(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 818 618 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
07.10.2026 Bulletin 2026/41

(21) Application number: **25168284.5**

(22) Date of filing: **03.04.2025**

(51) International Patent Classification (IPC):
F28D 9/00 *(2006.01)* ***F28F 3/00*** *(2006.01)*
F28F 3/08 *(2006.01)* ***F28F 3/10*** *(2006.01)*
F28F 11/00 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
F28D 9/005; F28F 3/005; F28F 3/083; F28F 3/10; F28F 11/00; F28F 2230/00; F28F 2265/16

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

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

(57) The present invention relates to a gasket arrangement (300) for a plate heat exchanger (2). A permeation barrier gasket member (310) is adapted at least partially circumscribe a port hole gasket (350) such that a permeation space (130) is defined between the permeation barrier gasket member (310) and the port hole gasket (350). An evacuation gasket member (320) is adapted to circumscribe an evacuation hole (160) in the heat exchanger plate (100, 100a) such that an evacuation space (150) is formed within the evacuation gasket member (320), at the evacuation hole (160). A channel member (330) is adapted to fluidly connect the permeation space (130) and the evacuation space (150) by extending between an outlet opening (312) through the permeation barrier gasket member (310) and an inlet opening (322) through the evacuation gasket member (320). The permeation barrier gasket member (310), the evacuation gasket member (320) and the channel member (330) are separately formed. A heat exchanger plate (100 100a), a heat exchanger cassette (200) and a semi-welded plate heat exchanger (2) are also provided.

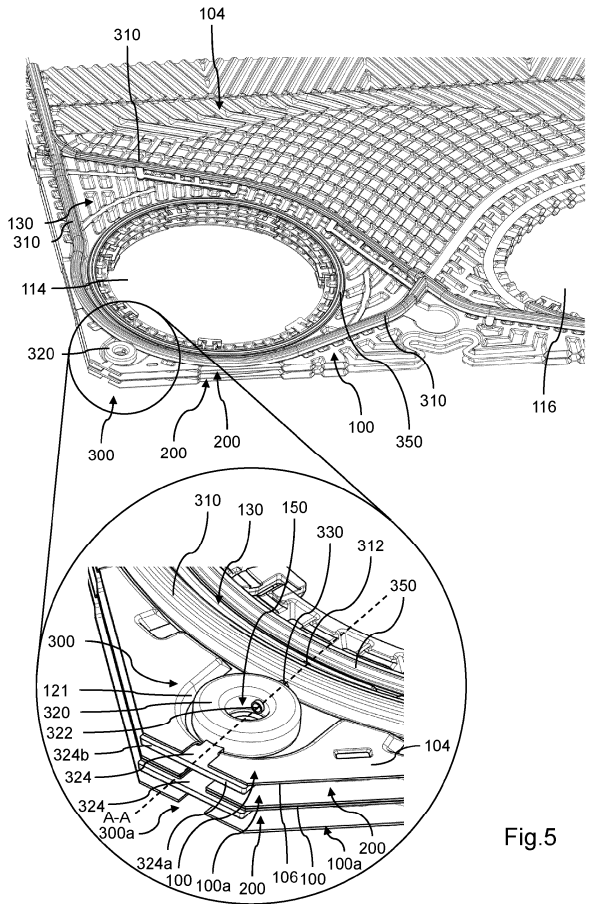


Fig.5

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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 a heat exchanger plate for a plate heat exchanger. The invention also relates to a heat exchanger cassette comprising such heat exchanger plate and to a semi-welded plate heat exchanger comprising such heat exchanger cassettes and gasket arrangements.

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 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 pate 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 capable 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 e.g. 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.

[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 flow of the fluids may be disturbed e.g. with an increased pressure drop and lower efficiency as a result. Moreover, the provision of an opening through the heat exchanger plates or cassettes which affects the flow of one or more of the fluids 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 be become weaker and more prone to leakage owing to the presence of such an opening.

[0008] Hence, there is room for improvement when it comes to handling fluid having 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, an improved plate for a plate heat exchanger, as well as an improved a heat exchanger cassette and a semi-welded plate heat exchanger.

[0010] Another objective is to provide such a gasket arrangement which is capable of evacuating permeated fluid in a safe way while not negatively affecting the heat transfer performance.

[0011] Another objective is to provide such a gasket

arrangement which is adaptable in terms of its design.

[0012] Another objective is to provide such a gasket arrangement which may be modularly formed.

[0013] Another objective is to provide such a gasket arrangement which may be modularly formed so as to fit heat exchanger plates of different designs.

[0014] Another objective is to provide such a gasket arrangement which may be used with heat exchanger plates of different designs.

[0015] Another objective is to provide such a gasket arrangement which is more cost-effective.

[0016] Another objective is to provide such a heat exchanger plate which is capable of evacuating permeated fluid in a safe way.

[0017] Another objective is to provide such a heat exchanger plate which is capable of evacuating permeated fluid in a safe way while not negatively affecting the heat transfer performance.

[0018] Another objective is to provide such a heat exchanger plate which is capable of evacuating permeated fluid while not negatively affecting the flow of the fluids between which heat is to be exchanged.

[0019] Another objective is to provide such a heat exchanger plate which is less prone to cracking or breaking.

[0020] Another objective is to provide such a heat exchanger plate which is more cost-effective.

[0021] 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 heat exchanger plate for a plate heat exchanger is provided according to claim 12. A heat exchanger cassette for a plate heat exchanger, comprising a heat exchanger plate is provided according to claim 14. A semi-welded plate heat exchanger comprising a plurality of gasket arrangements and cassette arrangements is provided according to claim 15.

[0022] More specifically, according to a first aspect, there is provided a gasket arrangement for a plate heat exchanger, comprising:

a permeation barrier gasket member adapted to be arranged on a first side of a heat exchanger plate and to at least partially circumscribe a port hole gasket at least partially circumscribing a port hole of the heat exchanger plate such that a permeation space is defined at the first side of the heat exchanger plate between the permeation barrier gasket member and the port hole gasket,

an evacuation gasket member adapted to be arranged on the first side of the heat exchanger plate and to circumscribe an evacuation hole in the heat exchanger plate such that an evacuation space is formed within the evacuation gasket member, at the evacuation hole, and

a channel member adapted to fluidly connect the permeation space and the evacuation space by extending between an outlet opening through the permeation barrier gasket member and an inlet opening through the evacuation gasket member,

wherein the permeation barrier gasket member, the evacuation gasket member and the channel member are separately formed.

[0023] Hereby an improved gasket arrangement for a plate heat exchanger is provided.

[0024] The gasket arrangement is designed for, and hence suitable to be used with gasketed PHEs and semi-welded PHEs.

[0025] The present invention is based on the realization that by providing a gasket arrangement in which parts of the gasket arrangement are separately formed, allows for a gasket arrangement with an adaptable design which at the same time provides for efficient evacuation of permeated fluid. Moreover, the gasket arrangement may efficiently evacuate fluid having permeated a port hole gasket of a PHE with no or minimal impact on the performance of the PHE at hand. Thus, fluid having permeated through a port hole gasket of a PHE may be evacuated in a safe way while not affecting the performance of the PHE in which the gasket arrangement is used. Further, by parts of the gasket arrangement being separately formed, locations of the respective parts in relation to each other may be adapted. In this way, the gasket arrangement may be adapted to fit heat exchanger plates and cassettes of different designs. Furthermore, the gasket arrangement may at least in part be formed by standard gaskets or standard parts. As a result, the gasket arrangement may be cost-effective.

[0026] More specifically, by the gasket arrangement comprising a permeation barrier gasket member adapted to be arranged on a first side of a heat exchanger plate and to at least partially circumscribe a port hole gasket circumscribing a port hole of the heat exchanger plate, the gasket arrangement may define a permeation space between the port hole gasket and the permeation barrier gasket member. Thus, in practice, the gasket arrangement may define a permeation space between the port hole gasket and the permeation barrier gasket member when arranged on a first side of a heat exchanger plate, given that the port hole gasket is in place. 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, the porthole gasket 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 port hole gasket and the permeation barrier gasket member of the gasket arrangement.

[0027] In this way, fluid which has permeated through the port hole gasket may be captured in the permeation

space and consequently prevented or counteracted from escaping the permeation space by the permeation barrier gasket member. So captured permeated fluid may in turn leave the permeation space and enter into the evacuation space formed within the evacuation gasket member, at the evacuation hole, via the channel member. This because the channel member is adapted to fluidly connect the permeation space and the evacuation space by extending between an outlet opening through the permeation barrier gasket member and an inlet opening through the evacuation gasket member. In other words, the channel member will fluidly connect the permeation space, the evacuation space and hence the evacuation hole when the gasket arrangement is used in a PHE. In this way, the channel member may lead or convey fluid which has permeated through the port hole gasket to the evacuation space and hence to the evacuation hole.

[0028] By the permeation barrier gasket member, the evacuation gasket member and the channel member being separately formed, the design and properties of the respective parts (permeation barrier gasket member, evacuation gasket member and channel member) may be adapted independently of each other. As a result, the channel member may for instance be molded into a desired location of the permeation barrier gasket member and into a desired location of the evacuation gasket member. Further, the gasket arrangement may be modularly formed or modularly assembled. More specifically, gasket arrangements of different designs may be modularly formed or modularly assembled from a limited number of parts or components. In this way, the gasket arrangement may be adapted to fit heat exchanger plates or cassettes of different designs. Moreover, the amount of permeated fluid which the gasket arrangement may evacuate may be adapted by e.g. adapting a cross sectional area of the channel member.

[0029] It should be noted that within the context of this application the term "port hole gasket" may mean any type of gasket, 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.

[0030] It should be noted that within the context of this application the term "permeation barrier gasket member" may mean any type of gasket, 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 gasket. The permeation barrier gasket member may comprise more than one part. As an example, the permeation barrier gasket member may comprise a first part and a separate second part. The permeation barrier gasket member may in practice be adapted to circumscribe the porthole gasket so as to form a permeation space therebetween. In other words, the permeation barrier gasket member may typically be adapted to prevent fluid having permeated through the port hole gasket from escaping the permeation space.

[0031] It should be noted that within the context of this application the term "evacuation gasket member" may mean any type of gasket, sealing, or similar which is adapted to circumscribe an evacuation hole of a heat exchanger plate such that an evacuation space is formed within the evacuation gasket member at the evacuation hole. In this way, the evacuation space will fluidly connect to the evacuation hole. As a result, a corresponding evacuation space of an evacuation gasket member of an adjoining gasket arrangement may fluidly connect to the evacuation space via the evacuation hole.

[0032] It should be noted that within the context of this application the term "channel member" may mean any type element which is capable of fluidly connecting an outlet opening through the permeation barrier gasket member and an inlet opening through the evacuation gasket member. The channel member may comprise more than one part.

[0033] The gasket arrangement may be assembled by a first end portion of the channel member being molded into the material of the permeation barrier gasket member and by a second end portion of the channel member being molded into the material of the evacuation gasket member. In this way, the gasket arrangement may be assembled or formed from a pre-manufactured channel member which is molded into the material of the of the permeation barrier gasket member and into the material of the evacuation gasket member. Thus, the permeation barrier gasket member and the evacuation gasket member may be separately formed at different end portions of the channel member. In practice, the permeation barrier gasket member and the evacuation gasket member may be separately formed although they may be formed simultaneously. Further, by the channel element being molded into the material of the permeation barrier gasket member and into the material of the evacuation gasket member, a fluid tight connection between the permeation space and the evacuation space may be established via the channel element. Moreover, the location of the channel member in relation to the permeation barrier gasket member and the evacuation gasket member may be adapted.

[0034] The gasket arrangement may be adapted to be assembled by inserting a first end portion of the channel member into the outlet opening of the permeation barrier gasket member and inserting a second end portion of the channel member into the inlet opening of the evacuation gasket member. In this way, the gasket arrangement may be assembled or formed from a pre-manufactured channel member which is inserted into openings of the permeation barrier gasket member and the evacuation gasket member respectively. Thus, the gasket arrangement may be assembled or formed in a simple yet effective manner while a fluid tight connection between the permeation space and the evacuation space may be established via the channel element. Further, the outlet opening of the permeation barrier gasket member may be fabricated subsequent to fabricating the permeation barrier gasket member. Correspondingly, the inlet opening of the of the evacuation gasket member may be formed

subsequent to fabricating the evacuation gasket member. In this way, the position, size and shape of the outlet opening of the permeation barrier gasket may be adapted. As a result, the design of the gasket arrangement may be adapted when being assembled. However, the inlet opening of the of the evacuation gasket member may be formed when fabricating the evacuation gasket member. Correspondingly, the outlet opening of the permeation barrier gasket member may be fabricated when fabricating the permeation barrier gasket member.

[0035] The channel member may comprise two or more parts jointly fluidly connecting the permeation space and the evacuation space. In this way, the properties of the channel member may be adapted by adapting the two or more parts. Moreover, assembly of the gasket arrangement may be facilitated. As an example, a first part of the channel member may be molded into the material of the permeation barrier gasket member and a second part of the channel member may be molded into the material of the evacuation gasket member. The first and second part may thereafter by connected directly or indirectly to each other for forming the channel member. As an example, an end portion of the first part facing away from the permeation barrier gasket member may be inserted into the second part, or vice versa. As an example, a pipe or hose section may be used to connect such first and second parts of the channel member.

[0036] The channel member may be formed of a material different from a material of the permeation barrier gasket member and from a material of the evacuation gasket member. In this way, the channel member may be formed of a material suitable for fluidly connecting the permeation space and the evacuation space, whereas the permeation barrier gasket member and the evacuation gasket member may be formed of a material or materials having different properties. As an example, permeation barrier gasket member 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 evacuation gasket member may be formed of a material suitable for providing a fluid tight seal when in abutment with a heat exchanger plate or cassette.

[0037] The channel member may comprise a material selected from the group consisting of plastic materials, metal materials, glass materials, stainless steel, aluminum, silicone materials and laminated materials.

[0038] The channel member may comprise a pipe element extending between the outlet opening of the permeation barrier gasket member and the inlet opening of the evacuation gasket member. By the channel member comprising a pipe element extending between the outlet opening and the inlet opening, the channel member may efficiently fluidly connect the permeation space and the evacuation space and hence the evacuation hole. In practice, the channel member may be formed of a pipe element extending between the outlet opening and the inlet opening. However, the channel member may comprise two or more pipe elements connected in series.

[0039] The pipe element may have a diameter of 1mm to 8mm, such as 1,5mm to 5mm.

[0040] The pipe element may have a diameter of 1mm to 8mm.

[0041] The pipe element may have a diameter of 1,5mm to 5mm.

[0042] The pipe element may have a diameter of 1mm to 5mm.

[0043] The pipe element may have a diameter of 1,5mm to 3mm.

[0044] The permeation barrier gasket member and/or the evacuation gasket member may comprise a material selected from the group consisting of polymer materials, elastomer materials, hydrated nitrile materials, chloroprene materials, ethylene propylene diene monomer materials, nitrile butadiene rubber materials and fluoroelastomer materials.

[0045] The permeation barrier gasket member may comprise a material selected from the group consisting of polymer materials, elastomer materials, hydrated nitrile materials, chloroprene materials, ethylene propylene diene monomer materials, nitrile butadiene rubber materials and fluoroelastomer materials.

[0046] The evacuation gasket member may comprise a material selected from the group consisting of polymer materials, elastomer materials, hydrated nitrile materials, chloroprene materials, ethylene propylene diene monomer materials, nitrile butadiene rubber materials and fluoroelastomer materials.

[0047] The gasket arrangement may further comprise a further evacuation gasket member adapted to be arranged on a second side, opposite to the first side, of the heat exchanger plate and to circumscribe the evacuation hole such that the evacuation space extends into the further evacuation gasket member via the evacuation hole. In this way, the further evacuation gasket member may seal around the evacuation hole on the second side of the heat exchanger plate while the evacuation space extends into the further evacuation gasket member. In practice, the need for welding heat exchanger plates of a cassette to each other around the evacuation holes may be eliminated by the provision of the further evacuation gasket member. More specifically, the further evacuation gasket member may be sandwiched between the heat exchanger plates at respective evacuation holes. Thus, the heat exchanger plates of a cassette may not abut each other at the respective evacuation holes.

[0048] The evacuation gasket member and the further evacuation gasket member may be connected via a connection segment configured to extend between the first side of the heat exchanger plate and the second side of the heat exchanger plate via an outer perimeter of the heat exchanger plate. In this way, the evacuation gasket member and the further evacuation gasket member may be attached to each other while the function of the evacuation gasket member and the further evacuation gasket member may not be affected. Moreover, the evacua-

tion gasket member and the further evacuation gasket member may be integrally formed. Further, the further evacuation gasket member may be prevented or counteracted from being lost or accidentally falling away from the other portions or parts of the gasket arrangement.

[0049] The channel member may be formed of a rigid material.

[0050] The evacuation gasket member may comprise one or more support members adapted to engage with the heat exchanger plate for supporting the external segment.

[0051] The permeation barrier gasket member may comprise a first part and a separate second part.

[0052] The permeation barrier gasket member may be integrally formed.

[0053] A first portion of the permeation barrier gasket member may be adapted to form a barrier between the permeation space and a heat exchange area at the first side of the heat exchanger plate. Thus, the permeation barrier gasket member may in part be common to what is commonly referred to as a field gasket.

[0054] The permeation barrier gasket member may be integrally formed with a gasket member adapted to define a gasketed heat exchange area at the first side of the heat exchanger plate.

[0055] The permeation barrier gasket member may be integrally formed with a field gasket.

[0056] At least a portion of a length extension of the permeation barrier gasket member may have a generally L-shaped, C-shaped or I-shaped cross section so as to from a passageway along said at least a portion of the length extension of the permeation barrier gasket member.

[0057] At least a portion of a length extension of the permeation barrier gasket member may be provided with a rib so as to from a passageway along said at least a portion of the length extension of the permeation barrier gasket member.

[0058] At least a portion of a length extension of the permeation barrier gasket member may be provided with a set of projections so as to from a passageway along said at least a portion of the length extension of the permeation barrier gasket member.

[0059] According to a second aspect of the invention, there is provided a heat exchanger plate for a plate heat exchanger, comprising:

a port hole,

a port hole gasket seat provided on a first side of the heat exchanger plate and circumscribing the port hole, the port hole gasket seat being adapted to receive a port hole gasket,

a permeation barrier seat at least partially circumscribing the port hole gasket seat and adapted to receive a permeation barrier gasket member such that a permeation space is defined at the first side of the heat exchanger plate between the permeation barrier seat and the port hole gasket seat,

an evacuation hole arranged outside of the permeation barrier seat, and

an evacuation hole seat circumscribing the evacuation hole and adapted to receive an evacuation gasket member such that an evacuation space fluidly connected to the permeation space is formed within the evacuation gasket member, at the evacuation hole.

[0060] Hereby an improved heat exchanger plate for a plate heat exchanger is provided.

[0061] The heat exchanger plate is designed for, and hence suitable to be used with, gasketed PHEs and semi-welded PHEs. In particular, heat exchanger plate is designed to be used with a gasket arrangement according to first aspect. Thus, the heat exchanger plate is designed to interrelate with gasket arrangement according to the first aspect.

[0062] 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.

[0063] The port hole gasket seat may comprise a groove configured to retain the port hole gasket, and/or the permeation barrier seat may comprise a groove configured to retain the permeation barrier gasket member, and/or the evacuation hole seat may be partially surrounded by a wall section configured to retain the evacuation gasket member.

[0064] The heat exchanger plate may comprise a channel seat extending between the permeation barrier seat and the evacuation hole seat and adapted to receive a channel member for fluidly connecting the permeation space and the evacuation space by extending between an outlet opening through the permeation barrier gasket member and an inlet opening through the evacuation gasket member.

[0065] According to a third aspect of the invention, there is provided a heat exchanger cassette for a plate heat exchanger comprising a heat exchanger plate according to the first 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, wherein a further evacuation hole of the further heat exchanger plate aligns with the evacuation hole and wherein the evacuation space extends further through the further evacuation hole.

[0066] In general, features of this third aspect 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.

[0067] However, by the evacuation hole and the further evacuation hole aligning and the evacuation space extending further through the further evacuation hole, fluid may be evacuated via the evacuation hole and the further evacuation hole. In practice, fluid may be evacuated along a stacking direction of a plurality of cassettes.

Put differently, fluid may be evacuated along a pack or stack of a PHE.

[0068] According to a fourth aspect of the invention, there is provided a semi-welded plate heat exchanger comprising a plurality of gasket arrangements according to the first aspect and a plurality of cassettes according to the third aspect alternatingly stacked.

[0069] In general, features of this third aspect 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.

[0070] A gasketed plate heat exchanger comprising a plurality of gasket arrangements according to the first aspect and a plurality of heat exchanger plates according to the second aspect alternatingly stacked.

[0071] 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 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.

[0073] 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

[0074] 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.

[0075] 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 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 perspective view of a portion of a pair of heat exchanger cassettes which are stacked on top of each other and a gasket arrangement.

Fig. 6 is a plane view of a portion of the uppermost plate of the uppermost cassette of Fig. 5

Fig. 7 is a cross sectional view through the uppermost cassette and the gasket arrangement of Fig. 5.

Fig. 8 is a plane view of the gasket arrangement of Figs. 5 and 7.

Fig. 9 is a perspective view of a portion of a pair of heat exchanger cassettes of a different design which are stacked on top of each other and a gasket arrangement of a different design.

Fig. 10 is a plane view of a portion of the uppermost plate of the uppermost cassette of Fig. 9

Fig. 11 is a cross sectional view through the uppermost cassette and the gasket arrangement of Fig. 9.

Fig. 12 is a plane view of the gasket arrangement of Figs. 9 and 11.

Fig. 13 is a cross sectional view through a cassette and a gasket arrangement of a different design.

Fig. 14 is a cross sectional view through a cassette and a gasket arrangement of yet a different design.

Detailed Description

[0076] 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.

[0077] 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.

[0078] 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.

[0079] 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.

[0080] 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, refence 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.

[0081] 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.

[0082] 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.

[0083] 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.

[0084] 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.

[0085] Now referring to Figs. 5. Fig. 5 illustrates a portion of a pair of heat exchanger cassettes 200 which are stacked on top of each other. Fig. 5 also illustrates an enlarged view of the corner region. A gasket arrangement 300 is arranged on the uppermost one of the cassettes 200. A corresponding gasket arrangement 300a is arranged between the cassettes 200. Each cassette 200 comprises a pair of heat exchanger plates 100, 100a which are welded to each other to form the cassette 200. The cassettes 200 are designed to be used in a semi welded PHE 2 of the type discussed above in relation to Figs. 1, 2 and 4.

[0086] More specifically, a corner region of the cassettes 200 are illustrated. As a consequence, a corner region of the upper plate 100 of the uppermost cassette 200 is clearly visible whereas the other plates 100, 100a of the cassettes 200 are 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 (the uppermost 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 region at an opposite short

end of the plate 100 may have a corresponding design.

[0087] Further, as is known in the art, a pack 8 of a gasketed PHE 2 or a semi-welded PHE 2 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.

[0088] 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.

[0089] Further, the illustrated region of the plate 100 in Fig. 5 comprises a porthole 114 to the left and porthole 116 to the right. The porthole 116 to the right 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 left will however be discussed to some extent when describing the interrelation between the plate 100 and the gasket arrangement 300.

[0090] As illustrated in Fig. 5, the port hole 114 may typically be circumscribed by a port hole gasket 350. The depicted port hole gasket 350 is generally speaking a ring shaped gasket which is arranged on a first side 104 of the heat exchanger plate 100. However, as is known in the art, the shape of the port hole 114 and consequently the port hole gasket 350 may vary. Further, the function of the port hole gasket 350 is known in the art and will not be discussed in greater detail herein. Furthermore, it is to be understood that the porthole gasket 350 may partially circumscribe port hole 114.

[0091] Further, in case the plate 100 forms part of a cassette 200, like in Fig. 5, the port hole gasket 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 port hole gasket 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 port hole gaskets 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 port hole gaskets 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 port hole gasket 350 depicted in Fig. 5. Correspondingly, fluids prone to permeating gasket materials may when flowing between plates 100 of a gasketed PHE risk permeating the port hole gaskets 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 port hole gasket 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.

[0092] In the following, the gasket arrangement 300 of Fig. 5 will be discussed in greater detail. In doing so, the plate 100 (the uppermost 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 a permeation barrier gasket member 310. The depicted permeation barrier gasket member 310 is arranged on the first side 104 of the heat exchanger plate 100. Further, the permeation barrier gasket member 310 circumscribes the port hole gasket 350. Thus, the permeation barrier gasket member 310 circumscribes the port hole gasket 350 as well as the port hole 114. In this way, a permeation space 130 is defined at the first side 104 of the heat exchanger plate 100 between the permeation barrier gasket member 310 and the port hole gasket 350. In practice, the permeation space 130 is formed at the first side 104 of the plate 100 between the port hole gasket 350 and the permeation barrier gasket member 310, when the porthole gasket 350 and the permeation barrier gasket member 310 of the gasket arrangement 300 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 104 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 port hole gasket 350 and the permeation barrier gasket member 310. It is, however, to be noted that the permeation barrier gasket member 310 may be adapted to at least partially circumscribe the port hole gasket 350 to define a permeation space 130 between the port hole gasket 350 and the permeation barrier gasket member 310.

[0094] Further, the depicted gasket arrangement 300 of Fig. 5 comprises an evacuation gasket member 320. The evacuation gasket member 320 may, as best illustrated in the enlarged view of Fig. 5, be arranged on the first side 104 of the heat exchanger plate 100 in such a way that it circumscribes an evacuation hole 160 in the heat exchanger plate 100. The evacuation hole 160 as such is more clearly illustrated in Fig. 6, which is a top view of a portion of the plate 100 of Fig. 5 but without the port hole gasket 350 and the gasket arrangement 300. As

is clearly illustrated in the enlarged view of Fig. 5 an evacuation space 150 is formed within the evacuation gasket member 320, at the evacuation hole 160. Thus, the so formed evacuation space 150 is fluidly connected to the evacuation hole 160 of the 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 gasket member 320 will in practice be sandwiched between a pair of heat exchanger plates 100 or cassettes 200. In this way, the so formed evacuation space 150 will in practice be fluidly connected to an evacuation hole 160 of each one of the plates 100 between which the evacuation gasket member 320 is sandwiched. Thus, the evacuation space 150 will in practice connect to a pair of corresponding evacuation spaces 150 of adjoining evacuation gasket members 320 of adjoining gasket arrangements 300. This will be discussed further below.

[0095] Further, the depicted gasket arrangement 300 of Fig. 5 comprises a channel member 330. The channel member 300 is adapted to fluidly connect the permeation space 130 and the evacuation space 150. To this end, the channel member 330 extends between the permeation barrier gasket member 310 and the evacuation gasket member 320. More specifically, the channel member 330 extends between an outlet opening 312 through the permeation barrier gasket 310 member and an inlet opening 322 through the evacuation gasket member 320. The design of the channel member 330 of Fig. 5 is more clearly illustrated in Fig. 7 to which reference is also made. More specifically, Fig. 7 illustrates a cross sectional view through the gasket arrangement 300, the port hole gasket 350 and the uppermost cassette 200 of Fig. 5 along the line A-A indicated in Fig. 5. Thus, in Fig. 7 it is clearly illustrated how the channel member 330 fluidly connects the permeation space 130 and the evacuation space 150 by extending between the outlet opening 312 through the permeation barrier gasket member 310 and the inlet opening 322 through the evacuation gasket member 320. Further, the gasket arrangement 300 is illustrated in isolation in Fig. 8 to which reference is also made.

[0096] The overall function of the permeation space 130, the evacuation space 150 and the channel member 330 will be described further below.

[0097] Further, the permeation barrier gasket member 310, the evacuation gasket member 320 and the channel member 330 of the gasket arrangement 300 of Figs. 5 and 7 are separately formed. Thus, the permeation barrier gasket member 310, the evacuation gasket member 320 and the channel member 330 of the gasket arrangement 300 have been formed temporally and/or spatially separately. This means that the gasket arrangement 300 may be assembled from separately formed parts or that the gasket arrangement 300 may be assembled while forming one or more parts thereof.

[0098] According to an example, the gasket arrangement 300 may be assembled from a channel member 330 which is molded into the material of the permeation barrier gasket member 310 and into the material of the evacuation gasket member 320. In practice, a first end portion 313 of the channel member 330 may be molded into the material of the permeation barrier gasket member 310 and a second end portion 323 of the channel member 330 may be molded into the material of the evacuation gasket member 320. In this way, a channel member 330, such as a pipe, may be molded into the molded into the material of the permeation barrier gasket member 310 while forming the permeation barrier gasket member 310. Correspondingly, the channel member 330 may be molded into the material of the evacuation gasket member 320 while forming the evacuation gasket member 320.

[0099] According to another example, the gasket arrangement 300 may be assembled by inserting the first end portion 313 of the channel member 330 into the outlet opening 312 of the permeation barrier gasket member 310 and inserting the second end portion 323 of the channel member 330 into the inlet opening 322 of the evacuation gasket member 320. In this way, the first end portion 313 of the channel member 330 may be inserted into a premade outlet opening 312 of the permeation barrier gasket member 310. Correspondingly, the second end portion 323 of the channel member 330 may be inserted into a premade inlet opening 322 of the of the evacuation gasket member 320. Thus, the gasket arrangement 300 may be assembled from premade or prefabricated parts.

[0100] When the gasket arrangement 300 is fabricated and assembled according to the above examples, the channel member 330 may be formed of a material different from a material of the permeation barrier gasket member 310 and from a material of the evacuation gasket member 320. The permeation barrier gasket member 310 and the evacuation gasket member 320 of Figs. 5, 7 and 8 may typically be made of flexible materials which are suitable to seal against the plate 100 and an adjoining plate. To this end, the permeation barrier gasket member 310 and the evacuation gasket member 320 may typically be made polymer materials and/or elastomer materials. Suitable examples of materials for the permeation barrier gasket member 310 and the evacuation gasket member 320 include but are not limited to hydrated nitrile materials, chloroprene materials, ethylene propylene diene monomer materials, nitrile butadiene rubber materials and fluoroelastomer materials. Further, the permeation barrier gasket member 310 and the evacuation gasket member 320 may typically be molded into a desired shape. On the other hand, channel member 330 may be made of a material suitable for forming a fluid channel or passage. In other words, the channel member 330 may be made of a material suitable for fluidly connecting the permeation space 130 and the evacua-

tion space 150. Suitable materials for the channel member 330 include but are not limited to plastic materials, metal materials, glass materials, stainless steel, aluminum, silicone materials and laminated materials. Thus, the channel member 330 may be made of a rigid material or a semirigid material. In this way the channel member 330 may be made relatively speaking narrow while preventing or counteracting the channel member 330 collapses and cuts of the fluid connection between the permeation space 130 and the evacuation space 150.

[0101] In practice, and as best illustrated in Figs. 5 and 7, the channel member 330 may be formed of, or comprise, a pipe element 331. Such pipe element 331 may as best illustrated in Fig. 7 extend between the outlet opening 312 of the permeation barrier gasket member 310 and the inlet opening 322 of the evacuation gasket member 320. In this way, the pipe element 331 may provide for a fluid connection between the permeation space 130 and the evacuation space 150. It is currently believed that when such pipe element 331 has a dimeter in a range of 1mm to 8mm a good balance between establishing a sufficient fluid connection and stability may be achieved. Further, when such pipe element 331 has a dimeter in a range of 1,5mm to 5mm it is currently believed that an optimal balance between establishing a sufficient fluid connection and stability may be achieved. Other diameters of such pipe element 331 are however conceivable.

[0102] As best illustrated in Figs. 5 and 8, the evacuation gasket member 320 may be provided with a support member 324. The support member 324 is designed to be inserted between a pair of adjoining plates 100 while extending through a notch 115 in the plate 100. In this way, the evacuation gasket member 320 may be held in position by the support member 324 engaging the plate 100 and the notch 115 thereof. More specifically, 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 and to extend into opposite directions of the notch 115 as best illustrated in the enlarged view of Fig, 5. In general terms, the support member 324 is adapted to engage with the heat exchanger plate 100 for supporting the evacuation gasket member 320. It is to be noted that the evacuation gasket member 320 may comprise more than one support member 324.

[0103] Further, it is to be noted that the evacuation gasket member 320 may be void of any support member 324. In such case, the evacuation gasket member 320 may simply be sandwiched between a pair of adjacent plates 100. However, the evacuation gasket member 320 may be glued to the plate 100 so as to be supported or fixed in relation to the plate 100. Moreover, the evacuation gasket member 320 may be supported or fixed in relation to the plate 100 by tape, such as double-sided tape.

[0104] Further, the channel member 330 may be formed of or comprise two or more parts jointly fluidly connecting the permeation space 130 and the evacuation space 150. According to an example, the channel member 300 may comprise two or more pipe elements 331 connected in series. In this way, a first pipe element may be molded into the permeation barrier gasket member 310 and a second pipe element may be molded into the evacuation gasket member 320. The first and second pipe elements may then be connected to each other when assembling the gasket arrangement 300. According to an example, the first pipe element may be inserted into the second pipe element or vice versa. According to another example, the first and second pipe elements may be inserted into a third pipe element or vice versa.

[0105] According to an example, the channel member 300 may comprise two or more pipe elements 331 connected in parallel.

[0106] Now turning in particular to Fig. 6. As previously described, Fig. 6 illustrates the plate 100 (the uppermost plate 100) of Fig. 5.

[0107] In order for the plate 100 to interrelate with the above described gasket arrangement 300, the plate 100 is designed such that it may receive the gasket arrangement 300 and a port hole gasket 350.

[0108] To this end, the plate 100 is provided with a port hole gasket seat 118. The port hole gasket seat is provided on the first side 104 of the heat exchanger plate 100 and circumscribes the port hole 114. The depicted port hole gasket seat 118 is adapted to receive a port hole gasket 350 of the type generally described above. The port hole gasket seat 118 may as illustrated in Fig. 6 comprise a groove configured to retain the port hole gasket 350. It is however to be noted that the port hole gasket seat 118 may be designed such that it partially circumscribes the port hole 114.

[0109] Further, the depicted plate 100 is provided with a permeation barrier seat 110. The permeation barrier seat 110 circumscribes the port hole gasket seat 118. Further, the permeation barrier seat 110 is adapted to receive a permeation barrier gasket member 310 of the type generally described above. The permeation barrier seat 110 may as illustrated in Fig. 6 comprise a groove configured to retain the permeation barrier gasket member 310. In this way, the permeation space 130 may be defined at the first side 104 of the heat exchanger plate 100 between the permeation barrier seat 110 and the port hole gasket seat 118. Thus, in practice, the permeation space 130 may be defined at the first side 104 of the heat exchanger plate 100 between the permeation barrier seat 110 and the port hole gasket seat 118, when the port hole gasket 350 is received in the port hole gasket seat 118 and when the permeation barrier gasket member 310 is received in the permeation barrier seat 110. It is however to be noted that the permeation barrier seat may be designed such that it partially circumscribes the port hole gasket seat 118.

[0110] Further, as illustrated in Fig. 6, a portion 110a of the permeation barrier seat 110 may extend essentially along a perimeter of the plate 100 outside of the porthole

gasket seat 118 and serve the purpose of receiving a portion of the permeation barrier gasket member 310. However, another portion 110b of the permeation barrier gasket seat 110 may be defined by a groove 110b adapted to receive a portion of the permeation barrier gasket member 310 which also serves the purpose of sealing against a patterned distribution area 108 and a patterned heat exchange area 106. Thus, such portion 110b may be adapted to receive a portion of a permeation barrier gasket member 310 which also forms part of what is generally referred to as a field gasket.

[0111] Further, as already briefly described, the depicted plate 100 is provided with an evacuation hole 160. The evacuation hole 160 is arranged outside of the permeation barrier seat 110. That is, the evacuation hole 160 is located outside of the permeation barrier seat 120 as seen from the evacuation space 130 and the port hole 114. As illustrated in Fig. 6, the evacuation hole 160 is located in an edge region or a peripheral region of the plate 100. More specifically, the evacuation hole 160 is located in a corner region of the plate 100. Importantly, the evacuation hole 160 of the plate 100 is located outside of any area where a first fluid or a second fluid is flowing when the plate 100 forms part of a pack 8 of a PHE 2. As a result, the evacuation hole 160 will not influence the flow of the first fluid and will also not influence the flow of the second fluid. Thus, the presence of the evacuation hole 160 may not influence or hamper the performance of a PHE 2 in which the plate 100 is used.

[0112] Further, as illustrated in Fig. 6, the depicted plate 100 is provided with an evacuation hole seat 120. The evacuation hole seat 120 circumscribes the evacuation hole 160. Further, the evacuation hole seat 120 is adapted to receive an evacuation gasket member 320 of the type generally described above. In this way, an evacuation space 150 fluidly connected to the permeation space 130 may be formed within the evacuation gasket member 320, at the evacuation hole 160, i.e. as explained above. The depicted evacuation hole seat 120 of Fig. 6 is basically a flat surface surrounding the evacuation hole 160. However, other shapes or types of evacuation hole seats 120 are conceivable.

[0113] Further, as best illustrated in Figs. 5 and 6, the evacuation hole seat 120 may be partially surrounded by a wall section 121. The wall section 121 may be configured to retain the evacuation gasket member 320. In practice, the wall section 121 may be configured to prevent or counteract that the evacuation gasket member 320 slides along the first side 104 of the plate 100. The wall section 121 may typically be pressed into the material of the plate 100.

[0114] When the plate 100 of Fig. 6 forms part of a cassette 200, i.e. as illustrated in Figs. 5 and 7, a further heat exchanger plate 100a is welded to a second side 106, opposite to the first side 104, of the heat exchanger plate 100. Further, a further evacuation hole 160 of the further heat exchanger plate 100a aligns with the evacuation hole 160 as best illustrated in Fig. 7. Thus, in practice, the evacuation hole 160 and the further evacuation hole 160 may be said to jointly form an evacuation hole 160. Thus, in this way, the evacuation space 150 will extend further through the further evacuation hole 160. In practice, the plate 100 and the further plate 100a may typically be welded to each other around the evacuation hole 160 (and the further evacuation hole 160) such that fluid tight connection between the plate 100 and the further plate 100a is provided at the evacuation hole 160 (and the further evacuation hole 160).

[0115] Now referring to Fig. 9. Fig. 9 illustrates a portion of a pair of heat exchanger cassettes 200 which are stacked on top of each other. Fig. 9 also illustrates an enlarged view of the corner region. Fig. 9 is similar to Fig. 5. A gasket arrangement 300 is arranged on the uppermost one of the cassettes 200. A corresponding gasket arrangement 300a is arranged between the cassettes 200. Each cassette 200 comprises a pair of heat exchanger plates 100, 100a which are welded to each other to form the cassette 200. The cassettes 200, the plates 100, 100a and the gasket arrangement 300 all have similar designs to the cassettes 200, the plates 100, 100a and the gasket arrangement 300 of Figs. 5-8. Given the similarities, only relevant differences will be described hereinafter.

[0116] Reference is also made to Figs. 10-12. Fig 10 is a top view of a portion of the plate 100 (the uppermost plate 100) of Fig. 9 but without the port hole gasket 350 and the gasket arrangement 300. Fig. 11 illustrates a cross sectional view through the gasket arrangement 300, the port hole gasket 350 and the uppermost cassette 200 of Fig. 9 along the line A-A indicated in Fig. 9. The gasket arrangement 300 of Figs. 9 and 11 is illustrated in isolation in Fig. 12.

[0117] As best illustrated in Figs. 11 and 12, the gasket arrangement 300 of Figs. 9, 11 and 12 comprises a further evacuation gasket member 320a. As best illustrated in Fig. 11, the further evacuation gasket member 320a is adapted to be arranged on a second side 106, opposite to the first side 104, of the heat exchanger plate 100. Further, the further evacuation gasket member 320a is adapted to circumscribe the evacuation hole 160, i.e. as illustrated in Figs. 9 and 11. As a result, the evacuation space 150 will extend into the further evacuation gasket member 320a via the evacuation hole 160.

[0118] In practice, the further evacuation gasket member 320a may be sandwiched between the upper plate 100 and the lower plate 100a of the cassette 200 as illustrated in Fig. 11. As clearly illustrated in Fig. 11, the upper plate 100 and the lower plate 100a of the depicted cassette 200 do not abut each other at the location of the evacuation hole 160, as opposed to what has been described above in relation to Figs. 5-8. As a result, the need for welding the upper plate 100 and the lower plate 100a of the cassette 200 to each other at the location of the evacuation hole 160 may efficiently be eliminated. However, in order to seal between the upper plate 100 and the lower plate 100a of the cassette 200 at

the location of the evacuation hole 160 the further evacuation gasket member 320a may be sandwiched between the upper plate 100 and the lower plate 100a of the cassette 200, i.e. as illustrated in Fig. 11. As a result of the above design, the evacuation gasket member 320 and the further evacuation gasket member 320a have a joint height or thickness corresponding to or substantially corresponding to a height or thickness of the evacuation gasket member 320 of Figs. 5, 7 and 8. The above design further means that the evacuation hole seat 120 of the plate 100 of Fig. 10 is located higher up as compared to the evacuation hole seat 120 of the plate 100 of Fig. 6. Put differently, the evacuation hole seat 120 of the plate 100 of Fig. 10 is less recessed in relation to an uppermost plane of the plate 100 as compared to the evacuation hole seat 120 of the plate 100 of Fig. 6. As a result, a step 124 is formed between the permeation barrier seat 110 and the evacuation hole seat 120 of the plate 100 of Fig. 10. This also means that the wall section of the wall section 121 of the plate 100 of Fig. 10 is lower as compared to the wall section 121 of the plate 100 of Fig. 6.

[0119] When the plate 100 of Fig. 10 forms part of a cassette 200, i.e. as illustrated in Figs. 9 and 11, a further heat exchanger plate 100a is welded to a second side 106, opposite to the first side 104, of the heat exchanger plate 100. Further, a further evacuation hole 160 of the further heat exchanger plate 100a aligns with the evacuation hole 160 of the plate 100 as best illustrated in Fig. 11. It is to be noted that the evacuation hole 160 of the plate 100 aligns with the further evacuation hole 160 of the further heat exchanger plate 100a although the plate 100 and the further plate 100a do not abut each other at the location of the evacuation hole 160 and the further evacuation hole 160. As a result, the evacuation space 150 may generally speaking be said to extend further through the further evacuation gasket member 320a and the further evacuation hole 160 of the further plate 100a. Hence, although the plate 100 and the further plate 100a are not welded to each other around the evacuation hole 160 (and the further evacuation hole 160) a fluid tight connection between the plate 100 and the further plate 100a may be provided at the evacuation hole 160 and the further evacuation hole 160 by means of the further evacuation gasket member 320a being sandwiched between the plate 100 and the further plate 100a while in alignment with the evacuation hole 160 and the further evacuation hole 160.

[0120] Further, as illustrated in Figs. 9, 11 and 12, the evacuation gasket member 320 and the further evacuation gasket member 320a may be connected to each other via a connection segment 325. The connection segment 325 may be internally formed with the evacuation gasket member 320 and the further evacuation gasket member 320a, i.e. as best illustrated in Fig. 12. However, the connection segment 325 may be formed separately from the evacuation gasket member 320 and the further evacuation gasket member 320a and attached thereto. The depicted connection segment 325 of Figs. 9, 11 and 12 is configured to extend between the first side 104 of the heat exchanger plate 100 and the second side 106 of the heat exchanger plate 100 via the outer perimeter of the heat exchanger plate 100, i.e. as best illustrated in Fig. 11.

[0121] In practice, the connection section 325 may be a flexible section which is bend or folded around the outer perimeter of the plate 100. By the connection section 325 being flexible the connection section 325 may be molded as illustrated in Fig. 12. Thus, the connection section 325 may generally speaking be molded in the same plane as the other parts of the gasket arrangement 300 and subsequently be bent or folded into place on the second side 106 of the plate 100.

[0122] Now referring to Fig. 13. Fig 13 is similar to Fig. 11. However, as illustrated in Fig. 13 the permeation barrier gasket member 310 may be provided with a rib 311. Such rib 311 may as illustrated in Fig. 13 extend along a length extension of the permeation barrier gasket member 310 so as to form a passageway along the permeation barrier gasket member 310. In this way, fluid having permeated through the port hole gasket 350 may more easily flow along the permeation space 130. Put differently fluid having permeated through the port hole gasket 350 may more easily flow between the port hole gasket 350 and the permeation barrier gasket member 310 so as to reach the outlet opening 312 of the channel member 330. It is to be noted that such a rib 311 may extend along a portion of the length extension of the permeation barrier gasket member 310.

[0123] Now referring to Fig. 14. Fig 13 is similar to Figs. 11 and 13. However, as illustrated in Fig. 14 the permeation barrier gasket member 310 may be provided with a set of projections 315. Such projections 315 may as illustrated in Fig. 13 be distributed along a length extension of the permeation barrier gasket member 310 so as to form a passageway along the permeation barrier gasket member 310. In this way, fluid having permeated through the port hole gasket 350 may more easily flow along the permeation space 130. Put differently fluid having permeated through the port hole gasket 350 may more easily flow between the port hole gasket 350 and the permeation barrier gasket member 310 so as to reach the outlet opening 312 of the channel member 330. It is to be noted that such projections 315 may be distributed along a portion of the length extension of the permeation barrier gasket member 310.

[0124] In the following the main aspects of the interplay between the different elements and features of the plate 100 and the permeation barrier gasket arrangement 300 will be briefly discussed. As already explained, fluid may permeate the port hole gasket 350 meaning that fluid may escape through the material of the port hole gasket 350 although the port hole gasket as such is intact. By the permeation barrier gasket member 310 being received in the permeation barrier seat 110 such that it circumscribes or at least partially circumscribes the port hole gasket 350, fluid having permeated through the port hole gasket

350 may be caught in the permeation space 130, i.e. between the port hole gasket 350 and the permeation barrier gasket member 310. Such permeated fluid may then reach the evacuation hole 160 via the channel member 330 and evacuation space 150. 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 holes 160 of the plates 100 of the pack 8. To this end, the frame plate 4 of the PHE 2 at hand may be provided with an evacuation outlet. Such an evacuation outlet 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, if the permeation barrier gasket member 310 is provided with one or more inlet openings extending therethrough and being in fluid communication with the ambient, a forced flow of air may be provided through the permeation space 130 and out of the evacuation hole 160 via the channel member 330 and the evacuation space 150.

[0125] However, the elements and features of the plate 100 and the permeation barrier 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 hole 160, the evacuation space 150 and the channel member 330. In this way, the port hole gasket 350 may be prevented or counteracted from being affected by substances present in the ambient surrounding the PHE 2 at hand. In such a case, the permeation barrier gasket member 310 may to advantage be void of any inlet openings extending therethrough.

[0126] Another use for the elements and features of the plate 100 and the permeation barrier gasket arrangement 300 is to pressurize the permeation space 130 by forcing a gas into the permeation space 130 via the evacuation hole 160, the evacuation space 150 and the channel member 330. By providing an overpressure to the permeation space 130 a significant reduction of fluid permeating through the port hole gasket 350 may be achieved since the overpressure will act as counterpressure. In such a case, the permeation barrier gasket arrangement 300 may to advantage be void of any inlet openings extending therethrough.

[0127] 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.

[0128] 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) for a plate heat exchanger (2), comprising:

   a permeation barrier gasket member (310) 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 gasket (350) at least partially circumscribing a port hole (114) of the heat exchanger plate (100, 100a) such that a permeation space (130) is defined at the first side (104) of the heat exchanger plate (100, 100a) between the permeation barrier gasket member (310) and the port hole gasket (350),
   an evacuation gasket member (320) adapted to be arranged on the first side (104) of the heat exchanger plate (100 ,100a) and to circumscribe an evacuation hole (160) in the heat exchanger plate (100, 100a) such that an evacuation space (150) is formed within the evacuation gasket member (320), at the evacuation hole (160), and a channel member (330) adapted to fluidly connect the permeation space (130) and the evacuation space (150) by extending between an outlet opening (312) through the permeation barrier gasket member (310) and an inlet opening (322) through the evacuation gasket member (320),
   wherein the permeation barrier gasket member (310), the evacuation gasket member (320) and the channel member (330) are separately formed.

2. The gasket arrangement (300) according to claim 1, wherein the gasket arrangement (300) is assembled by a first end portion (313) of the channel member (330) being molded into the material of the permeation barrier gasket member (310) and by a second end portion (323) of the channel member (330) being molded into the material of the evacuation gasket member (320).

3. The gasket arrangement (300) according to claim 1, wherein the gasket arrangement (300) is adapted to be assembled by inserting a first end portion (313) of the channel member (330) into the outlet opening (312) of the permeation barrier gasket member (310) and inserting a second end portion (323) of the channel member (330) into the inlet opening (322) of the evacuation gasket member (320).

4. The gasket arrangement (300) according to any one of the preceding claims, wherein the channel member (330) comprises two or more parts jointly fluidly connecting the permeation space (130) and the evacuation space (150).

5. The gasket arrangement (300) according to any one of the preceding claims, wherein the channel member (330) is formed of a material different from a material of the permeation barrier gasket member (310) and from a material of the evacuation gasket member (320).

6. The gasket arrangement (300) according to any one of the preceding claims, wherein the channel member (330) comprises a material selected from the group consisting of plastic materials, metal materials, glass materials, stainless steel, aluminum, silicone materials and laminated materials.

7. The gasket arrangement (300) according to any one of the preceding claims, wherein the channel member (330) comprises a pipe element (331) extending between the outlet opening (312) of the permeation barrier gasket member (310) and the inlet opening (322) of the evacuation gasket member (320).

8. The gasket arrangement according to claim 7, wherein the pipe element has a diameter of 1mm to 8mm, such as 1,5mm to 5mm.

9. The gasket arrangement according to any one of the preceding claims, wherein the permeation barrier gasket member and/or the evacuation gasket member comprises a material selected from the group consisting of polymer materials, elastomer materials, hydrated nitrile materials, chloroprene materials, ethylene propylene diene monomer materials, nitrile butadiene rubber materials and fluoroelastomer materials.

10. The gasket arrangement (300) according to any one of the preceding claims, further comprising a further evacuation gasket member (320a) adapted to be arranged on a second side (106), opposite to the first side (104), of the heat exchanger plate (100) and to circumscribe the evacuation hole (160) such that the evacuation space (150) extends into the further evacuation gasket member (320a) via the evacuation hole (160).

11. The gasket arrangement (300) according to claim 10, wherein the evacuation gasket member (320) and the further evacuation gasket member (320a) are connected via a connection segment (325) configured to extend between the first side (104) of the heat exchanger plate (100) and the second side (106) of the heat exchanger plate (100) via an outer perimeter of the heat exchanger plate (100).

12. A heat exchanger plate (100 100a) for a plate heat exchanger (8), comprising:

a port hole (114),

a port hole gasket seat (118) provided on a first side (104) of the heat exchanger plate (100, 100a) and at least partially circumscribing the port hole (114), the port hole gasket seat (118) being adapted to receive a port hole gasket (350),

a permeation barrier seat (110) at least partially circumscribing the port hole gasket seat (118) and adapted to receive a permeation barrier gasket member (310) such that a permeation space (130) is defined at the first side (104) of the heat exchanger plate (100, 100a) between the permeation barrier seat (110) and the port hole gasket seat (118),

an evacuation hole (160) arranged outside of the permeation barrier seat (110), and

an evacuation hole seat (120) circumscribing the evacuation hole (160) and adapted to receive an evacuation gasket member (320) such that an evacuation space (150) fluidly connected to the permeation space (130) is formed within the evacuation gasket member (320), at the evacuation hole (160).

13. The heat exchanger plate (100, 100a) according to claim 12, wherein the port hole gasket seat (118) comprises a groove configured to retain the port hole gasket (350), and/or wherein the permeation barrier seat (110) comprises a groove configured to retain the permeation barrier gasket member (310), and/or wherein the evacuation hole seat (120) is partially surrounded by a wall section (121) configured to retain the evacuation gasket member (320).

14. A heat exchanger cassette (200) for a plate heat exchanger (2) comprising a heat exchanger plate (100) according to any one of claims 12-13 and a further heat exchanger plate (100a), wherein the further heat exchanger plate (100a) is welded to a second side (106), opposite to the first side (104), of the heat exchanger plate (100), wherein a further evacuation hole (160) of the further heat exchanger plate (110a) aligns with the evacuation hole (160) and wherein the evacuation space (150) extends further through the further evacuation hole (160).

15. A semi-welded plate heat exchanger (2) comprising a plurality of gasket arrangements (300) according to any one of claims 1-11 and a plurality of cassettes (200) according to claim 14 alternatingly stacked.

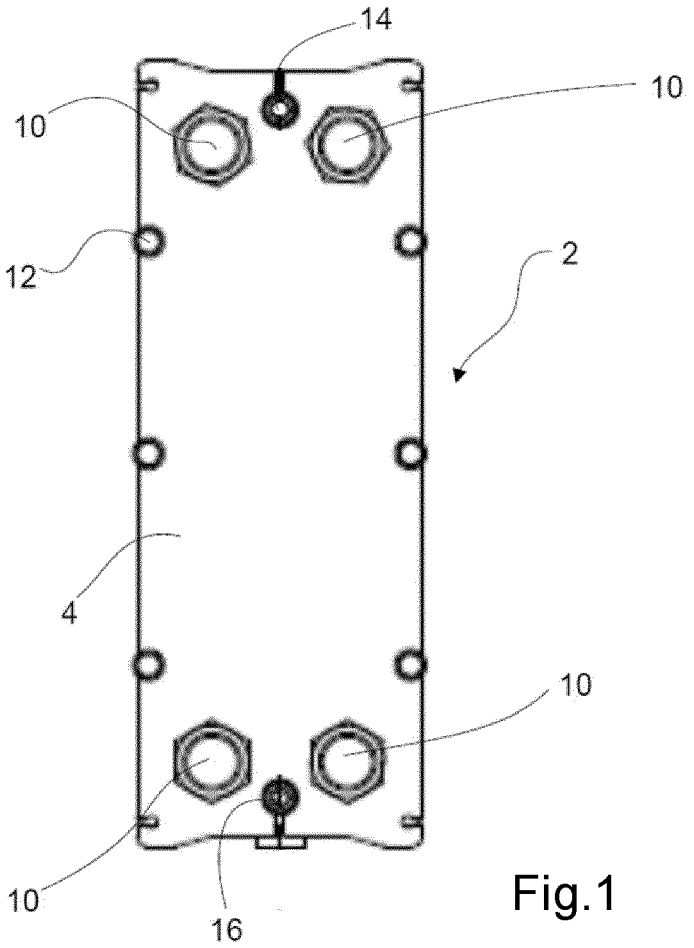


Fig.1

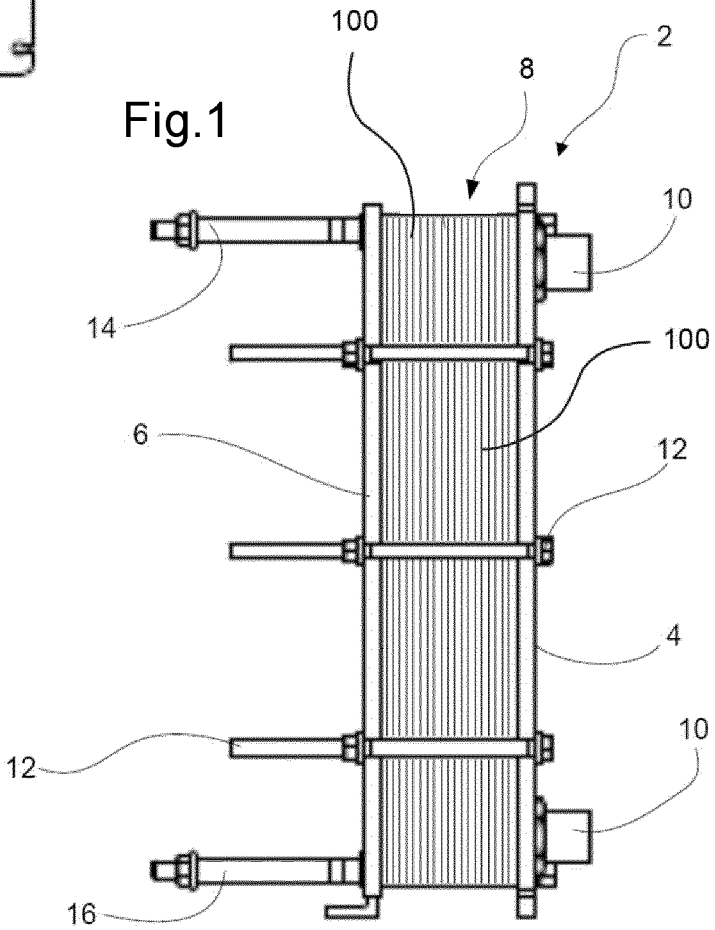


Fig.2

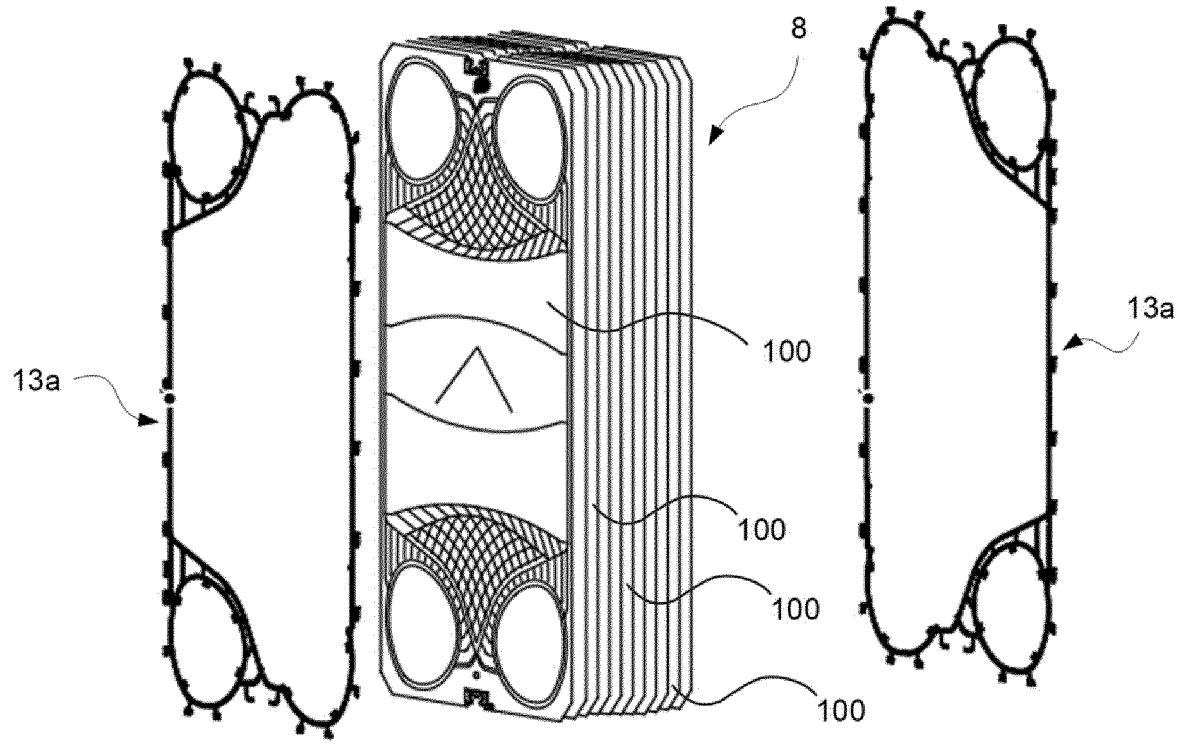


Fig.3

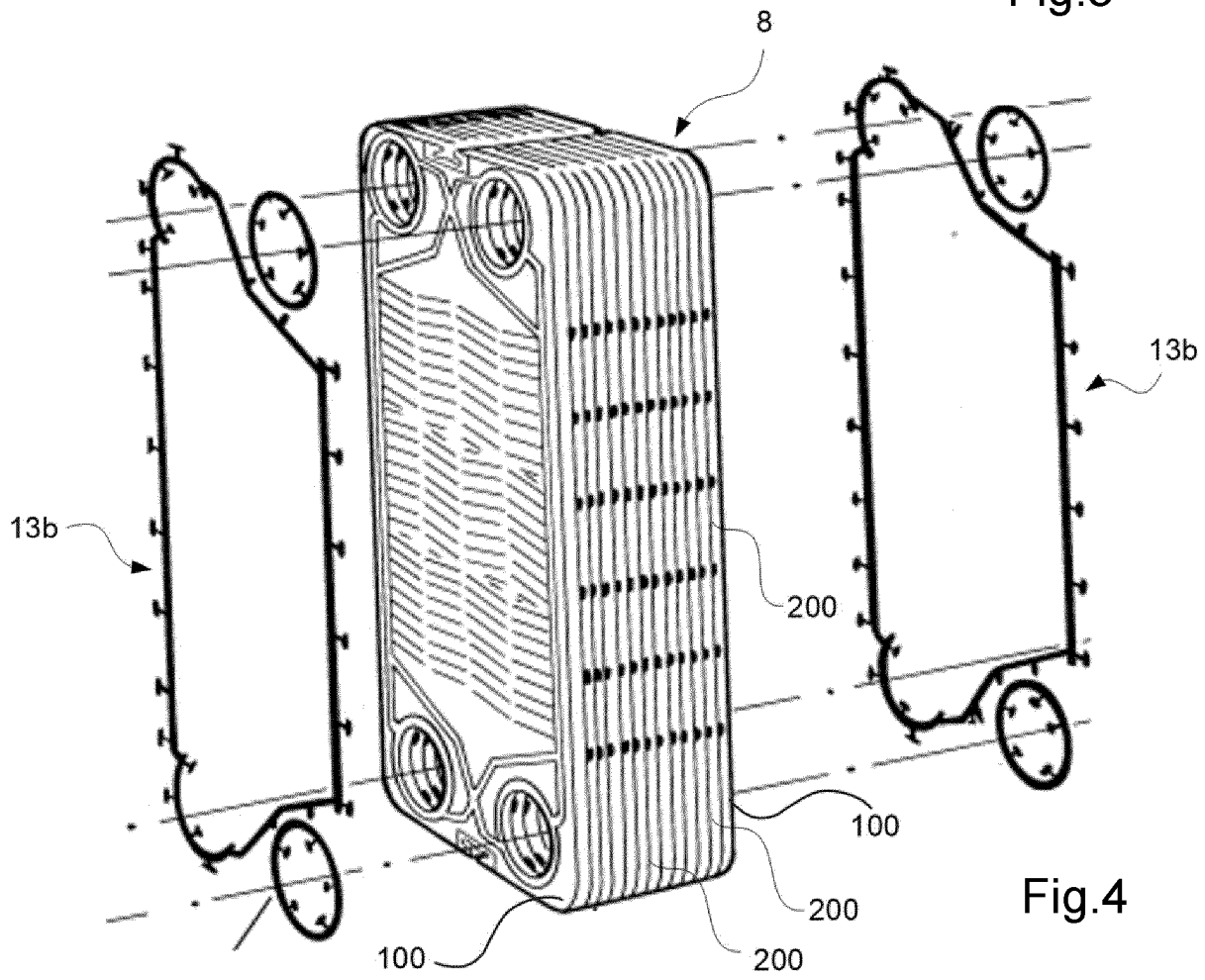


Fig.4

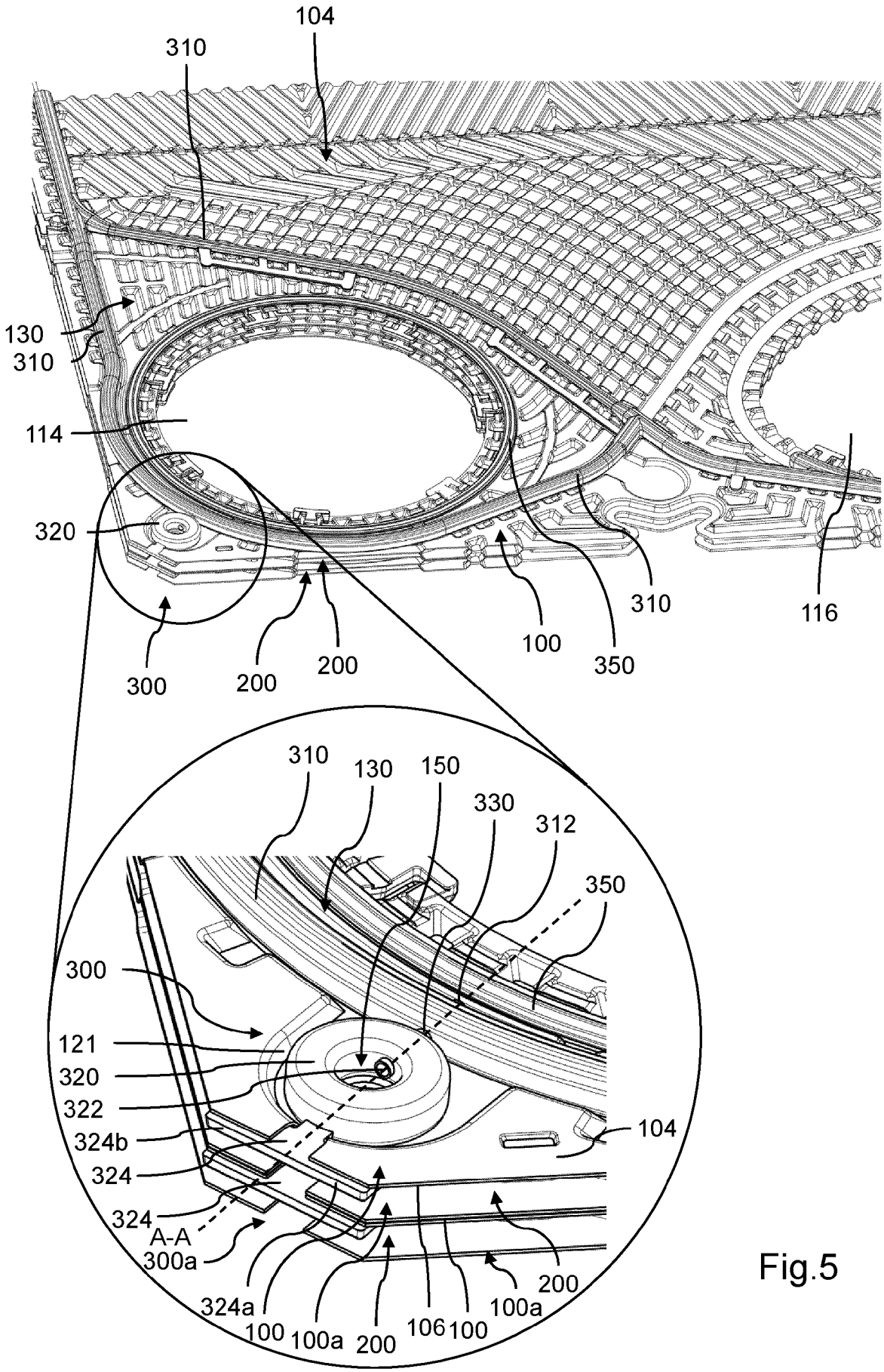

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Fig.5

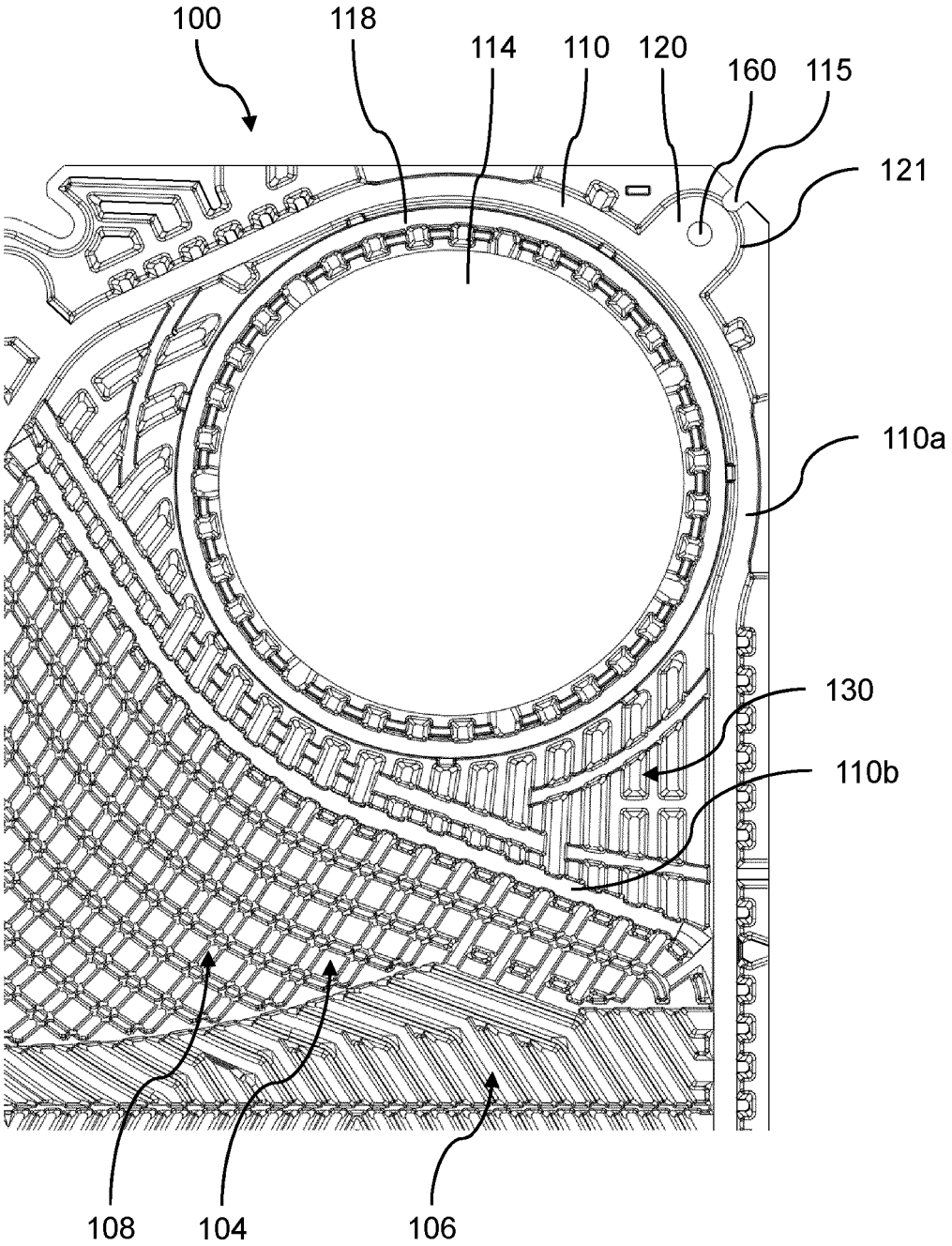


Fig.6

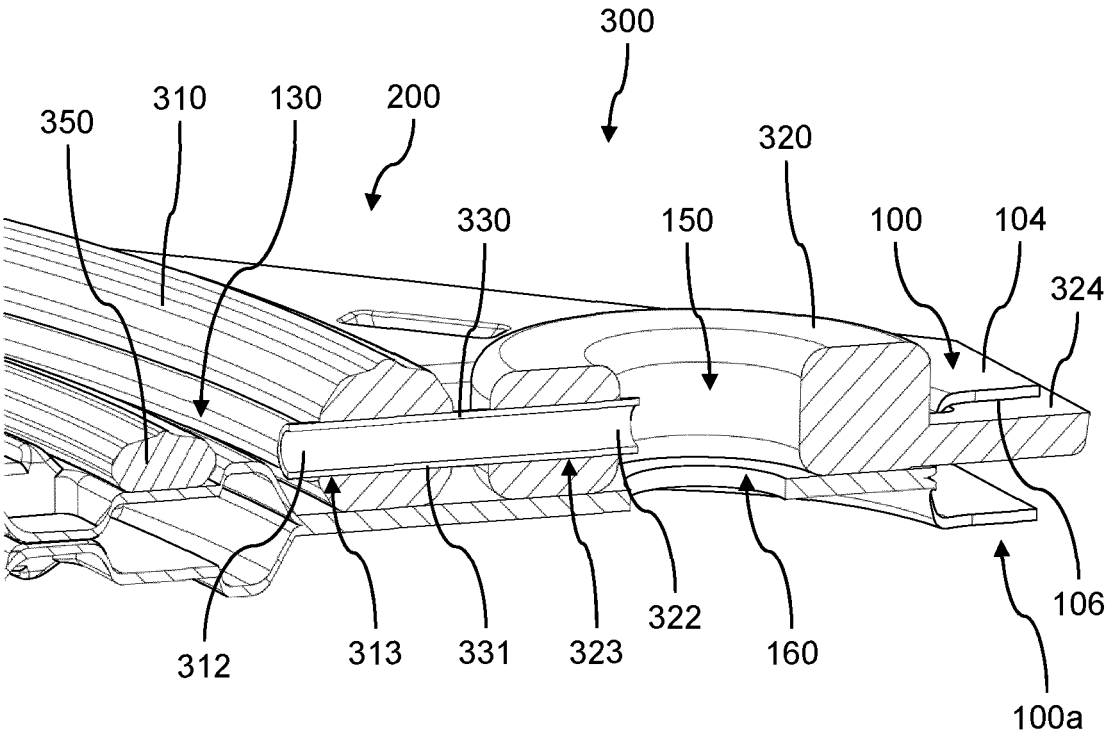

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Fig.7

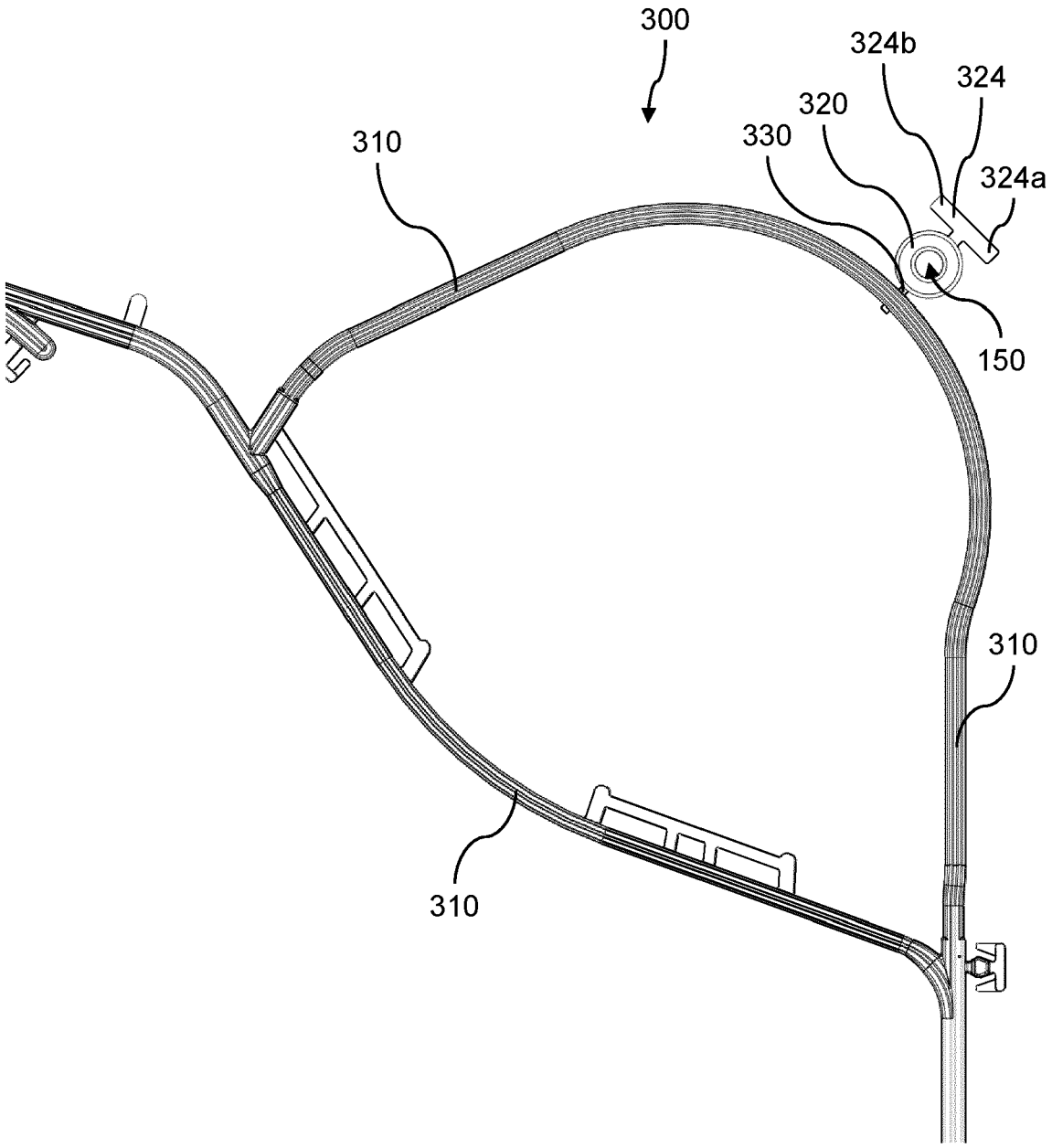


Fig.8

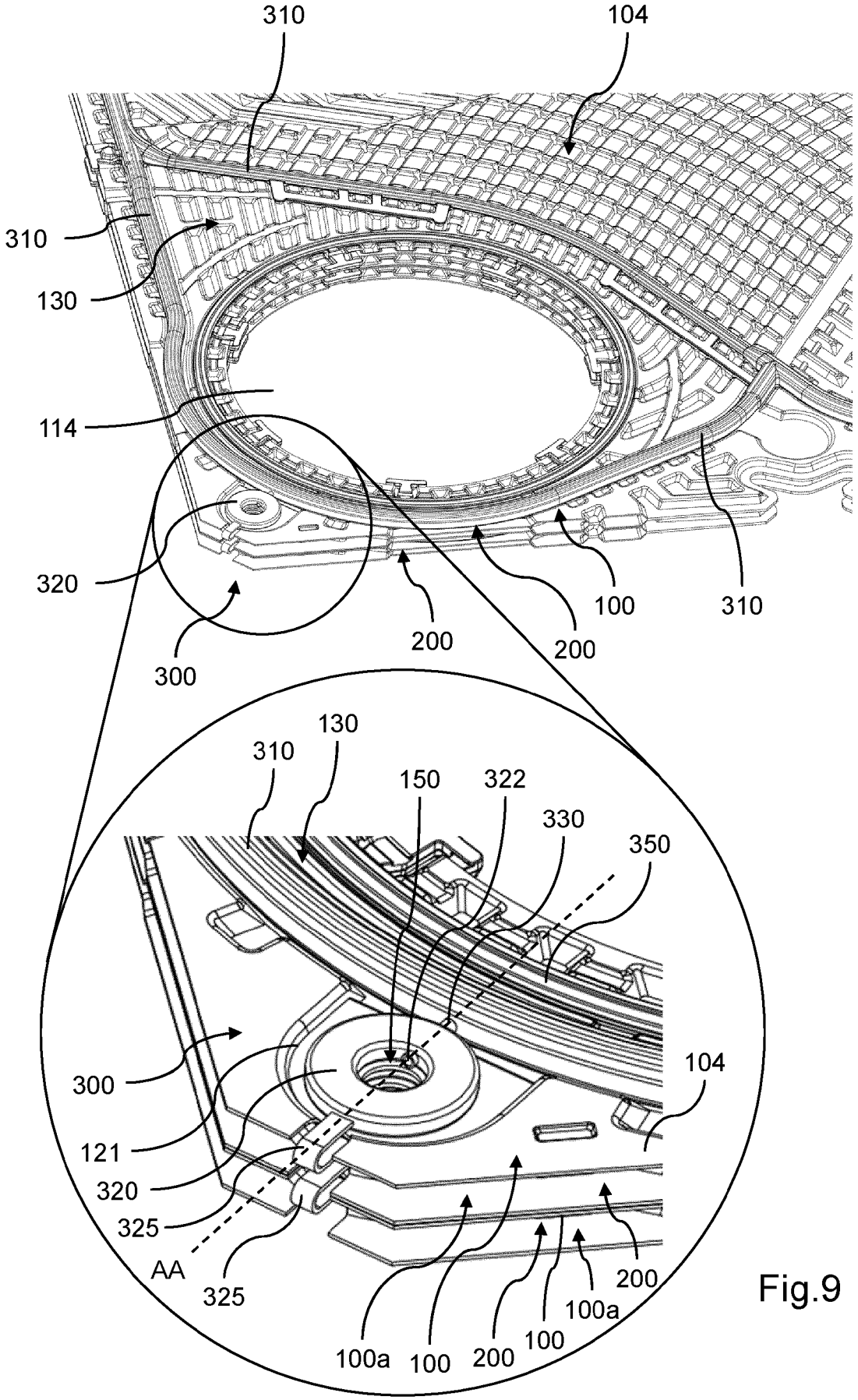

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Fig.9

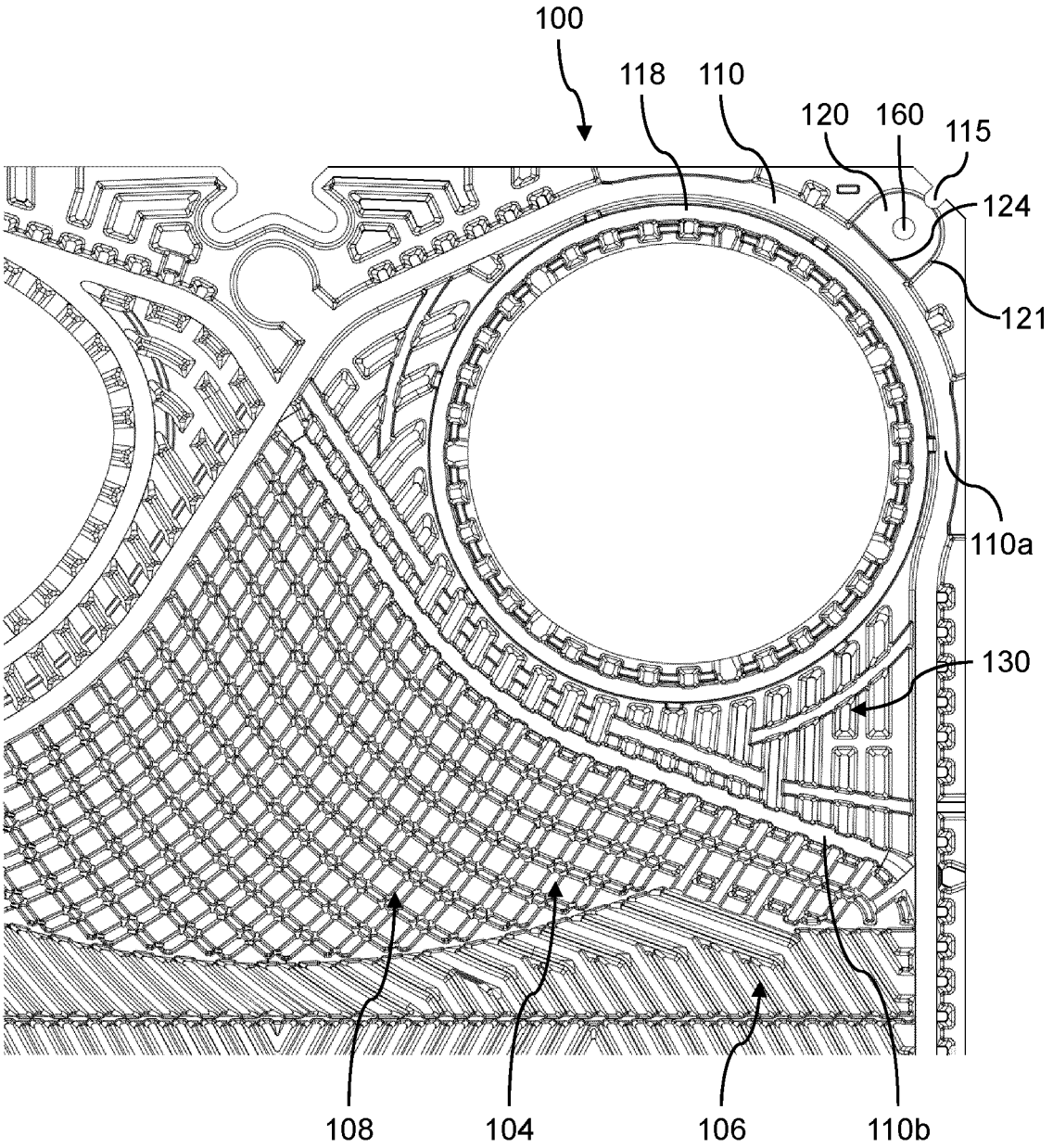


Fig.10

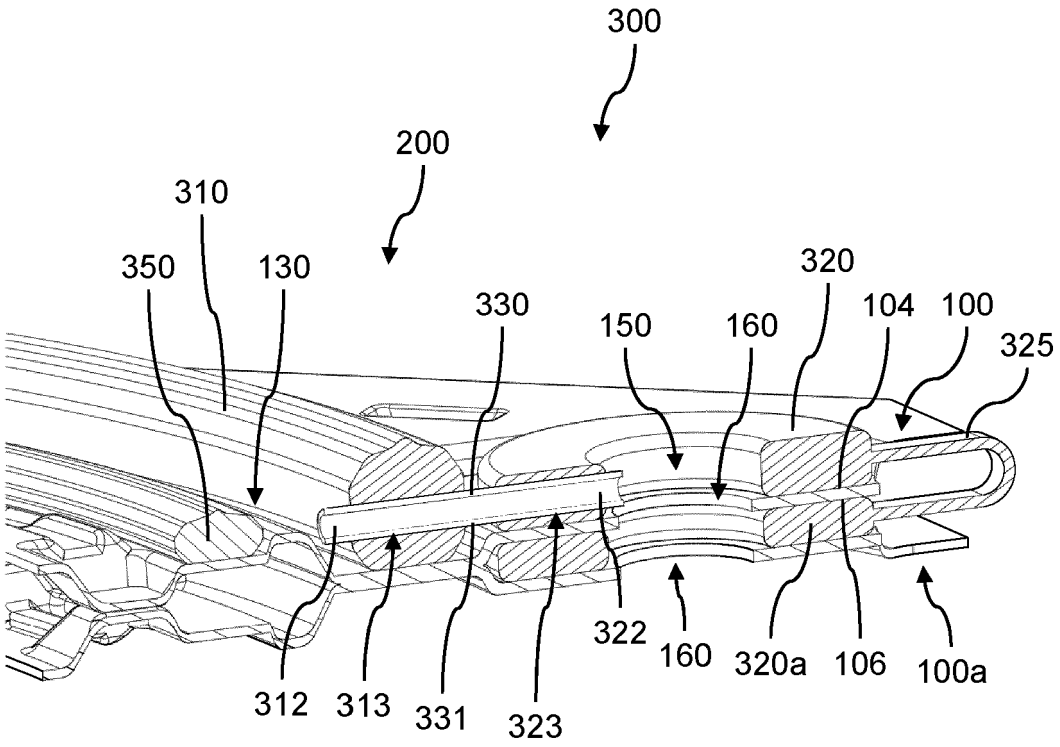

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Fig.11

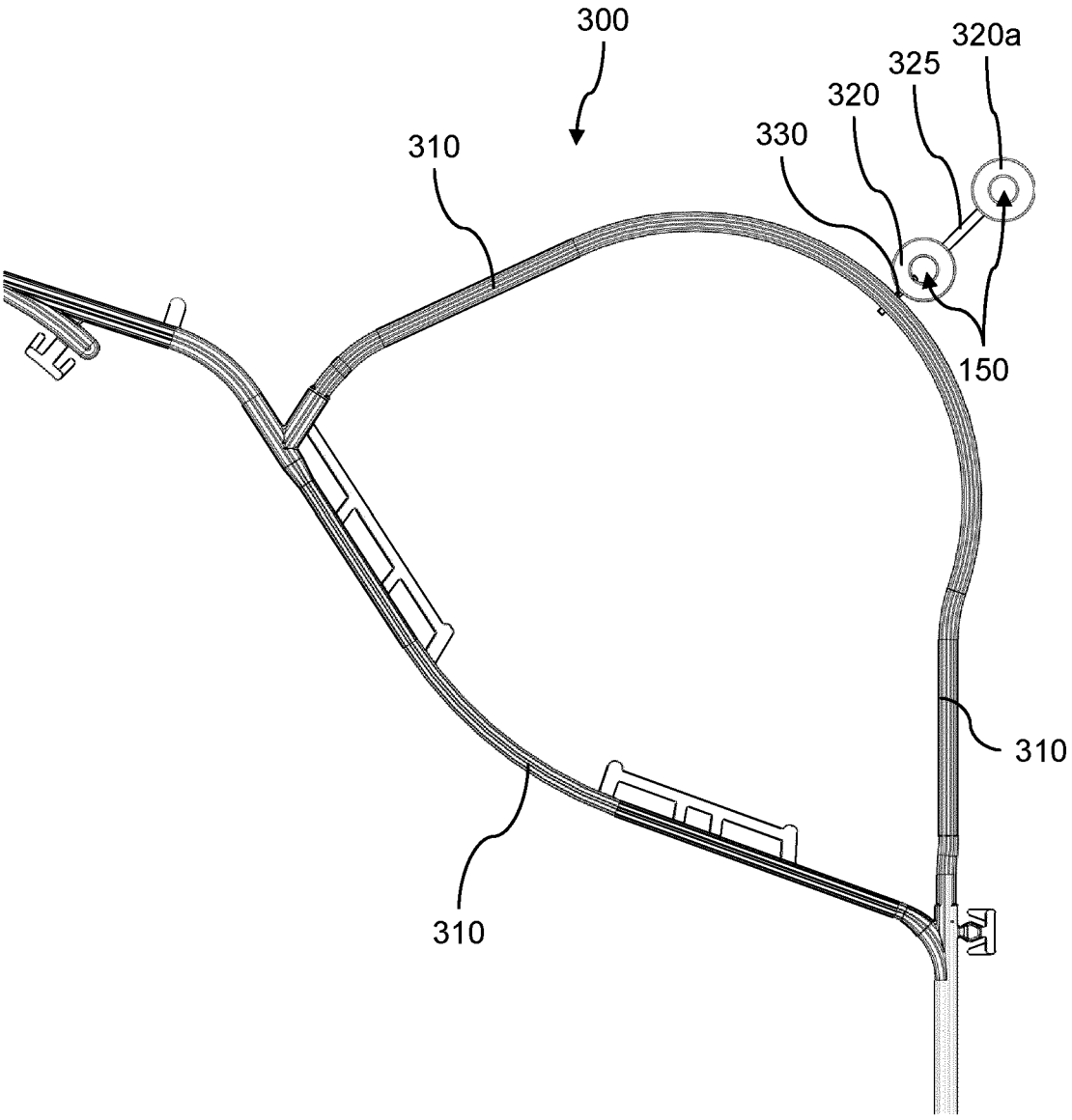


Fig.12

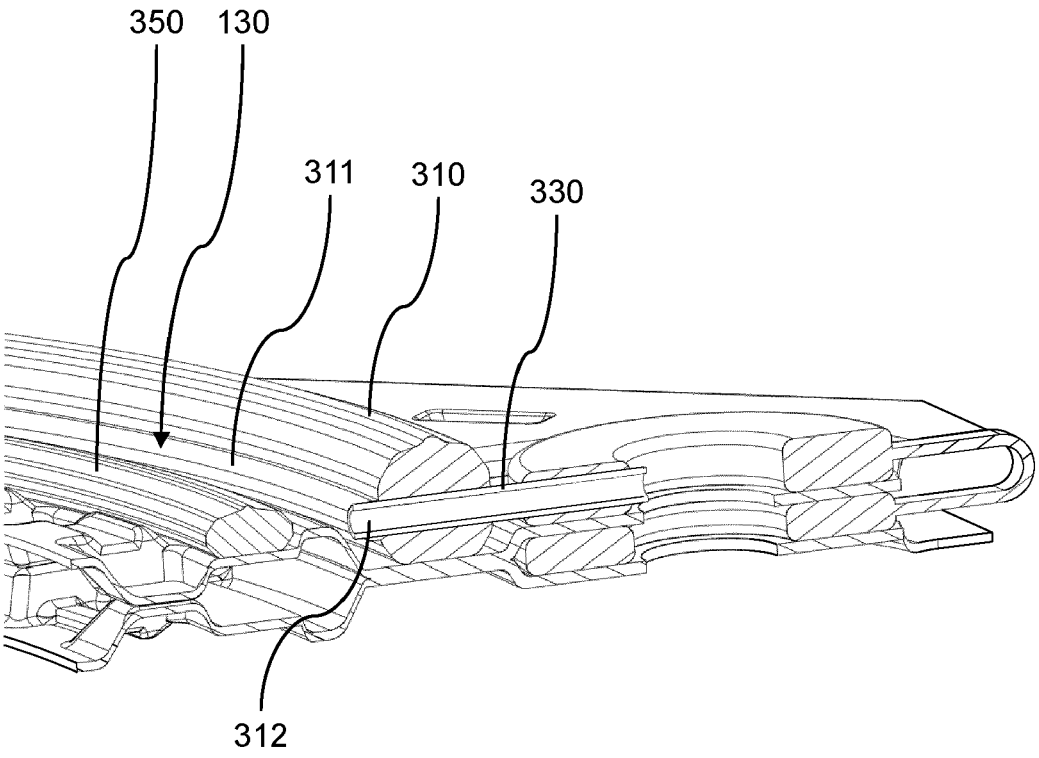


Fig.13

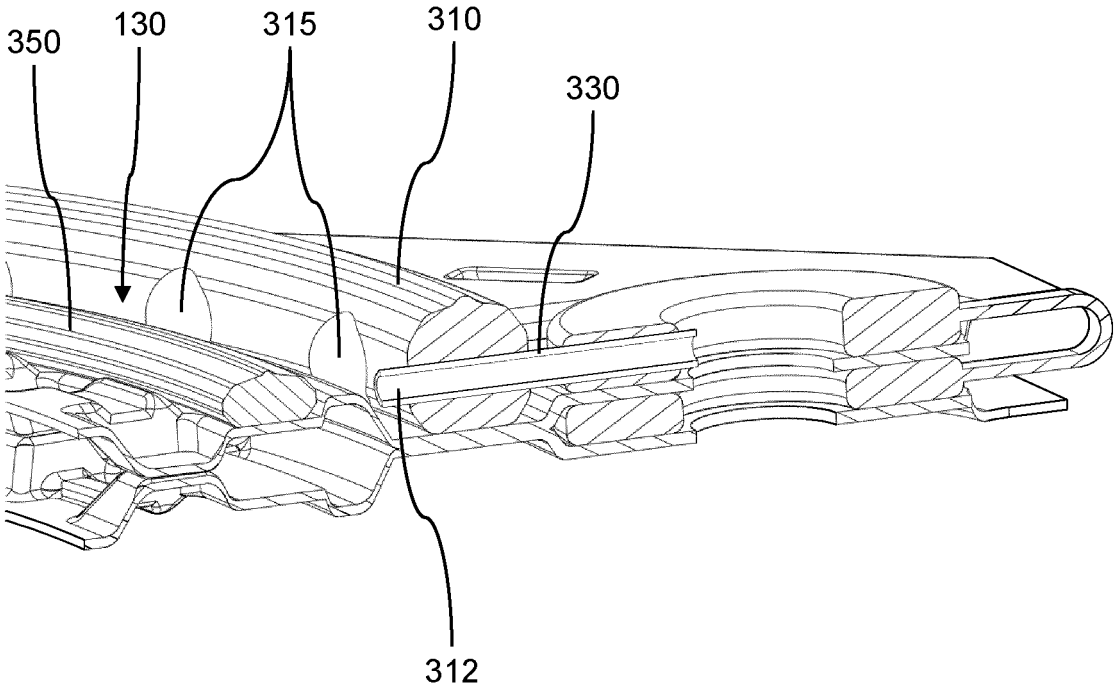


Fig.14

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EUROPEAN SEARCH REPORT

Application Number
EP 25 16 8284

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 3 835 702 A1 (ALFA LAVAL CORP AB [SE]) 16 June 2021 (2021-06-16) * figure 7 *	1-15	INV. F28D9/00 F28F3/00 F28F3/08 F28F3/10 F28F11/00
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	13 August 2025	Delaitre, Maxime

CATEGORY OF CITED DOCUMENTS

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