segment comprising a loop portion for at least partially defining the evacuation space, the evacuation space may be at least partially defined within the loop portion in a simple yet efficient manner. In practice, the entire evacuation space may be defined by a loop portion of the external segment.

[0034] The channel may comprise a first channel element extending between the outer segment and the external segment, and a second channel element adapted to abut the first channel element such that the first channel element and the second channel element, when in abutment, jointly fluidly connect the permeation space and the evacuation space. In this way, the permeation space and the evacuation space may be fluidly connected to each other by arranging the first channel element and the second channel element in abutment which may significantly simplify the fabrication of the gasket arrangement.

[0035] The first channel element may comprise a first channel groove extending at least partially between the outlet opening of the outer segment and the inlet opening of the external segment, and/or the second channel element may comprise a second channel groove extending at least partially between the outlet opening of the outer segment and the inlet opening of the external segment, wherein the first channel groove and/or the second channel groove are adapted to fluidly connect the permeation space and the evacuation space. In this way, the channel may for instance be formed in a simple

yet effective manner by molding the first channel element and the second channel element and arranging the first and second channel elements in abutment. This e.g. because such molding of the first channel element and the second channel element may not involve molding any interior or partially closed volumes or spaces. Moreover, at least one of the first channel element and the second channel element may be formed of a flexible or elastic material which is suitable for providing a fluid tight connection when in abutment.

[0036] The first channel groove may extend between the outlet opening of the outer segment and the inlet opening of the external segment.

[0037] The second channel groove may extend between the outlet opening of the outer segment and the inlet opening of the external segment.

[0038] The external segment may comprise a first external segment element integrally formed with the first channel element, and a second external segment element integrally formed with the second channel element, wherein the first external segment element and the second external segment element are adapted to abut each other, such that the first external segment element and the second external segment element jointly define the evacuation space when in abutment. In this way, the channel and the external segment may be formed in a simple yet effective manner. More specifically, the first external segment element and the first channel element may be integrally formed by being molded. Correspondingly, the second external segment element and the second channel element may be integrally formed by being molded. Followingly, the channel and the external segment may be formed by arranging said integrally formed elements in abutment.

[0039] The first external segment element and the second external segment element may be connected to each other via a flexible connection section adapted to guide the second external segment element to abut the first external segment element, such that the first external segment element and the second external segment element, when in abutment, jointly define the evacuation space. In this way, the first external segment element and the second external segment element may jointly define the evacuation space in a secure manner where the first external segment element and the second external segment element are guided into their intended positions. The flexible connection section may be integrally formed with the first external segment element and the second external segment element. As a result, the first channel element, the first external segment element, the second channel element and the second external segment element may be integrally formed. As a further result, the first channel element and the second channel element may jointly define the channel in a secure manner where the first channel element and the second channel element are guided into their intended positions.

[0040] The first external segment element and the second external segment element may be connected

to each other via a flexible connection section.

[0041] The flexible connection section may be formed as a hinge portion.

[0042] The channel may comprise a first channel element extending between the outer segment and the external segment, and the gasket arrangement may further comprise a further channel element adapted to be arranged on a second side, opposite to the first side, of the heat exchanger plate to form at least a portion of an adjacent channel. In this way, the gasket arrangement may contribute to forming an adjacent channel.

[0043] A first external segment element may be integrally formed with the first channel element and a further external segment element may be integrally formed with the further channel element, and wherein the first external segment element and the further external segment element may be connected to each other via a flexible connection section adapted to guide the further external segment element and the further channel element to an intended position on the second side of the heat exchanger plate. In this way, the further external segment element and the further channel element may be guided to the second side of the heat exchanger plate in a secure manner where the further external segment element and the further channel element are guided into their intended positions. Thus, the further external segment element and the further channel element may form part of an adjacent evacuation space and adjacent channel respectively.

[0044] The external segment may be adapted to abut an adjoining external segment of an adjoining gasket arrangement such that the evacuation space and an evacuation space of the adjoining external segment fluidly connect. In this way, a joint evacuation space fluidly connecting a plurality of evacuation spaces of different gasket arrangements may be formed. In practice, a joint evacuation space connecting an evacuation space of each gasket arrangement of a PHE may be formed along the stack of heat exchanger plates or cassettes of the PHE, i.e. along a stacking direction of the plates or cassettes of the PHE. As a result, fluid having permeated the inner segment may be evacuated in a secure way via such joint evacuation space.

[0045] The external segment may comprise one or more support members adapted to engage with the heat exchanger plate for supporting the external segment. By the external segment comprising one or more support members adapted to engage with the heat exchanger plate for supporting the external segment, the external segment may be held or fixed in relation to the concerned heat exchanger plate or cassette. Thus, the external segment may be prevented or counteracted from moving in an undesired manner in relation to the concerned heat exchanger plate or cassette.

[0046] The one or more support members may be of any suitable type. The one or more support members may comprise one or more portions adapted to be sandwiched between a pair of heat exchanger plates or cas-

settes. The one or more support members may comprise one or more hook portions for hooking engagement with the concerned heat exchanger plate or cassette.

[0047] The external segment may constitute a portion of an external member adapted to extend in a stacking direction of a plurality of stacked heat exchanger plates for defining a joint evacuation space for the plurality of stacked heat exchanger plates. By the external segment constituting a portion of an external member adapted to extend in a stacking direction of a plurality of stacked heat exchanger plates for defining a joint evacuation space for the plurality of stacked heat exchanger plates, a joint evacuation space for evacuating fluid having permeated through a plurality of inner segments may be realized in an efficient manner. Moreover, by utilizing an external member to define a joint evacuation space for a plurality of stacked heat exchanger plates potential leakage from the joint evacuation space as such may efficiently be minimized or at least reduced.

[0048] The external member may be of any suitable type. The external member may comprise a bar member adapted to extend in a stacking direction of a plurality of stacked heat exchanger plates. Such bar member may have a generally U-shaped cross section. In this way, the bar member may be open on one side. Such bar structure may further be adapted to abut an outer side of a stack of a plurality heat exchanger plates or cassettes. Such bar member may be adapted to seal against an outer side of a stack of a plurality heat exchanger plates or cassettes. To this end, one or more gaskets or seals may be used for sealing between such bar member and an outer side of a stack of a plurality heat exchanger plates or cassettes. In practice, such gaskets or seals may be at least partially sandwiched between one or more heat exchanger plates or cassettes of said stack.

[0049] The external member may comprise a pipe member adapted to extend in a stacking direction of a plurality of stacked heat exchanger plates. Such pipe member may comprise a plurality of inlet openings extending therethrough. In practice, such pipe member may comprise a set of inlet openings adapted to fluidly connect the joint evacuation space and a plurality of permeation spaces.

[0050] The inner segment may be generally ring shaped. However, the inner segment may have any suitable shape for at least partially circumscribing a port hole of the concerned heat exchanger plate.

[0051] A portion of the outer segment may be adapted to form a barrier between the permeation space and a heat exchange area at the first side of the concerned heat exchanger plate. Thus, the outer segment may in part be common to what is commonly referred to as a field gasket.

[0052] The outlet opening through the outer segment may be formed of a hole in the outer segment.

[0053] The outlet opening through the outer segment may be formed of a notch in the outer segment.

[0054] At least a portion of the outer segment may have

a generally L-shaped, C-shaped or I-shaped cross section so as to form a passageway along said at least a portion of the outer segment.

[0055] The inlet opening through the external segment may be formed of a hole in the external segment.

[0056] The external segment may comprise an outlet opening extending therethrough. By the external segment comprising an outlet opening extending therethrough, fluid may be allowed to exit the evacuation space via the outlet opening of the external segment. In this way, fluid having permeated through the inner segment which has reached the external segment via the channel may be evacuated in a safe way by e.g. being ventilated away or pumped away.

[0057] The outer segment may comprise an inlet opening extending therethrough. By the outer segment comprising an inlet opening extending therethrough, a forced flow of fluid, such as air, may be achieved through the permeation space.

[0058] The inlet opening of the outer segment may be fluidly connected to the ambient.

[0059] The gasket arrangement may further comprise a further inner segment adapted to be arranged on the first side of the heat exchanger plate and to circumscribe a further port hole, and a further outer segment adapted to be arranged on the first side of the heat exchanger plate and to circumscribe the further inner segment to define a further gasketed space between the further inner segment and the further outer segment, the gasket arrangement further comprising a further external segment defining a further evacuation space adapted to be arranged at least partially outside the footprint area of the heat exchanger plate, wherein a further channel fluidly connects the further gasketed space and the further evacuation space by extending between a further outlet opening through the further outer segment and a further inlet opening through the further external segment.

[0060] According to a second aspect of the invention, there is provided a plate arrangement for a plate heat exchanger, comprising:

a gasket arrangement according to the first aspect, and
a heat exchanger plate.

[0061] In general, features of this second aspect provide similar advantages as discussed above in relation to the first aspect. Consequently, said advantages will not be repeated in order to avoid undue repetition.

[0062] The heat exchanger plate may, at its perimeter, comprise a support slot configured to receive and support the external segment. By the heat exchanger plate, at its perimeter, comprising a support slot configured to receive and support the external segment, the external segment may be held or fixed in relation to the concerned heat exchanger plate or cassette. Thus, the external segment may be prevented or counteracted from moving in an undesired manner in relation to the concerned heat

exchanger plate or cassette.

[0063] The support slot may have any suitable shape. The support slot may be configured to receive and support a portion of the external segment.

[0064] The first side of the heat exchanger plate may comprise an inner segment seat configured to receive the inner segment.

[0065] The inner segment seat may extend along a perimeter of the port hole.

[0066] The inner segment seat may comprise a groove configured to receive and retain the inner segment.

[0067] The first side of the heat exchanger plate may comprise an outer segment seat configured to receive the outer segment.

[0068] The outer segment seat may comprise a groove configured to receive and retain the outer segment.

[0069] The first side of the heat exchanger plate may comprise a channel recess extending from a perimeter of the heat exchanger plate along the first side of the heat exchanger plate, the channel recess being configured to receive the channel.

[0070] The channel recess may extend between the outer segment groove and the perimeter of the heat exchanger plate.

[0071] A gasketed plate heat exchanger comprising a plurality of plate arrangements according to the second aspect is disclosed. In general, features of such gasketed plate heat exchanger provide similar advantages as discussed above in relation to the first aspect and the second aspect. Consequently, said advantages will not be repeated in order to avoid undue repetition.

[0072] A cassette arrangement comprising a plate arrangement according to the second aspect and a further heat exchanger plate, wherein the further heat exchanger plate is welded to a second side, opposite to the first side, of the heat exchanger plate is disclosed. In general, features of such cassette arrangement provide similar advantages as discussed above in relation to the first aspect and the second aspect. Consequently, said advantages will not be repeated in order to avoid undue repetition.

[0073] A semi-welded plate heat exchanger comprising a plurality of cassette arrangements is disclosed. In general, features of semi welded plate heat exchanger provide similar advantages as discussed above in relation to the first aspect and the second aspect. Consequently, said advantages will not be repeated in order to avoid undue repetition.

[0074] A further scope of applicability of the present invention will become apparent from the detailed description given below. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the scope of the invention will become apparent to those skilled in the art from this detailed description.

[0075] Hence, it is to be understood that this invention

is not limited to the particular component parts of the device described as such device may vary. It is also to be understood that the terminology used herein is for purpose of describing particular embodiments only and is not intended to be limiting. It must be noted that, as used in the specification and the appended claim, the articles "a," "an," "the," and "said" are intended to mean that there are one or more of the elements unless the context clearly dictates otherwise. Thus, for example, reference to "a unit" or "the unit" may include several devices, and the like. Furthermore, the words "comprising", "including", "containing" and similar wordings does not exclude other elements or steps.

Brief Description of the Drawings

[0076] The above and other aspects of the present inventive concept will now be described in more detail, with reference to appended figures showing variants. The figures should not be considered limiting, instead, they are used for explaining and understanding.

[0077] As illustrated in the figures, the sizes of layers and regions may be exaggerated for illustrative purposes and, thus, are provided to illustrate the general structures of variants. Like reference numerals refer to like elements throughout.

Fig. 1 is a schematic front view of a plate heat exchanger in which the present invention may be employed.

Fig. 2 is a schematic side view of the plate heat exchanger in Fig. 1.

Fig. 3 is a schematic perspective view of a portion of a pack of heat exchanger plates and associated gaskets which may be used in the plate heat exchanger of Figs. 1 and 2.

Fig. 4 is a schematic perspective view of a portion of a pack of heat exchanger cassettes and associated gaskets which may be used in the plate heat exchanger of Figs. 1 and 2.

Fig. 5 is a schematic perspective view a portion of a heat exchanger cassette employed with a gasket arrangement.

Fig. 6 is a schematic perspective view a portion of a pair of a heat exchanger cassettes employed with a respective gasket arrangement.

Fig. 7 is a schematic plane view a corner region of a heat exchanger plate employed with a gasket arrangement.

Fig. 8 is a schematic plane view of a corner region of the heat exchanger plate of Fig. 7 employed with a gasket arrangement of a different design.

Fig. 9 is a schematic plane view of the gasket arrangement of Fig. 8.

Fig. 10 is a schematic perspective view of a corner region of a heat exchanger cassette employed with a gasket arrangement of a different design.

Fig. 11 is a cross sectional view of the heat exchan-

ger cassette and the gasket arrangement of Fig. 10. Fig. 12 is a schematic perspective view of a corner region of a heat exchanger cassette employed with a gasket arrangement of a different design.

Fig. 13 is a schematic perspective view of a corner region of a heat exchanger cassette employed with a gasket arrangement of a different design.

Fig. 14 is a schematic perspective view of a corner region of a heat exchanger cassette employed with a gasket arrangement of a yet different design.

Fig. 15 is a schematic perspective partial view of plate heat exchanger employed with gasket arrangements of Fig. 14.

Detailed Description

[0078] The present inventive concept will now be described more fully hereinafter with reference to the accompanying drawings, in which currently preferred variants or embodiments of the inventive concept are shown. This inventive concept may, however, be implemented in many different forms and should not be construed as limited to the variants set forth herein; rather, these variants are provided for thoroughness and completeness, and fully convey the scope of the present inventive concept to the skilled person.

[0079] Figs. 1 and 2 show a plate heat exchanger 2 or PHE, 2. The PHE 2 comprises a frame plate 4 and a pressure plate 6. A pack 8 of heat exchanger plates 100 is sandwiched between the frame plate 4 and the pressure plate 6. At least a majority of the heat exchanger plates 100 or plates 100 of the pack 8 are all similar, which is common practice in PHEs. The frame plate 4 is provided with fluid inlets and fluid outlets 10. The fluid inlets and fluid outlets 10 are, as is known in the art, configured to receive and eject fluids between which heat is to be transferred. In the depicted PHE 2, one fluid inlet and one fluid outlet 10 are configured to receive and eject a first fluid, whereas another fluid inlet and another fluid outlet 10 are configured to receive and eject a second fluid. In this way, heat may be transferred between the first fluid and the second fluid. In the depicted PHE 2, the fluid inlet and the fluid outlet 10 to the left in Fig. 1 may be configured to receive and eject a first fluid. Similarly, in the depicted PHE 2, the fluid inlet and the fluid outlet 10 to the right in Fig. 1 may be configured to receive and eject a second fluid. Further, as is known in the art, porthole channels are formed through the pack 8 of heat transfer plates 100 for each one of the fluid inlets and the fluid outlets 10. Generally speaking, the porthole channels are formed by aligned portholes of the heat exchanger plates 100 of the pack 8. The depicted PHE further comprises tightening means 12, an upper bar 14 and a lower bar 16.

[0080] Fig. 3 schematically illustrates how the plates 100 of the pack 8 may be alternately stacked with gaskets 13a in between. Thus, in case the plates 100 of the pack 8 are stacked like in Fig. 3 with gaskets 13a in between each plate 100, the depicted PHE 2 of Figs. 1 and 2 is a

so-called gasketed PHE. The plates 100 of Fig. 3 are schematically illustrated. It is, however, to be understood that the design of the plates 100 may vary greatly e.g. depending on application, fluid type, size etcetera. Fig. 3 illustrates how eleven plates 100 are alternately stacked with gaskets 13a in between. However, in practice, the number of plates 100 in the pack 8 may vary greatly.

[0081] Fig. 4 illustrates how the plates 100 of the pack 8 may be welded in pairs, back side to back side, to form fluid tight heat exchanger cassettes 200 or cassettes 200. In other words, each cassette 200 comprises a first heat exchanger plate 100 and a second adjoining heat exchanger plate 100 wherein the second adjoining heat exchanger plate 100 is welded to the first heat exchanger plate 100. In yet other words, each cassette 200 comprises two plates 100 which are welded to each other. The cassettes 200 of Fig. 4 are alternately stacked with gaskets 13b in between. Hence, gaskets 13b are provided between adjoining cassettes 200. Thus, in case the plates 100 are welded in pairs to form cassettes 200, where the cassettes are stacked like in Fig. 4, the depicted PHE 2 of Figs. 1 and 2 is a so-called semi-welded PHE. The cassettes 200 of Fig. 4 are schematically illustrated. It is, however, to be understood that the design of the cassettes 200 may vary greatly e.g. depending on application, fluid type, size etcetera. Fig. 4 illustrates how fourteen cassettes 200, each comprising two plates 100 welded to each other, are alternately stacked with gaskets 13b in between. However, in practice, the number of cassettes 200 in the pack 8 may vary greatly.

[0082] Since gasketed PHEs 2 and semi-welded PHEs 2 are similar in many ways, the following description is generally applicable to both gasketed PHEs 2 and semi-welded PHEs 2. However, whenever appropriate, e.g. reasons of clarity, reference may be made to a gasketed PHE 2 or a semi-welded PHE 2. Despite this, it is to be noted that the herein described inventive concept is generally applicable to both gasketed PHEs 2 and semi-welded PHEs 2.

[0083] Further, the frame plate 4 and pressure plate 6 may be moved or pressed towards each other by tightening the tightening means 12. As a result, the pack 8 may be pressed between the frame plate 4 and pressure plate 6 by tightening the tightening means 12.

[0084] Thus, in the case of a gasketed PHE 2, the plates 100 of the pack 8 may be pressed against each other, whereby the gaskets 13a seal between the plates 100.

[0085] Correspondingly, in case of semi-welded PHE 2, the cassettes 200 of the pack 8 may be pressed against each other, whereby the gaskets 13b seal between the cassettes 200.

[0086] In this way parallel fluid channels are formed between the heat exchanger plates 100 of the pack 8. More specifically, one fluid channel is formed between each pair of adjacent heat exchanger plates 100. As a result, a first fluid and a second fluid of initially different temperatures, may be fed to/from the PHE 2 through the

fluid inlets and outlets 10, and flow alternately through every second fluid channel for transferring heat from the first fluid to the second fluid or vice versa.

[0087] Now referring to Figs. 5. Fig. 5 illustrates a portion of a heat exchanger cassette 200. A gasket arrangement 300 is arranged on the cassette 200. The cassette comprises a pair of heat exchanger plates 100, 100a which are welded to each other to form the cassette 200. The cassette 200 is designed to be used in a semi welded PHE 2 of the type discussed above in relation to Figs. 1, 2 and 4.

[0088] More specifically, a corner region of a cassette 200 is illustrated. As a consequence, a corner region of the upper plate 100 of the cassette 200 is clearly visible whereas the lower plate 100a of the cassette 200 is only visible to a very limited extent. In this regard, it is to be understood that a plate 100 of the cassette 200, may equally well be used in gasketed PHE 2 of the type discussed above in relation to Figs. 1, 2 and 3. In such a case, plates 100 will be alternately stacked with gaskets 13a in between, i.e. as illustrated in Fig. 3, instead of being welded to each other in pairs to form cassettes 200, i.e. as illustrated in Fig. 4. Given this, the following description will in large discuss the interplay between the gasket arrangement 300 and a single plate 100 whenever appropriate although the discussed plate 100 may form part of a cassette 200. As a consequence, Fig. 5 may equally well be discussed in terms of illustrating a portion of a plate 100 corresponding to a corner region of a plate 100 in Figs. 1-4. In practice, a bottom region at an opposite short end of the plate 100 may have a corresponding design.

[0089] Further, as is known in the art, a pack 8 of a gasketed PHE 2 or a semi-welded PHE may be formed of plates 100 of corresponding design. However, in order to establish desired fluid channels for a first fluid and a second fluid, the plates 100 may be rotated, turned or flipped in relation to each other as is known in the art. In this way, a pack 8 may be realized with a single type of plate 100. However, plates of different designs may be used in the pack 8 of the PHE 2.

[0090] The depicted plate 100 of Fig. 5 may in practice be formed by being cut from sheet metal which is pressed to become generally speaking corrugated or patterned. The depicted plate of 100 may be formed of an essentially rectangular sheet of stainless steel. Other materials are, however, conceivable as is known in the art.

[0091] Further, the illustrated region of the plate 100 in Fig. 5 comprises a porthole 114 to the right and porthole 116 to the left. The porthole 116 to the left is only partially shown in Fig. 5. The porthole 114 is for receiving or ejecting a first fluid, whereas the porthole 116 is for receiving or ejecting a second fluid, between which fluids heat is to be transferred. The function of the portholes 114, 116 are as such known in the art and will not be discussed in further detail herein. In the following, the porthole 114 to the right will however be discussed to some extent when describing the interrelation between

the plate 100 and the gasket arrangement 300.

[0092] In the following, the gasket arrangement 300 of Fig. 5 will be discussed in greater detail. In doing so, the plate 100 of Fig. 5 will also be discussed to a relevant extent to more clearly describe the function of the gasket arrangement 300.

[0093] As illustrated in Fig. 5, the gasket arrangement 300 comprises an inner segment 350. The depicted inner segment 350 is arranged on a first side 104 of the plate 100 where it circumscribes the port hole 114. The depicted inner segment 350 is generally speaking a ring shaped port hole gasket 350, i.e. a ring shaped gasket or gasket segment circumscribing the port hole 114. The inner segment 350 is consequently configured to seal around the port hole 114 between adjacent plates 100 when the plate 100 is arranged in a stacked configuration in a pack 8 of heat exchanger plates 100, i.e. as illustrated in Figs. 3 and 4. It is, however, to be noted that the inner segment 350 may be adapted to at least partially circumscribe a port hole 114 of a heat exchanger plate 100.

[0094] Further, in case the plate 100 forms part of a cassette 200, like in Fig. 5, the inner segment 350 will seal between adjacent plates 100 of adjoining cassettes 200 when arranged in a stacked configuration, i.e. in a pack 8 of the type illustrated in Fig. 4. In other words, in case the plate 100 forms part of a cassette 200, the inner segment 350 will seal between adjacent cassettes 200. Although a semi welded PHE utilizes generally speaking permeation tight welded cassettes 200, the fluid flowing through the welded plate interspaces or channels of the cassettes 200 will when flowing between cassettes 200 via portholes 114 flow past inner segments 350 of the type depicted in Fig. 5. As a consequence, fluids prone to permeating gasket materials may, when flowing between cassettes 200 risk permeating the inner segments 350 of a pack 8 of cassettes 200. Ammonia is a typical example of a fluid prone to permeating the material of gaskets, such as the inner segment 350 of the gasket arrangement 300. Correspondingly, fluids prone to permeating gasket materials may when flowing between plates 100 of a gasketed PHE risk permeating the inner segments 350 of a pack 8 of plates 100. In the case of a gasketed PHE 2 the risk of a fluid permeating a gasket of some type is, for natural reasons, more outspoken. Despite this, the gasket arrangement of the present inventive concept may significantly reduce the risk of fluid having permeated the inner segment 350 from escaping the PHE 2 at hand in an uncontrolled manner. As a result, the working environment at the PHE 2 at hand may be made safer or better.

[0095] Further, the depicted gasket arrangement 300 of Fig. 5 comprises an outer segment 310. The outer segment 310 of the depicted gasket arrangement 300 of Fig. 5 is arranged on the first side 104 of the heat exchanger plate 100 where it circumscribes the inner segment 350. By the outer segment 310 circumscribing the inner segment 350 a permeation space 130 is defined between the inner segment 350 and the outer segment 310. In practice, the permeation space 130 is formed at

the first side 104 of the plate 100 between the inner segment 350 and the outer segment 310, when the inner segment 350 and the outer segment 310 of the gasket arrangement are arranged on the first side 104 of the plate 100. In this regard, it is to be understood that the so formed permeation space 130 will be open in a normal direction of the first side 102 of the plate 100 unless arranged in a stack of heat exchanger plates 100 or a stack of cassettes 200. However, when the heat exchanger plate 100 is arranged in a pack 8 of heat exchanger plates 100 a gasketed or sealed permeation space 130 will be formed along the first side 104 of the heat exchanger plate 100 between the inner segment 350 and the outer segment 310. It is, however, to be noted that the outer segment 310 may be adapted to at least partially circumscribe the inner segment 350 to define a permeation space 130 between the inner segment 350 and the outer segment 310.

[0096] Further, the depicted gasket arrangement 300 of Fig. 5 comprises an external segment 320. The external segment 320 defines an evacuation space 150. As clearly illustrated in Fig. 5, the evacuation space 150 is arranged outside the footprint area of the heat exchanger plate 100. In other words, the evacuation space 150 is arranged outside of the overall perimeter of the plate 100. It is, however, to be noted that the evacuation space 150 may be arranged partially outside the footprint area of the heat exchanger plate 100. Generally speaking, the external segment 120 defines an evacuation space 150 adapted to be arranged at least partially outside the footprint area of the heat exchanger plate 100. In this regard, it is to be understood that the so formed evacuation space 150 of Fig. 5 will be open in both normal directions of the first side 104 of the plate 100. However, when the heat exchanger plate 100 and the gasket arrangement 300 of Fig. 5 are arranged in a pack 8 of heat exchanger plates 100 or cassettes 200 the evacuation space 150 will in practice meet a corresponding evacuation space 150 of an adjoining external segment 320 of an adjoining gasket arrangement 300. This will be discussed further below.

[0097] Further, the depicted gasket arrangement 300 of Fig. 5 comprises a channel 330. The channel 330 is adapted to fluidly connect the permeation space 130 and the evacuation space 150. To this end, the channel 330 extends between the outer segment 310 and external segment 320. More specifically, the channel 330 extends between an outlet opening 312 through the outer segment 310 and an inlet opening 322 through the external segment 320.

[0098] A plate 100 and a gasket arrangement 300, such as the plate 100 and gasket arrangement 300 of Fig. 5, may jointly form a plate arrangement 400.

[0099] The overall function of the permeation space 130, the evacuation space 150 and the channel 330 will be described further below.

[0100] As clearly illustrated in Fig. 5, the channel 330 may be formed by a pipe element 332. Such pipe element

332 may as illustrated in Fig. 5 extend between the outlet opening 312 of the outer segment 310 and the inlet opening 322 of the external segment 320.

[0101] Further, the depicted pipe element 332 of may be formed from a material being different from a material of the outer segment 310 and from a material of the external segment 320. The outer segment 310 and the external segment 320 of Fig. 5 may typically be made of flexible materials which are suitable to seal against the plate 100 and an adjoining plate. The outer segment 310 and the external segment 320 of Fig. 5 may typically be made of polymer materials and/or elastomer materials. The outer segment 310 and the external segment 320 may typically be molded into a desired shape. Suitable materials for the outer segment 310 and the external segment 320 include but are not limited to hydrated nitrile materials, chloroprene materials, ethylene propylene diene monomer materials, nitrile butadiene rubber materials and fluoroelastomer materials. On the other hand, the pipe element 332 may be made of a material suitable for forming the channel 330. In other words, the pipe element 332 may be made of a material suitable for fluidly connecting the permeation space 130 and the evacuation space 150. Suitable materials for the pipe element 332 include but are not limited to plastic material, metal materials and glass materials.

[0102] The pipe element 332 of Fig. 5 may be molded into the material of the outer segment 310 and into the material of the external segment 320. In this way, a fluid tight connection may be established between the pipe element 332 and the outer segment 310 as well as between the pipe element 332 and the external segment 320. More specifically, a fluid tight connection may be established between the pipe element 332 and the outer segment 310 as well as between the pipe element 332 and the external segment 320 when forming the outer segment 310 and the external segment 320.

[0103] Further, as clearly illustrated in Fig. 5, the external segment 320 may comprise a loop portion 321 for defining the evacuation space 150. In practice, the external segment 320 may be formed of a loop portion 321 defining the evacuation space 150. However, the external segment 320 may comprise a loop portion 321 for at least partially defining the evacuation space 150.

[0104] Now also turning to Fig. 6. Fig 6. illustrates how the cassette 200 and the gasket arrangement 300 of Fig. 5 are stacked on top of another cassette 200a or an adjoining cassette 220a with a gasket arrangement 300a in between the cassettes 200, 200a. The cassette 200a is of the same type as the cassette 200. Further, the gasket arrangement 300a is the same type as the gasket arrangement 300. As clearly illustrated in Fig. 6, the external segment 320 comes into contact with the external segment 320a of the gasket arrangement 300a which is sandwiched between the cassettes 200, 200a. In this way, the evacuation space 150 of the gasket arrangement 300 fluidly connects to a corresponding evacuation space 150a of the external segment 320a of the gasket

arrangement 300a which is sandwiched between the cassettes 200, 200a. Thus, the evacuation spaces 150, 150a may be said to form a joint evacuation space.

[0105] Now turning to Fig. 7. Fig 7 illustrates a plate 100 and a gasket arrangement 300 of a design similar to the plate 100 and gasket arrangement 300 of Fig. 5. Given the similarities, only relevant differences will be described hereinafter. In Fig. 7, the external segment 320 and the therein defined evacuation space 150 are arranged partially within the footprint area of the plate 100, as opposed to the external segment 320 and the therein defined evacuation space 150 of Fig. 5 which are arranged entirely outside of the footprint area of the associated plate 100. However, the external segment 320 and the therein defined evacuation space 150 of Fig. 7 are arranged partially outside of the footprint area of the plate 100. More specifically, as illustrated in Fig. 7, the external segment 320 is partially arranged or received in a support slot 110 formed at the perimeter of the plate 100. In this way, the portion of the external segment 320 which is not arranged in the support slot 110 is arranged outside of the footprint area of the plate 100, whereas the portion of the of the external segment 320 which is arranged in the support slot 110 is arranged inside of the footprint area of the plate 100. It is however to be noted that the external segment 320 is arranged outside of the plate 100 in the sense that it does not overlap with the plate 100. Furthermore, the external segment 320 and the therein defined evacuation space 150 are located at a corner region of the plate 100. Further, the support slot 110 is configured to receive and support the external segment 320. More specifically, the support slot 110 has a dimension such that the external segment 320 fits in the support slot with a press fit. In this way, the support slot 110 may support the external segment 320 and prevent or counteract the external segment 320 from moving unintentionally in relation to the plate 100. Further, the channel 330 and consequently the pipe element 332 are made shorter as compared to the channel 330 and the pipe element 332 of Fig. 5.

[0106] Now turning to Figs. 8 and 9. Fig 8 illustrates a plate 100 and a gasket arrangement 300. The plate 100 of Fig. 8 is of the same type as the plate 100 in Fig. 7. The gasket arrangement 300 of Fig 8 has a design similar to the gasket arrangement 300 of Fig. 7. Fig. 9 illustrates the outer segment 310, the channel 330 and the external segment 320 of the gasket arrangement 300 of Fig. 8 in isolation. Thus, Fig. 9 illustrates the gasket arrangement 300 of Fig. 8 without the inner segment 350. Given the similarities, only relevant differences will be described hereinafter. The external segment 320 of the gasket arrangement 300 of Figs. 8 and 9 is provided with a support member 324. The support member 324 is designed to be sandwiched between a pair of adjoining plates 100. Thus, the support member 324 is designed to be sandwiched between a pair of adjoining plates 100 of a cassette 200. The depicted support member 324 includes a pair tongues 324a, 324b which are adapted to

be inserted into a void formed between a pair of adjoining plates 100. In general terms, the support member 324 is adapted to engage with the heat exchanger plate 100 for supporting the external segment 320. It is to be noted that the external member may comprise more than one support member 324.

[0107] Now turning to Figs. 10 and 11. Fig. 10 illustrates a detailed perspective view of a corner region of a cassette 200, comprising a pair of plates 100, and a gasket arrangement 300. Fig. The plates 100 of Fig. 10 are of the type illustrated in Fig. 8 and will not be discussed further here. The inner segment 350 of the gasket arrangement 300 is of the type discussed in detail above with reference to Fig. 5. The outer segment 310 of the gasket arrangement 300 is in large the type discussed in detail above with reference to Fig. 5. However, the external segment 320 and the channel 330 are designed and formed differently. Given this, the design of the external segment 320 and the channel 330 of Figs. 10 and 11 will be discussed hereinafter.

[0108] As illustrated in Figs. 10 and 11, the channel 330 may comprise a first channel element 334 extending between the outer segment 310 and the external segment 320. Further, the channel 330 may comprise a second channel element 336. The second channel element 336 is adapted to abut the first channel element 334 as illustrates in Fig. 11. In this way, the first channel element 334 and the second channel element 336, when in abutment, will jointly fluidly connect the permeation space 130 and the evacuation space 150.

[0109] To this end, the first channel element 334 may be provided with a first channel groove 335. The first channel groove 335 may, as best illustrated in Fig. 11, be formed of a groove segment 335a on one side of the first channel element 334 and a groove segment 335b on an opposite side of the first channel element 334. In this way, as illustrated in Fig. 11, the first channel groove 335 may extend between the outlet opening 312 of the outer segment 310 and the inlet opening 322 of the external segment 320.

[0110] Further, as illustrated in Figs. 10 and 11, the second channel element 336 may comprise a second channel groove 337. As best illustrate in Fig. 11, the second channel groove 337 may extend partially between the outlet opening 312 of the outer segment 310 and the inlet opening 322 of the external segment 320. Given the abutment between the first channel element 334 and the second channel element 336, the first channel groove 335 and the second channel groove 337 will jointly fluidly connect the permeation space 130 and the evacuation space 150 as illustrated in Fig. 11.

[0111] It is however to be understood that the first channel groove 335 and/or the second channel groove 337 may extend partially between the outlet opening 312 of the outer segment 310 and the inlet opening 322 of the external segment 320 and still jointly fluidly connect the permeation space 130 and the evacuation space 150.

[0112] Further, as illustrated in Figs. 10 and 11, the

external segment 320 may include a first external segment element 326 integrally formed with the first channel element 334. Correspondingly, the external segment 320 may include a second external segment element 328 integrally formed with the second channel element 336. The first external segment element 326 and the second external segment element 328 may be designed so as to abut each other as illustrated in Fig. 11. In this way, the first external segment element 326 and the second external segment element 328 may jointly define the evacuation space 150 when in abutment. Put differently, the first external segment element 326 and the second external segment element 328 may jointly form the external segment 320 when in abutment as illustrated in Fig. 11.

[0113] Further, as illustrated in Figs. 10 and 11, the first external segment element 326 and the second external segment element 328 may be connected to each other via a flexible connection section 329. The flexible connection section 329 may generally speaking be adapted to guide the second external segment element 328 to abut the first external segment element 326, i.e. as illustrated in Fig. 11. In this way, the first external segment element 326 and the second external segment element 328, when in abutment, may jointly define the evacuation space 150.

[0114] While Figs. 10 and 11 illustrate a particular design of the flexible connection section 329, it is to be understood that the design of the flexible connection section 329 may vary greatly. For instance, the flexible connection section 329 may be formed as a hinge which when folded guides the second external segment element 328 to abut the first external segment element 326 in an indented position.

[0115] The first and second channel elements 334, 336, the first and second external segment elements 326, 328, and/or the flexible connection section 329 may be provided with guiding means 340 generally designed or adapted to guide respective details into their intended positions when in the abutting state illustrated in Fig. 11. The design of such guiding means 340 may vary greatly. For instance, such guiding means 340 may include protrusions 340a and mating openings 340b. For instance, such guiding means 340 may include a groove 340c and a mating extended protrusion 340d.

[0116] The extensions of the first and second channel elements 334, 336, the first and second external segment elements 326, 328, and the flexible connection section 329 are indicated by a set of parallel hatched lines in Fig. 10. Hatched lines serving the same purpose are also indicated in Fig. 11.

[0117] In practice, and as is illustrated in Figs. 10 and 11, the outer segment 310, the first and second channel elements 334, 336, the first and second external segment elements 326, 328, and the flexible connection section 329 may be integrally formed.

[0118] Now turning to Fig. 12. Fig. 12 illustrates a detailed perspective view of a corner region of a cassette

200 comprising a pair of plates 100 and a gasket arrangement 300. The plates 100 of Fig. 12 are of the type illustrated in Fig. 8 and will not be discussed further here. The gasket arrangement 300 is in large of the type discussed in detail above with reference to Figs. 10 and 11. However, in Fig. 12, the channel 330 and the external segment 320 are differently designed. More specifically, as illustrated in Fig. 12, the channel 330 of the gasket arrangement 300 comprises a first channel element 334 extending between the outer segment 310 and the external segment 320, i.e. like in Figs. 10 and 11. However, the gasket arrangement 300 of Fig. 12 further includes a further channel element 338. The further channel element 338 is designed and hence adapted to be arranged on a second side 106, opposite to the first side 104, of the heat exchanger plate 100, as illustrated in Fig. 12. In Fig. 12, the further channel element 338 is in practice arranged below both plates 100 forming the cassette 200, thus at the same time being arranged at the second side 106 of the upper plate 100 of Fig. 12. The further channel element 338 is consequently designed to form at least a portion of an adjacent channel, i.e. a lower channel in Fig. 12.

[0119] Further, as illustrated in Fig. 12, a first external segment element 326 may be integrally formed with the first channel element 334, i.e. like in Figs. 10 and 11. Moreover, a further external segment element 327 may be integrally formed with the further channel element 338. Further, the first external segment element 326 and the further external segment element 327 may be connected to each other via a flexible connection section 329. The flexible connection section 329 may be adapted to guide the further external segment element 327 and the further channel element 338 to an intended position on the second side 106 of the heat exchanger plate 100. Thus, the flexible connection section 329 of Fig. 12 has an overall similar purpose as the flexible connection section 329 of Figs. 10 and 11, although the further external segment element 327 and the further channel element 338 are guided to the second side 106 of the plate 100.

[0120] Now turning to Fig. 13. Fig 13 illustrates a region of cassette 200, formed of two plates 100, and a gasket arrangement 300. The gasket arrangement 300 is of a different design compared to the above described gasket arrangements 300. In the gasket arrangement 300 of Fig. 13, the channel 330 includes two pipe elements 332 extending in parallel. In this way, the cross sectional area of the channel 330 may be doubled. More specifically, the cross sectional area of the channel 330 may be doubled while maintaining a height of the channel 330. It is however to be noted that when the channel 330 includes more than one pipe element 332, the pipe elements 332 may extend in any suitable direction. According to an example, the channel 330 may include two pipe elements 332 extending in a normal or radial direction of the outer segment 310.

[0121] In general, in the above described designs of

the gasket arrangement, the external segment 320 may be adapted to abut an adjoining external segment 320a of an adjoining gasket arrangement 300, 300a. In this way, the evacuation space 150 and an evacuation space 150a of the adjoining external segment 320a may fluidly connect. Thus, the evacuation space 150 and an evacuation space 150a of an adjoining external segment 320a may jointly form a joint evacuation space. Such joint evacuation space may thus extend a stacking direction of a plurality of stacked heat exchanger plates. In practice, such joint evacuation space may extend across all plates 100 or cassettes 200 of a pack 8 of a type illustrated in Figs. 1-4.

[0122] Now turning to Figs. 14 and 15. Fig. 14 illustrate a plane view of a corner region of a plate 100 and a gasket arrangement 300. Fig. 15 schematically illustrates an upper portion of a PHE 2 generally of the type illustrated in Figs. 1 and 2. Above it has been thoroughly described with reference to Figs. 5-13, for various designs of the gasket arrangement 300, how the gasket arrangement 300 includes an external segment 320 which in practice is adapted to abut an adjoining external segment 320a of an adjoining gasket arrangement 300a. However, as illustrated in Figs. 14 and 15, the external segment 320 may constitute a portion of an external member 325. Thus, such external member 325 may be a single element or part of which different portions or sections are associated with different gasket arrangements 300. To this end, the external member 325 may as schematically illustrated in Fig. 15 extend in a stacking direction SD of a plurality of stacked heat exchanger plates 100 of a pack 8 of a PHE 2. In this way, the external member may define a joint evacuation space 152 for the plurality of stacked heat exchanger plates 100. In this regard, it is to be noted that the use of an external member 325 of the above described type is equally applicable for of a plurality of stacked heat exchanger cassettes 200 of a pack 8 of a PHE 2. Thus, the use of an external member 325 of the above described type is equally applicable for gasketed PHEs 2 and semi welded PHEs 2, as generally described and discussed in relation to Figs. 1-4.

[0123] The external member 325 may as illustrated in Figs. 14 and 15 be a rigid bar which is open in a direction facing the pack 8 of plates 100. In such a case, the channel 330 may generally speaking comprise or be formed of seals 330a, 330b as illustrated in Fig. 14. In such a case, the channel 330 may relatively speaking have a short extension and extend between an outlet opening 312 through the outer segment 310 and an inlet opening 322 through the external segment 320, i.e. a portion or section of the external member 325 associated with the gasket arrangement 300.

[0124] Other designs of the external member 325 are, however, conceivable. The external member 325 may, for example, be formed of a pipe or a hose. Such pipe or hose may have a respective inlet opening for each channel 330 of a plurality of gasket arrangements 300, 300a.

[0125] In the following the main aspects of the interplay

between the different elements and features of the plate 100 and the gasket arrangement 300 will be briefly discussed. As already explained, fluid may permeate the inner segment 350 meaning that fluid may escape through the material of the inner segment 350 although the inner segment 350 as such is intact. By the outer segment 310 circumscribing or at least partially circumscribing the inner segment 350, fluid having permeated through the inner segment 350 may be caught in the permeation space 130, i.e. between the inner segment 350 and the outer segment 310. Such permeated fluid may then reach the evacuation space 150 via the channel 330. The fluid may then be evacuated from the pack 8 of the PHE 2 at hand via a plurality of aligned or substantially aligned evacuation spaces 150 forming a joint evacuation space. To this end, the frame plate 4 of the PHE 2 at hand may be provided with an evacuation outlet. Alternatively or additionally, one or more of the external segments 320, 320a may be provided with an outlet opening extending therethrough. By the one or more external segments 320, 320a having an outlet opening extending therethrough, fluid may be allowed to exit the evacuation space 150 or joint evacuation space via the outlet opening.

[0126] Alternatively or additionally, the fluid may be evacuated from the pack 8 of the PHE 2 at hand via an external member 325 of the above described type defining a joint evacuation space 152. To this end, the external member 325 may be provided with an evacuation opening 323 as illustrated in Fig. 15. Thus, such evacuation opening 323 may be used to evacuate permeated fluid form a plurality of permeation spaces 130 via the external member 325.

[0127] Further outlet openings of the above described type may for instance be connected to a vacuum source, such as a vacuum pump, or may be connected to a funnel for ventilating the permeated fluid to a safe location, such as to the outside of a room where the PHE 2 is located. Moreover, when outer segment 310 is provided with one or more inlet openings, a forced flow of air may be provided through the permeation space 130 and out of the evacuation space 150 via the channel 330.

[0128] However, the elements and features of the plate 100 and the gasket arrangement 300 may be used in different ways. For instance, an inert gas, such as nitrogen, may be provided to the permeation space 130 via the evacuation space 150 and the channel 330. In this way, the inner segment 350 may be prevented or counteracted from being affected by substances present in the ambient surrounding the PHE 2 at hand. In this way, the lifetime of the inner segment 350 may be prolonged. In such a case, the outer segment 310 may to advantage be void of any inlet openings.

[0129] Another use for the elements and features of the plate 100 and the gasket arrangement 300 is to pressurize the permeation space 130 by forcing a gas into the permeation space 130 via the evacuation space 150 and the channel. By providing an overpressure to the per-

meation space 130 a significant reduction of fluid permeating through the inner segment 350 may be achieved since the overpressure will act as counterpressure. In such a case, the outer segment 310 may to advantage be void of any inlet openings.

[0130] Further, 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. Some details in the figures may also be exaggerated for the sake of clarity. 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.

[0131] It will be appreciated that the present inventive concept is not limited to the variants and examples shown. Several modifications and variations are thus conceivable within the scope of the invention which thus is defined by the appended claims.

Claims

1. A gasket arrangement (300, 300a) for a plate heat exchanger (2) comprising:

an inner segment (350) adapted to be arranged on a first side (104) of a heat exchanger plate (100, 100a) and to at least partially circumscribe a port hole (114) of the heat exchanger plate (100, 100a),

an outer segment (310) adapted to be arranged on the first side (104) of the heat exchanger plate (100, 100a) and to at least partially circumscribe the inner segment (350) to define a permeation space (130) between the inner segment (350) and the outer segment (310),

an external segment (320, 320a) defining an evacuation space (150, 150a) adapted to be arranged at least partially outside a footprint area of the heat exchanger plate (100, 100a), and

a channel (330) adapted to fluidly connect the permeation space (130) and the evacuation space (150, 150a) by extending between an outlet opening (312) through the outer segment (310) and an inlet opening (322) through the external segment (320).

2. The gasket arrangement (300, 300a) according to claim 1, wherein the channel (330) comprises a pipe element (332) extending between the outlet opening (312) of the outer segment (310) and the inlet opening (322) of the external segment (320).

3. The gasket arrangement (300, 300a) according to claim 2, wherein the pipe element (332) is formed from a material being different from a material of the outer segment (310) and from a material of the

external segment (320).

4. The gasket arrangement (300, 300a) according to claim 2 or 3, wherein the pipe element (332) is molded into the material of the outer segment (310) and into the material of the external segment (320).

5. The gasket arrangement (300, 300a) according to any one of the preceding claims, wherein the external segment (320) comprises a loop portion (321) for at least partially defining the evacuation space (150).

6. The gasket arrangement (300, 300a) according to claim 1, wherein the channel (330) comprises a first channel element (334) extending between the outer segment (310) and the external segment (320), and a second channel element (336) adapted to abut the first channel element (334) such that the first channel element (334) and the second channel element (336), when in abutment, jointly fluidly connect the permeation space (130) and the evacuation space (150).

7. The gasket arrangement (300, 300a) according to claim 6, wherein the first channel element (334) comprises a first channel groove (335) extending at least partially between the outlet opening (312) of the outer segment (310) and the inlet opening (322) of the external segment (320), and/or wherein the second channel element (336) comprises a second channel groove (337) extending at least partially between the outlet opening (312) of the outer segment (310) and the inlet opening (322) of the external segment (320), wherein the first channel groove (335) and/or the second channel groove (337) are adapted to fluidly connect the permeation space (130) and the evacuation space (150).

8. The gasket arrangement (300, 300a) according to claim 6 or 7, wherein the external segment (320) comprises a first external segment element (326) integrally formed with the first channel element (334), and a second external segment element (328) integrally formed with the second channel element (336), wherein the first external segment element (326) and the second external segment element (328) are adapted to abut each other, such that the first external segment element (326) and the second external segment element (328) jointly define the evacuation space (150) when in abutment.

9. The gasket arrangement (300, 300a) according to claim 8, wherein the first external segment element (326) and the second external segment element (328) are connected to each other via a flexible connection section (329) adapted to guide the second external segment element (328) to abut the first

external segment element (326), such that the first external segment element (326) and the second external segment element (328), when in abutment, jointly define the evacuation space (150).

10. The gasket arrangement (300, 300a) according to claim 1, wherein the channel (330) comprises a first channel element (334) extending between the outer segment (310) and the external segment (320), and wherein the gasket arrangement (300, 300a) further comprises a further channel element (338) adapted to be arranged on a second side (106), opposite to the first side (104), of the heat exchanger plate (100, 100a) to form at least a portion of an adjacent channel.

11. The gasket arrangement (300, 300a) according to claim 10, wherein a first external segment element (326) is integrally formed with the first channel element (334) and a further external segment element (327) is integrally formed with the further channel element (338), and wherein the first external segment element (326) and the further external segment element (327) are connected to each other via a flexible connection section (329) adapted to guide the further external segment element (327) and the further channel element (338) to an intended position on the second side (106) of the heat exchanger plate (100, 100a).

12. The gasket arrangement (300, 300a) according to any one of the preceding claims, wherein the external segment (320, 320a) is adapted to abut an adjoining external segment (320, 320a) of an adjoining gasket arrangement (300, 300a) such that the evacuation space (150, 150a) and an evacuation space (150, 150a) of the adjoining external segment (320, 320a) fluidly connect.

13. The gasket arrangement (300, 300a) according to any one of the preceding claims, wherein the external segment (320, 320a) comprises one or more support members (324) adapted to engage with the heat exchanger plate (100, 100a) for supporting the external segment (320, 320a).

14. The gasket arrangement (300, 300a) according to claim 1, wherein the external segment (320, 320a) constitutes a portion of an external member (325) adapted to extend in a stacking direction (SD) of a plurality of stacked heat exchanger plates (100, 100a) for defining a joint evacuation space (152) for the plurality of stacked heat exchanger plates (100).

15. A plate arrangement (400) for a plate heat exchanger, comprising:

a gasket arrangement (300, 300a) according to any one of the preceding claims, and
a heat exchanger plate (100, 100a).

16. The plate arrangement according to claim 15, wherein the heat exchanger plate (100), at its perimeter, comprises a support slot (110) configured to receive and support the external segment (320, 320a).

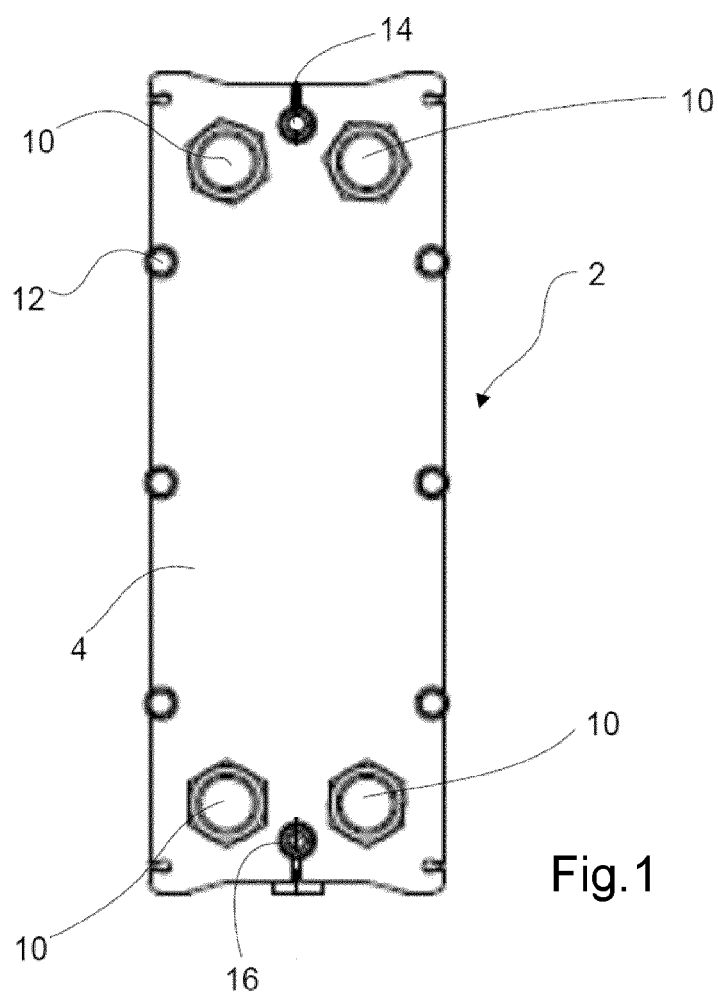


Fig.1

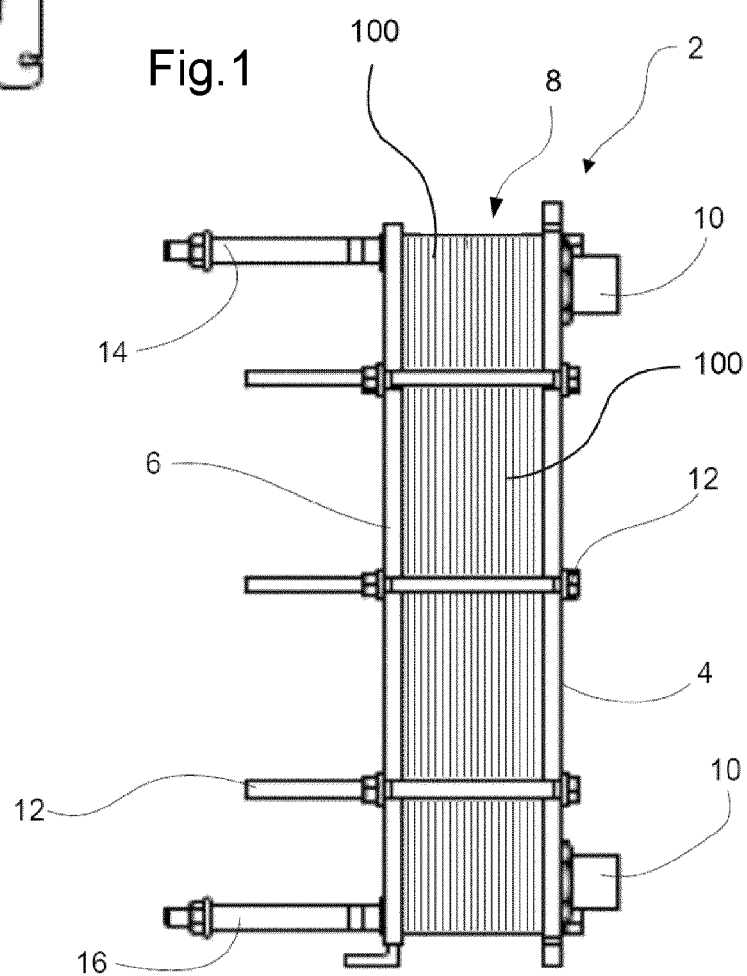


Fig.2

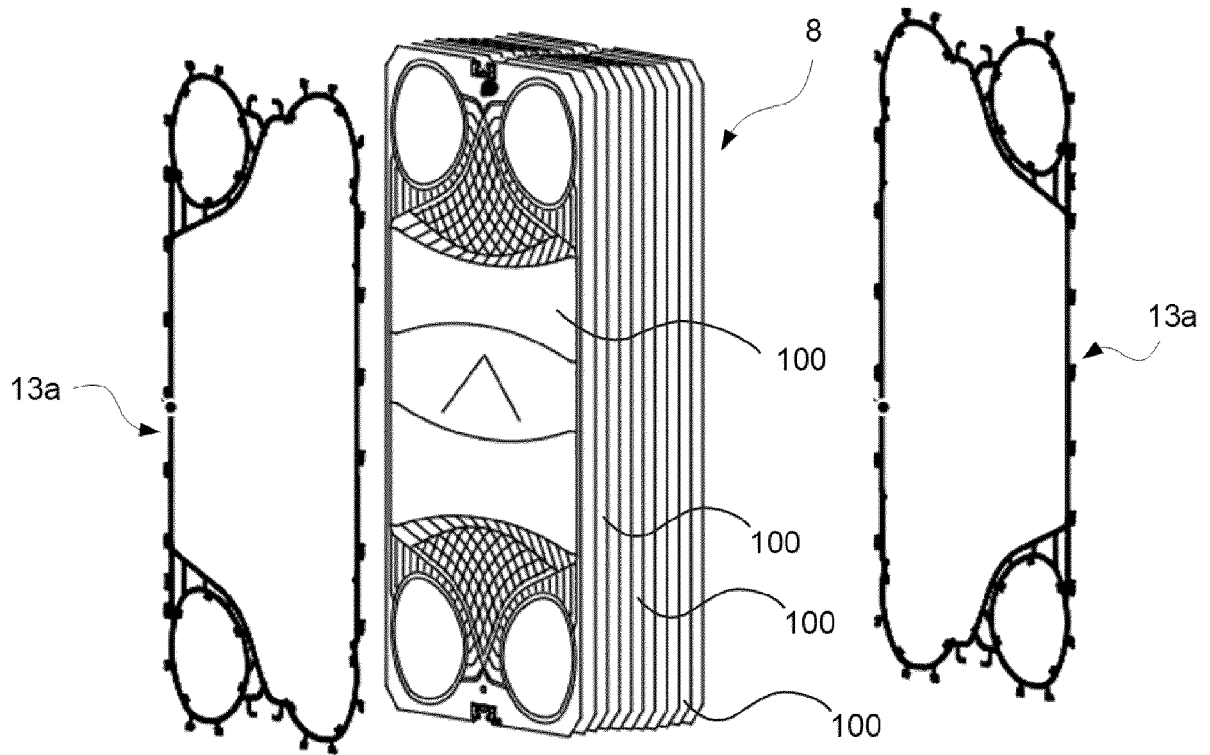


Fig. 3

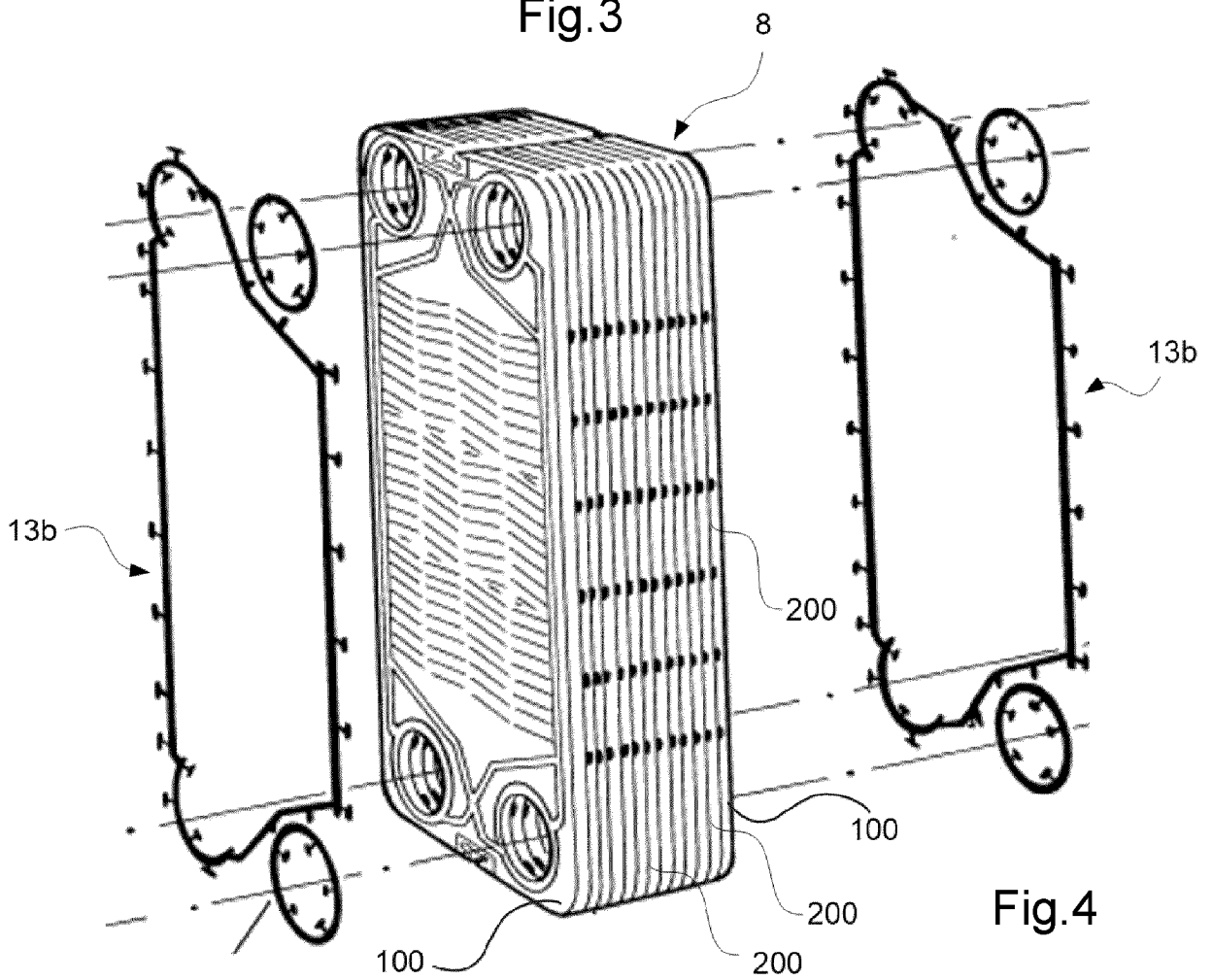


Fig. 4

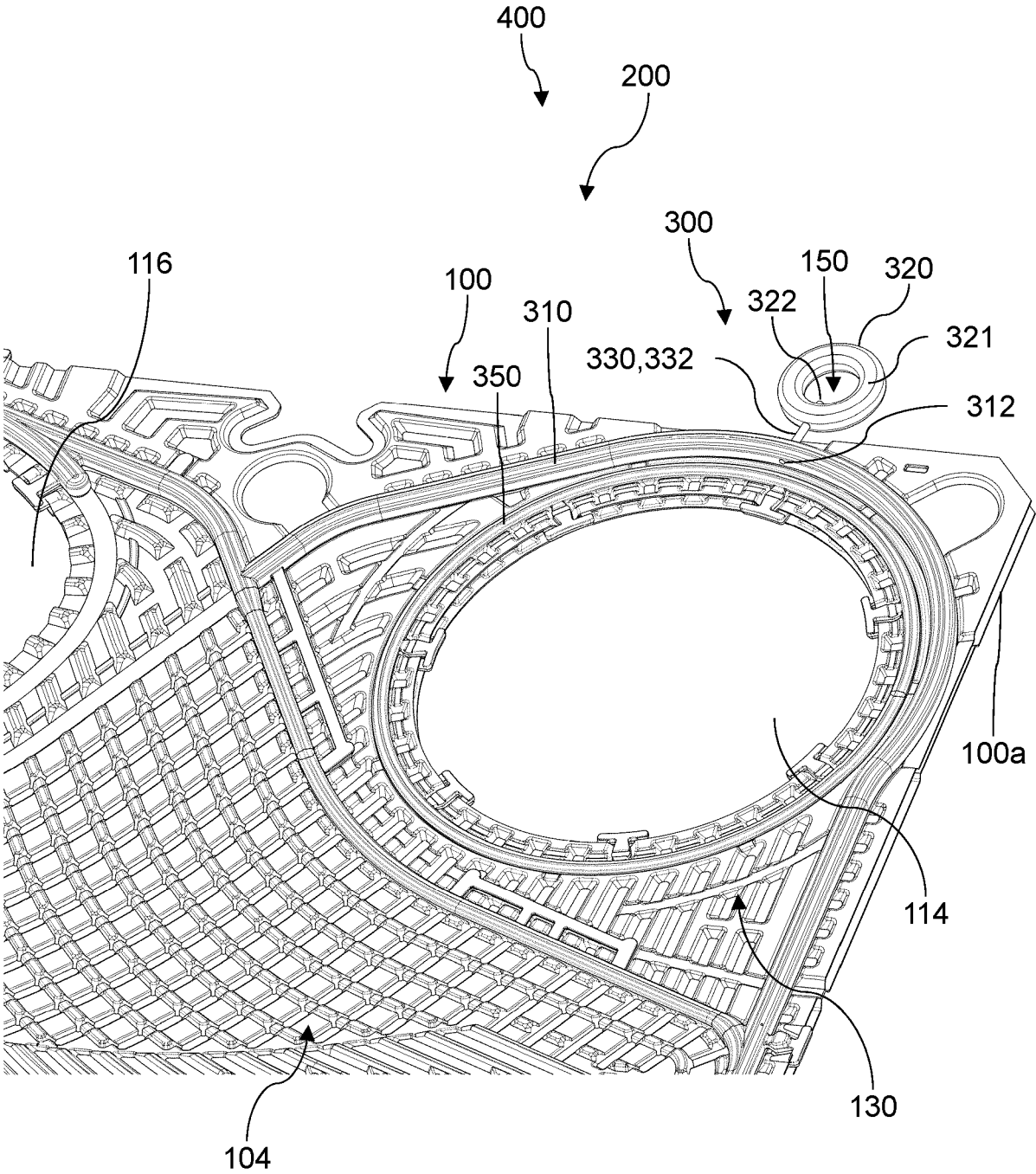


Fig.5

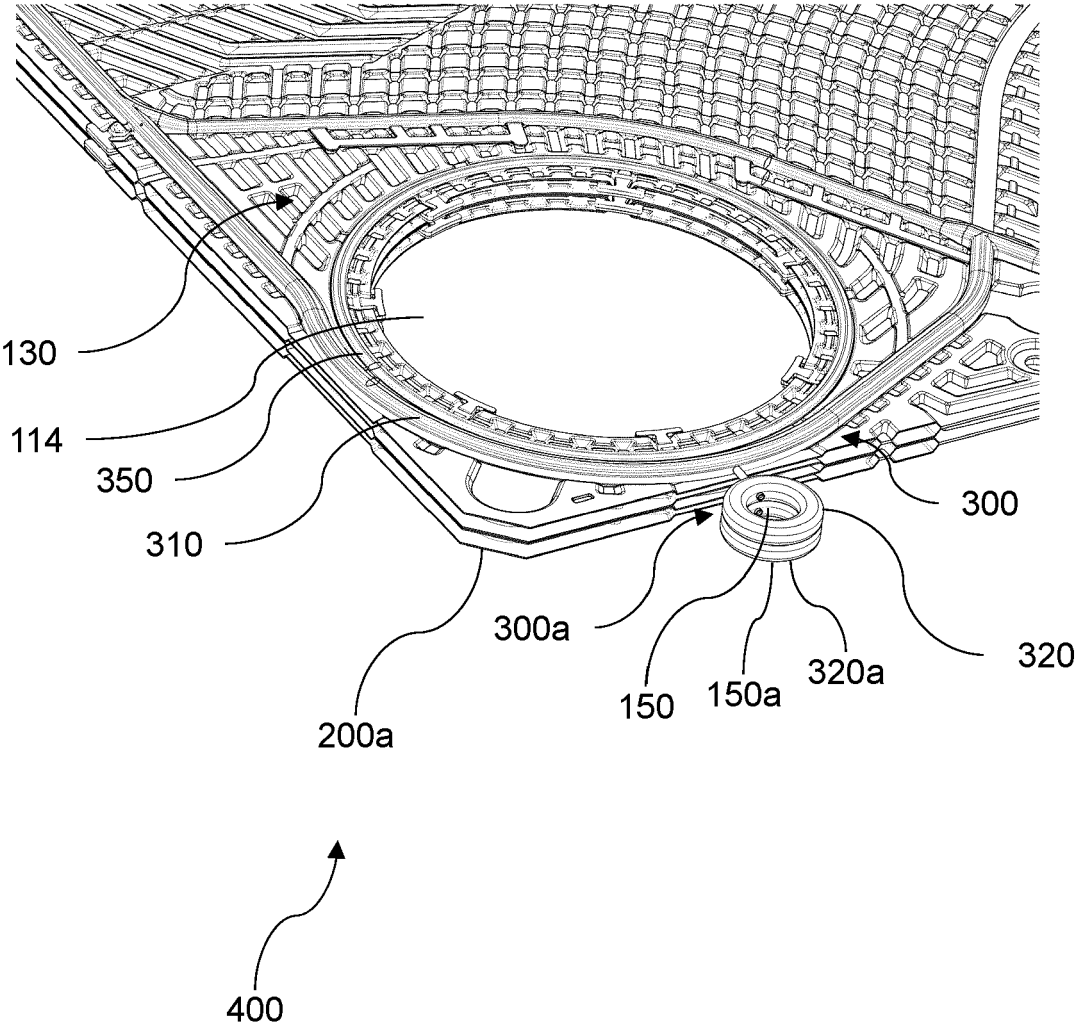


Fig.6

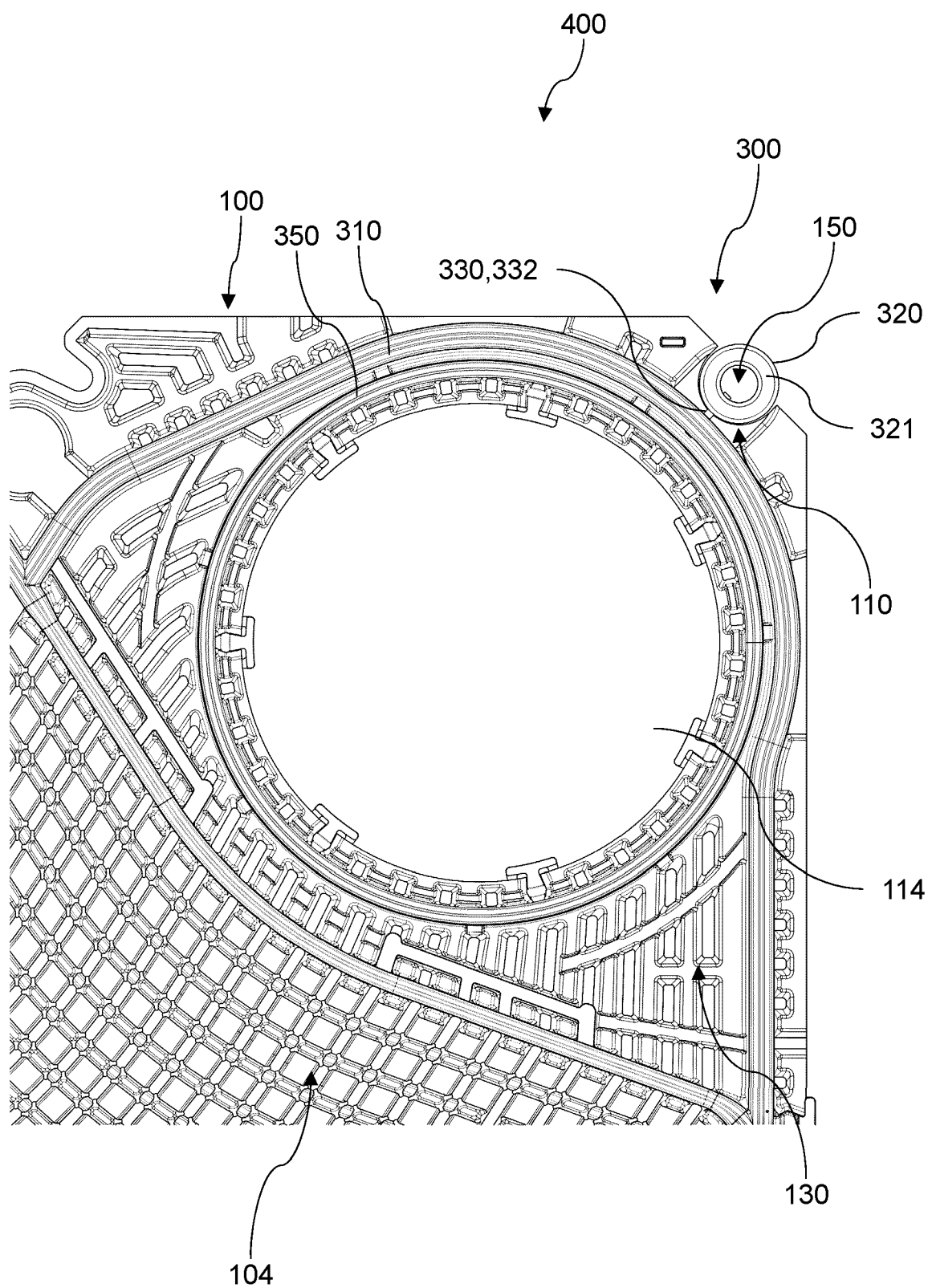


Fig.7

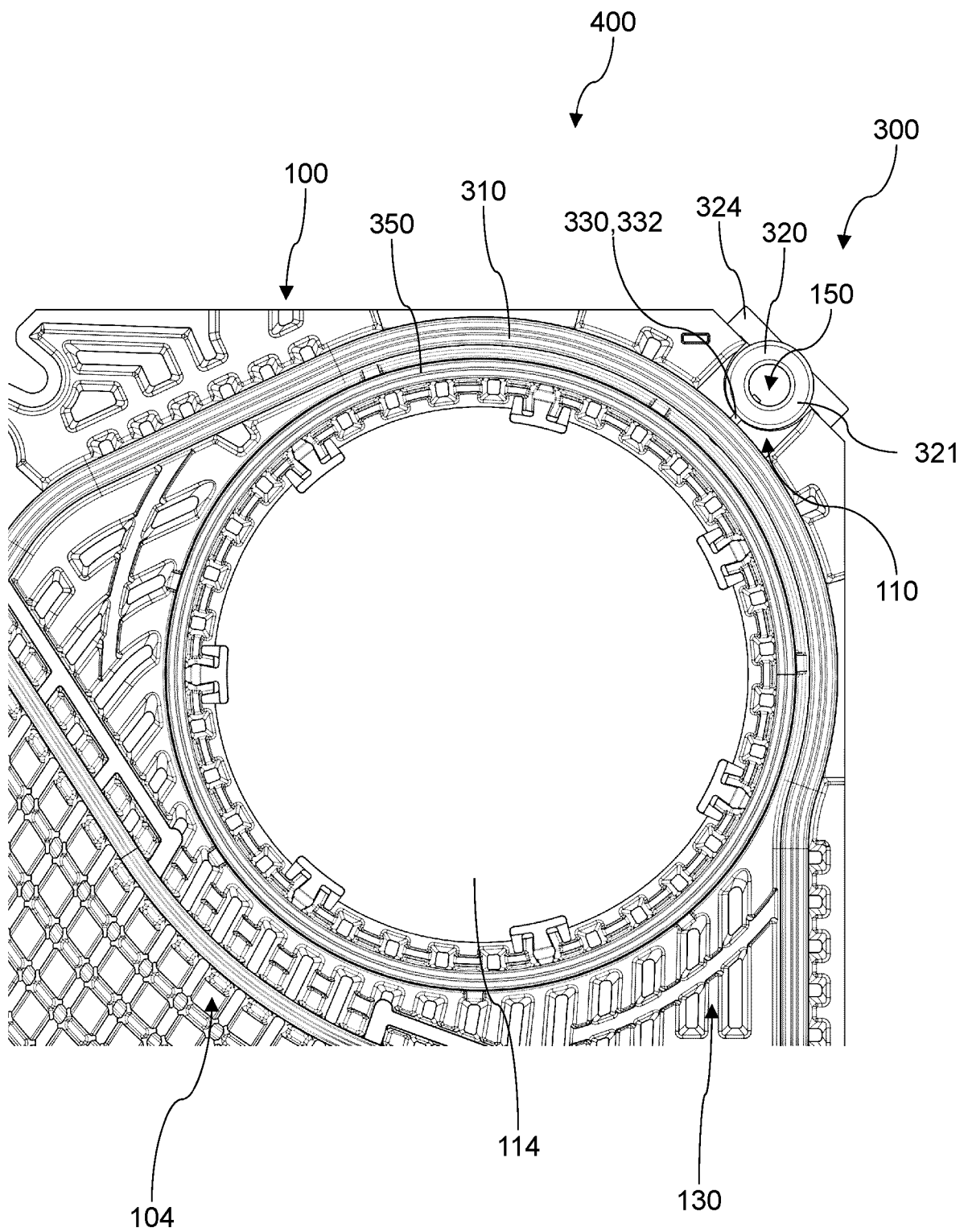


Fig.8

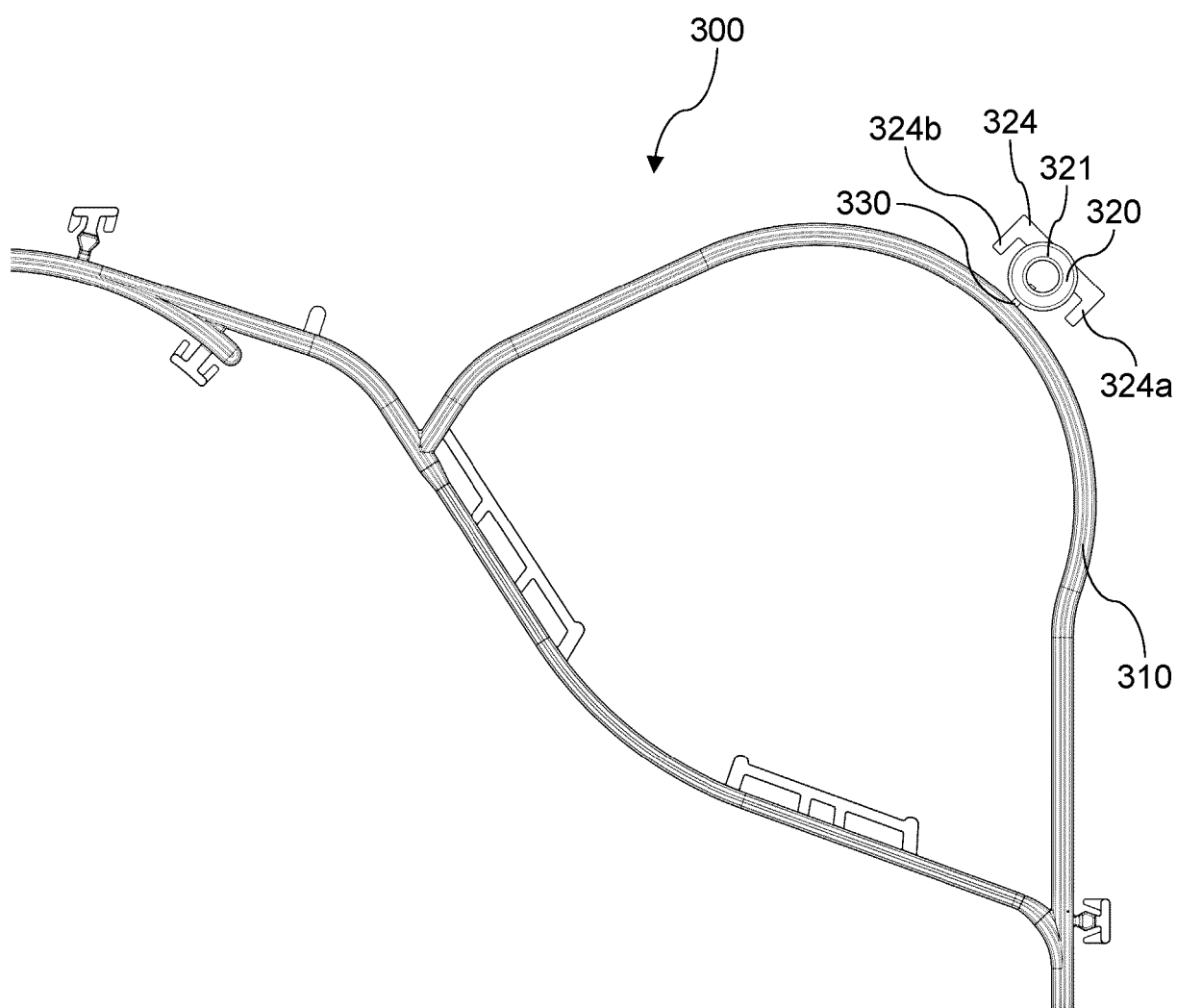


Fig.9

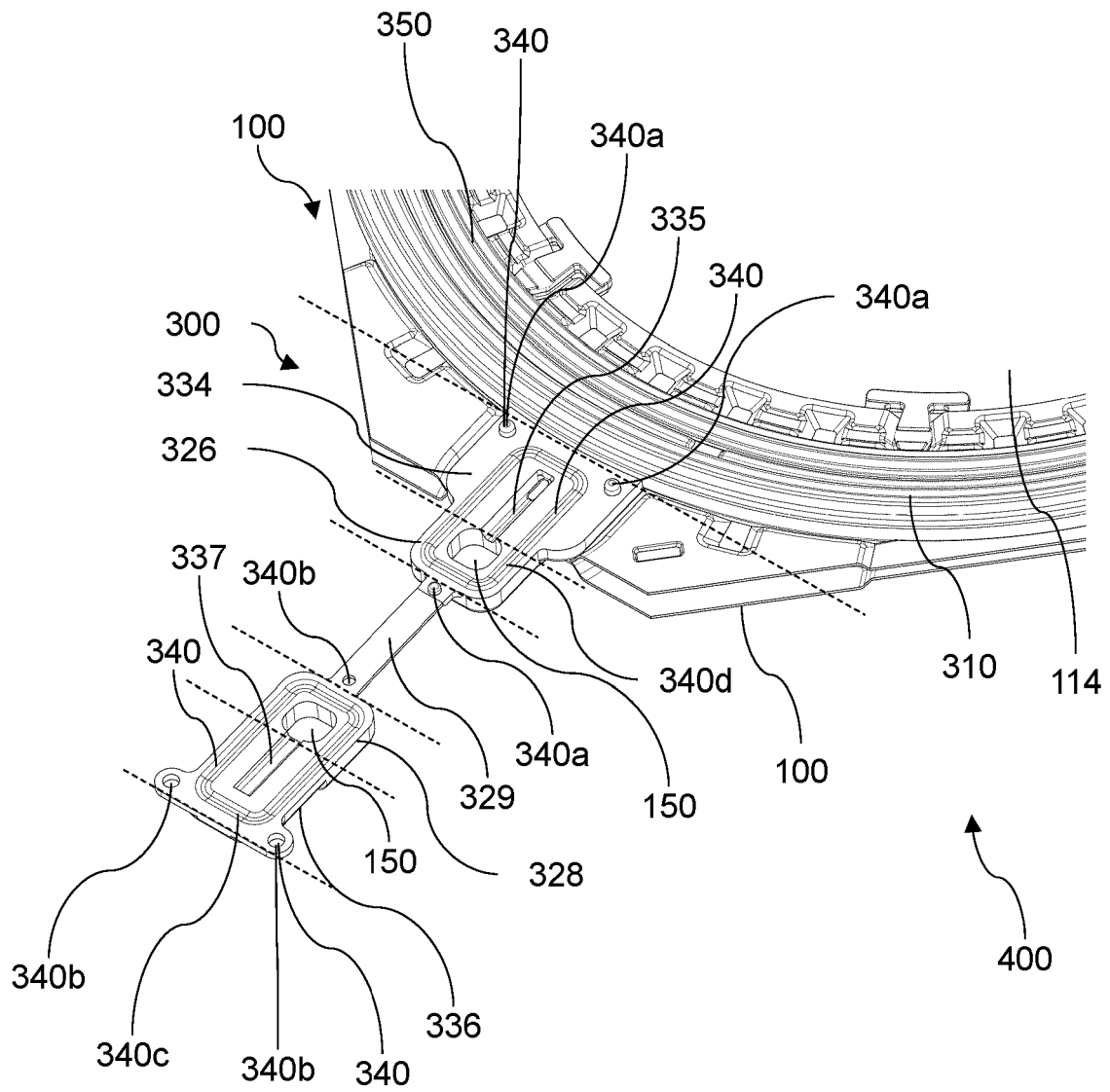


Fig.10

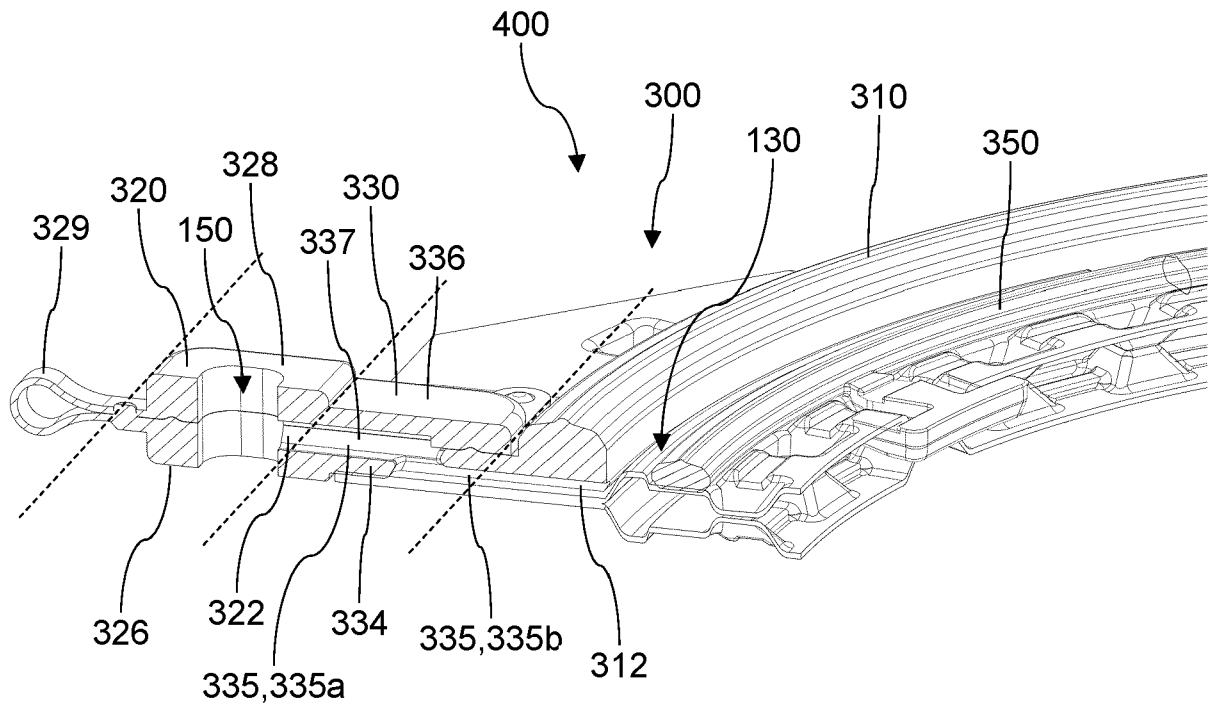


Fig.11

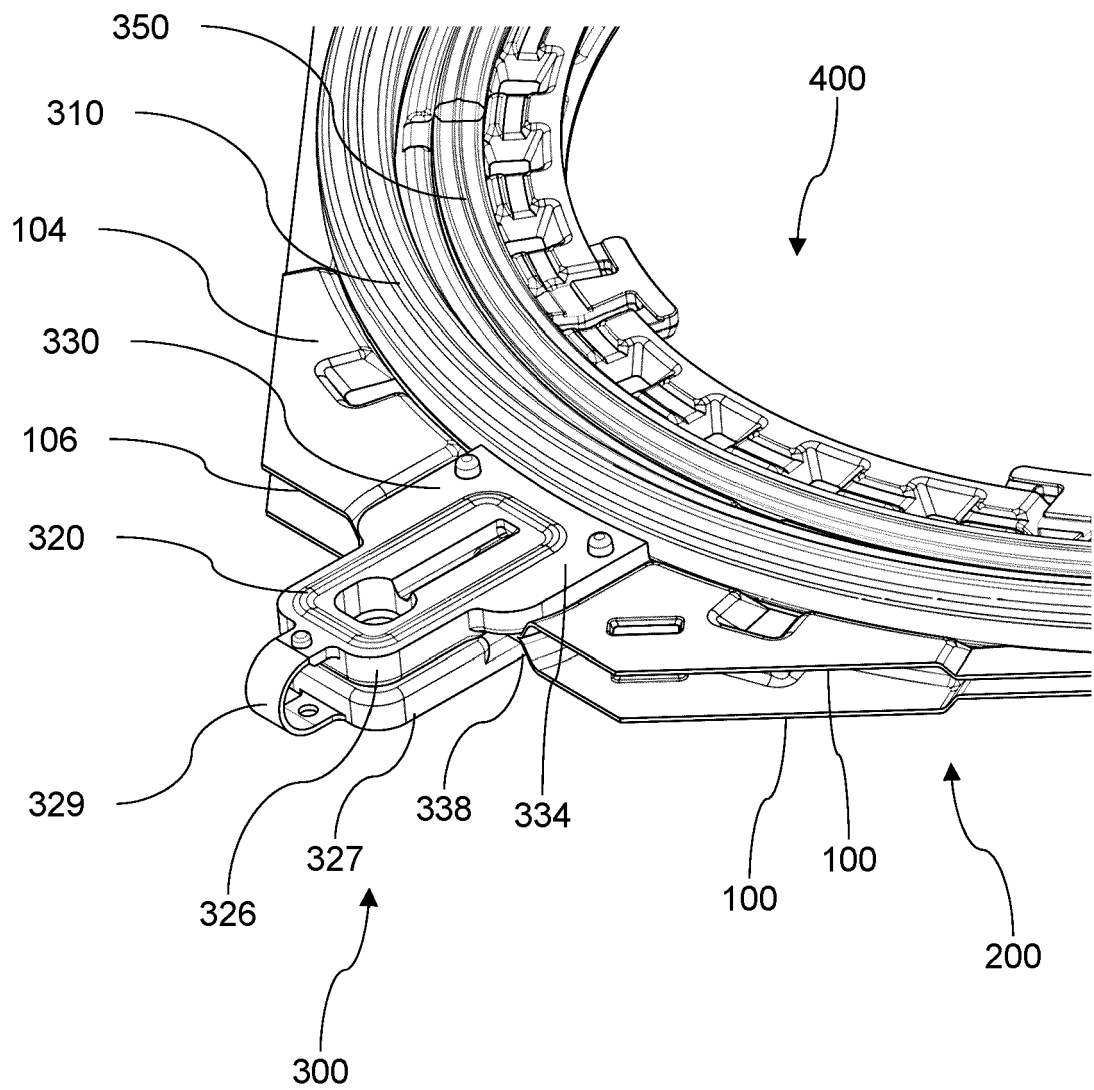


Fig.12

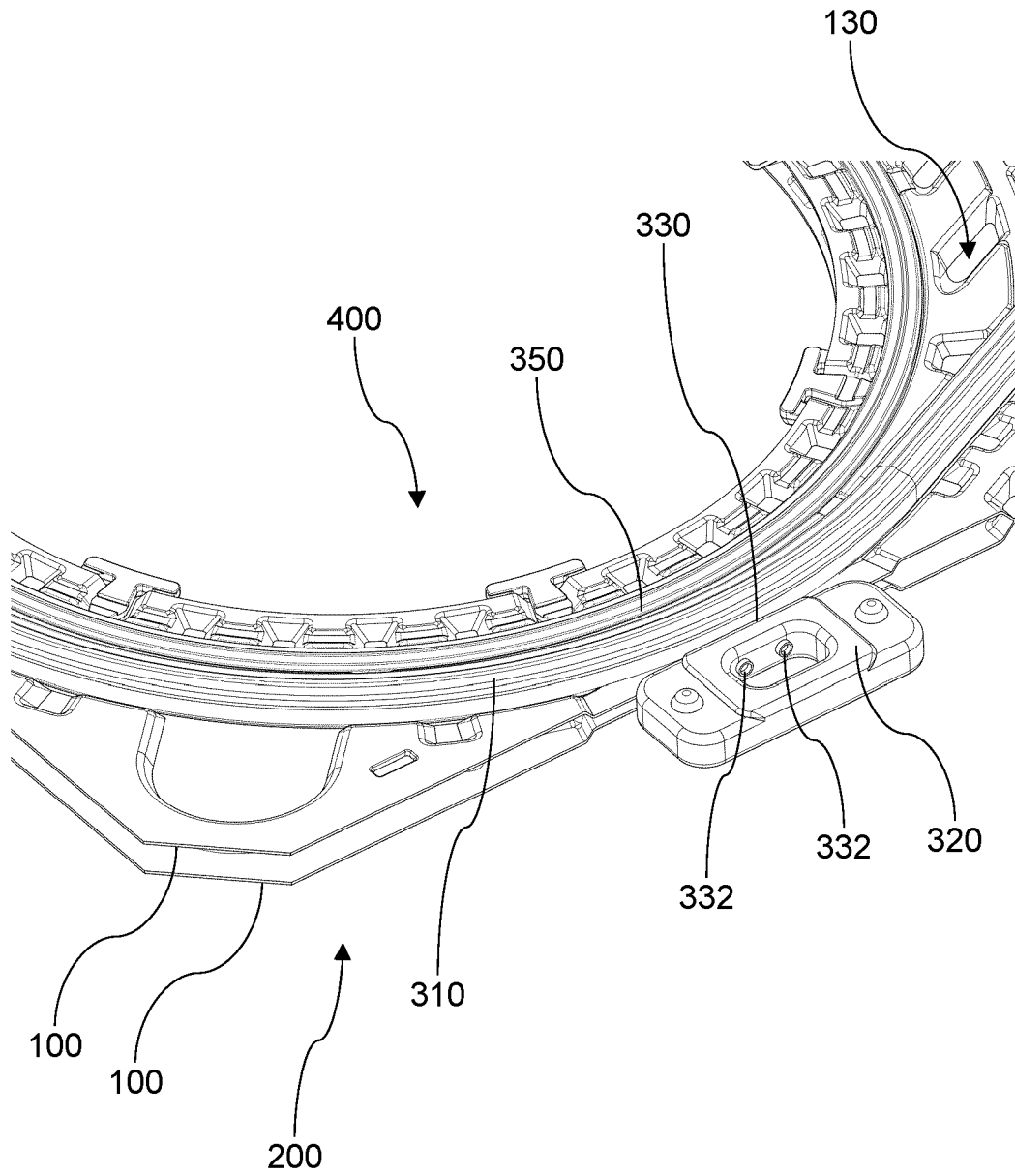


Fig.13

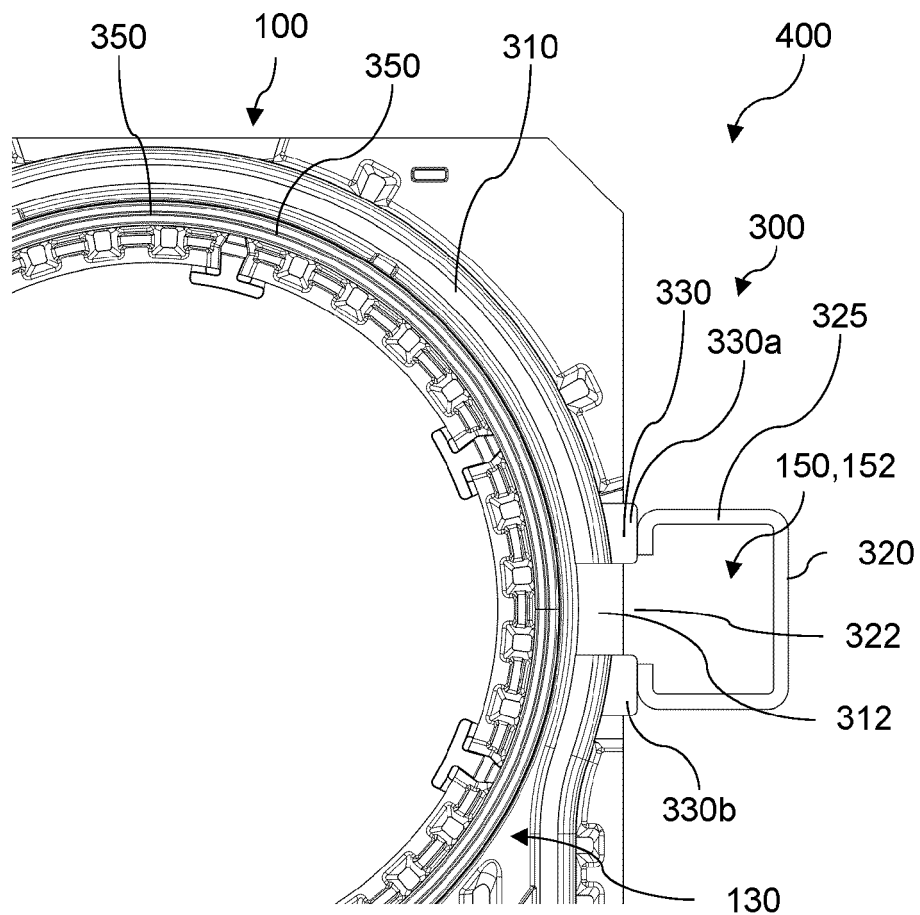


Fig. 14

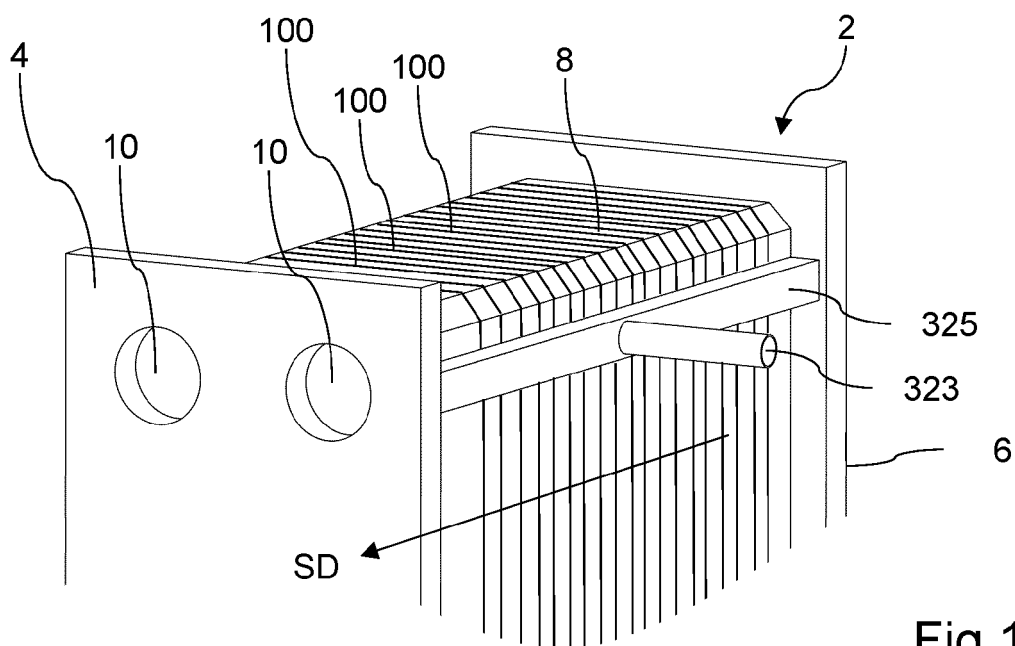


Fig. 15



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Application Number

EP 25 16 8285

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Place of search Munich		Date of completion of the search 7 August 2025	Examiner Bain, David
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