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

(11) EP 4 343 252 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
27.03.2024 Bulletin 2024/13

(21) Application number: **22196551.0**

(22) Date of filing: **20.09.2022**

(51) International Patent Classification (IPC):
F28D 9/00 *(2006.01)* ***F28F 3/02*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
F28D 9/005; F28F 3/025; 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 MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

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

(72) Inventors:
- **NORÉN, Mattias**
SE-238 31 OXIE (SE)
- **HAGHIGHI, Kamran**
SE-244 65 FURULUND (SE)

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

(54) A PLATE HEAT EXCHANGER

(57) The disclosure relates to a plate heat exchanger (1) comprising: a package of heat exchanger plates (2), each having a peripheral portion (4) and several port portions (6a,6b) with through flow ports (8a,8b); wherein the heat exchanger plates (2) are permanently joined to adjacent heat exchanger plates (2) of the package along their peripheral portions (4) in such manner that they leave flow passages (12) in a heat exchange portion (14) between adjacent heat exchanger plates (2). The through flow ports (8a,8b) of the heat exchanger plates (2) are aligned and form first inlet and outlet channels (16a,16b) through the package for a first heat exchange medium (18), which communicate with every other flow passage (12) between the heat exchanger plates (2), and second inlet and outlet channels (20a,20b) through the package for a second heat exchange medium (22), which communicate with remaining flow passages (12) between the heat exchanger plates (2). Fins (32) are arranged in the heat exchange portion (14) of the flow passages (12) between the adjacent heat exchanger plates (2), which fins (32) creates a number of parallel guide channels (34) for each of the first and second heat exchange medium (18,22), respective.

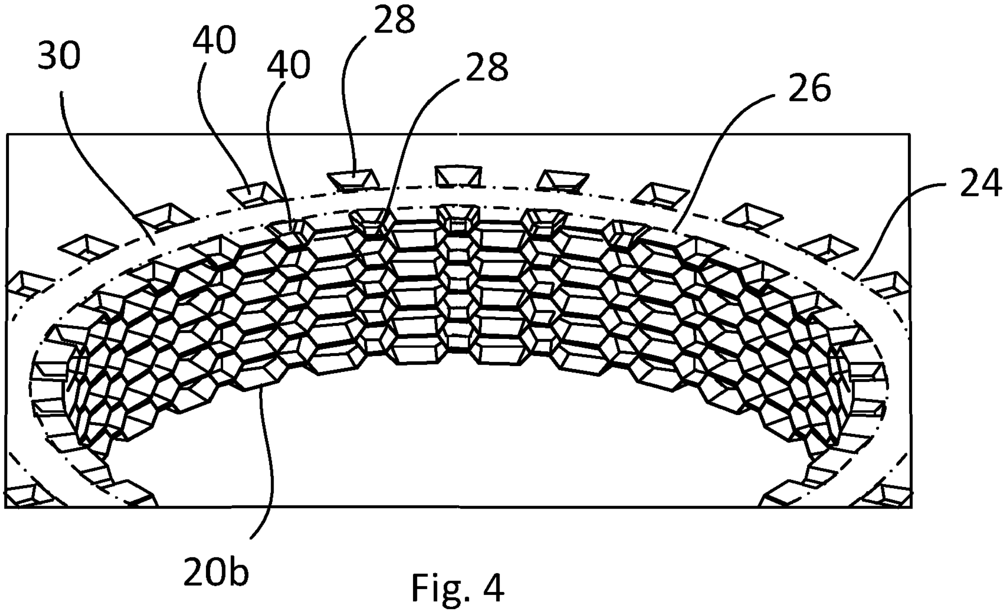

Fig. 4

EP 4 343 252 A1

Description

Technical field

[0001] The present disclosure relates to a plate heat exchanger. More specifically, the disclosure relates to a plate heat exchanger as defined in the introductory parts of the independent claim.

Background art

[0002] Plate heat exchangers, which are permanently joined to each other, do not require separate sealings between the plates and no external frame to hold the plates together. Instead of an external frame, the plates can be permanently joined by brazing, soldering, welding or gluing. The joints between the plates have a pressure bearing function and can thus resist pressures from the heat exchange medium in the plate heat exchangers. Joints may be formed by a joining method in which the plates are subjected to a heat lower than the melting point of the plates. Such joining methods may be one of brazing with an added brazing material in the form of a foil, a paste, or a powder comprising e.g., copper or nickel, or joining by means of the material of the plates by application of a melting depressant composition applied to the plates prior to being heated e.g., as discussed in document WO2013144211A1.

[0003] The inlet and outlet channels in the port portions of the plates have large projected areas and are provided with connecting joints between the heat exchanger plates. In order to enable a large volume flow of the heat exchange medium though the plate heat exchanger, the diameter of the inlet and outlet channels is increased, so that the exposed area of the channels in direction of flow passages in the heat exchanger increases. Further, the flow of the heat exchange medium between the plates in the heat exchanger is more evenly distributed when the diameter of the inlet and outlet channels is increased. Also, the distance between the inlet and outlet channels may influence on the distribution of the heat exchange medium between the plates.

[0004] Document WO8809473A1 discloses a plate heat exchanger comprising a package of heat exchange plates, which are permanently joined to each other along their peripheral portions and at a variety of places in their heat exchange portions. Projections pressed out from the plates are arranged to keep the port portions of the heat exchange plates together along the inlet and outlet channels. The projections are placed between an outer line and the inlet or outlet channel along each of the inlet and outlet channels in the plate interspace communicating with said inlet and outlet channel, respectively.

Summary

[0005] When increasing the overall dimensions of the known permanently joined plate heat exchangers and especially when increasing the diameter of the inlet and outlet channels, it is important to ensure a reliable seal between the heat exchanger plates in order to prevent leakage of heat exchange medium between the plates. At a pressure in the plate heat exchanger, which overloads a permanently joined plate heat exchanger, a leakage may arise located to the port portions and/or the peripheral portions of the heat exchanger plates in connection with the inlet and outlet channels.

[0006] Permanently joined plate heat exchangers with increased diameter of the inlet and outlet channels may during manufacturing be deformed, which may result in a leakage of heat exchange medium between the plates.

[0007] Further, when increasing the overall dimensions of the plate heat exchanger, the flow of the heat exchange medium between the plates in the heat exchanger may be subjected to turbulence affecting the heat exchange between the hot and cool heat exchange medium in the heat exchanger.

[0008] Despite known solutions in the field, it would be desirable to develop a plate heat exchanger, which overcome or alleviate at least some of the issues connected to the prior art plate heat exchangers.

[0009] It is an object of the present disclosure to mitigate, alleviate or eliminate one or more of the above-identified issues of the prior art and solve at least the above-mentioned difficulties.

[0010] It is thus an object to of the present invention is to provide a robust plate heat exchanger, which ensures a reliable seal between the heat exchanger plates.

[0011] Further, it is an object to of the present invention is to provide a plate heat exchanger, which during manufacturing can compensate for deformations in the plates and thus preventing leakage of heat exchange medium between the plates.

[0012] Further, it is an object to provide a plate heat exchanger, which allows a considerably higher pressure load than previously known plate heat exchangers of this kind.

[0013] Further, it is an object to of the present invention is to provide a plate heat exchanger with increased heat exchange between the hot and cool heat exchange medium in the heat exchanger.

[0014] These objectives are achieved with the above-mentioned plate heat exchanger according to the appended claims.

[0015] According to a first aspect there is provided a plate heat exchanger comprising: a package of heat exchanger plates, each having a peripheral portion and several port portions with through flow ports; wherein the heat exchanger plates are permanently joined to adjacent heat exchanger plates of the package along their peripheral portions in such manner that they leave flow passages in a heat exchange portion between adjacent heat exchanger plates; wherein the through flow ports of the heat exchanger plates are aligned and form first inlet and outlet channels through the package for a first heat exchange medium, which communicate with every other flow passage between the heat exchanger plates, and second inlet and outlet channels through the package for a second heat exchange medium, which communicate with remaining flow passages between the heat exchanger plates; and wherein along each of the inlet and outlet channels, the port portions of adjacent heat exchanger plates, which form a flow passage separated from the inlet and outlet channel, respectively, are permanently joined around the inlet and outlet channel, respectively, between an outer line and an inner line, which inner line is located closer to the inlet and outlet channel, respectively; and at least one connection part, which is arranged to keep the port portions of adjacent heat exchanger plates together along the inlet and outlet channels, which at least one connection part, along each of the inlet and outlet channels, is arranged in plate interspaces, which communicate with the inlet and outlet channels, respectively, and is permanently connected in each such plate interspace to both of the adjacent heat exchanger plates, which delimiting the plate interspace in question in an area around the inlet and outlet channel, respectively, located between the outer line and the inlet or outlet channel itself. Fins are arranged in the heat exchange portion of the flow passages between the adjacent heat exchanger plates, which fins creates a number of parallel guide channels for each of the first and second heat exchange medium, respective. The plate heat exchanger may comprise a number of heat exchange plates, which are arranged above each other between an upper, outer cover plate and a lower, outer cover plate. The ports of the heat exchange plates are aligned, so that they form an inlet channel and an outlet channel, which at the bottom are limited by the non-penetrated port portions of the lower, outer cover plate and which at the top communicate with the inlet pipe and the outlet pipe, respectively. The heat exchanger may have one inlet channel and one outlet channel for each of the two heat exchange media, which Inlet and outlet channels are located in the end portions of the heat exchange plates. The heat exchanger can alternatively be provided with several inlet or outlet channels. The shape of the channels and the location can be chosen freely. The flow of the first and second heat exchange medium may be in parallel in the heat exchange portion of the heat exchanger. However, the first inlet and outlet channels may be diagonally arranged in relation to the parallel flow in the heat exchange portion. Further, the second inlet and outlet channels may be diagonally arranged in relation to the parallel flow in heat exchange portion. Alternatively, the first inlet and outlet channels may be aligned in relation to the parallel flow in heat exchange portion. Further, the second inlet and outlet channels may be aligned in relation to the parallel flow in heat exchange portion. The number of heat exchange plates of the heat exchanger form together a package of heat exchange plates. The heat exchange plates may have a rectangular form, but other forms could be possible, such as round heat exchange plates. The number of heat exchange plates of the heat exchanger is depending on desired capacity. For the joining of the heat exchanger a suitable amount of plates are piled on each other, whereupon adjacent plates are joined together by brazing, soldering, welding or gluing. Adjacent heat exchange plates are permanently joined to each other. Therefore, no separate gaskets are required between the plates and neither any outer frame to hold the plates together. The expression permanently joined refers mainly to brazing, but also for example soldering, welding or gluing. Joints may be formed by a joining method in which the plates are subjected to a heat lower than the melting point of the plates. Such joining methods may be one of brazing with an added brazing material in the form of a foil, a paste, or a powder comprising e.g., copper or nickel, or joining by means of the material of the plates by application of a melting depressant composition applied to the plates prior to being heated. The peripheral portion of the heat exchange plates may be provided with a flank and a brim. The flank of one heat exchange plates may be joined to the flank of one adjacent heat exchange plate. The joined flanks will ensure a fluid tight connection along the peripheral portion of the heat exchange plates. The brim increases the stiffness and overall strength of the plate heat exchanger. The brim may however be excluded from the heat exchanger plate. The port portions surround an inlet or outlet channel, which communicating with the flow passages formed by the plates. The port portions may be placed in the two end planes of the plates, located furthest from each other. The at least one connection part within the above said inner line in each port portion, also avoids that the ports of the plate become oval during manufacturing of the plates. The connection parts may be formed as integral parts of respective heat exchange plate. Alternatively, the connection parts may be formed of loose elements arranged between the heat exchange plates. Flow passages are configured between adjacent plates. In the flow passages the heat exchange medium flows through the plate heat exchanger. Adjacent heat exchanger plates are connected and bounded together at several positions on their surfaces. Between these bonding positions, the flow passages are left. The heat exchange portion is arranged between adjacent plates and between the end portions of the heat exchanger. In the heat exchange portion heat is transferred from one of the heat exchange medium to the other heat exchange medium. Stacking the individual heat exchange plates on each other will align the through flow ports of the plates. The aligned through flow ports form inlet and outlet channels through the package of plates. The first inlet and outlet channels communicate with every other flow passage between the heat exchanger plates. The second inlet and outlet channels communicate with the remaining flow passages between the heat exchanger plates. There is only heat exchange between every other flow passage and the remaining flow passages but no fluid communication between these separated passages. The inner line is located closer to the Inlet and outlet channel, respectively, than the outer line. Plate interspaces are located in an area around the inlet and outlet channel, respectively, located between the outer line and the inlet or outlet channel itself. The at least one connection part is arranged in the plate interspace along each of the inlet and outlet channels. The fins may guide the flow of the first and second heat exchange medium in parallel through the heat exchange portion. The fins may be made of thermally conductive material, such as steel or an aluminum alloy. A number of individual fins may be arranged in parallel in the heat exchange portion, extending in a longitudinal direction of the heat exchanger, and creating guide channels between the individual fins. Alternatively, the individual fins may be connected to each other.

[0016] Such plate heat exchanger provides a robust construction of the plate heat exchanger, which ensures a reliable seal between the heat exchanger plates and prevents leakage of heat exchange medium between the plates. Such plate heat exchanger allows a considerably higher pressure load than previously known plate heat exchangers of this kind. Further, such plate heat exchanger can during manufacturing compensate for deformations in the plates and thus preventing leakage of heat exchange medium between the plates. In addition, such plate heat exchanger will increase the heat exchange between the hot and cool heat exchange medium in the heat exchanger.

[0017] Each parallel guide channel may be delimited by walls of the fins and a heat exchanger plate. Each fin may extend between two adjacent heat exchanger plates. The surfaces of the two adjacent plates and the surfaces of two adjacent fins may define one guide channel. The fins may be brazed, soldered, welded or glued to the surfaces of two adjacent plates. The distance between the fins and the distance between the plates affects the shape and size of the cross-sectional area of the individual guide channel. The distance between the fins may also decide the number of fins and channels in the heat exchange portion. The shape and the size of the cross-sectional area of the individual guide channel may have an impact on the volume flow of the heat exchange medium in the guide channel.

[0018] The fins may be created by a corrugated sheet metal, which has wave peaks and wave troughs. The fins may be created by a pleated sheet of thermally conductive material. The fins may have a wave shape. The parallel guide channels may be created between wave peaks and between wave troughs of the wave shaped fins.

[0019] The corrugated sheet metal has a thickness in the range of 0,05 - 1,5 mm, and preferably has a thickness of 0,1 mm. Such thickness of the corrugated sheet metal may result in a large number of fins in the heat exchange portion and thus a large number of guide channels in the heat exchange portion. A large number of fins in the heat exchange portion may result in a large contact surface between the heat exchange medium and the fins, which may result in a large heat exchange between the first and second heat exchange medium.

[0020] The wave peaks may be configured to be rigidly connected to a heat exchanger plate, and the wave troughs may be configured to be rigidly connected to an adjacent heat exchanger plate in the heat exchange portion between the adjacent heat exchanger plates. The wave peaks and the wave troughs may be brazed, soldered, welded or glued to the surfaces of two adjacent plates. The distance between the wave peaks, the distance between the wave troughs and the distance between the plates affects the shape and size of the cross-sectional area of the individual guide channel. The distance between the wave peaks and the distance between the wave troughs may also decide the number of fins and channels in the heat exchange portion. The shape and the size of the cross-sectional area of the individual guide channel may have an impact on the volume flow of the heat exchange medium in the guide channel.

[0021] A distance between walls of two adjacent fins at middle point of height of the fins are in the range of 0,25 - 10 mm, preferably in the range of 0,35 - 3 mm and most preferably in the range of 0,5 - 1 mm. Such configuration of the distance between walls of two adjacent fins at middle point of height of the fins may result in a shape and size of the cross-sectional area of the individual guide channel may have a low impact on the volume flow of the heat exchange medium in the guide channel. Further, the pressure fall over the heat exchange portion may be low when the distance between walls of two adjacent fins at middle point of height of the fins is in within this ranges.

[0022] The wave height of the fins of the corrugated sheet metal may correspond to the distance between two adjacent heat exchanger plates in the heat exchange portion. The wave peaks and the wave troughs of the fins may extend between two adjacent heat exchanger plates. The surface of one of the two adjacent plates and the surfaces of two adjacent fins having a common wave peak define one guide channel. The wave peaks and the wave troughs of the fins of the corrugated sheets may be brazed, soldered, welded or glued to the surfaces of two adjacent plates. The fins may have a wave height of the corrugated sheet metal, which is larger than a wave height after the two adjacent heat exchanger plates have been connected to the fins. Alternatively, the wave height of the of the corrugated sheet metal which corresponds to the wave height after the two adjacent heat exchanger plates have been connected to the fins. When two connection parts of two adjacent plates have contact and before they have been connected, the distance between the plates is larger than wave height. After the two connection parts of two adjacent plates have been connected, the distance between the plates correspond to the wave height. However, due to compression of the fins by the two plates, the wave high after compression of the fins may be smaller than the wave high before the compression of the fins. Alternatively, if there is no compression of the fins, the wave high before the connection of the two connection parts of the two adjacent plates, corresponds to the wave high after the connection of the two connection parts.

[0023] The sum of the height of the at least one connection part on one heat exchanger plate, perpendicularly to the heat exchanger plates, and the height of the at least one connection part on one adjacent heat exchanger plate, may be larger than the wave height of the fins. During manufacturing of the plate heat exchanger, adjacent heat exchanger plates are put together in a stack with fins arranged in the heat exchange portion of the flow passages between the adjacent heat exchanger plates. Due to tolerances in the height of the fins or the wave height of the fins of the corrugated sheet metal, the at least one connection part of the respective adjacent heat exchanger plates are configured to come in contact before the fins come in contact with the respective plates when the plates are put together. After the plates have been put together, the connection part of the respective adjacent heat exchanger plates are in contact, but due to tolerances the fins or not all fins are in contact with the respective adjacent plates. Thereafter, a force is applied on one of the plates or both of the adjacent plates, in order to press the plates together. During pressing the plates together the connection parts are slightly pressed and deformed until the sum of the height of the connection parts of the adjacent heat exchanger plates corresponds to the height of the fins. Finally, the connection parts are permanently joined to each other and the fins are permanently joined to the plates. At this stage, the adjacent plates also may be permanently joined along their peripheral portions. The expression permanently joined refers mainly to brazing, but also for example soldering, welding or gluing.

[0024] The at least one connection part may be arranged in an area around the inlet and outlet channel, respectively, located between the said inner line and the inlet or outlet channel, respectively, itself. The connection parts abutting each other and keeping together the port portions of the two heat exchange plates along the inlet and the outlet channels, respectively. The connection parts along each of the inlet and outlet channels are located in the plate interspaces which communicate with the inlet and the outlet channel respectively in an area located between the connecting areas of the plates and the channel itself. Between the connection parts in respective plate interspace there are openings which communicate with the flow passage between the heat exchange plates.

[0025] At least one further connection part may be arranged in an area around the inlet and outlet channel, respectively, located outside and adjacent to said outer line. The least one further connection part may increase the strength of the connection between the plates in the area located around the inlet and outlet channel, respectively. The least one further connection part may result in that allows a considerably higher pressure load than previously known plate heat exchangers of this kind are allowed. Further, during manufacturing, deformations are compensated for in the plates and thus preventing leakage of heat exchange medium between the plates.

[0026] Each connection part may at least partly constitute an integral part of a heat exchanger plate. During manufacturing of the heat exchanger plates, the connection parts may be shaped in the plates as an integral part. This may facilitate the manufacturing of the plates and increase the reliability of the plate heat exchanger.

[0027] The heat exchanger plates are made of thin material in which projections are shaped on both of their sides, each connection part comprises a projection being shaped in the port portion of a heat exchanger plate. The projections abutting each other and keeping together the port portions of the two heat exchange plates along the inlet and the outlet channels, respectively. The connection parts along each of the inlet and outlet channels are located in the plate interspaces which communicate with the inlet and the outlet channel respectively in an area located between the connecting areas of the plates and the channel itself. Between the connection parts in respective plate interspace there are openings which communicate with the flow passage between the heat exchange plates.

[0028] The port portions of two adjacent heat exchanger plates, which port portions surround an inlet or outlet channel communicating with the flow passage formed by the heat exchanger plates, may be placed at the end planes of the heat exchanger plates located furthest from each other, and each of the connection part may be formed of projections from two adjacent plates, which projections may be permanently joined to each other. During manufacturing of the plate heat exchanger, adjacent heat exchanger plates are put together. The projections of the respective adjacent heat exchanger plates are configured to come in contact when the plates are put together and the projections are permanently joined to each other by brazing, soldering, welding or gluing.

[0029] Each connection part placed in the different plate interspaces, may be arranged in line with each other perpendicularly to the heat exchanger plates along respective inlet and outlet channel. The line may be a circular line. The line may encircle the entire inlet and outlet channels. This placement of the connection parts may result in that the plate heat exchanger allows a considerably higher pressure load than previously known plate heat exchangers of this kind are allowed. Further, during manufacturing, deformations are compensated for in the plates by the connection parts and thus preventing leakage of heat exchange medium between the plates.

[0030] Each connection part may be configured as an indentation, which together creates a line of an indentations around the inlet or outlet channel, respectively. A number of connected indentations may together encircle the respective inlet and outlet channel. The connected indentations may create openings there between along the respective inlet and outlet channel for the flow of the first and second heat exchange medium.

[0031] Each connection part may create a solid line around the inlet or outlet channel, respectively. As an example and an alternatively, each connection part may create a solid line around the inlet or outlet channel, respectively. The solid line is a connection between adjacent plates. The connection between adjacent plates is fluid tight.

[0032] Additional objectives, advantages and novel features of the invention will be apparent to one skilled in the art from the following details, and through exercising the invention. While the invention is described below, it should be apparent that the invention may not be limited to the specifically described details. One skilled in the art, having access to the teachings herein, will recognize additional applications, modifications and incorporations in other areas, which are within the scope of the invention.

Brief descriptions of the drawings

[0033] The above objects, as well as additional objects, features and advantages of the present disclosure, will be more fully appreciated by reference to the following illustrative and non-limiting detailed description of example embodiments of the present disclosure, when taken in conjunction with the accompanying drawings.

Fig. 1 schematically illustrates a plate heat exchanger in a perspective view according to an example;

Fig. 2 schematically illustrates the plate heat exchanger in a section view along line X - X in fig. 1 according to an example;

Fig. 3 schematically illustrates a heat exchanger plate in a view from above according to an example;

Fig. 4 schematically illustrates in a view of perspective a part of an outlet cannel indicated in fig. 3;

Fig. 5 schematically illustrates the plate heat exchanger in a section view along line V - V in fig. 1 according to an example;

Fig. 6 schematically illustrates the plate heat exchanger in a section view along line V - V in fig. 1 according to an example;

Fig. 7 schematically illustrates in a front view, connection parts for connection of heat exchanger plates according to an example;

Fig. 8 schematically illustrates in a view of perspective, connection parts for connection of heat exchanger plates according to an example;

Figures 9 and 10 schematically illustrate a part of the plate heat exchanger in a section view before and after the heat exchanger plates have been connected to the fins, and

Fig. 11 schematically illustrates a part of the plate heat exchanger in a section view after the heat exchanger plates have been connected to the fins.

Detailed description

[0034] The present disclosure will now be described with reference to the accompanying drawings, in which preferred example embodiments of the disclosure are shown. The disclosure may, however, be embodied in other forms and should not be construed as limited to the herein disclosed embodiments. The disclosed embodiments are provided to fully convey the scope of the disclosure to the skilled person.

[0035] Figure 1 schematically illustrates a plate heat exchanger 1 in a perspective view according to an example. The plate heat exchanger 1 comprising a package of heat exchanger plates 2, each having a peripheral portion 4 and several port portions 6a,6b with through flow ports 8a,8b. The heat exchanger plates 2 are permanently joined to adjacent heat exchanger plates 2 of the package along their peripheral portions 4 in such manner that they leave flow passages 12 (fig. 2) in a heat exchange portion 14 between adjacent heat exchanger plates 2. The through flow ports 8a,8b of the heat exchanger plates 2 are aligned and form first inlet and outlet channels 16a,16b through the package for a first heat exchange medium 18, which communicate with every other flow passage 12 between the heat exchanger plates 2, and second inlet and outlet channels 20a,20b through the package for a second heat exchange medium 22, which communicate with remaining flow passages 12 between the heat exchanger plates 2. The port portions 6a,6b of two adjacent heat exchanger plates 2, which port portions 6a,6b surround an inlet or outlet channel 16a,16b; 20a,20b communicating with the flow passage 12 formed by the heat exchanger plates 2, are placed at the end planes 42 of the heat exchanger plates 2 located furthest from each other.

[0036] Fig. 2 schematically illustrates a part of the plate heat exchanger 1 in a section view along line X - X in fig. 1 according to an example. The heat exchanger plates 2 are permanently joined to adjacent heat exchanger plates 2 of the package along their peripheral portions 4 in such manner that they leave flow passages 12 in a heat exchange portion 14 between adjacent heat exchanger plates 2. Fins 32 are arranged in the heat exchange portion 14 of the flow passages 12 between the adjacent heat exchanger plates 2, which fins 32 creates a number of parallel guide channels 34 for each of the first and second heat exchange medium 18,22, respective. The peripheral portion of the heat exchange plates are provided with a flank 23 and a brim 25

[0037] Fig. 3 schematically illustrates a heat exchanger plate 2 in a view from above according to an example. The peripheral portion 4 encircle the entire plate 2. The heat exchanger plate 2 may be made of thin material and by means of pressing may be provided with projections

40 on both sides, each connection part 28 may comprise a projection 40 being pressed out from the port portion of a heat exchanger plate. This is disclosed in fig. 4. Through flow ports 8a,8b are arranged in the heat exchanger plate 2, which together with through flow ports 8a,8b of other plates 2 are configured to form inlet and outlet channels 16a,16b; 20a,20b through a package of plates 2 (fig 1).

[0038] Fig. 4 schematically illustrates in a view of perspective a part of an outlet cannel 20b indicated in fig. 3. Along each of the inlet and outlet channels 16a, 16b; 20a,20b, the port portions 6a,6b of adjacent heat exchanger plates 2, which form a flow passage 12 separated from the inlet and outlet channel 16a, 16b; 20a,20b, respectively, are permanently joined around the inlet and outlet channel 16a, 16b; 20a,20b, respectively, between an outer line 24 and an inner line 26. At least one connection part 28 is arranged to keep the port portions 6a,6b of adjacent heat exchanger plates 2 together along the inlet and outlet channels 16a, 16b; 20a,20b. At least one connection part 28, along each of the inlet and outlet channels 16a, 16b; 20a,20b is arranged in plate interspaces 30 which communicate with the inlet and outlet channels 16a, 16b; 20a,20b, respectively, and is permanently connected in each such plate interspace 30 to both of the adjacent heat exchanger plates 2, which delimiting the plate interspace 30 in question in an area around the inlet and outlet channel 16a, 16b; 20a,20b, respectively, located between the outer line 24 and the inlet or outlet channel 16a,16b; 20a,20b itself. Each connection part 28 is configured as indentations, which together creates a line of indentations around the inlet or outlet channel 16a, 16b; 20a,20b, respectively. At least one further connection part 28 is arranged in an area around the inlet and outlet channel 16a, 16b; 20a,20b, respectively, located outside and adjacent to said outer line 24. Each connection part 28 at least partly constitutes an integral part of a heat exchanger plate 2. The heat exchanger plates 2 are made of thin material and by means of pressing are provided with projections 40 on both of their sides, each connection part 28 comprises a projection 40 being pressed out from the port portion 6a, 6b of a heat exchanger plate 2.

[0039] Fig. 5 schematically illustrates the plate heat exchanger 1 in a section view along line V - V in fig. 1 according to an example. Each connection part 28 creates according to this example a solid line around the outlet or inlet channel16b, 20a, respectively. The second inlet channel 20a communicate with every other flow passage between the heat exchanger plates 2. The first outlet channel 16b communicate with the remaining flow passages between the heat exchanger plates 2. Fins 32 are arranged between the adjacent heat exchanger plates 2, which fins 32 creates a number of parallel guide channels 34.

[0040] Fig. 6 schematically illustrates the plate heat exchanger 1 in a section view along line V - V in fig. 1 according to an example. Along each of the inlet and outlet channels 6b, 20a the heat exchanger plates 2 are permanently joined by connection parts 28. The connection parts 28 are arranged to keep the port portions 6a,6b of adjacent heat exchanger plates 2 together along the inlet and outlet channels 16b, 20a. At least one connection part 28, along each of the inlet and outlet channels 16b, 20a is arranged in the plate interspaces 30, which communicate with the inlet and outlet channels 16b, 20a, respectively, and is permanently connected in each such plate interspace 30 to both of the adjacent heat exchanger plates 2. Fins 32 are arranged between the adjacent heat exchanger plates 2, which fins 32 creates a number of parallel guide channels 34.

[0041] Fig. 7 schematically illustrates in a front view, connection parts 28 for connection of heat exchanger plates 2 according to an example. Fig. 8 schematically illustrates in a view of perspective, connection parts 28 for connection of heat exchanger plates 2 according to an example. Each of the connection part 28 is formed of projections 40 from two adjacent plates 2, which projections 40 are permanently joined to each other. Each connection part 28 placed in the different plate interspaces 30, is arranged in line with each other perpendicularly to the heat exchanger plates 2. Arrows indicates the direction of flow of the first heat exchange medium 18, which is opposite to the direction of flow of the second heat exchange medium 22. The outer line 24 and inner line 26 are indicated in fig. 8.

[0042] Figures 9 and 10 schematically illustrate a part of the plate heat exchanger in a section view before and after the heat exchanger plates have been connected to the fins 32. Each parallel guide channel 34 is delimited by walls 36 of the fins 32 and a heat exchanger plate 2. The fins 32 are created by a corrugated sheet metal 38, which has wave peaks p1 ,p2 and wave troughs t1, t2. The corrugated sheet metal 38 has a thickness t1 in the range of 0,05 - 1,5 mm, and preferably has a thickness t1 of 0,1 mm. The wave peaks p1, p2 are configured to be rigidly connected to a heat exchanger plate 2, and the wave troughs t1, t2 are configured to be rigidly connected to an adjacent heat exchanger plate 2 in the heat exchange portion 14 between the adjacent heat exchanger plates 2. The fins 32 may have a wave height wh1 of the corrugated sheet metal 38, which is larger than a wave height wh2 after the two adjacent heat exchanger plates 2 have been connected to the fins 32. Alternatively, the wave height wh1 of the of the corrugated sheet metal 38 which corresponds to the wave height wh2 after the two adjacent heat exchanger plates 2 have been connected to the fins 32. When two connection parts 28 of two adjacent plates have contact and before they have been connected, the distance d1 between the plates is larger than wave height wh1. After the two connection parts 28 of two adjacent plates have been connected, the distance d2 between the plates correspond to the wave height wh2. However, due to compression of the fins 32 by the two plates 2, the wave high wd2 after compression of the fins 32 may be smaller than the wave high wh1 before the compression of the fins 32. Alternatively, if there is no compression of the fins 32, the wave high wh1 before the connection of the two connection parts 28 of the two adjacent plates, corresponds to the wave high wh2 after the connection of the two connection parts 28. In figures 9 and 10 a middle point of height MH of the wave height wh1, wh2 of the fins 32 is indicated. Further, the distance wd between walls 36 of two adjacent fins 32 at the middle point of height MH is indicated. The distance wd between the walls 36 of two adjacent fins 32 at the middle point of height MH are in the range of 0,25 - 10 mm, preferably in the range of 0,35 - 3 mm and most preferably in the range of 0,5 - 1 mm. The sum of the height hc1 of the at least one connection part 28 on one heat exchanger plate 2, perpendicularly to the heat exchanger plates 2, and the height hc2 of the at least one connection part 28 on one adjacent heat exchanger plate 2 is larger than the wave height wh1 of the fins 32. As an example, the heights hc1 and hc2 may be equal. As another example, the height hc1 may correspond to the thickness of the plate 2 and the height hc2 may correspond to the distance d1 between the plates when two adjacent plates 2 have contact and before they have been connected. The at least one connection part 28 is arranged in an area around the inlet and outlet channel 16a,16b;20a,20b, respectively, located between the said inner line 26 and the inlet or outlet channel 16a, 16b;20a,20b, respectively, itself.

[0043] Fig. 11 schematically illustrates a part of the plate heat exchanger 1 in a section view after the heat exchanger plates 2 have been connected to the fins 32. The shape of the fins 32 has an alternative configuration comparing to the shape of the fins 32 in figures 9 and 10. Each parallel guide channel 34 is delimited by walls 36 of the fins 32 and a heat exchanger plate 2. The fins 32 are created by a corrugated sheet metal 38, which has wave peaks p1,p2 and wave troughs t1, t2. A middle point of height MH of the wave height wh1 of the fins 32 is indicated. Further, the distance wd between the walls 36 of two adjacent fins 32 at the middle point of height MH is indicated. The distance wd between the walls 36 of two adjacent fins 32 at the middle point of height MH are in the range of 0,25 - 10 mm, preferably in the range of 0,35 - 3 mm and most preferably in the range of 0,5 - 1 mm.

[0044] The foregoing description of the embodiments has been furnished for illustrative and descriptive purposes. It is not intended to be exhaustive, or to limit the embodiments to the variations described. Many modifications and variations will obviously be apparent to one skilled in the art. The embodiments have been chosen and described in order to best explicate principles and practical applications, and to thereby enable one skilled in the art to understand the invention in terms of its various embodiments and with the various modifications that are applicable to its intended use. The components and features specified above may, within the framework of the disclosure, be combined between different embodiments specified.

Claims

1. A plate heat exchanger (1) comprising:

a package of heat exchanger plates (2), each having a peripheral portion (4) and several port portions (6a,6b) with through flow ports (8a,8b); wherein the heat exchanger plates (2) are permanently joined to adjacent heat exchanger plates (2) of the package along their peripheral portions (4) in such manner that they leave flow passages (12) in a heat exchange portion (14) between adjacent heat exchanger plates (2);
wherein the through flow ports (8a,8b) of the heat exchanger plates (2) are aligned and form first inlet and outlet channels (16a, 16b) through the package for a first heat exchange medium (18), which communicate with every other flow passage (12) between the heat exchanger plates (2), and second inlet and outlet channels (20a, 20b) through the package for a second heat exchange medium (22), which communicate with remaining flow passages (12) between the heat exchanger plates (2); and wherein along each of the inlet and outlet channels (16a,16b; 20a,20b), the port portions (6a,6b) of adjacent heat exchanger plates (2), which form a flow passage (12) separated from the inlet and outlet channel (16a,16b; 20a,20b), respectively, are permanently joined around the inlet and outlet channel (16a, 16b; 20a,20b), respectively, between an outer line (24) and an inner line (26), which inner line (26) is located closer to the Inlet and outlet channel, respectively; and
at least one connection part (28), which is arranged to keep the port portions (6a,6b) of adjacent heat exchanger plates (2) together along the inlet and outlet channels (16a, 16b; 20a,20b), which at least one connection part (28), along each of the inlet and outlet channels (16a, 16b; 20a,20b), is arranged in plate interspaces (30), which communicate with said inlet and outlet channels (16a,16b; 20a,20b), respectively, and is permanently connected in each such plate interspace (30) to both of the adjacent heat exchanger plates (2), which delimiting the plate interspace (30) in question in an area around the inlet and outlet channel (16a, 16b; 20a,20b), respectively, located between said outer line (24) and the inlet or outlet channel (16a, 16b; 20a,20b) itself, **characterised in that** fins (32) are arranged in the heat exchange portion (14) of the flow passages (12) between the adjacent heat exchanger plates (2), which fins (32) creates a number of parallel guide

channels (34) for each of the first and second heat exchange medium (18,22), respective.

2. The heat exchanger (1) according to claim 1, wherein each parallel guide channel (34) is delimited by walls (36) of the fins (32) and a heat exchanger plate (2).

3. The heat exchanger (1) according to any one of claims 1 and 2, wherein the fins (32) are created by a corrugated sheet metal (38), which has wave peaks (p1,p2) and wave troughs (t1,t2).

4. The heat exchanger (1) according to claim 3, wherein the corrugated sheet metal (38) has a thickness (t1) in the range of 0,05 - 1,5 mm, and preferably has a thickness (t1) of 0,1 mm.

5. The heat exchanger (1) according to any one of claims 3 and 4, wherein the wave peaks (p1,p2) are configured to be rigidly connected to a heat exchanger plate (2), and the wave troughs (t1,t2) are configured to be rigidly connected to an adjacent heat exchanger plate (2) in the heat exchange portion (14) between the adjacent heat exchanger plates (2).

6. The heat exchanger (1) according to any one of claims 3 - 5, wherein a distance (wd) between walls (36) of two adjacent fins (32) at middle point of height (MH) of the fins (32) are in the range of 0,25 - 10 mm, preferably in the range of 0,35 - 3 mm and most preferably in the range of 0,5 - 1 mm.

7. The heat exchanger (1) according to any one of claims 3 - 6, wherein the wave height (wh) of the fins (32) of the corrugated sheet metal (38) corresponds to the distance (d) between two adjacent heat exchanger plates (2) in the heat exchange portion (14).

8. The heat exchanger (1) according to any one of claims 3 - 7, wherein the sum of the height (hc1) of the at least one connection part (28) on one heat exchanger plate (2), perpendicularly to the heat exchanger plates (2), and the height (hc2) of the at least one connection part (28) on one adjacent heat exchanger plate (2) is larger than the wave height (wh1) of the fins (32).

9. The heat exchanger (1) according to any one of the preceding claims, wherein the at least one connection part (28) is arranged in an area around the inlet and outlet channel (16a, 16b; 20a,20b), respectively, located between the said inner line (26) and the inlet or outlet channel (16a, 16b; 20a,20b), respectively, itself.

10. The heat exchanger (1) according to any one of the preceding claims, wherein at least one further connection part (28) is arranged in an area around the inlet and outlet channel (16a, 16b; 20a,20b), respectively, located outside and adjacent to said outer line (24).

11. The heat exchanger (1) according to any one of the preceding claims, wherein each connection part (28) at least partly constitutes an integral part of a heat exchanger plate (2).

12. The heat exchanger (1) according to claim 11, wherein the heat exchanger plates (2) are made of thin material in which projections (40) are shaped on both of their sides, each connection part (28) comprises a projection (40) being shaped in the port portion (6a,6b) of a heat exchanger plate (2).

13. The heat exchanger (1) according to claim 12, wherein the port portions (6a,6b) of two adjacent heat exchanger plates (2), which port portions (6a,6b) surround an inlet or outlet channel (16a, 16b; 20a,20b) communicating with the flow passage (12) formed by the heat exchanger plates (2), are placed at the end planes (42) of the heat exchanger plates (2) located furthest from each other, and that each of the connection part (28) is formed of projections (40) from two adjacent plates (2), which projections (40) are permanently joined to each other.

14. The heat exchanger (1) according to claim 13, wherein each connection part (28) placed in the different plate interspaces (30), is arranged in line with each other perpendicularly to the heat exchanger plates (2) along respective inlet and outlet channel (16a, 16b; 20a,20b).

15. The heat exchanger (1) according to any one of the preceding claims, wherein each connection part (28) is configured as an indentation, which together creates a line of indentations around the inlet or outlet channel (16a, 16b; 20a,20b), respectively.

16. The heat exchanger (1) according to any one of the claims 1 - 15, wherein each connection part (28) creates a solid line around the inlet or outlet channel (16a, 16b; 20a,20b), respectively.

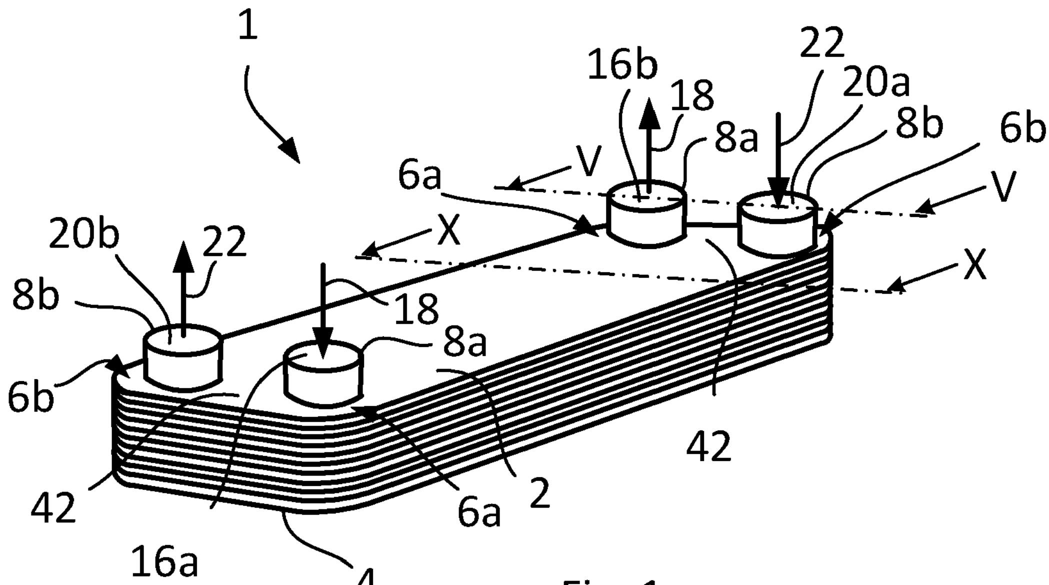
1
16b
18
22
20a
8a
8b
6b
6a
V
V
X
X
20b
22
8b
18
8a
6b
42
2
42
6a
16a
4

Fig. 1

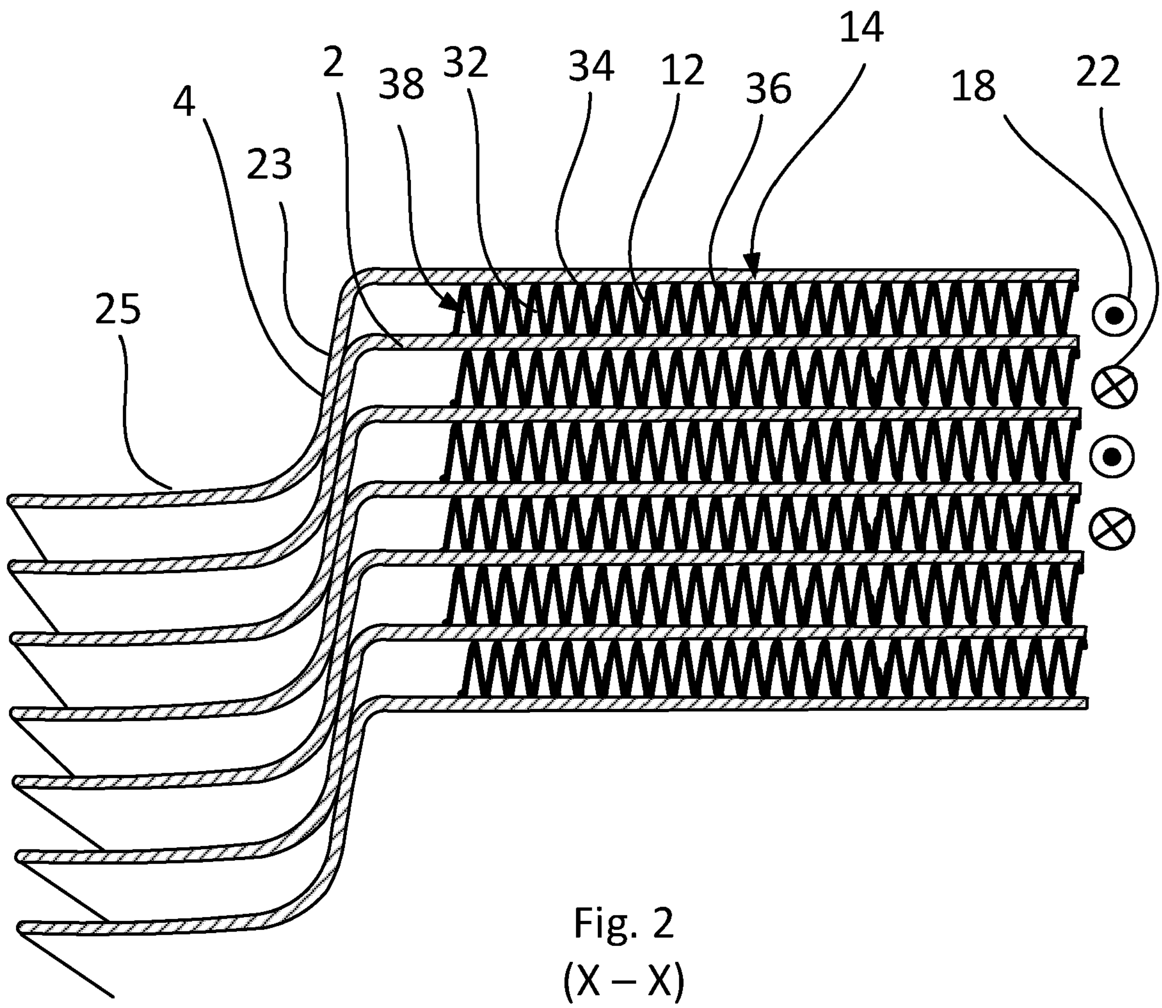
14
2
38
32
34
12
36
18
22
4
23
25

Fig. 2
(X – X)

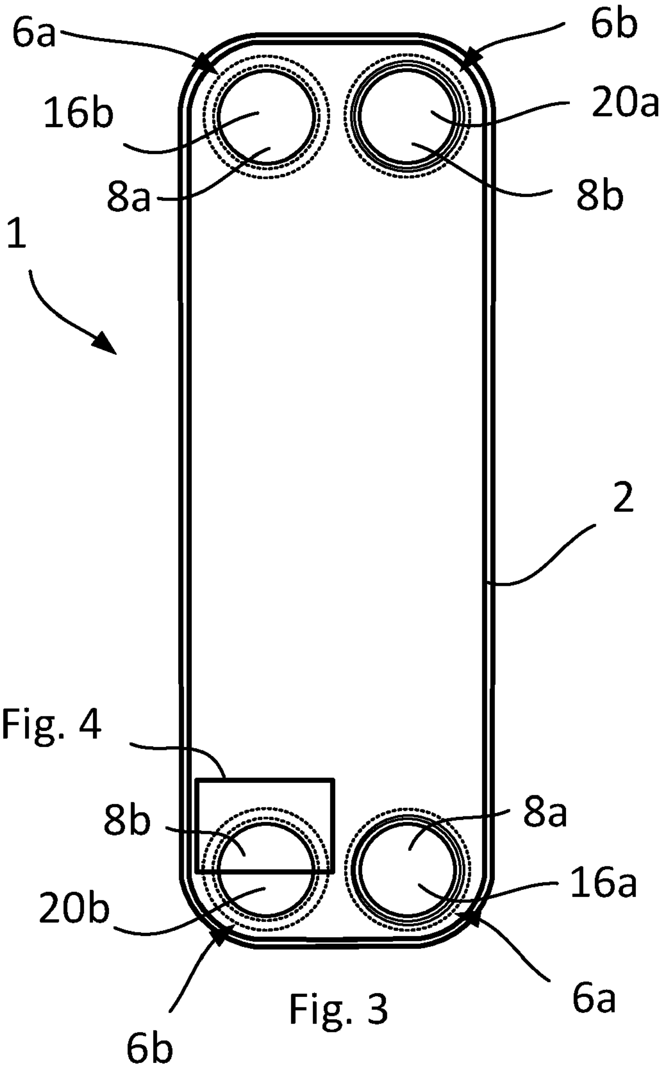
6a
6b
16b
20a
8a
8b
1
2
Fig. 4
8b
8a
20b
16a
6b
6a

Fig. 3

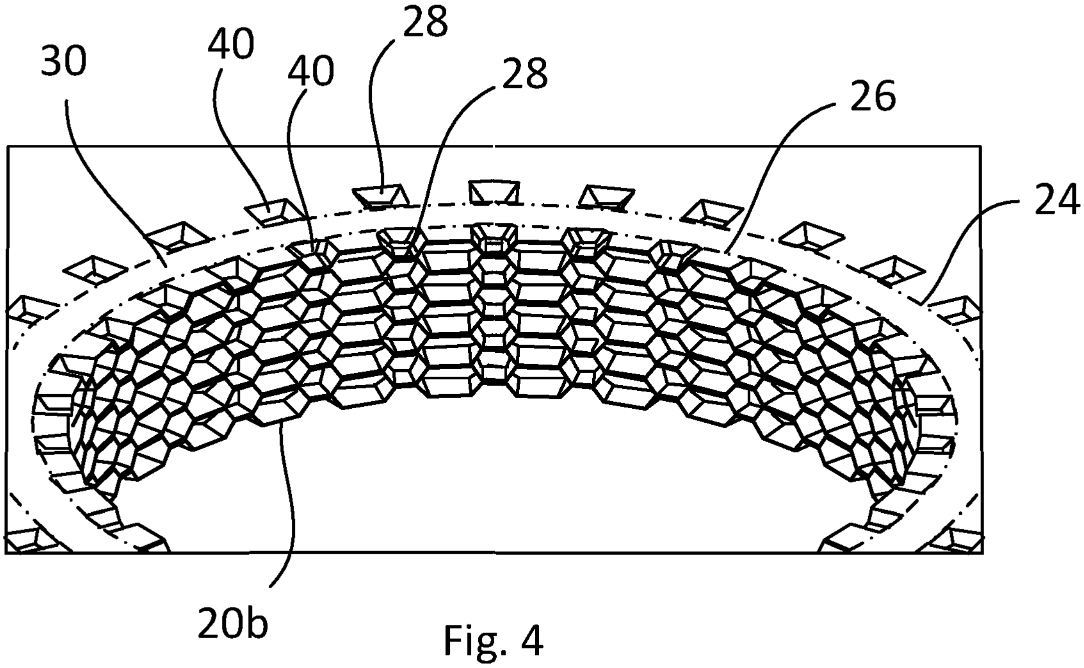
30
40
40
28
28
26
24
20b

Fig. 4

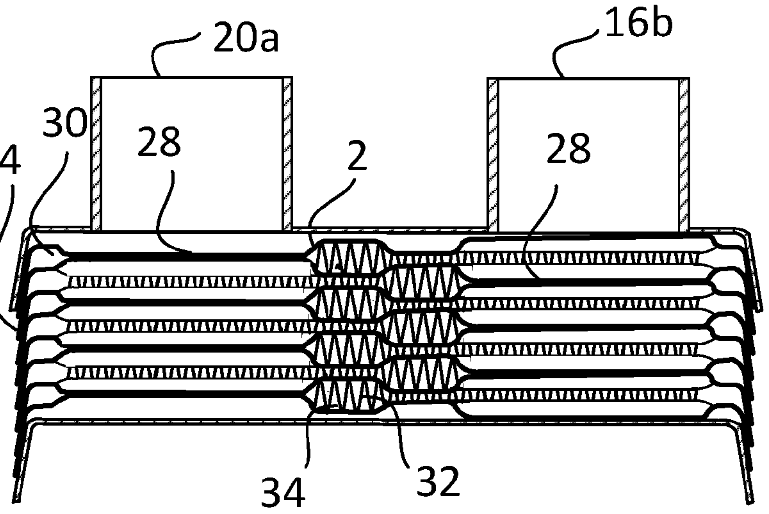

Fig. 5
(V – V)

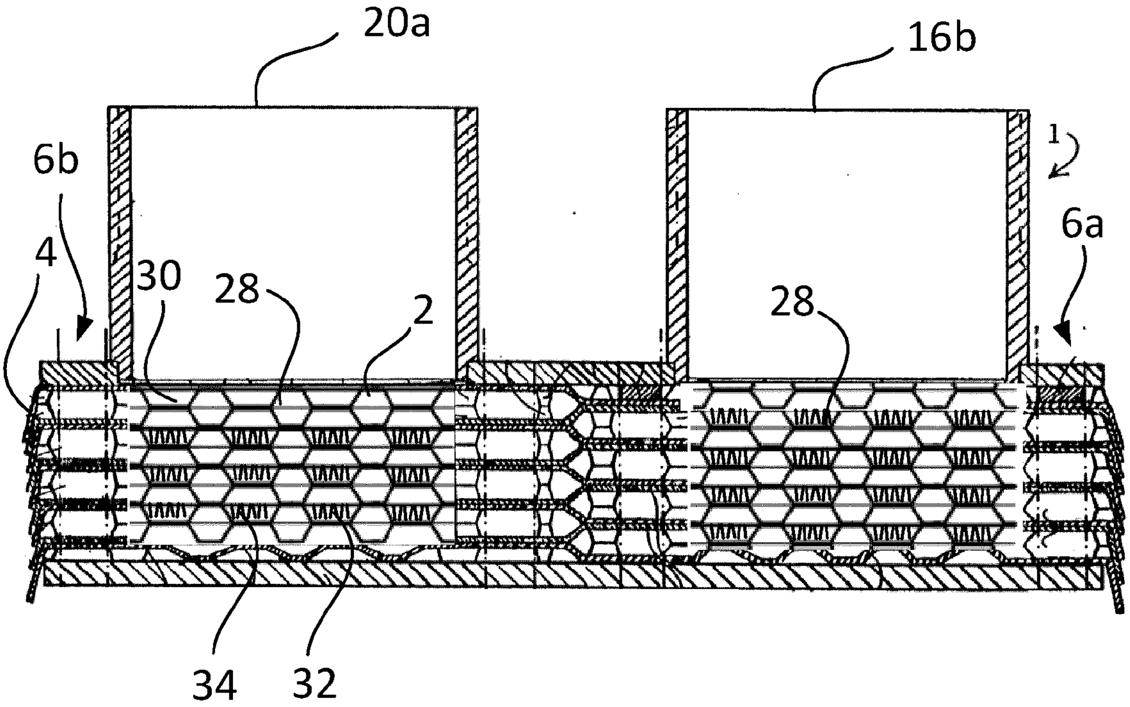

Fig. 6
(V – V)

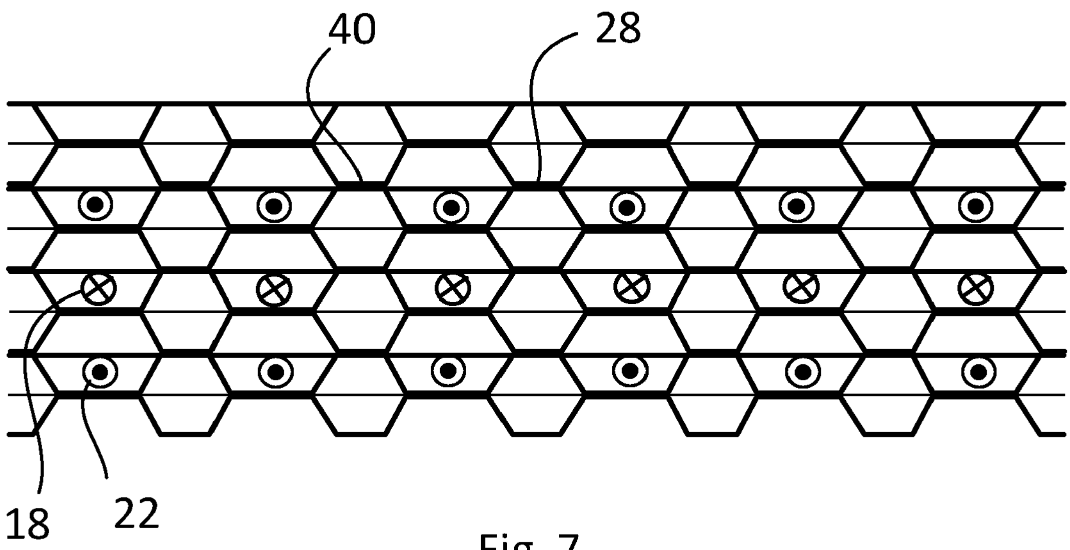

Fig. 7

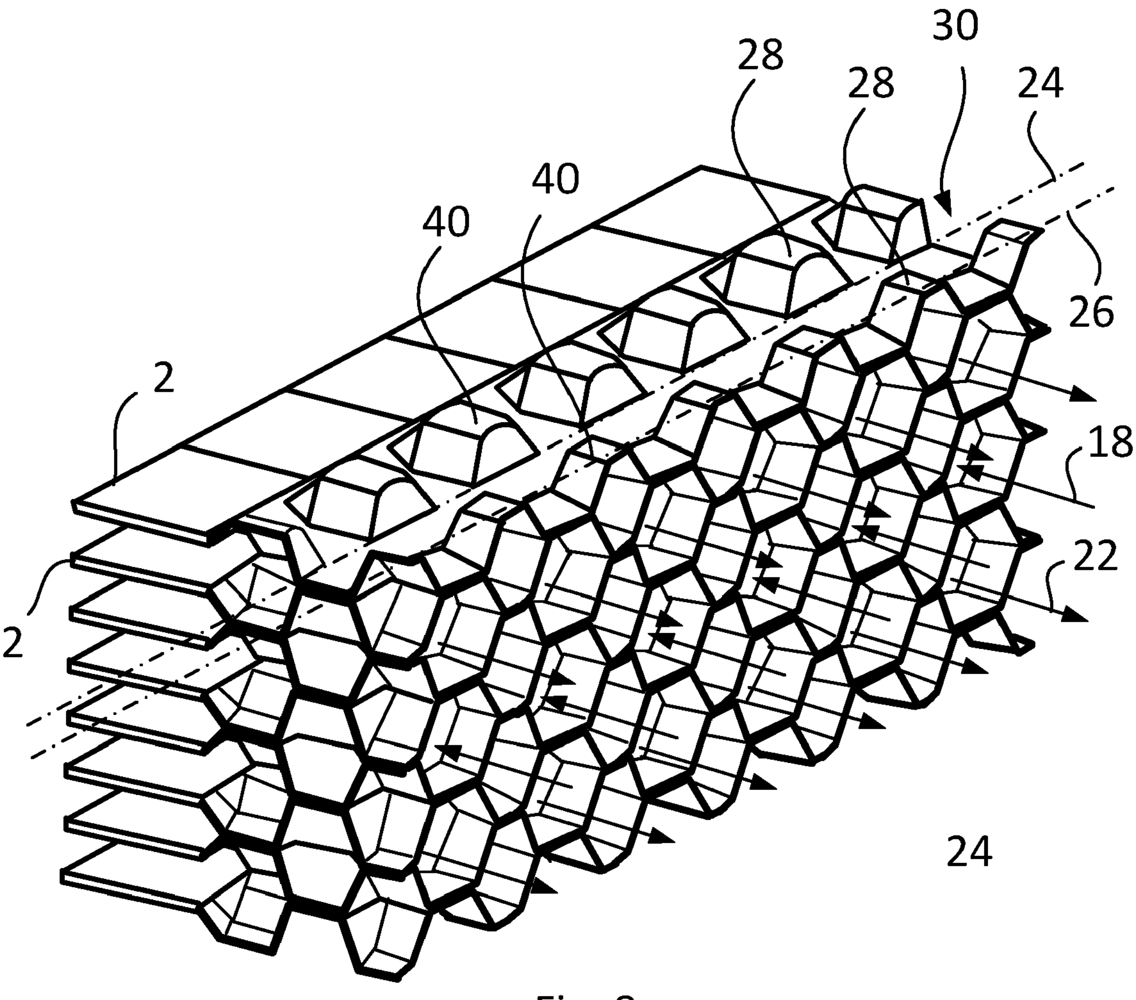

Fig. 8

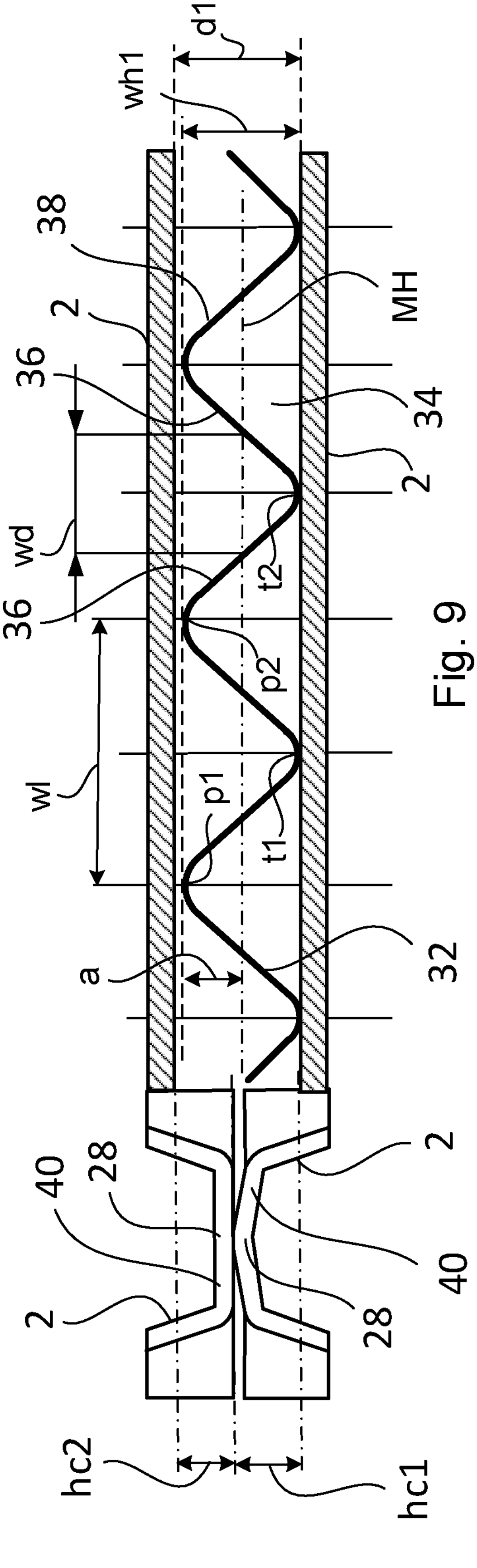
d1
wh1
38
2
36
MH
34
2
wd
36
t2
p2
wl
p1
t1
a
32
40
28
2
40
28
hc2
hc1

Fig. 9

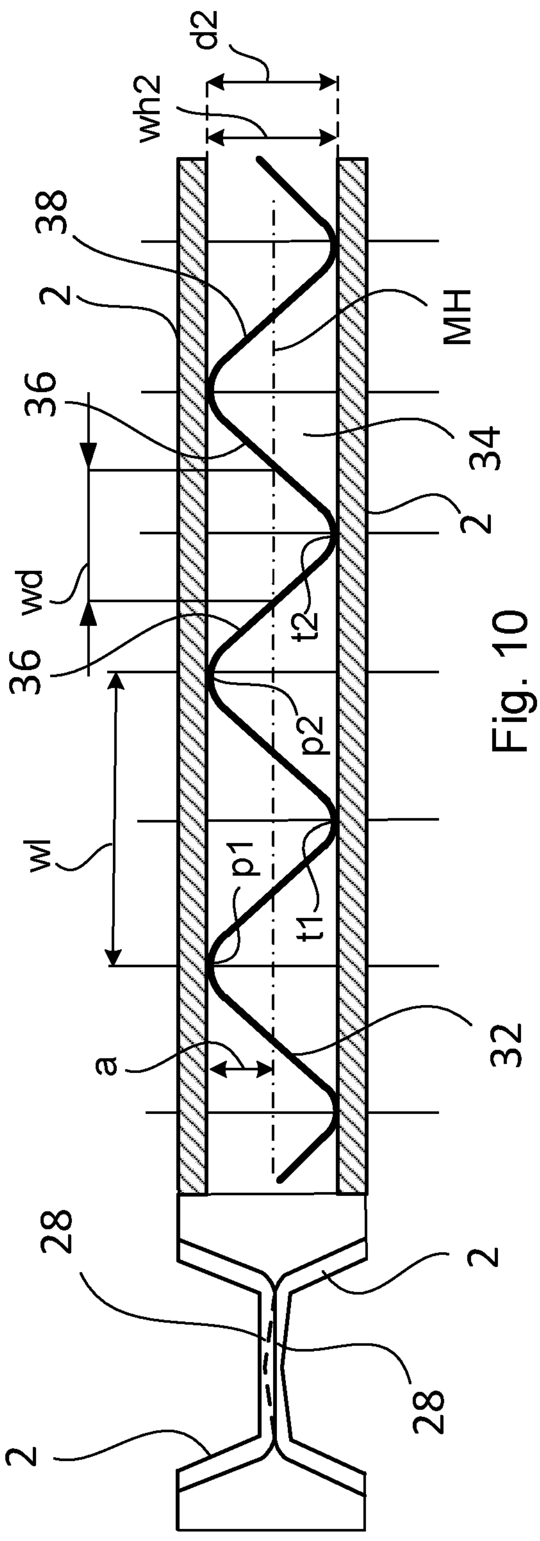
d2
wh2
38
2
36
MH
34
2
wd
36
t2
p2
wl
p1
t1
a
32
28
2
28
2

Fig. 10

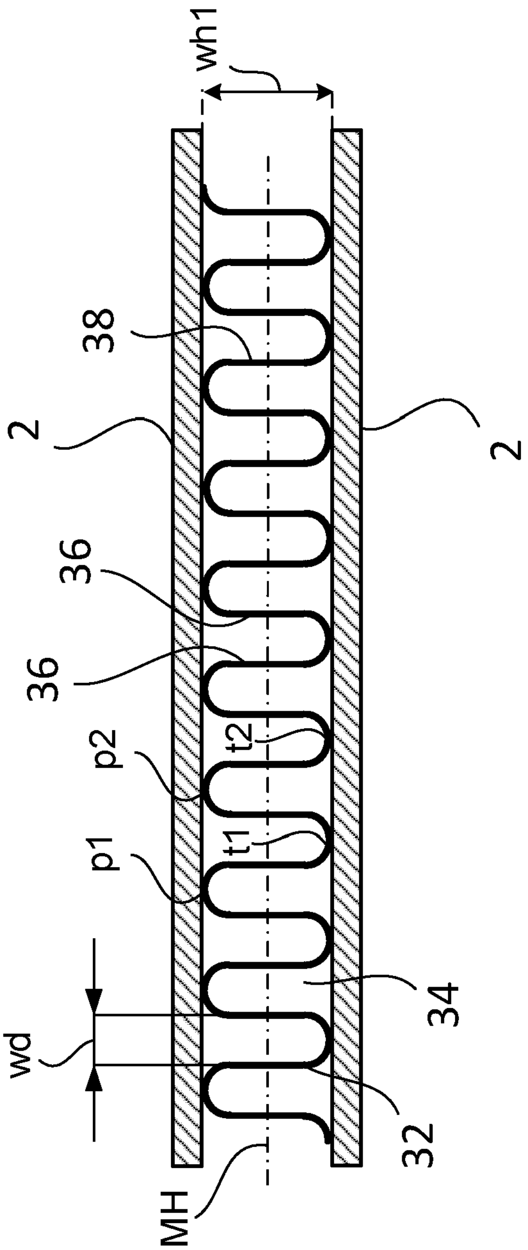

Fig. 11

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 22 19 6551

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y,D	WO 88/09473 A1 (ALFA LAVAL THERMAL [SE]) 1 December 1988 (1988-12-01) * figures 1-4 *	1-16	INV. F28D9/00 F28F3/02
Y	JP 2016 176618 A (PANASONIC IP MAN CORP) 6 October 2016 (2016-10-06) * the whole document *	1-16	
A	EP 3 882 556 A1 (MITSUBISHI ELECTRIC CORP [JP]) 22 September 2021 (2021-09-22) * paragraphs [0015] - [0036], [0055]; figures 1-5 *	1-16	
A	US 2005/133210 A1 (INAGAKI MITSUHARU [JP] ET AL) 23 June 2005 (2005-06-23) * paragraphs [0149] - [0150], [0160] - [0165]; figures 1, 2, 5-7 *	1-16	
A	US 2010/025026 A1 (DIETZ RAINER [DE] ET AL) 4 February 2010 (2010-02-04) * paragraphs [0027], [0028], [0032]; figures 1, 3b *	1-16	

TECHNICAL FIELDS SEARCHED (IPC)

F28D
F28F

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	10 February 2023	Leclaire, Thomas

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
& : member of the same patent family, corresponding document

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 22 19 6551

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

10-02-2023

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 8809473 A1	01-12-1988	AT 84140 T	15-01-1993
		DE 3877215 T2	29-04-1993
		DK 9189 A	10-01-1989
		EP 0418227 A1	27-03-1991
		JP 2719380 B2	25-02-1998
		JP H01503558 A	30-11-1989
		SE 458884 B	16-05-1989
		US 4987955 A	29-01-1991
		WO 8809473 A1	01-12-1988
JP 2016176618 A	06-10-2016	NONE	
EP 3882556 A1	22-09-2021	CN 112997045 A	18-06-2021
		EP 3882556 A1	22-09-2021
		JP 6529709 B1	12-06-2019
		JP WO2020100276 A1	15-02-2021
		US 2021341186 A1	04-11-2021
		WO 2020100276 A1	22-05-2020
US 2005133210 A1	23-06-2005	DE 102004059963 A1	11-08-2005
		US 2005133210 A1	23-06-2005
		US 2009008061 A1	08-01-2009
US 2010025026 A1	04-02-2010	CN 101629792 A	20-01-2010
		DE 102008033302 A1	21-01-2010
		US 2010025026 A1	04-02-2010

EPO FORM P0459

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

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- WO 2013144211 A1 **[0002]**
- WO 8809473 A1 **[0004]**