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(54) **HEADER ARRANGEMENT, METHOD OF ASSEMBLING A HEADER ARRANGEMENT AND HEAT EXCHANGER**

(57) The present invention provides a header arrangement for a heat exchanger, in particular for a shell and tube heat exchanger, comprising: a sheet, in particular tubesheet, a cover, in particular head cover, configured to be arranged abutting a first side of the sheet and fluidly seal said first side to form a chamber, a structural

connection element configured to be connected to the cover and extend through the chamber to structurally support the sheet. Furthermore, the invention provides a method of assembling a header arrangement for a heat exchanger and a heat exchanger.

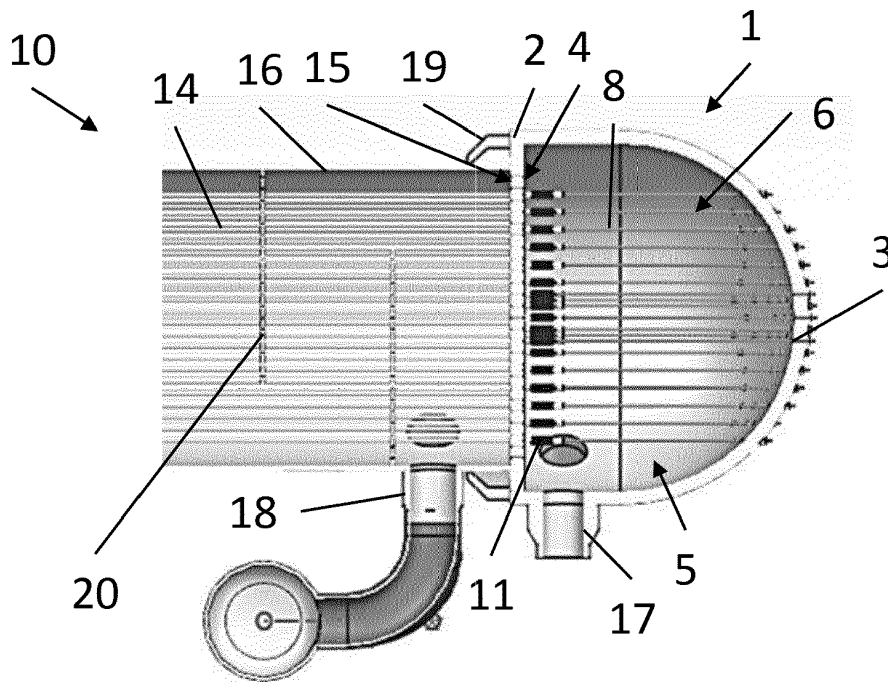


Fig. 4

Description

FIELD OF THE INVENTION

[0001] The present invention relates to a header arrangement for a heat exchanger, a method of assembling such a header arrangement and a heat exchanger comprising such a header arrangement.

BACKGROUND OF THE INVENTION

[0002] Heat exchangers are configured to transfer heat between two working fluids and are utilized with the aim of cooling or heating. Uses for heat exchangers are common but not limited to refrigeration, air conditioning, power stations, petrochemical plants, natural gas processing, etc. As the application areas are diverse, a plurality of different types and/or designs of heat exchangers can be chosen from in order to fulfil specific requirements.

[0003] One type of heat exchanger design is the so-called shell and tube heat exchanger, which is commonly used for example in oil refineries and other large chemical processes. A shell and tube heat exchanger is an indirect heat exchanger that exchanges heat between two working fluids without any mixture of said fluids. As such, a first working fluid flows through multiple tubes while a second working fluid flows through a shell, which encompasses said tubes. Consequently, the exchange of heat takes place along the circumferential walls of the respective tubes and is influenced by their surface area. The ends of the tubes are usually connected to a flat sheet or plate that acts as a barrier, which leads to a chamber.

[0004] Since the tubes often carry high pressure working fluid, the sheets are exposed to said high pressure, and are usually exposed to the highest pressure within the shell and tube heat exchanger. In order to compensate for the high pressure, the flat sheet must be dimensioned accordingly and it often becomes the thickest component in the heat exchanger. Furthermore, due to the nature of the heat exchanger and the high thickness of the sheet, the flat sheet experiences large expansion differences due to temperature gradients across said thickness, which result in high thermal stresses.

SUMMARY OF THE INVENTION

[0005] In view of the above, an object of the present invention is to provide an improved header arrangement for a heat exchanger allowing for improved internal pressure distribution, a corresponding improved method of assembling a header arrangement and an improved heat exchanger.

[0006] Accordingly, the present invention provides a header arrangement for a heat exchanger as recited in claim 1, a method of assembling a header arrangement as recited in claim 11, and a heat exchanger as recited in claim 15.

[0007] Accordingly, the present invention provides:

- A header arrangement for a heat exchanger, in particular for a shell and tube heat exchanger, comprising: a sheet, in particular tubesheet, a cover, in particular head cover, configured to be arranged abutting a first side of the sheet and fluidly seal said first side to form a chamber, a structural connection element configured to be connected to the cover and extend through the chamber to structurally support the sheet.

- A method of assembling a header arrangement for a heat exchanger, in particular a header arrangement according to the invention, comprising the following steps: providing a sheet, in particular tubesheet, providing a cover, in particular head cover, providing a structural connection element configured to be connected to the cover and extend through the chamber to structurally support the sheet, coupling the structural connection element to the a first side of the sheet, and arranging the cover abutting the first side of the sheet in order to fluidly seal said first side to form a chamber.

- A heat exchanger, in particular shell and tube heat exchanger, comprising: a header arrangement according to the invention or manufactured according to the method according to the invention, a plurality of tubes configured to be arranged abutting a second side of the sheet, a shell configured to enclose the plurality of tubes and to be arranged abutting and fluidly seal the second side of the sheet, wherein each respective tube is received through the respective predetermined through hole in the sheet in order to fluidly connect the respective tube to the chamber on the first side of the sheet.

[0008] The underlying discovery on which the present invention is based is therefore that the sheet does not necessarily have to be dimensioned with a high thickness in order to withstand high pressures/forces, but may be dimensioned thinner if supported.

[0009] The idea on which the present invention is based is therefore to provide a structural connection element within the chamber in order to structurally support the sheet through redistribution of pressure. The structural connection element is therefore connected to the cover, extends through the chamber and structurally supports the sheet.

[0010] Advantageously, the sheet of the header arrangement according to the invention can be dimensioned with a thinner thickness compared to a sheet within a header arrangement without a structural connection element, while fulfilling the same requirements. In this way, a thinner sheet is provided that is less susceptible to thermal stresses across its thickness. In this way, mechanical fatigue damage can be strongly reduced or avoided. Accordingly, the header arrangement can be utilized effectively in operations involving fast start-ups

with steep load ramps, with regard to temperature and/or pressure, and/or a high number of such start-ups.

[0011] Moreover, with the structural connection element being connected with the cover, in addition to the redistribution of pressure it is advantageously possible to increase the thickness of the cover to the point where the sheet and cover are equally critical for temperature transients. Consequently, the thickness of the sheet can be reduced, in particular up to 50% in comparison to a sheet in a header arrangement of same dimension and under similar conditions without a structural connection element.

[0012] Furthermore, the weight of the sheet itself and accordingly the overall weight of the entire header arrangement is effectively reduced. In this way, tooling, manufacturing and handling costs and effort is effectively reduced through the reduction of size and weight of the involved components. Especially, the manufacturing of the sheet becomes easier due to the reduced weight and furthermore less expensive due to the reduction of used materials.

[0013] Moreover and through the redistribution of pressure, the sheet can be optimized with regard to its function relating to providing a basis for the connection of the plurality of tubes, in particular within a shell and tube heat exchanger. Since the sheet is supported by the structural connection element, less care has to be taken with regard to ensuring the structural stability of the sheet in itself. Therefore, especially in case of a tubesheet, more care can be taken with regard to providing the maximum amount of area for the reception of the maximum amount of tubes. In this way, it is possible to increase the efficiency and/or effectiveness of the heat exchanger by providing higher surface area for the exchange of heat. Especially, in an embodiment it is even possible to integrate the structure of tube reception with a connection to the structural connection element.

[0014] Advantageously, the method of assembling a header arrangement for a heat exchanger provides a simple, easily controllable, easily carried out and overall efficient way of assembling the improved header arrangement according to the invention.

[0015] Advantageously, the heat exchanger comprising a header arrangement according to the invention exhibits improved characteristics with regard to internal pressure and fatigue resistance and cost effectivity. In particular, the heat exchanger is configured as a U-type heat exchanger comprising two header arrangements.

[0016] Preferably, the heat exchanger contains at least one baffle configured to be arranged within the shell and act as a wall to guide the working fluid around the respective tubes. In this way, the path the working fluid has to take through the shell is increased, which increases cooling performance. The baffle can be arranged essentially perpendicular to the tubes.

[0017] Additionally, the heat exchanger can comprise ribs, in particular reinforcing ribs, arranged along the circumference of the sheet and/or cover. The ribs can be

configured to structurally reinforce the connection of the shell and the sheet and/or cover. In this way, a more structurally rigid heat exchanger is provided.

[0018] The tube sheet can be configured to have an essentially cylindrical shape, in particular resembling a flat plate with a predefined thickness and diameter. The sheet comprises a first side and a second side, which correspond to the two larger sides arranged opposite to each other. In an embodiment, the sheet has a round, e. g. circular or elliptic, shape. Furthermore, the sheet can be manufactured from a material that can withstand high pressures, high temperatures and exhibits high heat resistance. For example, the sheet can be manufactured from a steel, in particular, a low carbon steel, and can comprise a stainless steel and/or alloy cladding.

[0019] The cover of the header arrangement can comprise an inlet/outlet arranged integral with the cover and configured to enable working fluid to flow to/from the sheet. Additionally, the cover can comprise manholes configured and dimensioned to allow an individual (human worker) or a robot or other machine to enter the cover in order to clean and/or examine the inside of the cover and/or chamber. Furthermore, the cover can be configured as a bonnet, channel, pressure closure, floating head, stationary head or combination therefrom.

[0020] Preferably, the cover can be configured to be attached to the sheet through any practical detachable or non-detachable connection means, for example through screws/bolts, rivets, welds, etc. The fluidic seal between the cover and the sheet can be assisted through welding seams and/or the utilizations of mechanical seals and/or gaskets in order to prevent any leakage.

[0021] The sheet and cover can be configured to have a similar diameter in order for an efficient material usage during production. Alternatively, the sheet and cover can be dimensioned so that the sheet extends radially from circumferential edges of the cover in order to provide a flange for further connections.

[0022] The chamber formed by the arrangement of the cover abutting the first side of the sheet can be configured to support and/or assist the flow of fluid to/from the header arrangement, especially in case of a tubesheet through the tubes connected to the sheet on the second side. Additionally, the chamber can comprise a large hollow volume in order to avoid any backpressure leading to inefficient pressure drops, which could disturb the flow of the working fluid in the header arrangement.

[0023] The structural connection element can be configured as a sturdy and mechanically rigid component or comprise a plurality of such components in order to effectively structurally support the sheet against internal pressure and/or other forces, such as thermal stress and/or deformation. In this way, the structural connection element increases internal pressure distribution within the header arrangement. Additionally, the structural connection element can be arranged to essentially not obstruct or minimize its obstruction of the flow of the working fluid into/out of the chamber and to/from the sheet.

[0024] Preferably, the structural connection element is configured to be scalable in order to be increased and/or decreased with regard to the amount of support it can provide to the sheet to effectively fulfil any requirements. Additionally, the structural connection element can be configured as a single piece or be configured as comprising multiple individual components in order to distribute the pressure.

[0025] Furthermore, in an embodiment, the structural connection element can be configured as an integral or fixedly connected component with the sheet or with the cover. In this way, the amount and/or variety of parts of the header arrangement is reduced.

[0026] Advantageous or preferred features of the invention are recited in the dependent claims.

[0027] In an embodiment, the sheet comprises a plurality of through holes, wherein the structural connection element is configured to be connected to the sheet via at least one predetermined through hole. In this way, the through holes of the sheet, which are configured for fluid flow, perform an additional task of providing a connection means for the structural connection element. Advantageously, no additional connection means have to be provided within the chamber of the header arrangement, which could obstruct the flow of the working fluid. Additionally, the through holes can be configured to fluidly connect the first side of the sheet within the chamber and the second side of the sheet. The diameter of the respective individual through holes, for example, can range from between 10-30 mm, preferably between 15-25 mm.

[0028] Alternatively, the connection of the structural connection element and at least one predetermined through hole can be realized by means of a designated connection element. The designated connection element can be configured as an internal thread, in particular female thread, within the predetermined through hole or be configured as a standalone component that acts as an intermediate piece. Preferably, the connection of the structural connection element and at least one predetermined through hole comprises a relatively high matching and/or coinciding surface area in order to effectively transfer force between the structural connection element and the sheet.

[0029] In a preferred embodiment, the through holes are arranged in a triangular pattern on the sheet, in particular rotated 30° or 60° or a square pattern, in particular rotated square pattern. The rotated patterns of the through holes on the sheet are to be understood as being rotated relative to a central axis of the sheet. Further arrangement patterns of the through holes of the sheet, such as hexagonal or octagonal patterns and their rotated modifications, are also feasible.

[0030] In an embodiment, the structural connection element comprises a plurality of rods configured to extend from the cover through the chamber, in particular essentially in parallel to each other and/or essentially perpendicular to the sheet. In this way, a cost effective component is provided, which performs the task of structurally

supporting the sheet. The rods can be dimensioned as cylinders, in particular with a relatively thin diameter, in order to not block or obstruct the flow of working fluid within the cover and/or chamber. Furthermore, the respective rods can be configured to be arranged integral with the sheet, in particular integral with a respective through hole in the sheet. In an embodiment, the header arrangement can comprise between 75-150 rods. The plurality of rods can be arranged evenly within the chamber in order to distribute the force between themselves and for uniform transfer of force to the cover.

[0031] In an embodiment, the structural connection element comprises a hollow section configured to fluidly connect the chamber to the at least one predetermined through hole. In this way, an integration of multiple functions is realized and the fluidic throughput of the sheet itself is not reduced by the structural connection element. Accordingly, it can be connected to the sheet via at least one predetermined through hole without blocking any fluid from passing from the chamber into the at least one predetermined through hole. In an embodiment, the hollow section of the structural connection element can be configured to extend between approximately 5-20% of the length and approximately 5-20% of the circumference of the structural connection element. For example, the hollow section can be configured as an axial bore hole in the structural connection element with a lateral opening. In this way, the hollow section does not have an adverse effect on the rigidity of the structural connection element, its ability to support the sheet, and/or its ability of guiding working fluid.

[0032] In an embodiment, the header arrangement further comprises an adaptor arranged between the structural connection element and the sheet. The adaptor is configured for connecting the sheet to the structural connection element. In this way, a component is provided that acts as an intermediate piece between the structural connection element and the sheet. Advantageously, the adaptor can be configured to act as a predetermined breaking feature that in the case of damage, for example due to pressure overload, would be the first to fail, with the aim of avoiding any further damage happening to the sheet or cover. In this way, only a comparatively inexpensive component would fail that can be easily replaced, saving the more expensive sheet and/or cover from any damage. Additionally, the adaptor can be configured to be integral with the sheet in order to provide sufficient transfer of force and/or reducing possible error sources. The adaptor can be configured as a cylinder. In this way, the shape of the adaptor minimizes obstruction of the flow of the working fluid.

[0033] In an embodiment, the adaptor is configured to be attachable to the at least one predetermined through hole. In this way, the existing through holes of the sheet are utilized in order to receive the adaptor, which eliminates any dedicated attachment points and/or elements being required on or within the sheet for receiving the adaptor. The attachment of the adaptor to the through

hole can be realized by any practical detachable or non-detachable connection means, for example through a threaded connection, press fit, welding, adhesive joint, screws/bolts, rivets, etc. Preferably, the adaptor is configured to be attachable from the first side of the sheet. In this way, the adaptor, the structural connection element and the cover are all configured to be attachable from the same side, in particular the first side, of the sheet.

[0034] In an embodiment, the adaptor comprises an opening, e.g. a radial/lateral opening, configured to fluidly connect the chamber to the at least one predetermined through hole. In this way, the fluidic throughput of the sheet itself is not reduced by the adaptor being configured to be attachable to the at least one predetermined through hole and therefore blocking any fluid from passing from the chamber into said at least one predetermined through hole. In an embodiment, the opening of the adaptor can be configured to extend between approximately 50-75% of the length and approximately 5-20% of the circumference of the adaptor. In this way, the opening does not have an adverse effect on the structural rigidity of the adaptor and/or its ability for transferring force from the sheet to the structural connection element.

[0035] Preferably, the opening of the adaptor consists of multiple axial slits, in particular 3-5 axial slits, evenly spaced around the circumference of the adaptor to form a radial opening. Furthermore, other shapes of the opening are also feasible, for example square oval, circular, etc.

[0036] In an embodiment, the respective adaptor, the respective predetermined through hole and the structural connection element are arranged collinear. In this way, the transfer of the mechanical stresses occurring during operation of the heat exchanger with a header arrangement according to the invention along the individual components is eased and/or supported through the collinearity of the components. In particular, mechanical stresses are thus transferred mainly as tensional forces via the adaptor, predetermined through hole and structural connection element. Furthermore, unfavorable shear, torsion and/or bending stresses are effectively avoided.

[0037] In an embodiment, the header arrangement further comprises an attachment element configured to receive a distal end of the structural connection element within the cover. In particular, a distal end of the structural connection element is received within a hole in the cover. In this way, a component is provided that enables the connection of the structural connection element within the cover. The attachment element can be configured as a detachable connection means, for example a screw or bolt. Furthermore, the cover can comprise a designated attachment section configured to receive the attachment element. In an embodiment, the attachment section can be configured as a surface essentially parallel to the surface of the sheet. Preferably, the attachment section comprises an optimized surface, in particular through surface treatment, in order to ensure a secure fit of the attachment element. Furthermore, the attachment sec-

tion can be configured as an internally threaded hole or nut corresponding to the attachment element.

[0038] Preferably, the distal end of the structural connection element can be configured to pass through a hole in the cover in order to be fixed on the outside surface of said cover with the attachment element. The hole in the cover can be configured to correspond to the diameter of the structural connection element and suitable seals and/or gaskets can be utilized in order to prevent leakage.

[0039] In an embodiment, the cover at least partially has a hemispherical shape. Especially, the cover is formed in the manner of a calotte of dome. In this way, in terms of pressure resistance an optimally formed cover is provided that advantageously also withstands forces transferred along the structural connection element. Furthermore, the cover can be manufactured thinner while resisting the same amount of pressure in comparison to a cover with edges, for example, a squared cover or flat head cover, which comprises numerous local stress concentrations.

[0040] In an embodiment of the method, the sheet comprises a plurality of through holes, wherein the structural connection element is connected to the sheet via at least one predetermined through hole. In this way, the assembly of the header arrangement is improved, as no further attachment elements have to be arranged on the sheet since the existing through holes are utilized. Advantageously this reduces the amount of assembly steps, which in turn reduces assembly time and costs.

[0041] In an embodiment of the method, an adaptor is arranged between the structural connection element and the sheet to connect the sheet to the structural connection element, wherein the adaptor is in particular attached to the at least one predetermined through hole. In this way, the structural connection element can be connected to the sheet easily and fast during assembly. Further possible embodiments, features and advantages of the adaptor are as described above.

[0042] In an embodiment of the method, the structural connection element is connected to the cover. In particular, the structural connection element is coupled to the cover via at least one predetermined hole in the cover, which corresponds to the structural connection element. Furthermore, a distal end of the structural connection element is secured in the hole with an attachment element, especially on the outside surface of the cover. In this way, the structural connection element can be connected to the cover easily and fast during assembly. Further possible embodiments, features and advantages of the at least one predetermined hole in the cover and of the attachment element are as described above.

[0043] The above embodiments can be combined with each other as desired, if useful. Further possible embodiments, further configurations and implementations of the invention also include combinations, not explicitly mentioned, of features of the invention described herein with respect to the embodiments. In particular, the skilled person will thereby also add individual aspects as improve-

ments or additions to the respective basic form of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0044] For a more comprehensive understanding of the invention and the advantages thereof, exemplary embodiments of the invention are explained in more detail in the following description with reference to the accompanying drawing figures, in which like reference characters designate like parts and in which:

- Fig. 1 shows a schematic representation of a header arrangement;
- Fig. 2 shows a schematic representation of an adaptor and structural connection element according to an embodiment;
- Fig. 3 shows a schematic representation of a heat exchanger;
- Fig. 4 shows a partial sectional view of a heat exchanger according to an embodiment;
- Fig. 5 shows a partial perspective sectional view of a heat exchanger according to the embodiment of Fig. 4; and
- Fig. 6 shows an isometric view of a U-shaped heat exchanger.

[0045] The accompanying drawings are included to provide a further understanding of the present invention and are incorporated in and constitute a part of this specification. The drawings illustrate particular embodiments of the invention and together with the description serve to explain the principles of the invention. Other embodiments of the invention and many of the resulting advantages of the invention will be readily appreciated as they become better understood with reference to the following detailed description.

[0046] It will be appreciated that common and/or well understood elements that may be useful or necessary in a commercially feasible embodiment are not necessarily depicted in order to facilitate a more abstracted view of the embodiments. The elements of the drawings are not necessarily illustrated to scale relative to each other. It will further be appreciated that certain actions and/or steps in an embodiment of a method may be described or depicted in a particular order of occurrences while those skilled in the art will understand that such specificity with respect to sequence is not actually required. It will also be understood that the terms and expressions used in the present specification have the ordinary meaning as is accorded to such terms and expressions with respect to their corresponding respective areas of inquiry and study, except where specific meanings have other-

wise been set forth herein.

DETAILED DESCRIPTION OF EMBODIMENTS

[0047] Fig. 1 shows a schematic representation of a header arrangement 1.

[0048] The shown schematic representation depicts a header arrangement 1 in a sectional view. The individual components are not shown to scale and/or are not shown in an appropriate quantity, but only intended to show the functional relationship.

[0049] In the shown representation, the header arrangement 1 is for a heat exchanger 10. In particular, the header arrangement 1 may be for a shell and tube heat exchanger.

[0050] The header arrangement 1 comprises a sheet 2, a cover 3 and a structural connection element 6. In particular the sheet 2 is configured as a tubesheet, as is common with shell and tube heat exchangers. Furthermore, the cover 3 is configured to be arranged abutting a first side 4 of the sheet 2. In particular, the cover 3 may be configured as a head cover. As shown, the cover 3 is arranged in order to fluidly seal said first side 4 of the sheet 2 to form a chamber 5. As a non-limiting example, the cover 3 is shown at least partially having an essentially hemispherical shape. Accordingly, the chamber 5 encapsulates a hemispherical volume.

[0051] Additionally, the header arrangement 1 comprises a structural connection element 6, which is configured to be connected to the cover 3 and extend through the chamber 5. The structural connection element 6 is configured to structurally support the sheet 2. As shown, the structural connection element 6 is depicted as three vertically spaced elongate members, e.g. cylinders, arranged extending through the chamber 5 between the sheet 2 and the cover 3.

[0052] Fig. 2 shows a schematic representation of an adaptor 11 and structural connection element 6 according to an embodiment.

[0053] The shown schematic representation depicts an embodiment with an adaptor 11 connected to the sheet 4 and structural connection element 6. In this embodiment, the header arrangement 1 further comprises the adaptor 11, which is arranged between the structural connection element 6 and the sheet 2 and configured for connecting the sheet 2 to the structural connection element 6.

[0054] In the shown embodiment, the structural connection element 6 comprises a plurality of rods 6; a single rod 6 is connected to adaptor 11 as depicted. Furthermore, the adaptor 11 is configured to be attachable to the at least one predetermined through hole 7 in sheet 2. In the shown example, the through hole 7 is covered by the adaptor 11.

[0055] As shown, the adaptor 11 is configured as a cylindrical element extending from the through hole 7 towards the structural connection element 6. The rod 8 is connected to the adaptor 11 opposite from the sheet 2.

The connection of the rod 8 and the adaptor 11 can be realized through any practical connection means, for example with an internal thread within the adaptor 11.

[0056] As shown, the adaptor 11 comprises an opening 12 configured to fluidly connect the chamber 5 to the at least one predetermined through hole 7. The opening 12 is shown as an ovalar aperture in the circumferential surface of the adaptor 11. The shape of the opening 12 is to be understood as non-limiting, the opening 12 can also be shaped as a circle, slit, square, etc. Furthermore, the adaptor 11 can comprise multiple openings 12, which are spaced, in particular evenly, around the circumference of the adaptor 11.

[0057] Moreover, the adaptor 11, the predetermined through hole 7 and the structural connection element 6 are arranged collinear with each other. As a result, the individual components share a common central axis M.

[0058] In further embodiments, the structural connection element 5 comprises a hollow section 9 (not shown) configured to fluidly connect the chamber 5 to the at least one predetermined through hole 7. In such an embodiment, the structural connection element 6 and/or the rod 8 are/is directly connected to the sheet 2 without the use of an adaptor 11.

[0059] Fig. 3 shows a schematic representation of a heat exchanger 10.

[0060] The shown schematic representation depicts a simplified heat exchanger 10 in a sectional view. The individual components are not shown to scale and/or are not shown in an appropriate quantity. Furthermore, the shown representation contains a break on the left side in order to show a detailed view of the header arrangement 1.

[0061] In the shown representation, the heat exchanger 10 is configured as a shell and tube heat exchanger. The heat exchanger 10 comprises a header arrangement 1 according to Fig. 1, a plurality of tubes 14 and a shell 16. As shown, the plurality of tubes are configured to be arranged abutting a second side 15 of the sheet 2.

[0062] As shown, the shell 16 is configured to enclose the plurality of tubes 14 and is configured to be arranged abutting and fluidly seal said second side 15 of the sheet 2. The connection of the shell 16 and the sheet 2 can be realized through any practical detachable or non-detachable connection means, for example through welding, screws/bolts, rivets, etc. Furthermore, the shell 16 and/or the sheet 2 can comprise a flanged section in order to facilitate the connection between themselves.

[0063] Each respective tube 14 is received through the respective predetermined through hole 7 in the sheet 2 in order to fluidly connect the respective tube 14 to the chamber 5 on the first side 4 of the sheet 2. In this way, a first working fluid that enters into the chamber 5 through the tube inlet 17 can flow from the chamber 5 on the first side 4 of the sheet 2 through a respective through hole 7 and into a respective tube 14. Simultaneously a second working fluid enters shell inlet 18 into the shell 16. The tube inlet 17 and shell inlet 18 can respectively be con-

figured to act as outlets.

[0064] Fig. 4 shows a partial sectional view of a heat exchanger 10 according to an embodiment.

[0065] The shown depiction of the heat exchanger 10 contains a break on the left side in order to show a detailed view of the header arrangement 1.

[0066] As shown, the structural connection element 6 comprises a plurality of rods 8 configured to extend from the cover 3 through the chamber 5. In particular, the structural connection element 6 and/or the plurality of rods 8 are essentially arranged in parallel to each other and/or essentially perpendicular to the sheet 2.

[0067] The cover 3 as shown at least partially has a hemispherical shape. In addition, the heat exchanger 10 comprises ribs 19 arranged circumferentially around the outer perimeter of the shell 16 and connecting the shell 16 to the sheet 2. The depicted ribs 19 act as a reinforcement for transferring mechanical stress between the shell 16, sheet 2 and cover 3.

[0068] Furthermore, the heat exchanger 16 comprises baffles 20. The baffles 20 act as walls within the shell 16 that guide the working fluid through the shell 16. The baffles 20 are configured to be arranged essentially perpendicular to the tubes 14. Moreover, the tube inlet 17 and shell inlet 18 are shown arranged at the lower end of the chamber 5 and shell 16 respectively.

[0069] Fig. 5 shows a partial perspective sectional view of a heat exchanger 10 according to Fig. 4.

[0070] As shown, the sheet 2 comprises a plurality of through holes 7. The through holes 7 are configured to fluidly connect the chamber 5 arranged on the first side 4 of the sheet 2 with the tubes 14 arranged on the second side 15 (not shown) of the sheet 2.

[0071] Furthermore, the structural connection element 6, comprising rods 8, is configured to be connected to the sheet 2 via at least one predetermined through hole 7. In the shown embodiment the header arrangement 10 comprises adaptors 11 arranged between the rods 8 and the predetermined through holes 7. As depicted, the rods 8 are arranged and connected to the sheet 2 in a specific pattern within the chamber 5. Furthermore, the amount of rods 8 of the structural connection element 6 and the pattern in which they are arranged can be chosen depending on different requirements of the heat exchanger 10.

[0072] The header arrangement 1 comprises an attachment element 21 configured to receive a distal end 13 of the structural connection element 6 within the cover 3. As shown, the connection of the structural connection element 6 within the cover 3 can be realized by providing a hole in the cover 3, which corresponds to the structural connection element 6, and securing the distal end 13 with the attachment element 21 on the outside surface of the cover 3, for example by means of a threaded hole and/or a nut.

[0073] The method of assembling a header arrangement for a heat exchanger as shown in Fig 5, comprises the following steps: providing the sheet 2, in particular

tubesheet, providing the cover 3, in particular head cover, providing the structural connection element 6 configured to be connected to the cover 3 and extend through the chamber 5 to structurally support the sheet 2, coupling the structural connection element 6 to the first side 4 of the sheet 2 and arranging the cover 3 abutting the first side 4 of the sheet 2 in order to fluidly seal said first side 4 to form the chamber 5.

[0074] As shown, the sheet 2 comprises a plurality of through holes 7 and the structural connection element 6 is connected to the sheet 2 via at least one predetermined through hole 7. Moreover, the adaptor 11 is arranged between the structural connection element 6 and the sheet 2 to connect the sheet 2 to the structural connection element 6, wherein the adaptor 11 is in particular attached to the at least one predetermined through hole 7.

[0075] The structural connection element 6 is connected to the cover 3, in particular by coupling the structural connection element 6 to the cover 3 via at least one predetermined through hole 7 in the cover 3 which corresponds to the structural connection element 6. In addition, securing the distal end 13 of the structural connection element 6 with an attachment element 21, especially on the outside surface of the cover 3.

[0076] Fig. 6 shows an isometric view of a U-shaped heat exchanger.

[0077] The shown heat exchanger 10 is configured as a U-type shell and tube heat exchanger, which is characterized by the shell 16 being shaped as the letter "U", wherein both ends of the "U" are sealed with a header arrangement 1 as shown with respect to the heat exchanger 10 according to Fig. 4. Furthermore, the heat exchanger 1 comprises a plurality of tubes 14 configured to be arranged abutting a second side 15 of the respective sheets 2 of the respective header arrangements 1.

[0078] The shell 16 is configured to enclose the plurality of tubes 14 and is configured to be arranged abutting and fluidly seal the second side 15 of the respective sheets 2 of the respective header arrangements 1. Each respective tube 14 is received through the respective predetermined through hole 7 in the respective sheet 2 in order to fluidly connect the respective tube 14 to the respective chamber 5 on the first side 4 of the respective sheets 2 of the respective header arrangements 1.

[0079] Although specific embodiments of the invention are illustrated and described herein, it will be appreciated by those of ordinary skill in the art that a variety of alternative and/or equivalent implementations exist. It should be appreciated that the exemplary embodiment or exemplary embodiments are examples only and are not intended to limit the scope, applicability, or configuration in any way. Rather, the foregoing summary and detailed description will provide those skilled in the art with a convenient road map for implementing at least one exemplary embodiment, it being understood that various changes may be made in the function and arrangement of elements described in an exemplary embodiment without departing from the scope as set forth in the appended

claims and their legal equivalents. Generally, this application is intended to cover any adaptations or variations of the specific embodiments discussed herein.

[0080] It will also be appreciated that in this document the terms "comprise", "comprising", "include", "including", "contain", "containing", "have", "having", and any variations thereof, are intended to be understood in an inclusive (i.e. non-exclusive) sense, such that the process, method, device, apparatus or system described herein is not limited to those features or parts or elements or steps recited but may include other elements, features, parts or steps not expressly listed or inherent to such process, method, article, or apparatus. Furthermore, the terms "a" and "an" used herein are intended to be understood as meaning one or more unless explicitly stated otherwise. Moreover, the terms "first", "second", "third", etc. are used merely as labels, and are not intended to impose numerical requirements on or to establish a certain ranking of importance of their objects.

Claims

1. Header arrangement (1) for a heat exchanger, in particular for a shell and tube heat exchanger, comprising:
 - a sheet (2), in particular tubesheet;
 - a cover (3), in particular head cover, configured to be arranged abutting a first side (4) of the sheet (2) and fluidly seal said first side (4) to form a chamber (5);
 - a structural connection element (6) configured to be connected to the cover (3) and extend through the chamber (5) to structurally support the sheet (2).
2. Header arrangement according to claim 1, wherein the sheet (2) comprises a plurality of through holes (7), and wherein the structural connection element (6) is configured to be connected to the sheet (2) via at least one predetermined through hole (7).
3. Header arrangement according to claim 1 or 2, wherein the structural connection element (6) comprises a plurality of rods (8) configured to extend from the cover (3) through the chamber (5), in particular essentially in parallel to each other and/or essentially perpendicular to the sheet (2) .
4. Header arrangement according to claim 3, wherein the structural connection element (6) comprises a hollow section (9) configured to fluidly connect the chamber (5) to the at least one predetermined through hole (7).
5. Header arrangement according to any one of the

- claims 1 to 3, further comprising an adaptor (11) arranged between the structural connection element (6) and the sheet (2), and wherein the adaptor (11) is configured for connecting the sheet (2) to the structural connection element (6). 5
- 6.** Header arrangement according to claim 5, wherein the adaptor (11) is configured to be attachable to the at least one predetermined through hole (7). 10
- 7.** Header arrangement according to claim 6, wherein the adaptor (11) comprises an opening (12) configured to fluidly connect the chamber (5) to the at least one predetermined through hole (7). 15
- 8.** Header arrangement according to any of claims 5 to 7, wherein the respective adaptor (11), the respective predetermined through hole (7) and the structural connection element (6) are arranged collinear. 20
- 9.** Header arrangement according to any of the preceding claims, further comprising an attachment element (21) configured to receive a distal end (13) of the structural connection element (6) within the cover (3), in particular within a hole in the cover. 25
- 10.** Header arrangement according to any of the preceding claims, wherein the cover (3) at least partially has a hemispherical shape. 30
- 11.** Method of assembling a header arrangement for a heat exchanger, in particular a header arrangement (1) according to any of the preceding claims, comprising the following steps: 35
- providing a sheet (2), in particular tubesheet; providing a cover (3), in particular head cover; providing a structural connection element (6) configured to be connected to the cover (3) and extend through the chamber (5) to structurally support the sheet (2); 40
- coupling the structural connection element (6) to the a first side (4) of the sheet (2); and arranging the cover (3) abutting the first side (4) of the sheet (2) in order to fluidly seal said first side (4) to form a chamber (5). 45
- 12.** Method of assembling a header arrangement for a heat exchanger according to claim 11, wherein the sheet (2) comprises a plurality of through holes (7), and wherein the structural connection element (6) is connected to the sheet (2) via at least one predetermined through hole (7). 50
- 13.** Method of assembling a header arrangement for a heat exchanger according to claim 12, wherein an adaptor (11) is arranged between the structural connection element (6) and the sheet (2) to connect the sheet (2) to the structural connection element (6), wherein the adaptor (11) is in particular attached to the at least one predetermined through hole (7). 55
- 14.** Method of assembling a header arrangement for a heat exchanger according to any one of claims 11 to 13, wherein the structural connection element (6) is connected to the cover (3), in particular by coupling the structural connection element (6) to the cover (3) via at least one predetermined through hole (7) in the cover (3) which corresponds to the structural connection element (6), and securing a distal end (13) of the structural connection element (6) with an attachment element (21), especially on the outside surface of the cover (3).
- 15.** Heat exchanger (10), in particular shell and tube heat exchanger, comprising:
- a header arrangement (1) according to any of the claims 1 to 10 or manufactured according to the method of any of the claims 11 to 14;
- a plurality of tubes (14) configured to be arranged abutting a second side (15) of the sheet (2);
- a shell (16) configured to enclose the plurality of tubes (14) and to be arranged abutting and fluidly seal the second side (15) of the sheet (2); wherein each respective tube (14) is received through the respective predetermined through hole (7) in the sheet (2) in order to fluidly connect the respective tube (14) to the chamber (5) on the first side (4) of the sheet (2).

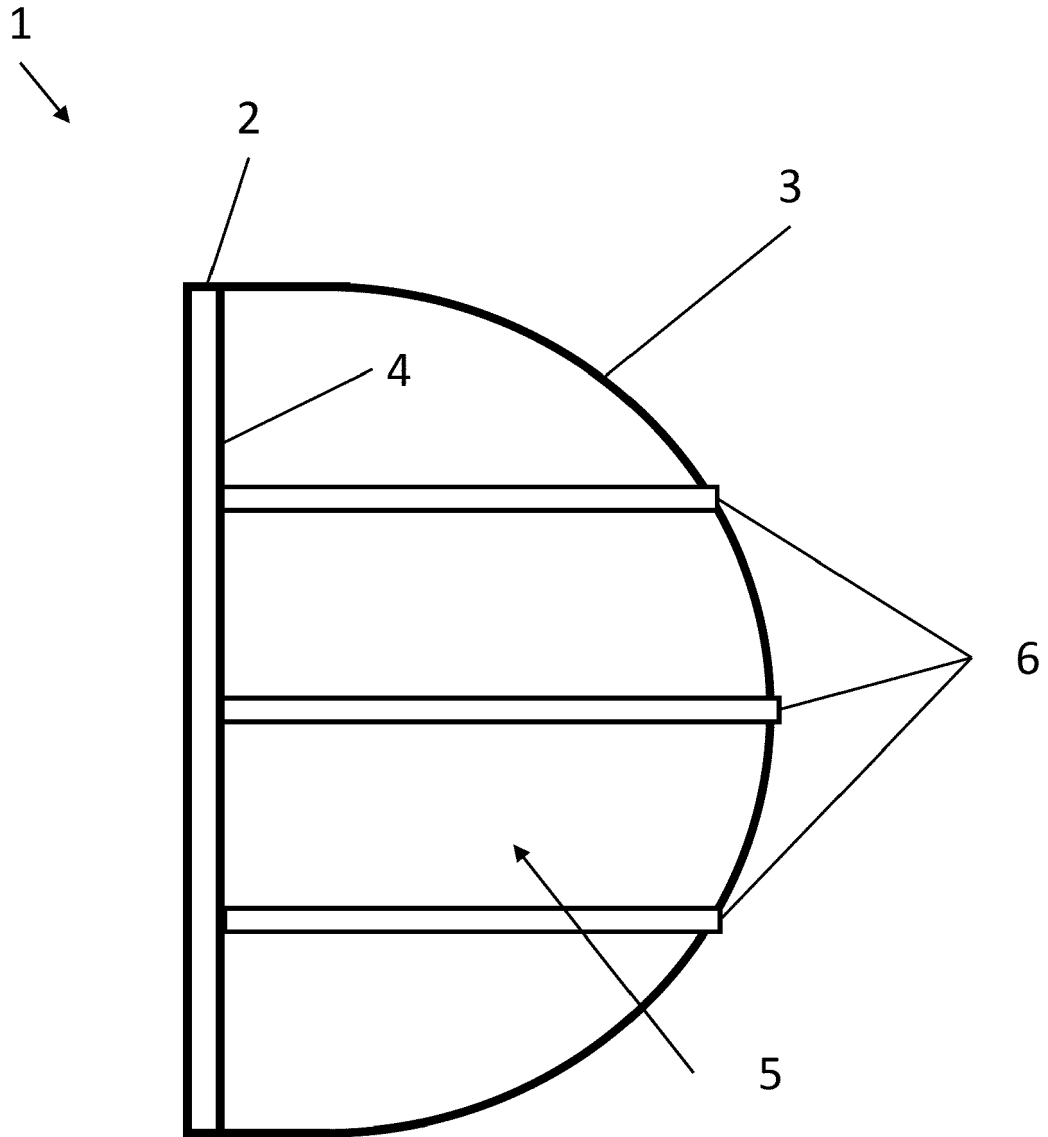


Fig. 1

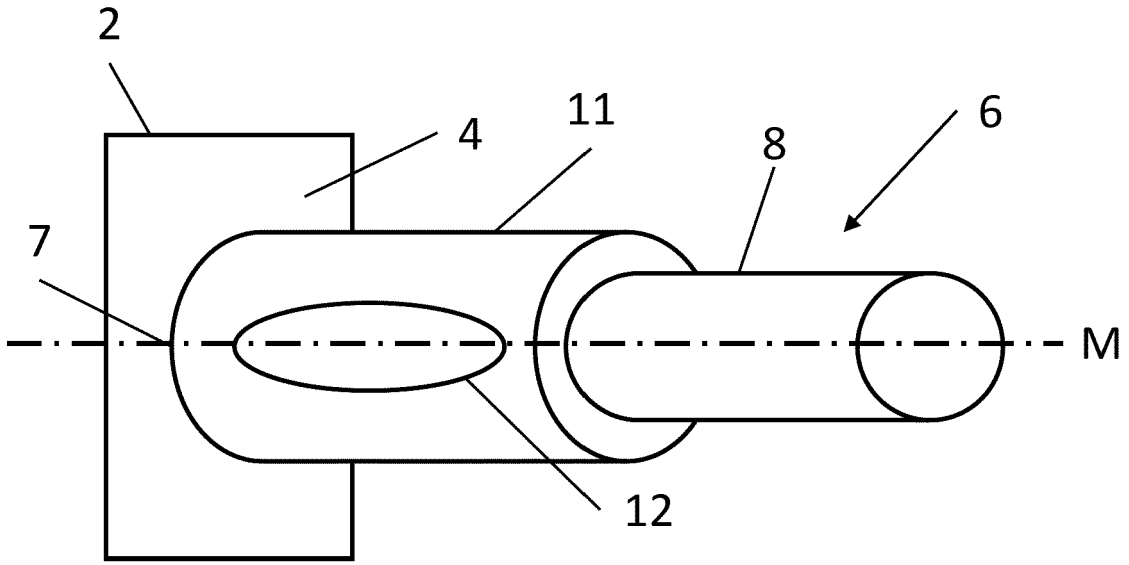


Fig. 2

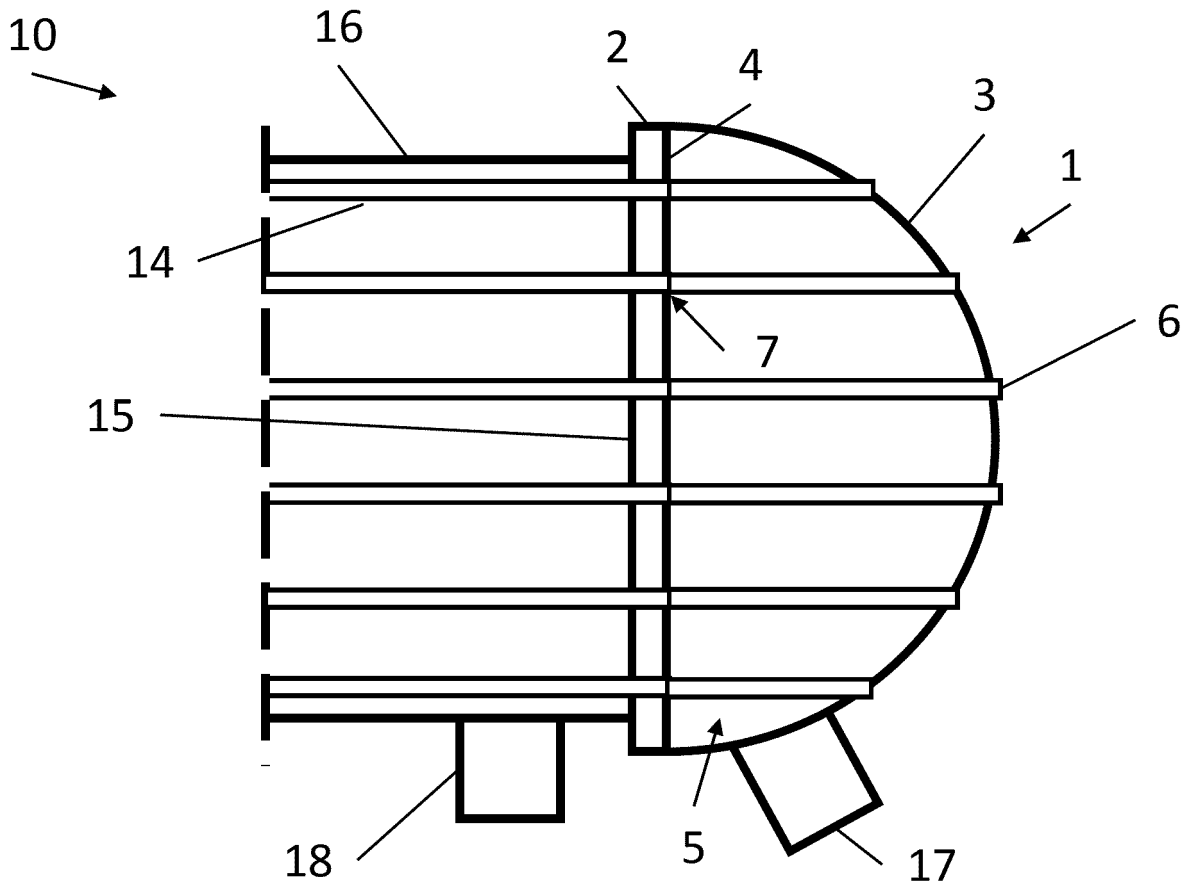


Fig. 3

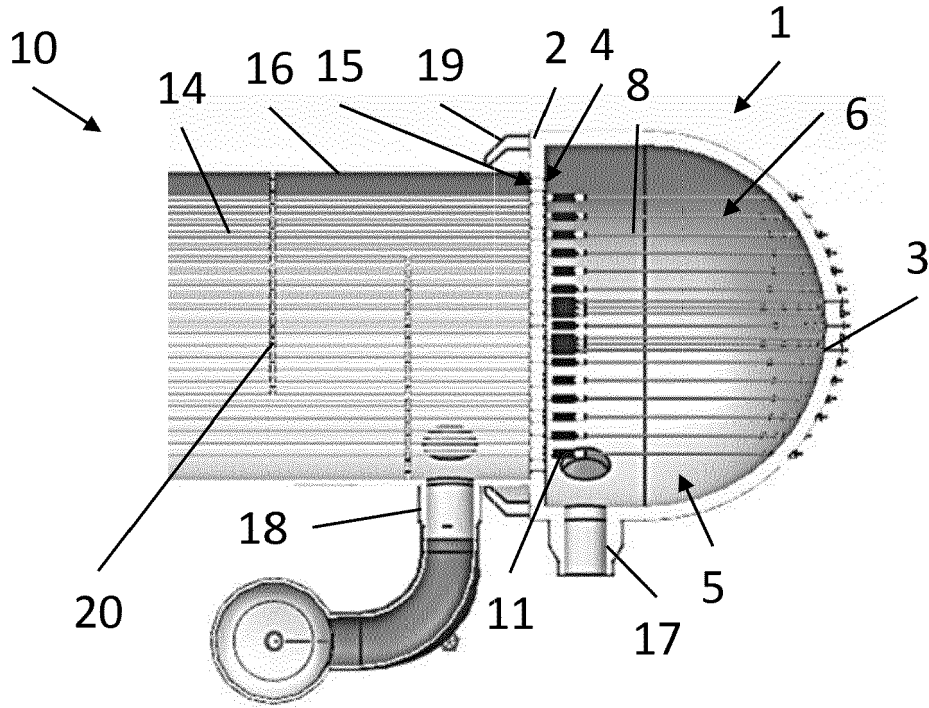


Fig. 4

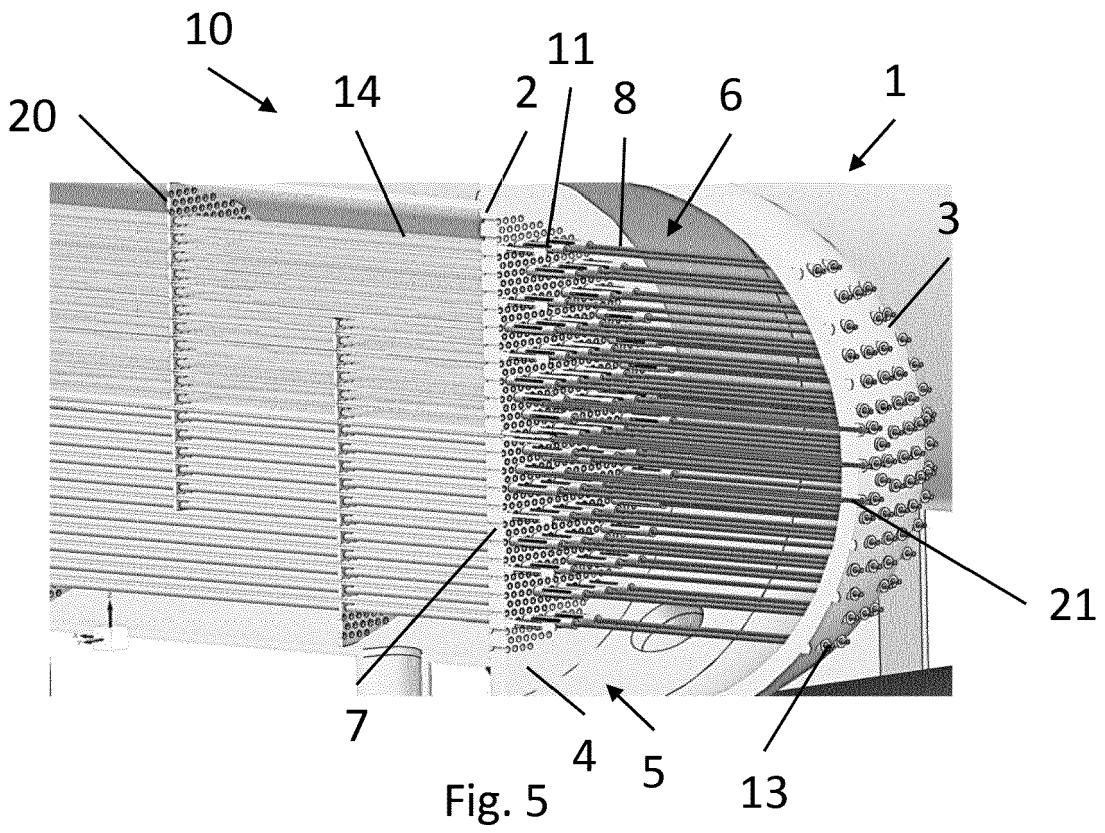


Fig. 5

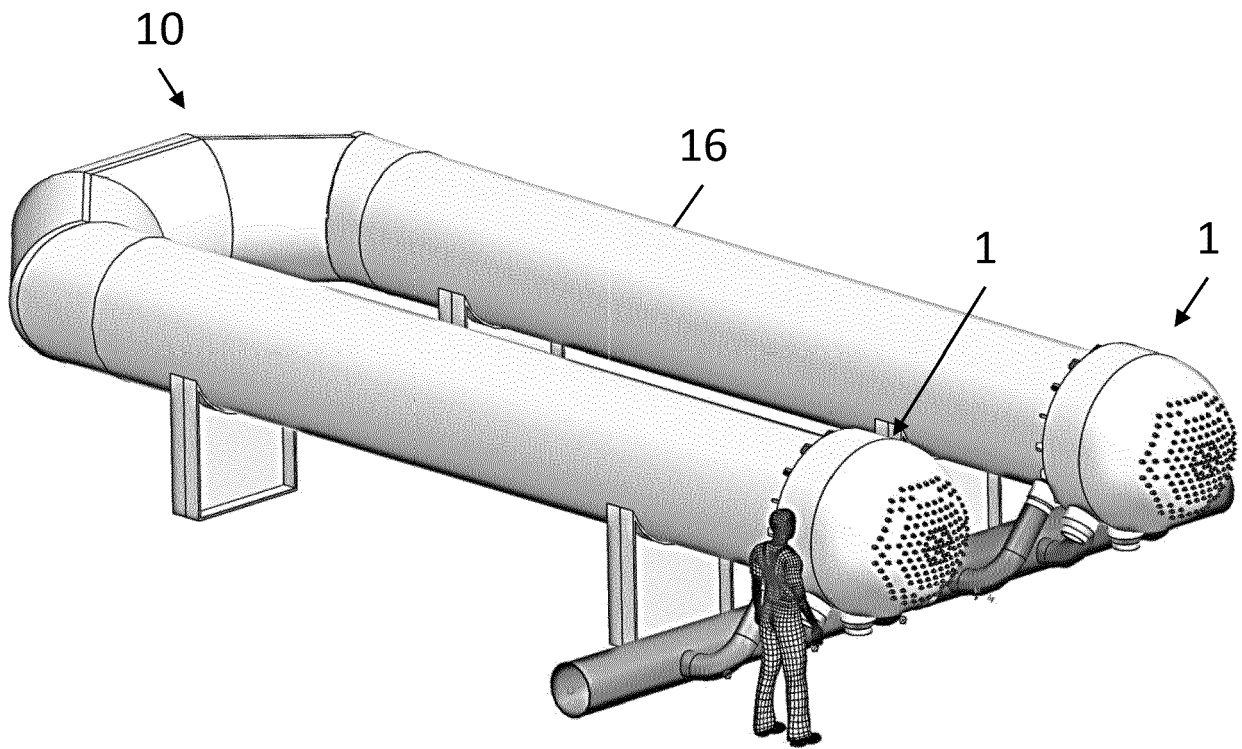


Fig. 6



EUROPEAN SEARCH REPORT

Application Number

EP 22 20 5859

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The present search report has been drawn up for all claims

Place of search Munich	Date of completion of the search 15 March 2023	Examiner Vassoille, Bruno
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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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