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(54) PLATE HEAT EXCHANGER

(57) The present disclosure provides a plate heat exchanger comprising: a plurality of heat transfer plates; a first fluid channel and a second fluid channel formed between adjacent heat transfer plates and fluidly isolated from each other; an upstream outlet port and a downstream inlet port formed in each of the heat transfer plates; and a fluid communication device. The first fluid channel comprises a fluid channel upstream portion and a fluid channel downstream portion that are separated

from each other. The upstream outlet port is communicated to the fluid channel upstream portion of the first fluid channel, while the downstream inlet port is communicated to the fluid channel downstream portion of the first fluid channel. The upstream outlet port and downstream inlet port are fluidly communicated with each other through the fluid communication device. By adopting the plate heat exchanger according to the present disclosure, a number of parts may be reduced.

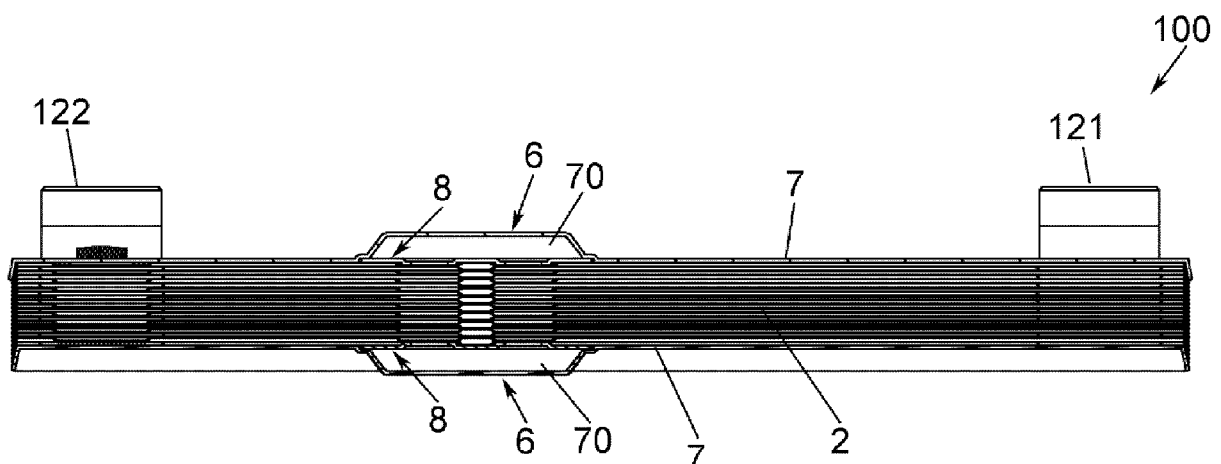


Fig.2

Description

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the priority of Chinese Application No.CN2023220970861 filed on August 4, 2023, the whole disclosure of which is incorporated herein by reference.

TECHNICAL FIELD

[0002] The present disclosure relates to a plate heat exchanger.

BACKGROUND

[0003] A traditional plate heat exchanger comprises two end plates (the two end plates may also be referred to as an end plate and a bottom plate or a cover plate and a bottom plate, respectively) and at least one heat transfer plate between the two end plates. Fluid channels used for two or more fluids are formed between adjacent heat transfer plates so as to conduct heat exchange among the two or more fluids.

SUMMARY OF THE INVENTION

[0004] A purpose of the embodiments of the present disclosure is to provide a plate heat exchanger, thereby such as reducing a number of parts.

[0005] An embodiment of the present disclosure provides a plate heat exchanger comprising: a plurality of heat transfer plates; a first fluid channel and a second fluid channel formed between adjacent heat transfer plates and fluidly isolated from each other, wherein the first fluid channel comprises a fluid channel upstream portion and a fluid channel downstream portion that are separated from each other; an upstream outlet port formed in each of the heat transfer plates and communicated to the fluid channel upstream portion of the first fluid channel, and a downstream inlet port formed in each of the heat transfer plates and communicated to the fluid channel downstream portion of the first fluid channel; and a fluid communication device, through which the upstream outlet port and the downstream inlet port are fluidly communicated with each other.

[0006] According to an embodiment of the present disclosure, the plate heat exchanger further comprises: an end plate disposed on an outer side of an outermost heat transfer plate and having an end plate outer recess that is recessed in a direction away from the outermost heat transfer plate, wherein the end plate outer recess is configured to form a chamber as the fluid communication device with a portion of the outermost heat transfer plate corresponding to the end plate outer recess.

[0007] According to an embodiment of the present disclosure, the plate heat exchanger further comprises: a sealing plate comprising: first and second openings;

and first and second annular protrusions respectively surrounding the first and second openings and protruding towards their sides facing away from the end plate; and wherein the sealing plate is disposed between the end plate and the outermost heat transfer plate.

[0008] According to an embodiment of the present disclosure, an annular edge surface portion of the sealing plate on a side of the sealing plate facing the end plate is in contact with an annular surface portion of the end plate surrounding the end plate outer recess so as to form a seal between the annular edge surface portion of the sealing plate and the annular surface portion of the end plate, and the first and second annular protrusions of the sealing plate are in contact with a first annular surface portion around the upstream outlet port of the outermost heat transfer plate and a second annular surface portion around the downstream inlet port of the outermost heat transfer plate, respectively, so as to form a seal between the first annular protrusion of the sealing plate and the first annular surface portion of the outermost heat transfer plate and a seal between the second annular protrusion of the sealing plate and the second annular surface portion of the outermost heat transfer plate, respectively.

[0009] According to an embodiment of the present disclosure, the outermost heat transfer plate is configured to have first and second heat transfer plate recesses recessed towards its side facing away from the end plate, and the first annular surface portion of the outermost heat transfer plate is disposed in a bottom of the first heat transfer plate recess of the outermost heat transfer plate, and the second annular surface portion of the outermost heat transfer plate is disposed in a bottom of the second heat transfer plate recess of the outermost heat transfer plate.

[0010] According to an embodiment of the present disclosure, the plate heat exchanger further comprises: a sealing plate comprising: an opening; and an annular protrusion protruding surrounding the opening and protruding towards its side facing away from the end plate; and wherein the sealing plate is disposed between the end plate and the outermost heat transfer plate.

[0011] According to an embodiment of the present disclosure, an annular edge surface portion of the sealing plate on a side of the sealing plate facing the end plate is in contact with an annular surface portion of the end plate surrounding the end plate outer recess so as to form a seal between the annular edge surface portion of the sealing plate and the annular surface portion of the end plate, and the annular protrusion of the sealing plate is in contact with the annular surface portion around the upstream outlet port and downstream inlet port of the outermost heat transfer plate so as to form a seal between the annular protrusion of the sealing plate and the annular surface portion of the outermost heat transfer plate.

[0012] According to an embodiment of the present disclosure, the outermost heat transfer plate is configured to have a heat transfer plate recess that is recessed towards its side facing away from the end plate, and the

annular surface portion of the outermost heat transfer plate is disposed in the bottom of the heat transfer plate recess of the outermost heat transfer plate.

[0013] According to an embodiment of the present disclosure, the end plate is configured to further have a step portion surrounding the end plate outer recess and recessed in a direction away from the outermost heat transfer plate, and the annular surface portion of the end plate surrounding the end plate outer recess is disposed on the step portion.

[0014] According to an embodiment of the present disclosure, the sealing plate is formed of metal and connected to the end plate and the outermost heat transfer plate through brazing respectively.

[0015] According to an embodiment of the present disclosure, the annular surface portion of the end plate surrounding the end plate outer recess is in contact with the annular surface portion of the outermost heat transfer plate around the upstream outlet port and downstream inlet port so as to form a seal between the annular surface portion of the end plate and the annular surface portion of the outermost heat transfer plate.

[0016] According to an embodiment of the present disclosure, the outermost heat transfer plate is configured to have an annular heat transfer plate recess around the upstream outlet port and downstream inlet port and recessed in a direction away from the end plate, and a bottom of the annular heat transfer plate recess of the outermost heat transfer plate is in contact with an adjacent heat transfer plate so as to form a seal between the bottom of the annular heat transfer plate recess of the outermost heat transfer plate and the adjacent heat transfer plate.

[0017] According to an embodiment of the present disclosure, the outermost heat transfer plate is configured to have a plurality of separated heat transfer plate recesses around the upstream outlet port and downstream inlet port and recessed in a direction away from the end plate, and bottoms of the plurality of separated heat transfer plate recesses of the outermost heat transfer plate are in contact with an adjacent heat transfer plate respectively.

[0018] According to an embodiment of the present disclosure, the heat transfer plate recess of the outermost heat transfer plate is located on an inner and/or outer side of the annular surface portion of the outermost heat transfer plate.

[0019] According to an embodiment of the present disclosure, the plate heat exchanger further comprises: an end plate disposed on an outer side of the outermost heat transfer plate and having an opening; and a chamber plate comprising: an annular plate portion disposed between the annular plate portion of the end plate surrounding the opening of the end plate and the annular surface portion of the outermost heat transfer plate around the upstream outlet port and downstream inlet port so as to form seals between the annular plate portion of the end plate and the annular plate portion of the

chamber plate, as well as between the annular plate portion of the chamber plate and the annular surface portion of the outermost heat transfer plate; and a chamber plate recess recessed to an outer side of the end plate through the opening of the end plate from the annular plate portion of the chamber plate in a direction away from the outermost heat transfer plate, the chamber plate recess and a portion of the outermost heat transfer plate corresponding to the chamber plate recess forming a chamber as the fluid communication device.

[0020] According to an embodiment of the present disclosure, the outermost heat transfer plate is configured to have a heat transfer plate recess that is recessed towards its side facing away from the end plate, and the annular surface portion of the outermost heat transfer plate is disposed in a bottom of the heat transfer plate recess of the outermost heat transfer plate.

[0021] According to an embodiment of the present disclosure, the plate heat exchanger further comprises: an end plate disposed on an outer side of the outermost heat transfer plate and having a first through hole communicated to the upstream outlet port and a second through hole communicated to the downstream inlet port.

[0022] According to an embodiment of the present disclosure, the end plate is configured to have first and second end plate inner recesses that are recessed to its side facing towards the outermost heat transfer plate respectively, and the first and second through holes of the end plate are respectively disposed in a bottom of the first end plate inner recess and a bottom of the second end plate inner recess of the end plate, a first annular bottom surface of the bottom of the first end plate inner recess of the end plate around the first through hole and a second annular bottom surface of the bottom of the second end plate inner recess of the end plate around the second through hole are in contact with a first annular surface portion of the outermost heat transfer plate around the upstream outlet port and a second annular surface portion of the outermost heat transfer plate around the downstream inlet port, respectively, so as to form a seal between a first annular bottom surface of the bottom of the first end plate inner recess of the end plate and the first annular surface portion of the outermost heat transfer plate, and a seal between a second annular bottom surface of the bottom of the second end plate inner recess of the end plate and the second annular surface portion of the outermost heat transfer plate, respectively.

[0023] According to an embodiment of the present disclosure, the outermost heat transfer plate is configured to have a first heat transfer plate recess and a second heat transfer plate recess, the first annular surface portion of the outermost heat transfer plate is disposed in a bottom of the first heat transfer plate recess of the outermost heat transfer plate, and the second annular surface portion of the outermost heat transfer plate is disposed in a bottom of the second heat transfer plate recess of the outermost heat transfer plate.

[0024] According to an embodiment of the present disclosure, the fluid communication device comprises a communicating tube connected to the end plate so as to connect the first through hole with the second through hole through the communicating tube.

[0025] According to an embodiment of the present disclosure, the communicating tube is generally U-shaped.

[0026] According to an embodiment of the present disclosure, the communicating tube is configured to have a projection protruding outward from its wall.

[0027] According to an embodiment of the present disclosure, the projection of the wall of the communicating tube is located at a portion of the wall of the communicating tube facing away from the end plate.

[0028] Adopting a plate heat exchanger according to the embodiments of the present disclosure, for example, may reduce the number of parts.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029]

FIG. 1 is a schematic perspective view of a plate heat exchanger according to an embodiment of the present disclosure.

FIG. 2 is a schematic cross-sectional view of the plate heat exchanger shown in FIG. 1 taken in a length direction.

FIG. 3 is a schematic partial enlarged cross-sectional view of the plate heat exchanger shown in FIG. 2.

FIG. 4 is a schematic cross-sectional view of the plate heat exchanger shown in FIG. 1 taken in a width direction.

FIG. 5 is a schematic partial enlarged cross-sectional view of the plate heat exchanger shown in FIG. 4.

FIG. 6A is a schematic perspective view of a sealing plate of the plate heat exchanger shown in FIG. 1.

FIG. 6B is a schematic front view of a sealing plate of the plate heat exchanger shown in FIG. 6A.

FIG. 6C is a schematic cross-sectional view of a sealing plate of the plate heat exchanger shown in FIG. 6A.

FIG. 7 is a schematic cross-sectional view of a plate heat exchanger taken in a width direction according to a variant of the embodiment shown in FIG. 1.

FIG. 8 is a schematic partial enlarged cross-sectional view of the plate heat exchanger shown in FIG. 7.

FIG. 9 is a schematic cross-sectional view of a plate heat exchanger taken in a length direction according to another embodiment of the present disclosure.

FIG. 10 is a schematic partial enlarged cross-sectional view of the plate heat exchanger shown in FIG. 9.

FIG. 11 is a schematic partial enlarged cross-sectional view of a plate heat exchanger taken in a length direction according to another embodiment of the present disclosure.

FIG. 12 is a schematic partial enlarged cross-sectional view of a plate heat exchanger taken in a length direction according to a variant of the embodiment shown in FIG. 11.

FIG. 13 is a schematic partial enlarged cross-sectional view of a plate heat exchanger taken in a length direction according to another variant of the embodiment shown in FIG. 11.

FIG. 14 is a schematic partial enlarged cross-sectional view of a plate heat exchanger taken in a length direction according to another variant of the embodiment shown in FIG. 11.

DETAILED DESCRIPTION OF THE INVENTION

[0030] The present invention will be described below in further detail in conjunction with the drawings and specific embodiments. Referring to FIGS. 1 to 5 and 7 to 14, a plate heat exchanger 100 according to an embodiment of the present disclosure comprises: a plurality of heat transfer plates 2; a first fluid channel 3 and a second fluid channel 4 formed between adjacent heat transfer plates 2 and fluidly isolated from each other; an upstream outlet port 51 and downstream inlet port 52 formed in each of the heat transfer plates 2; and a fluid communication device 6. The first fluid channel 3 comprises a fluid channel upstream portion 31 and a fluid channel downstream portion 32 that are separated from each other. The upstream outlet port 51 is communicated to the fluid channel upstream portion 31 of the first fluid channel 3, while the downstream inlet port 52 is communicated to the fluid channel downstream portion 32 of the first fluid channel 3. The upstream outlet port 51 and downstream inlet port 52 are fluidly communicated through the fluid communication device 6. According to the embodiment of the present disclosure, the plate heat exchanger 100 further comprises an end plate 7, which is disposed on an outer side of an outermost heat transfer plate 2U. The plate heat exchanger 100 further comprises: a first fluid inlet 111, a first fluid outlet 112, a second fluid outlet 122 (for a counter flow evaporator), and a second fluid inlet 121 (for a counter flow evaporator). A first fluid such as refrigerant flows in the first fluid channel 3, while a second fluid such as water flows in the second fluid channel 4. The heat transfer plates 10 are stacked together, thereby alternately forming the first fluid channel 3 and the second fluid channel 4 in the stacking direction, or alternatively forming three or more fluid channels in the stacking direction. The first fluid channel is divided into the fluid channel upstream portion 31 and the fluid channel downstream portion 32, while the second fluid channel is directly communicated.

[0031] Referring to FIGS. 1 to 5 and 7 to 14, according to the embodiment of the present disclosure, the first fluid enters the plate heat exchanger 100 from the first fluid

inlet 111, then enters the fluid channel upstream portion 31 of the first fluid channel 3, enters the fluid communication device 6 from the upstream outlet port 51, then enters the downstream inlet port 52 from the fluid communication device 6, then enters the fluid channel downstream portion 32 of the first fluid channel 3, and finally flows out from the first fluid outlet 112. The second fluid enters the plate heat exchanger 100 from the second fluid inlet 121, then enters the second fluid channel, and finally flows out from the second fluid outlet 122.

[0032] Referring to FIGS. 3 to 5, in the embodiment of the present disclosure, the end plate 7 is configured to have an end plate outer recess 70 that is recessed in a direction away from the outermost heat transfer plate 2U. The end plate outer recess 70 is configured to form a chamber 60 as the fluid communication device 6 with a corresponding portion of the outermost heat transfer plate 2U. Referring to FIGS. 3 to 6C, in an example of the present disclosure, the plate heat exchanger 100 further comprises a sealing plate 8, wherein the sealing plate 8 comprises first and second openings 80A, 80B; and first and second annular protrusions 81A, 81B respectively surrounding the first and second openings 80A, 80B and protruding in a direction away from the end plate 7. The sealing plate 8 is disposed between the end plate 7 and the outermost heat transfer plate 2U. According to the example of the present disclosure, an annular edge surface portion 82 of the sealing plate 8 on a side of the sealing plate 8 facing the end plate 7 is in contact with an annular surface portion 71 of the end plate 7 surrounding the end plate outer recess 70 to form a seal between the annular edge surface portion 82 of the sealing plate 8 and the annular surface portion 71 of the end plate 7, and the first and second annular protrusions 81A, 81B of the sealing plate 8 are in contact with the first annular surface portion 20A around the upstream outlet port 51 of the outermost heat transfer plate 2U and the second annular surface portion 20B around the downstream inlet port 52 of the outermost heat transfer plate 2U, respectively, to form a seal between the annular protrusion 81A, 81B of the sealing plate 8 and the annular surface portion 20A, 20B of the outermost heat transfer plate 2U, respectively (i.e., a seal between the annular protrusion 81A and the annular surface portion 20A, and a seal between the annular protrusion 81B and the annular surface portion 20B). The outermost heat transfer plate 2U may have a first heat transfer plate recess 21A and a second heat transfer plate recess 21B recessed towards their sides facing away from the end plate 7. The first annular surface portion 20A of the outermost heat transfer plate 2U is disposed in a bottom 22A of the first heat transfer plate recess 21A of the outermost heat transfer plate 2U, and the second annular surface portion 20B of the outermost heat transfer plate 2U is disposed in a bottom 22B of the second heat transfer plate recess 21B of the outermost heat transfer plate 2U. The upstream outlet port 51 and downstream inlet port 52 are respectively disposed in the bottom 22A of the first heat

transfer plate recess 21A and the bottom 22B of the second heat transfer plate recess 21B of the outermost heat transfer plate 2U. The bottom 22A of the first heat transfer plate recess 21A and the bottom 22B of the second heat transfer plate recess 21B of the outermost heat transfer plate 2U respectively come into contact with the annular surface portions of an adjacent heat transfer plate 2N surrounding the upstream outlet port 51 and the downstream inlet port 52 to form a seal, thereby isolating the second fluid passage 4 from the upstream outlet port 51 and the downstream inlet port 52. As a result, the upstream outlet port 51 is only communicated to the fluid channel upstream portion 31 of the first fluid channel 3, while the downstream inlet port 52 is only communicated to the fluid channel downstream portion 32 of the first fluid channel 3.

[0033] In the embodiments shown in FIGS. 2 to 6, the sealing plate 8 comprises two openings corresponding to the upstream outlet port 51 and the downstream inlet port 52 respectively. However, the sealing plate 8 may only comprise one opening, which corresponds to the upstream outlet port 51 or the downstream inlet port 52. Specifically, the sealing plate comprises: an opening; an annular protrusion protruding surrounding the opening and protruding in a direction away from the end plate 7, wherein, the sealing plate 8 is disposed between the end plate 7 and the outermost heat transfer plate 2U. An annular edge surface portion 82 of the sealing plate 8 on the side of the sealing plate 8 facing the end plate 7 is in contact with an annular surface portion 71 of the end plate 7 surrounding the end plate outer recess 70 so as to form a seal between the annular edge surface portion 82 of the sealing plate 8 and the annular surface portion 71 of the end plate 7, and the annular protrusion of the sealing plate 8 is in contact with the annular surface portion around the upstream outlet port 51 and downstream inlet port 52 of the outermost heat transfer plate 2U so as to form a seal between the annular protrusion of the sealing plate 8 and the annular surface portion of the outermost heat transfer plate 2U. The outermost heat transfer plate 2U may have a heat transfer plate recess that is recessed towards its side facing away from the end plate 7, and the annular surface portion of the outermost heat transfer plate 2U is disposed in the bottom of the heat transfer plate recess of the outermost heat transfer plate 2U.

[0034] Referring to FIG. 3, in the embodiment of the present disclosure, the end plate 7 is configured to further have a step portion 72 surrounding the end plate outer recess 70 and recessed in a direction away from the outermost heat transfer plate 2U. The annular surface portion 71 of the end plate 7 surrounding the end plate outer recess 70 is disposed on the step portion 72. The sealing plate 8 may be formed of metal and may be connected to the end plate 7 and the outermost heat transfer plate 2U through brazing.

[0035] Referring to FIGS. 1 to 5, according to an embodiment of the present disclosure, the end plate has an end plate outer recess 70, which may play a role in

regulating a fluid distribution. By means of the end plate outer recess 70, a separate liquid collection box may be eliminated and a complexity of the brazing process may be reduced.

[0036] In addition, by using a single sealing plate, a number of parts is reduced and an assembly process is simplified. During the assembly process, the sealing plate may be self-adapted to the step portion 72 of the end plate so as to achieve a precise positioning. At the same time, the sealing plate is made of composite bimetallic materials, such as, a copper is composited on both sides of a stainless steel sealing plate. After the copper is melted at a high temperature, the sealing plate is welded to the end plate and the outermost heat transfer plate respectively. As a result, a process of adding additional solder may be eliminated, thereby reducing a manufacturing complexity and shortening a manufacturing cycle.

[0037] FIG. 7 is a schematic cross-sectional view of a plate heat exchanger taken in a width direction according to a variant of the embodiment shown in FIG. 1. FIG. 8 is a schematic partial enlarged cross-sectional view of the plate heat exchanger shown in FIG. 7. In the variant shown in FIGS. 7 and 8, the end plate 7 is in contact with the outermost heat transfer plate 2U, forming a seal and thus eliminating the sealing plate in the embodiments shown in FIGS. 1 to 6C.

[0038] Referring to FIGS. 7 to 8 and in combination with FIGS. 2 and 3, in some embodiments of the present disclosure, the annular surface portion 71 of the end plate 7 surrounding the end plate outer recess 70 is in contact with the annular surface portion 20 of the outermost heat transfer plate 2U around the upstream outlet port 51 and downstream inlet port 52 so as to form a seal between the annular surface portion 71 of the end plate 7 and the annular surface portion 20 of the outermost heat transfer plate 2U. The outermost heat transfer plate 2U is configured to have an annular heat transfer plate recess 23 around the upstream outlet port 51 and downstream inlet port 52 and recessed in a direction away from the end plate 7, and the bottom 24 of the annular heat transfer plate recess 23 of the outermost heat transfer plate 2U is in contact with an adjacent heat transfer plate 2N so as to form a seal between the bottom 24 of the annular heat transfer plate recess 23 of the outermost heat transfer plate 2U and the adjacent heat transfer plate 2N. The heat transfer plate recess 23 of the outermost heat transfer plate 2U may be located on an outer side of the annular surface portion 20 of the outermost heat transfer plate 2U. Referring to FIGS. 7 to 8, in other embodiments of the present disclosure, the heat transfer plate recess 23 comprises a plurality of discrete heat transfer plate recesses 23. Specifically, the outermost heat transfer plate 2U is configured to have a plurality of separated heat transfer plate recesses 23 around the upstream outlet port 51 and downstream inlet port 52 and recessed in a direction away from the end plate 7, and the bottoms 24 of the plurality of separated heat transfer plate recesses 23 of the outermost heat transfer plate 2U are in

contact with an adjacent heat transfer plate 2N. A number of the annular heat transfer plate recess 23 of the outermost heat transfer plate 2U may be one, and the one annular heat transfer plate recess 23 surrounds the upstream outlet port 51 and the downstream inlet port 52. The number of the annular heat transfer plate recesses 23 may also be two, and the two annular heat transfer plate recesses 23 surround the upstream outlet port 51 and the downstream inlet port 52, respectively. The heat transfer plate recess 23 of the outermost heat transfer plate 2U is located on an outer side of the annular surface portion 71 of the outermost heat transfer plate. It may be understood that the heat transfer plate recess 23 of the outermost heat transfer plate 2U may also be located on an inner side of the annular surface portion 71 of the outermost heat transfer plate. For example, a sealing connection between the outermost heat transfer plate 2U and the adjacent heat transfer plate 2N may be achieved by an interconnection of the annular portions around the upstream outlet port 51 and the downstream inlet port 52 (referring to a manner of connection of the adjacent heat transfer plates at the downstream inlet port 52 in FIGS. 7 and 8, where the upper heat transfer plate is configured to have an annular recess surrounding the port, which is hermetically connected to the annular portion of the lower heat transfer plate).

[0039] Referring to FIGS. 7 to 8, according to an embodiment of the present disclosure, the end plate is configured to have an end plate outer recess 70, which may regulate the fluid distribution. Through the end plate outer recess 70, a separate liquid collection box may be eliminated, reducing the complexity of the brazing process. At the same time, by bending the outermost heat transfer plate 2U, the annular surface portion 20 of the outermost heat transfer plate 2U is in contact with the end plate, playing a role of sealing and eliminating a need for a separate sealing ring.

[0040] Referring to FIGS. 9 to 10, in an embodiment of the present disclosure, the end plate 7 is configured to have an opening 73. According to the embodiment of the present disclosure, the plate heat exchanger 100 further comprises a chamber plate 9. The chamber plate 9 comprises an annular plate portion 90 and the chamber plate recess 91. The annular plate portion 90 may be located generally in one plane. The annular plate portion 90 is disposed between the annular plate portion 74 of the end plate 7 surrounding the opening 73 of the end plate 7 and the annular surface portion 20 of the outermost heat transfer plate 2U around the upstream outlet port 51 and downstream inlet port 52 so as to form a seal between the annular plate portion 74 of the end plate 7 and the annular plate portion 90 of the chamber plate 9, and a seal between the annular plate portion 90 of the chamber plate 9 and the annular surface portion 20 of the outermost heat transfer plate 2U. The chamber plate recess 91 is configured to be recessed to the outer side of the end plate 7 through the opening 73 of the end plate 7 from the annular plate portion 90 of the chamber plate 9 towards a

direction away from the outermost heat transfer plate 2U, and the chamber plate recess 91 and a portion of the outermost heat transfer plate 2U corresponding to the chamber plate recess 91 form a chamber 60 as the fluid communication device 6. The outermost heat transfer plate 2U may have a heat transfer plate recess 23 that is recessed towards its side facing away from the end plate 7, and the annular surface portion 20 of the outermost heat transfer plate 2U is disposed in the bottom 24 of the heat transfer plate recess 23 of the outermost heat transfer plate 2U. The bottom of the heat transfer plate recess of the outermost heat transfer plate is in contact with the annular surface portions of the adjacent heat transfer plates around the upstream outlet port and downstream inlet port so as to form a seal, thereby isolating the second fluid channel from the upstream outlet port and downstream inlet port. Therefore, the upstream outlet port is only communicated to the fluid channel upstream portion of the first fluid channel, while the downstream inlet port is only communicated to the fluid channel downstream portion of the first fluid channel.

[0041] Referring to FIGS. 9 to 10, in an embodiment of the present disclosure, the end plate 7 is configured to have an opening 73. The plate heat exchanger 100 further comprises a chamber plate 9. The annular plate portion 90 of the chamber plate 9 is sealed between the end plate and the outermost heat transfer plate, and at the same time, the chamber plate recess 91 of the chamber plate 9 forms a chamber 60 as the fluid communication device 6 with the corresponding portion of the outermost heat transfer plate 2U. Therefore, it may regulate the fluid. A structure of the plate heat exchanger in accordance with this embodiment is compact, the two functions of the liquid collection box and the sealing ring are combined to one, thereby improving a manufacturing stability and shortening a production cycle of the plate heat exchanger 100.

[0042] FIG. 11 is a schematic partial enlarged cross-sectional view of a plate heat exchanger taken in a length direction according to another embodiment of the present disclosure. FIG. 12 is a schematic partial enlarged cross-sectional view of a plate heat exchanger taken in a length direction according to a variant of the embodiment shown in FIG. 11. FIG. 13 is a schematic partial enlarged cross-sectional view of a plate heat exchanger taken in a length direction according to another variant of the embodiment shown in FIG. 11. FIG. 14 is a schematic partial enlarged cross-sectional view of a plate heat exchanger taken in a length direction according to another yet variant of the embodiment shown in FIG. 11.

[0043] Referring to FIG. 11, in an embodiment of the present disclosure, the end plate 7 is configured to have a first through hole 75A communicated to the upstream outlet port 51 and a second through hole 75B communicated to the downstream inlet port 52. The end plate 7 may have first and second end plate inner recesses 76A, 76B that are recessed to its side facing towards the

outermost heat transfer plate 2U, and the first and second through holes 75A, 75B of the end plate 7 are respectively disposed in the bottom 77A of the first end plate inner recess 76A and the bottom 77B of the second end plate inner recess 76B of the end plate 7, a first annular bottom surface 78A of the bottom 77A of the first end plate inner recess 76A of the end plate 7 around the first through hole 75A and a second annular bottom surface 78B of the bottom 77B of the second end plate inner recess 76B of the end plate 7 around the second through hole 75B are in contact with the first annular surface portion 20A of the outermost heat transfer plate 2U around the upstream outlet port 51 and the second annular surface portion 20B of the outermost heat transfer plate 2U around the downstream inlet port 52, respectively, so as to form a seal between a first annular bottom surface 78A of the bottom 77A of the first end plate inner recess 76A of the end plate 7 and the first annular surface portion 20A of the outermost heat transfer plate 2U, and a seal between a second annular bottom surface 78B of the bottom 77B of the second end plate inner recess 76B of the end plate 7 and the second annular surface portion 20B of the outermost heat transfer plate 2U, respectively. The outermost heat transfer plate 2U is configured to have a first heat transfer plate recess 21A and a second heat transfer plate recess 21B, the first annular surface portion 20A of the outermost heat transfer plate 2U is disposed in the bottom 22A of the first heat transfer plate recess 21A of the outermost heat transfer plate 2U, and the second annular surface portion 20B of the outermost heat transfer plate 2U is disposed in the bottom 22B of the second heat transfer plate recess 21B of the outermost heat transfer plate 2U. The fluid communication device 6 may comprise a communicating tube 61 connected to the end plate 7 so as to connect the first through hole 75A with the second through hole 75B through the communicating tube 61. The communicating tube 61 is generally U-shaped. As shown in FIGS. 13 and 14, the communicating tube 61 may have a projection 63 protruding outward from its wall 62. The projection 63 of the wall 62 of the communicating tube 61 may be located at a portion of the wall 62 of the communicating tube 61 facing away from the end plate 7 or at another suitable position. Furthermore, although FIGS. 11 to 14 show that the fluid communication device 6 comprises the communicating tube 61, the fluid communication device 6 may also comprise the chamber plate 9 as shown in FIGS. 9 and 10, and the annular plate portion 90 of the chamber plate 9 may cover an outer side surface of the end plate 7.

[0044] A difference between the variant shown in FIG. 12 and the embodiment shown in FIG. 11 lies in that: in the embodiment shown in FIG. 11, an end face of each of ends of the communicating tube 61 is in contact with the end plate 7, while in the variant shown in FIG. 12, each of the ends of the communicating tube 61 is inserted into corresponding one of the through holes of the end plate 7. A difference between the variant shown in FIG. 13 and the embodiment shown in FIG. 11 lies in that: in the variant

shown in FIG. 13, the wall 62 of the communicating tube 61 has the projection 63 protruding outward. A difference between the variant shown in FIG. 14 and the embodiment shown in FIG. 11 lies in that: in the embodiment shown in FIG. 11, the end face of each of ends of the communicating tube 61 is in contact with the end plate 7, while in the variant shown in FIG. 14, each of ends of the communicating tube 61 is inserted into corresponding one of the through holes of the end plate 7, and the wall 62 of the communicating tube 61 has the projection 63 protruding outward.

[0045] Referring to FIGS. 11 to 14, in an embodiment of the present disclosure, the end plate is configured to have an end plate inner recess, whose bottom is in contact with the outermost heat transfer plate 2U to achieve a sealing function. At the same time, through holes are provided in the end plate inner recess of the end plate, and the through holes are connected to each other through a communicating tube (such as a tubeline that may be quickly installed, such as flame-brazed copper tube, etc.). The shape, length, and size of the tubeline may be adjusted according to the requirements of fluid distribution. The wall 62 of the communicating tube 61 may have the projection 63 protruding outward, thereby enhancing a disturbance of the fluid.

[0046] Although the present disclosure has been described in conjunction with embodiments, it is not limited to the aforementioned embodiments. For example, some embodiments and some technical features in all the embodiments may be combined to form new embodiments.

Claims

1. A plate heat exchanger **characterized by** comprising:

a plurality of heat transfer plates;
 a first fluid channel and a second fluid channel formed between adjacent heat transfer plates and fluidly isolated from each other, wherein the first fluid channel comprises a fluid channel upstream portion and a fluid channel downstream portion that are separated from each other;
 an upstream outlet port formed in each of the heat transfer plates and communicated to the fluid channel upstream portion of the first fluid channel, and a downstream inlet port formed in each of the heat transfer plates and communicated to the fluid channel downstream portion of the first fluid channel; and
 a fluid communication device, through which the upstream outlet port and the downstream inlet port are fluidly communicated with each other.

2. The plate heat exchanger according to claim 1, **characterized by** further comprising:

an end plate disposed on an outer side of an outermost heat transfer plate and having an end plate outer recess that is recessed in a direction away from the outermost heat transfer plate, wherein the end plate outer recess is configured to form a chamber as the fluid communication device with a portion of the outermost heat transfer plate corresponding to the end plate outer recess.

3. The plate heat exchanger according to claim 2, **characterized by** further comprising:

a sealing plate comprising:

first and second openings; and
 first and second annular protrusions respectively surrounding the first and second openings and protruding towards their sides facing away from the end plate; and

wherein the sealing plate is disposed between the end plate and the outermost heat transfer plate.

4. The plate heat exchanger according to claim 3, **characterized in that** an annular edge surface portion of the sealing plate on a side of the sealing plate facing the end plate is in contact with an annular surface portion of the end plate surrounding the end plate outer recess so as to form a seal between the annular edge surface portion of the sealing plate and the annular surface portion of the end plate, and the first and second annular protrusions of the sealing plate are in contact with a first annular surface portion around the upstream outlet port of the outermost heat transfer plate and a second annular surface portion around the downstream inlet port of the outermost heat transfer plate, respectively, so as to form a seal between the first annular protrusion of the sealing plate and the first annular surface portion of the outermost heat transfer plate and a seal between the second annular protrusion of the sealing plate and the second annular surface portion of the outermost heat transfer plate, respectively.

5. The plate heat exchanger according to claim 4, **characterized in that** the outermost heat transfer plate is configured to have first and second heat transfer plate recesses recessed towards its side facing away from the end plate, and the first annular surface portion of the outermost heat transfer plate is disposed in a bottom of the first heat transfer plate recess of the outermost heat transfer plate, and the second annular surface portion of the outermost heat transfer plate is disposed in a bottom of the second heat transfer plate recess of the outermost heat transfer plate.

6. The plate heat exchanger according to claim 2, **characterized by** further comprising:

a sealing plate comprising:

an opening; and
an annular protrusion protruding surrounding the opening and protruding towards its side facing away from the end plate; and

wherein the sealing plate is disposed between the end plate and the outermost heat transfer plate.

7. The plate heat exchanger according to claim 6, **characterized in that** an annular edge surface portion of the sealing plate on a side of the sealing plate facing the end plate is in contact with an annular surface portion of the end plate surrounding the end plate outer recess so as to form a seal between the annular edge surface portion of the sealing plate and the annular surface portion of the end plate, and the annular protrusion of the sealing plate is in contact with the annular surface portion around the upstream outlet port and downstream inlet port of the outermost heat transfer plate so as to form a seal between the annular protrusion of the sealing plate and the annular surface portion of the outermost heat transfer plate.

8. The plate heat exchanger according to claim 7, **characterized in that** the outermost heat transfer plate is configured to have a heat transfer plate recess that is recessed towards its side facing away from the end plate, and the annular surface portion of the outermost heat transfer plate is disposed in the bottom of the heat transfer plate recess of the outermost heat transfer plate.

9. The plate heat exchanger according to claim 3 or 6, **characterized in that** the end plate is configured to further have a step portion surrounding the end plate outer recess and recessed in a direction away from the outermost heat transfer plate, and the annular surface portion of the end plate surrounding the end plate outer recess is disposed on the step portion.

10. The plate heat exchanger according to claim 3 or 6, **characterized in that** the sealing plate is formed of metal and connected to the end plate and the outermost heat transfer plate through brazing respectively.

11. The plate heat exchanger according to claim 2, **characterized in that** the annular surface portion of the end plate surrounding the end plate outer recess is in contact with the annular surface portion of the outermost heat transfer plate around the up-

stream outlet port and downstream inlet port so as to form a seal between the annular surface portion of the end plate and the annular surface portion of the outermost heat transfer plate.

12. The plate heat exchanger according to claim 11, **characterized in that** the outermost heat transfer plate is configured to have an annular heat transfer plate recess around the upstream outlet port and downstream inlet port and recessed in a direction away from the end plate, and a bottom of the annular heat transfer plate recess of the outermost heat transfer plate is in contact with an adjacent heat transfer plate so as to form a seal between the bottom of the annular heat transfer plate recess of the outermost heat transfer plate and the adjacent heat transfer plate.

13. The plate heat exchanger according to claim 11, **characterized in that** the outermost heat transfer plate is configured to have a plurality of separated heat transfer plate recesses around the upstream outlet port and downstream inlet port and recessed in a direction away from the end plate, and bottoms of the plurality of separated heat transfer plate recesses of the outermost heat transfer plate are in contact with an adjacent heat transfer plate respectively.

14. The plate heat exchanger according to claim 1, **characterized by** further comprising:

an end plate disposed on an outer side of the outermost heat transfer plate and having an opening; and

a chamber plate comprising:

an annular plate portion disposed between the annular plate portion of the end plate surrounding the opening of the end plate and the annular surface portion of the outermost heat transfer plate around the upstream outlet port and downstream inlet port so as to form seals between the annular plate portion of the end plate and the annular plate portion of the chamber plate, as well as between the annular plate portion of the chamber plate and the annular surface portion of the outermost heat transfer plate; and

a chamber plate recess recessed to an outer side of the end plate through the opening of the end plate from the annular plate portion of the chamber plate in a direction away from the outermost heat transfer plate, the chamber plate recess and a portion of the outermost heat transfer plate corresponding to the chamber plate recess forming a chamber as the fluid communication device. 15. The plate heat exchanger according to claim 1, **characterized by** further comprising:

an end plate disposed on an outer side of the outermost heat transfer plate and having a first through hole communicated to the upstream outlet port and a second through hole communicated to the downstream inlet port, **wherein** 5
the end plate is configured to have first and second end plate inner recesses that are recessed to its side facing towards the outermost heat transfer plate respectively, and the first and second through holes of the end plate are respectively disposed in a bottom of the first end plate inner recess and a bottom of the second end plate inner recess of the end plate, a first annular bottom surface of the bottom of the first end plate inner recess of the end plate around the first through hole and a second annular bottom surface of the bottom of the second end plate inner recess of the end plate around the second through hole are in contact with a first annular surface portion of the outermost heat transfer plate around the upstream outlet port and a second annular surface portion of the outermost heat transfer plate around the downstream inlet port, respectively, so as to form a seal between a first annular bottom surface of the bottom of the first end plate inner recess of the end plate and the first annular surface portion of the outermost heat transfer plate, and a seal between a second annular bottom surface of the bottom of the second end plate inner recess of the end plate and the second annular surface portion of the outermost heat transfer plate, respectively.

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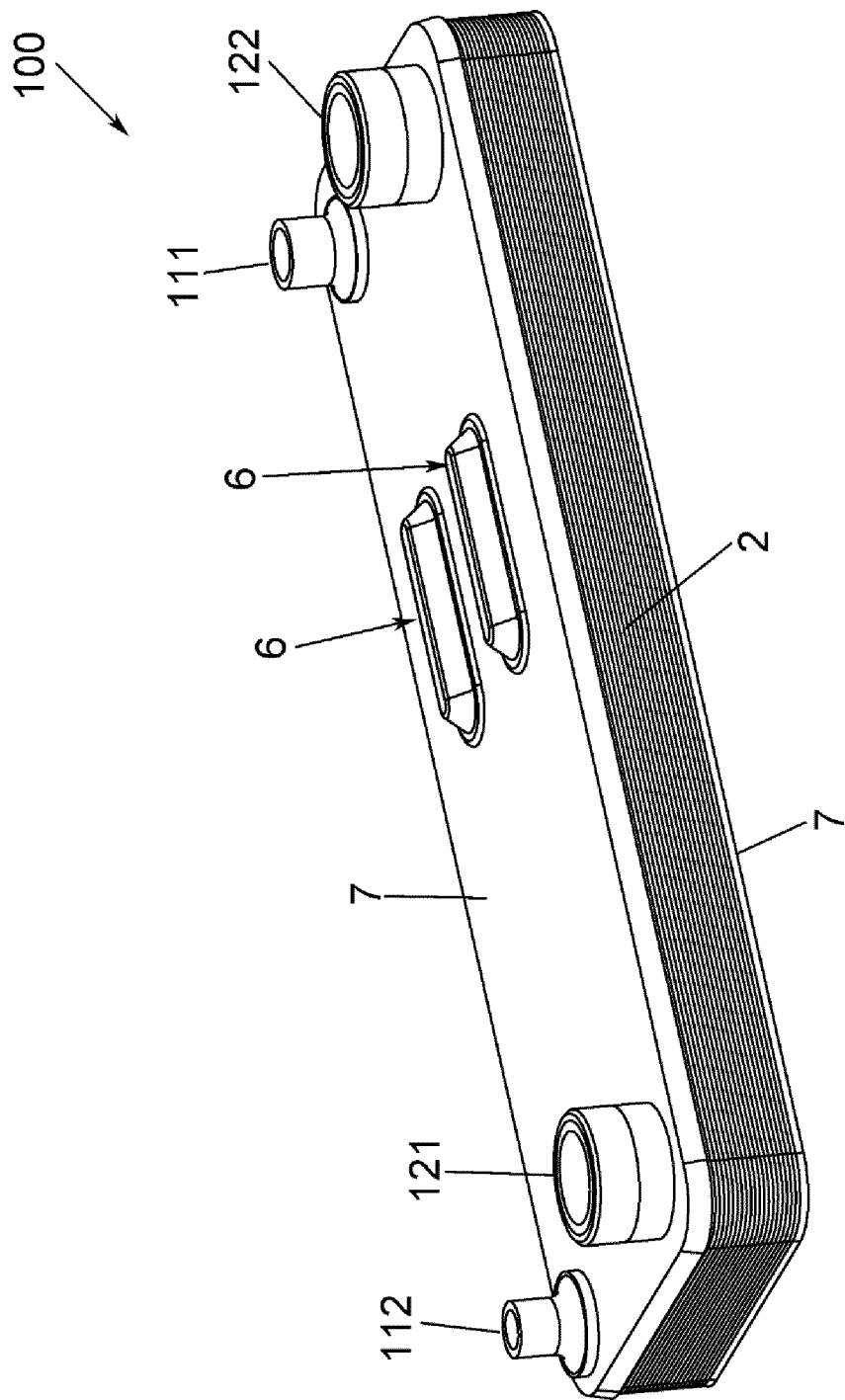


Fig.1

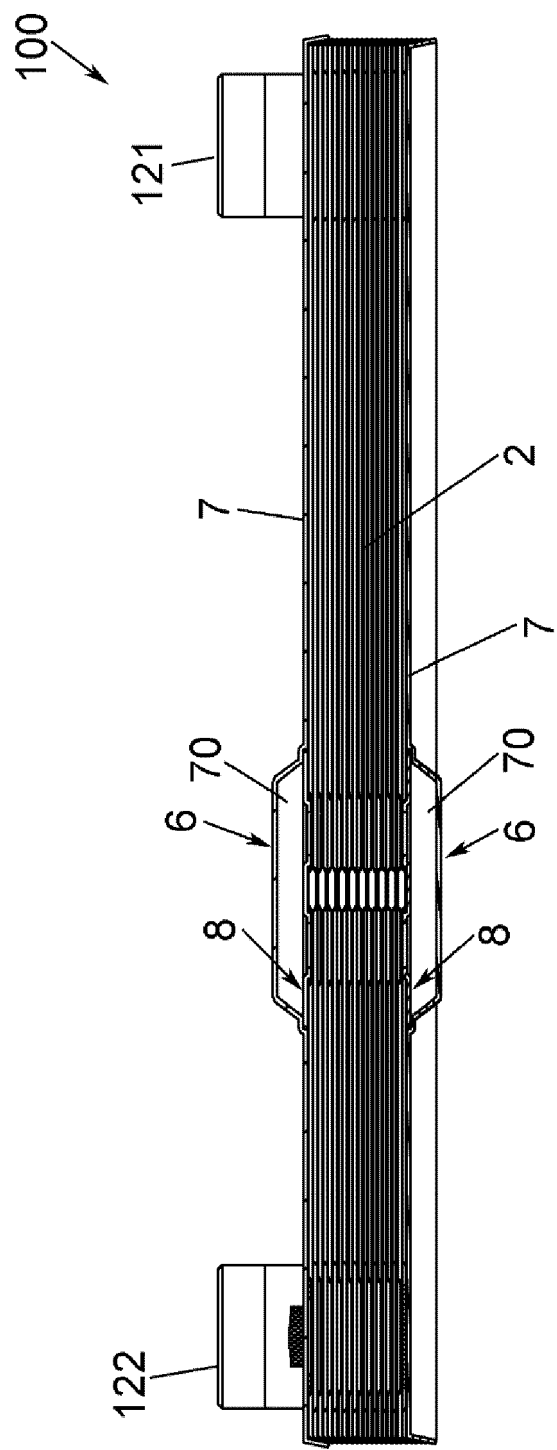


Fig.2

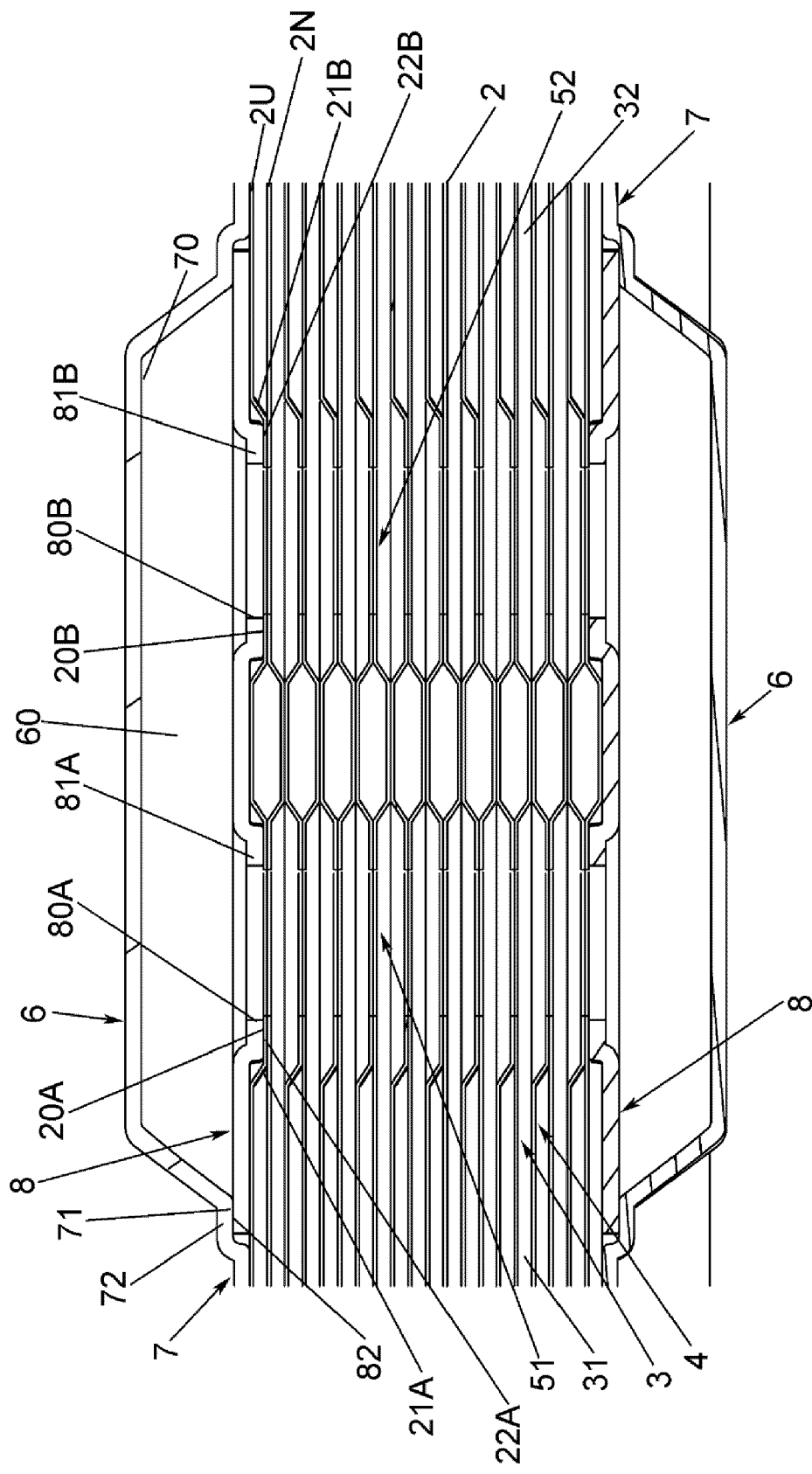


Fig.3

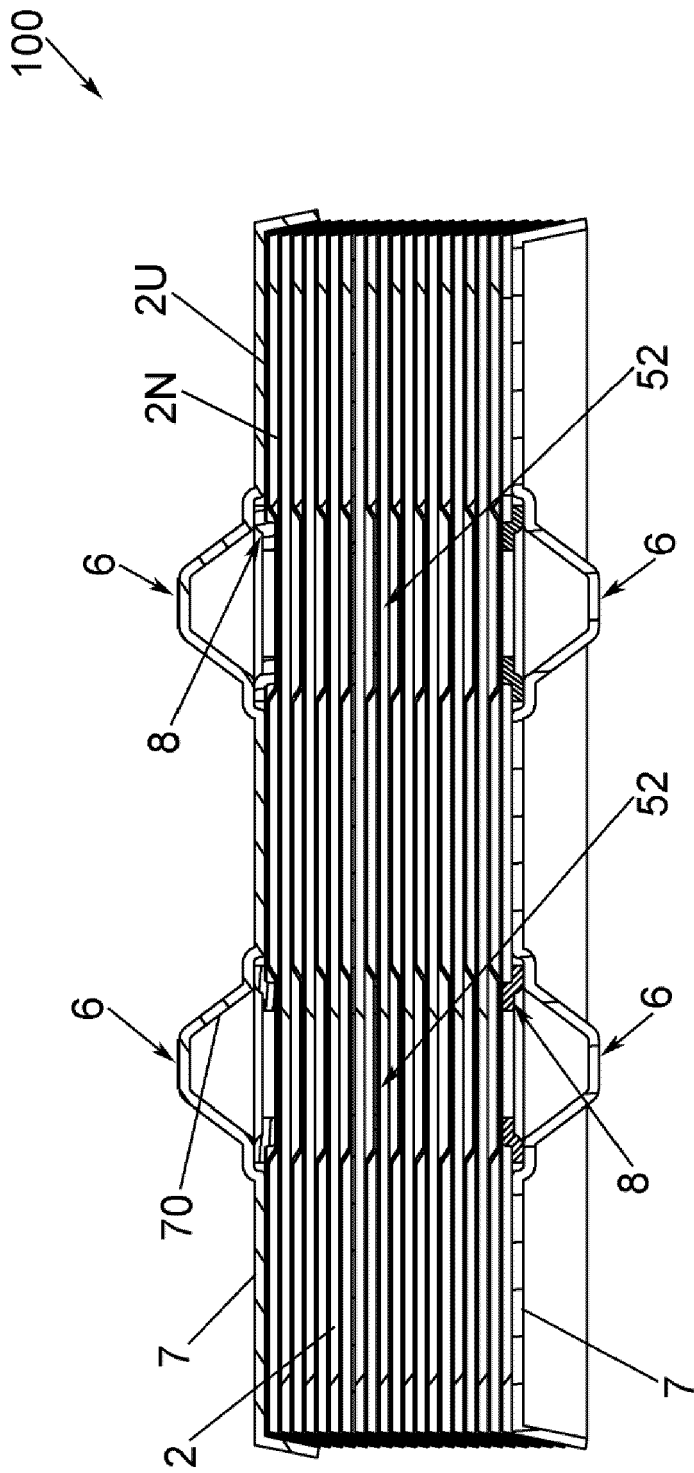


Fig.4

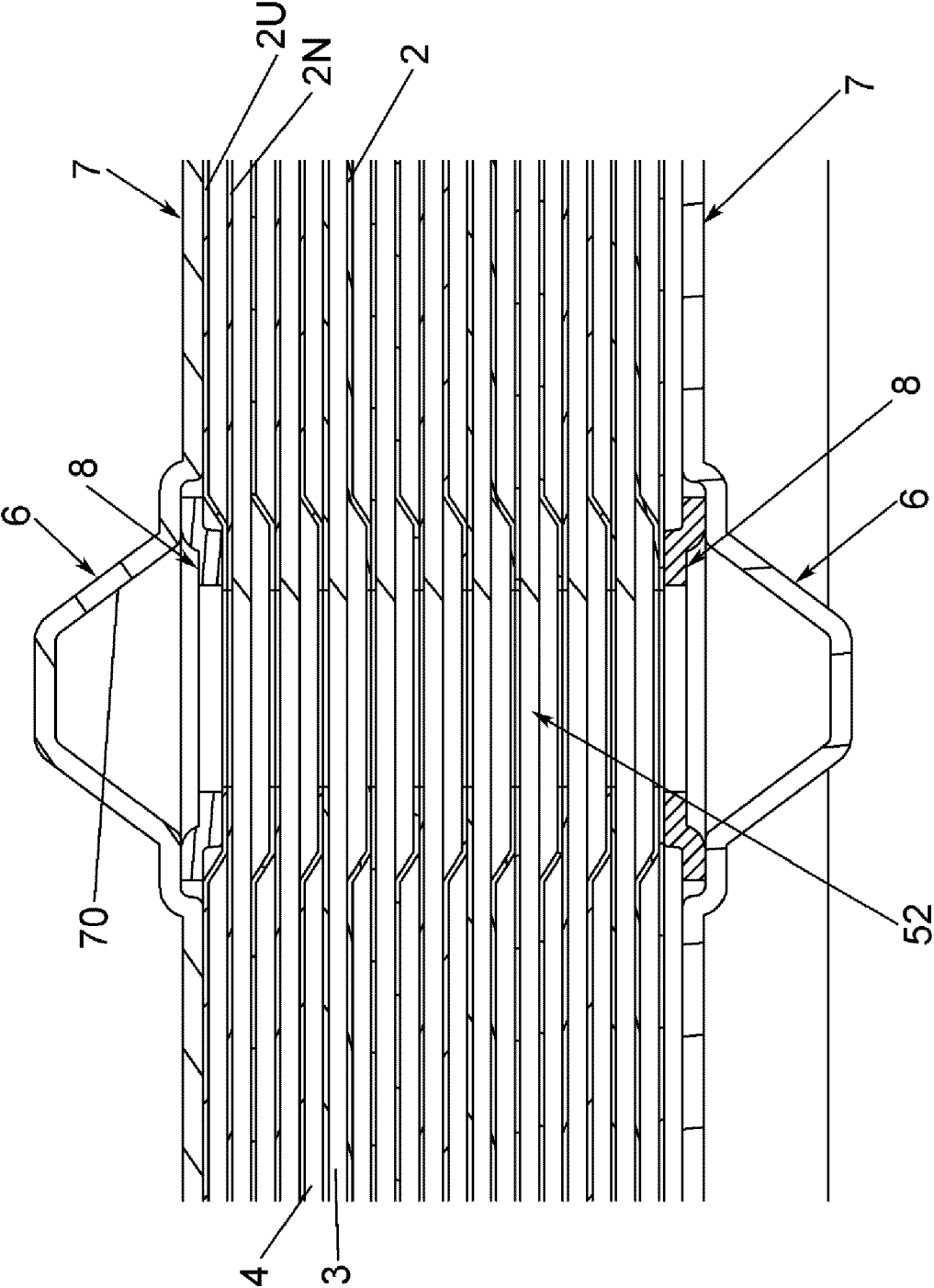


Fig.5

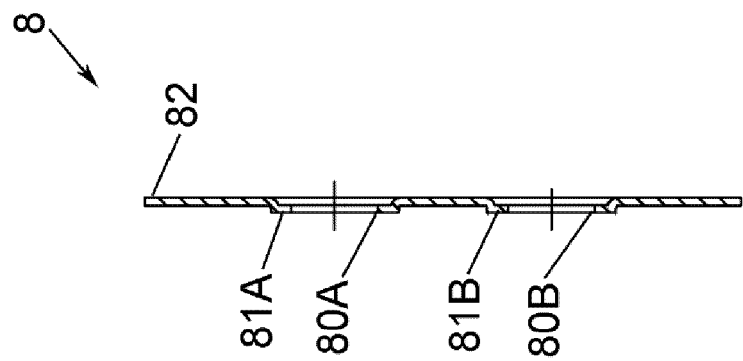


Fig. 6C

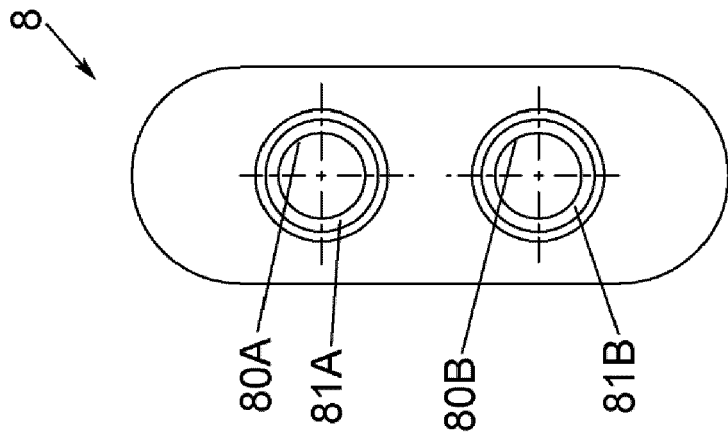


Fig. 6B

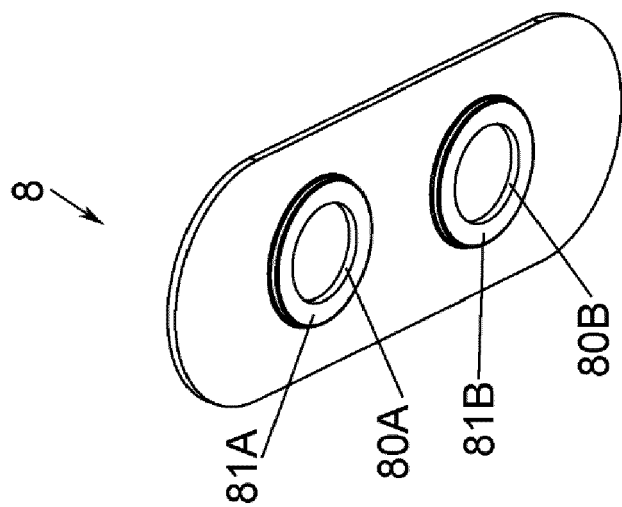


Fig. 6A

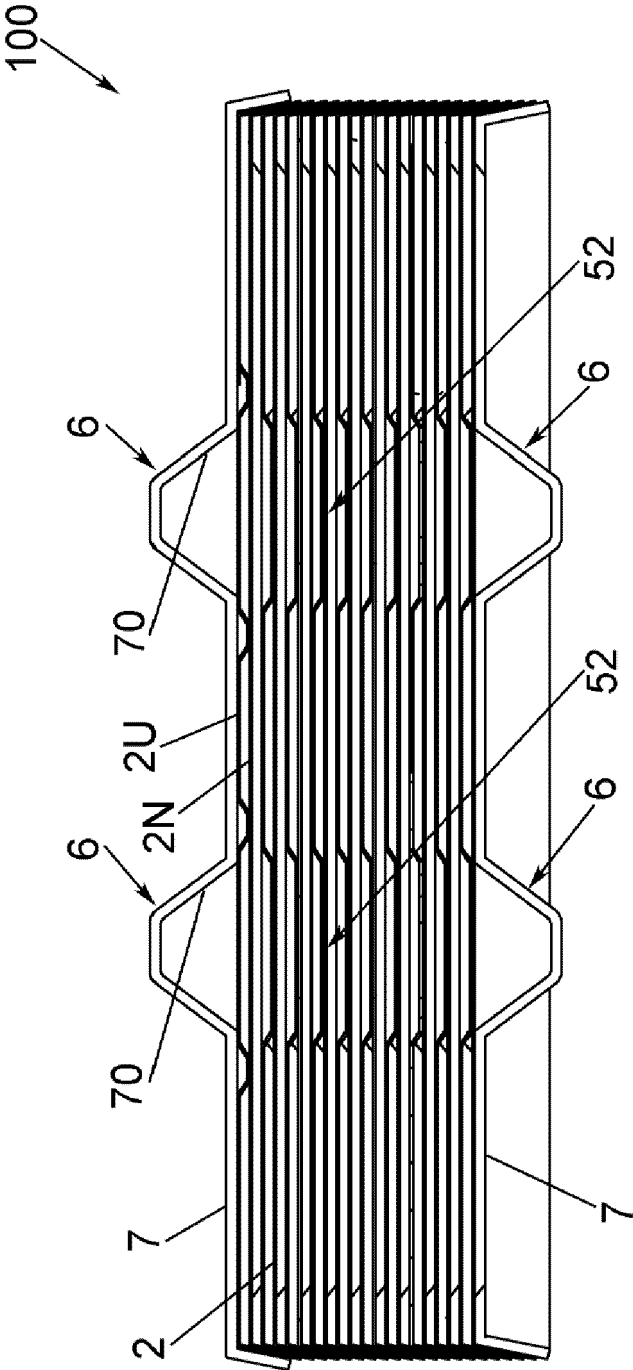


Fig. 7

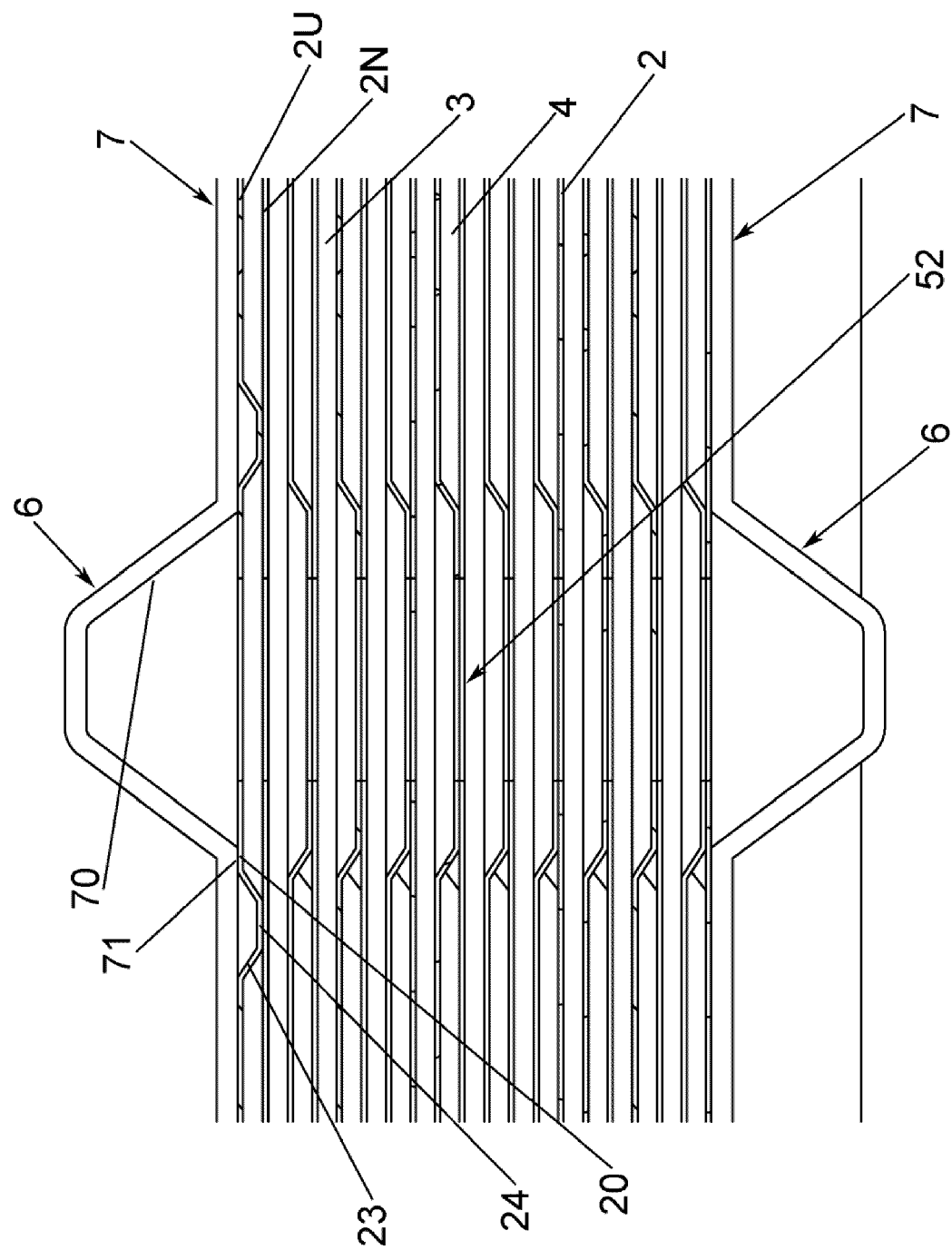


Fig.8

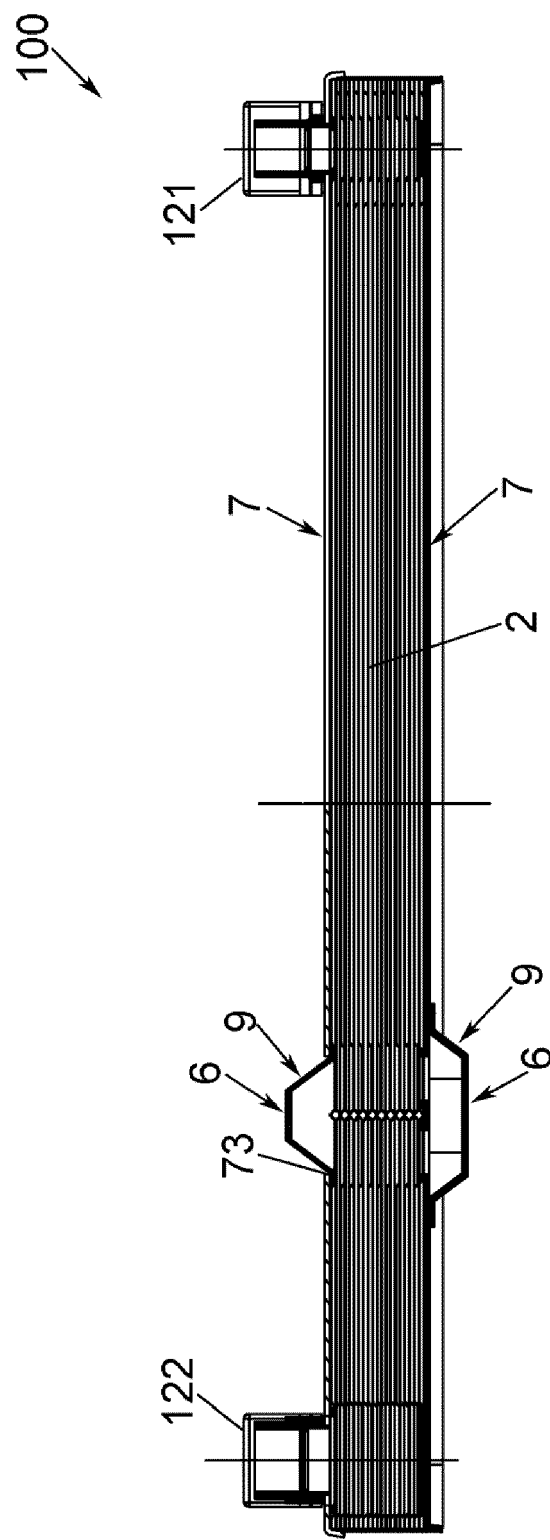


Fig.9

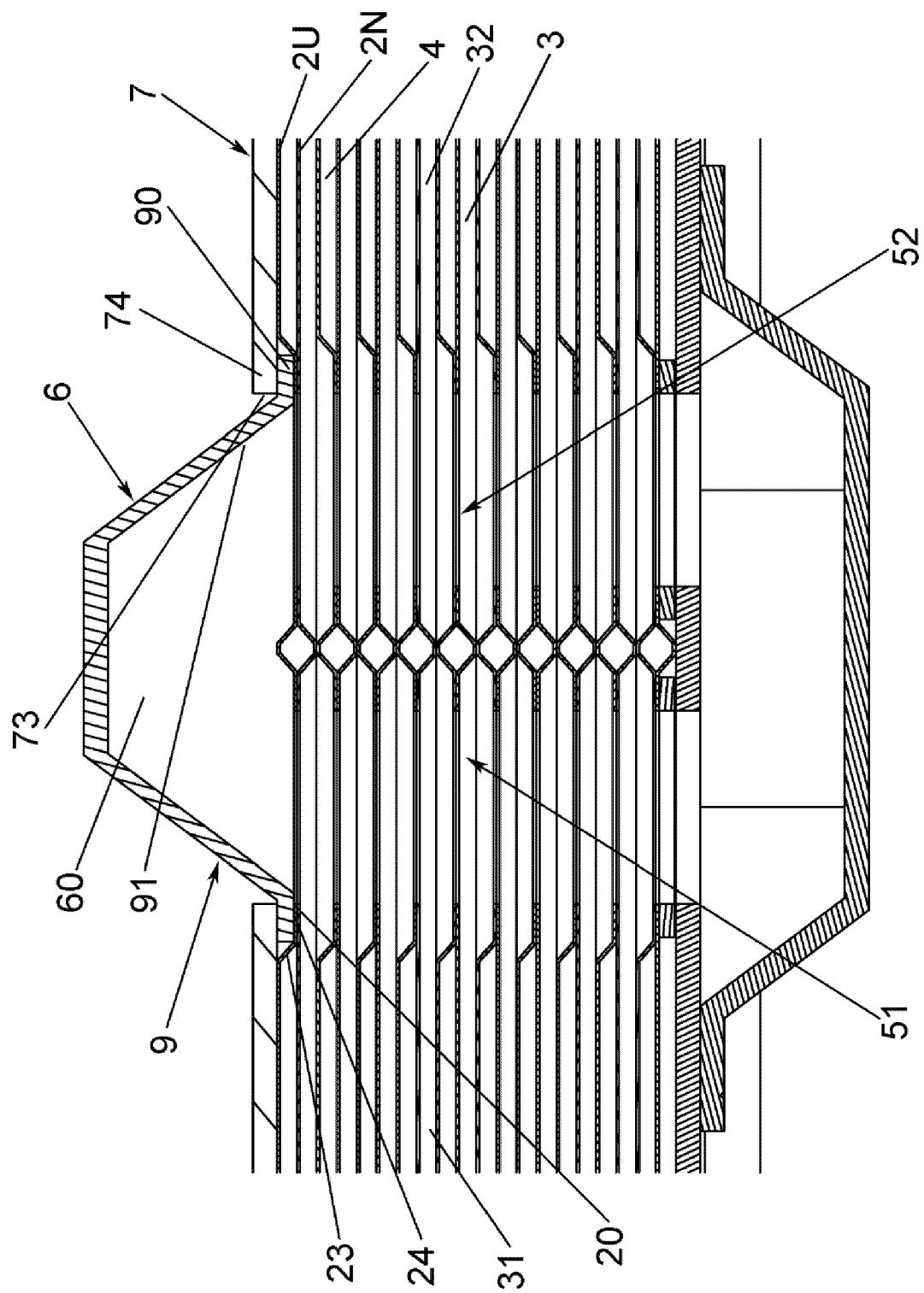


Fig.10

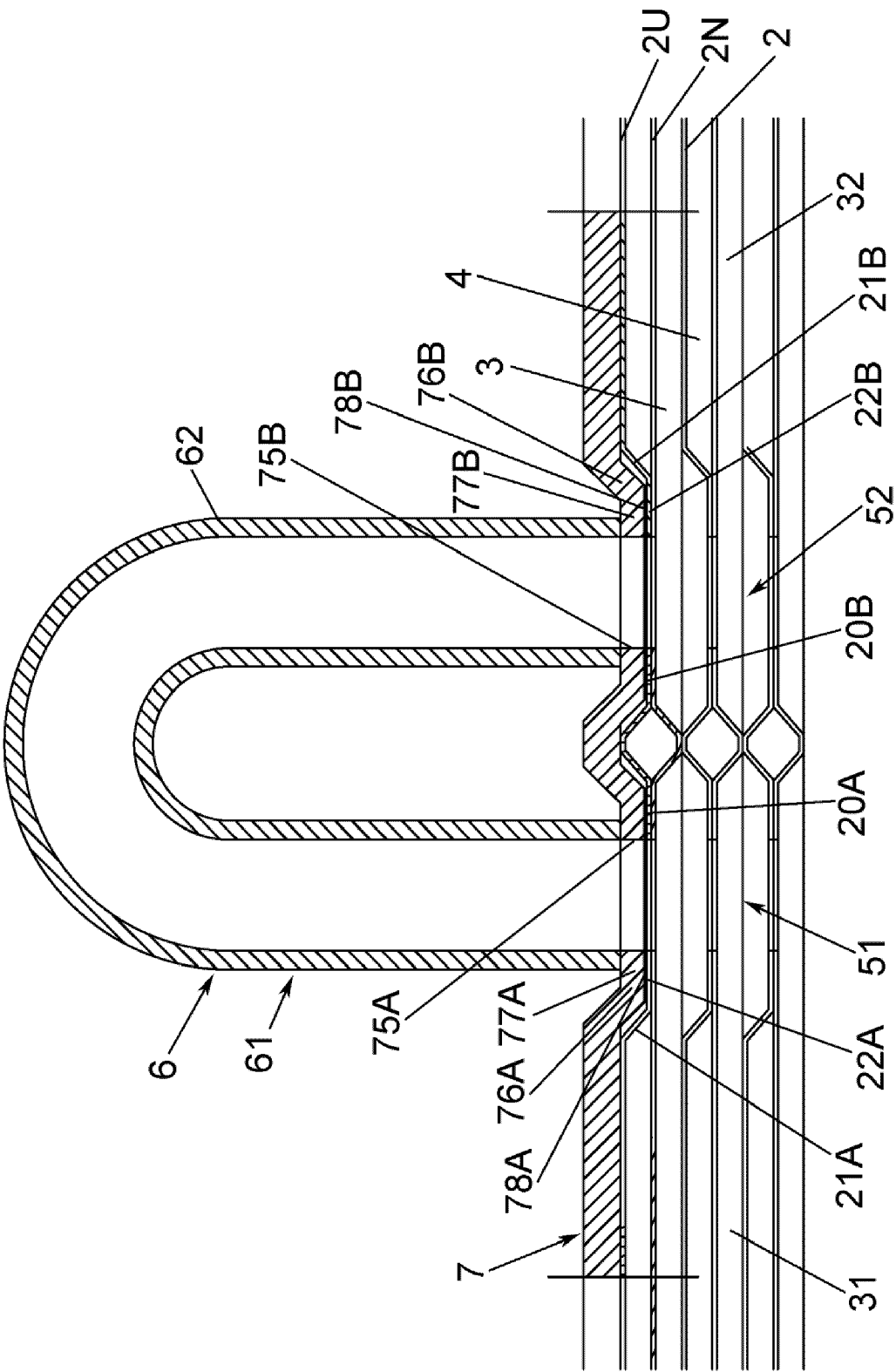


Fig.11

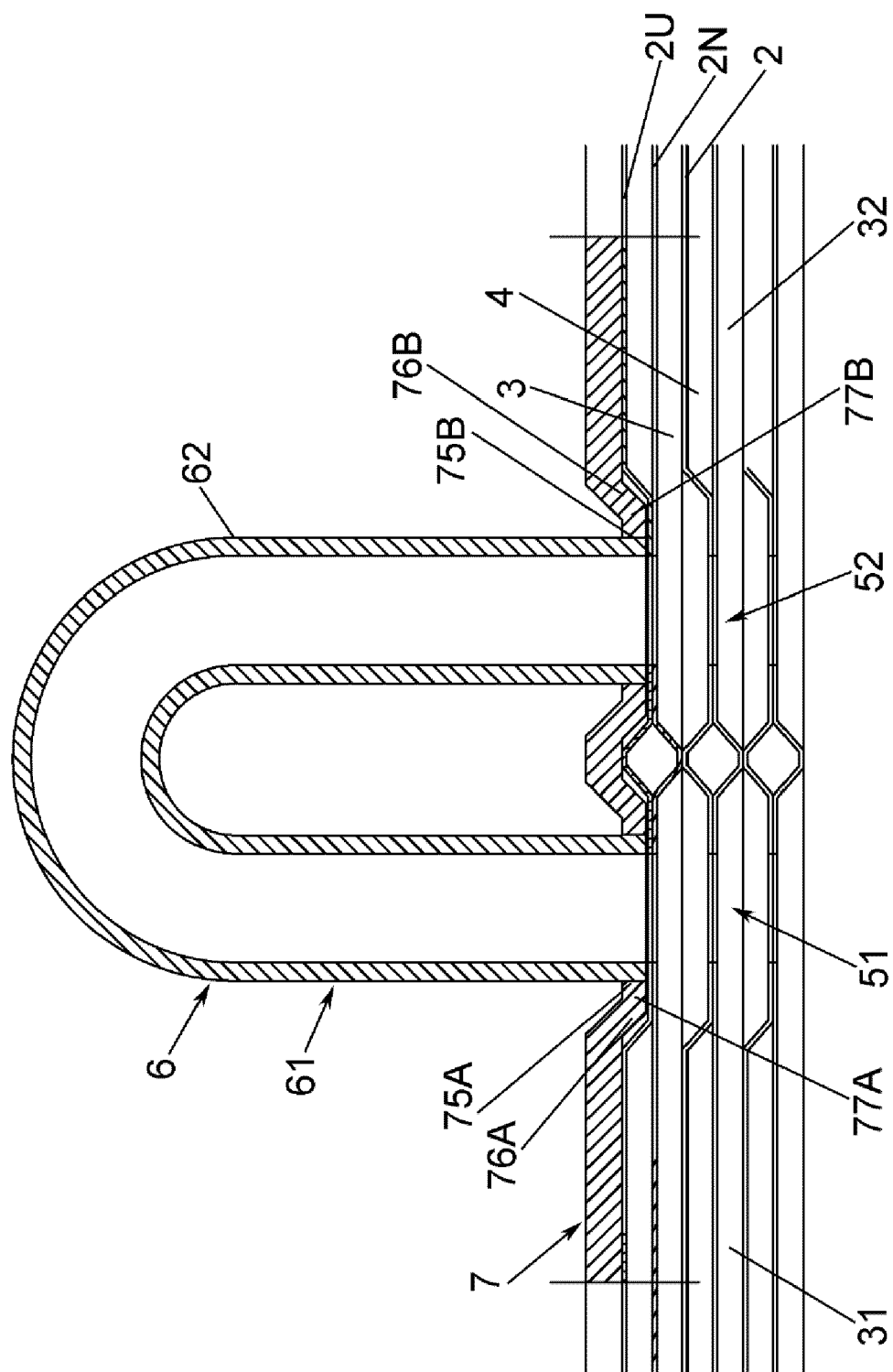


Fig.12

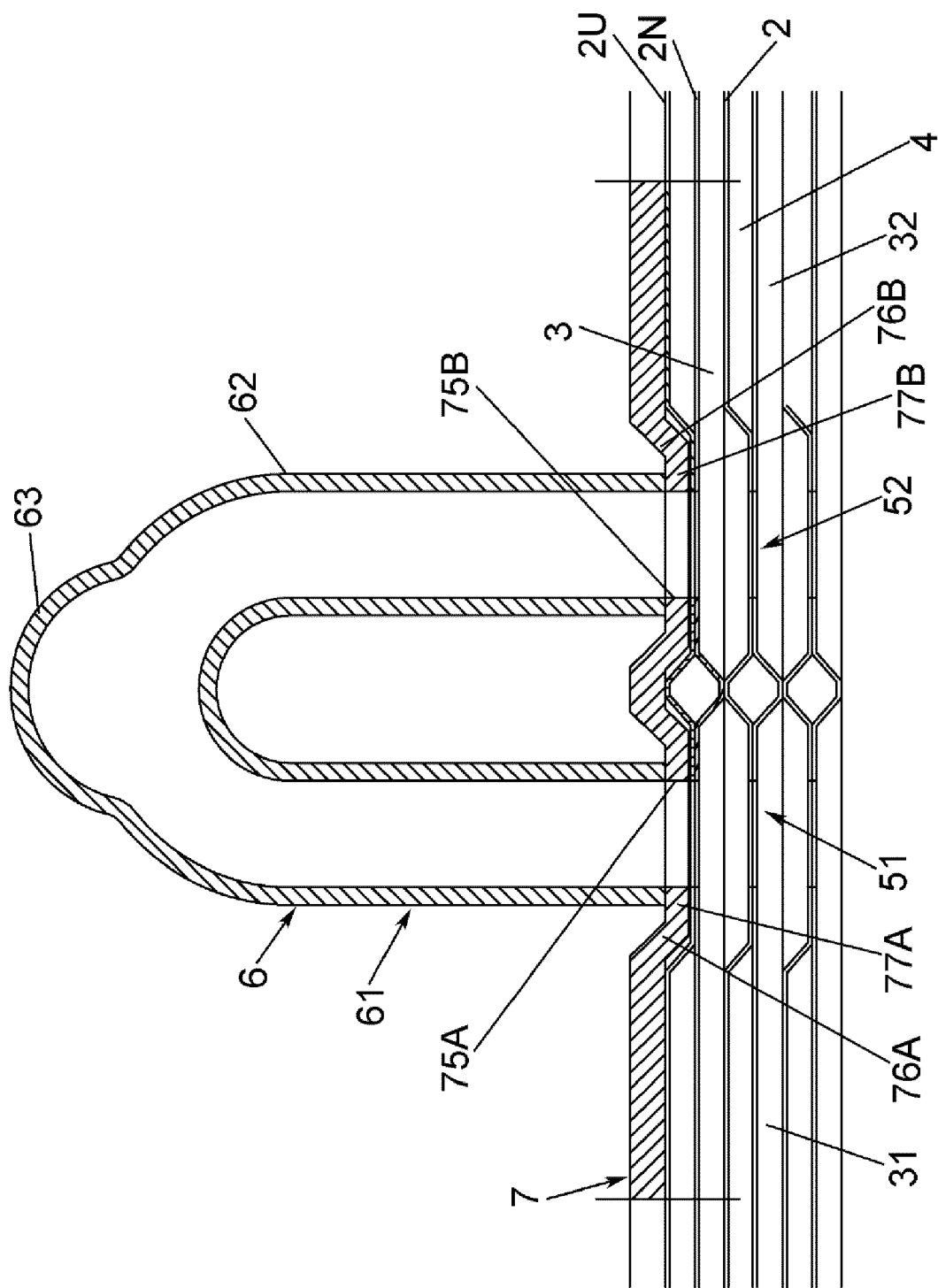


Fig.13

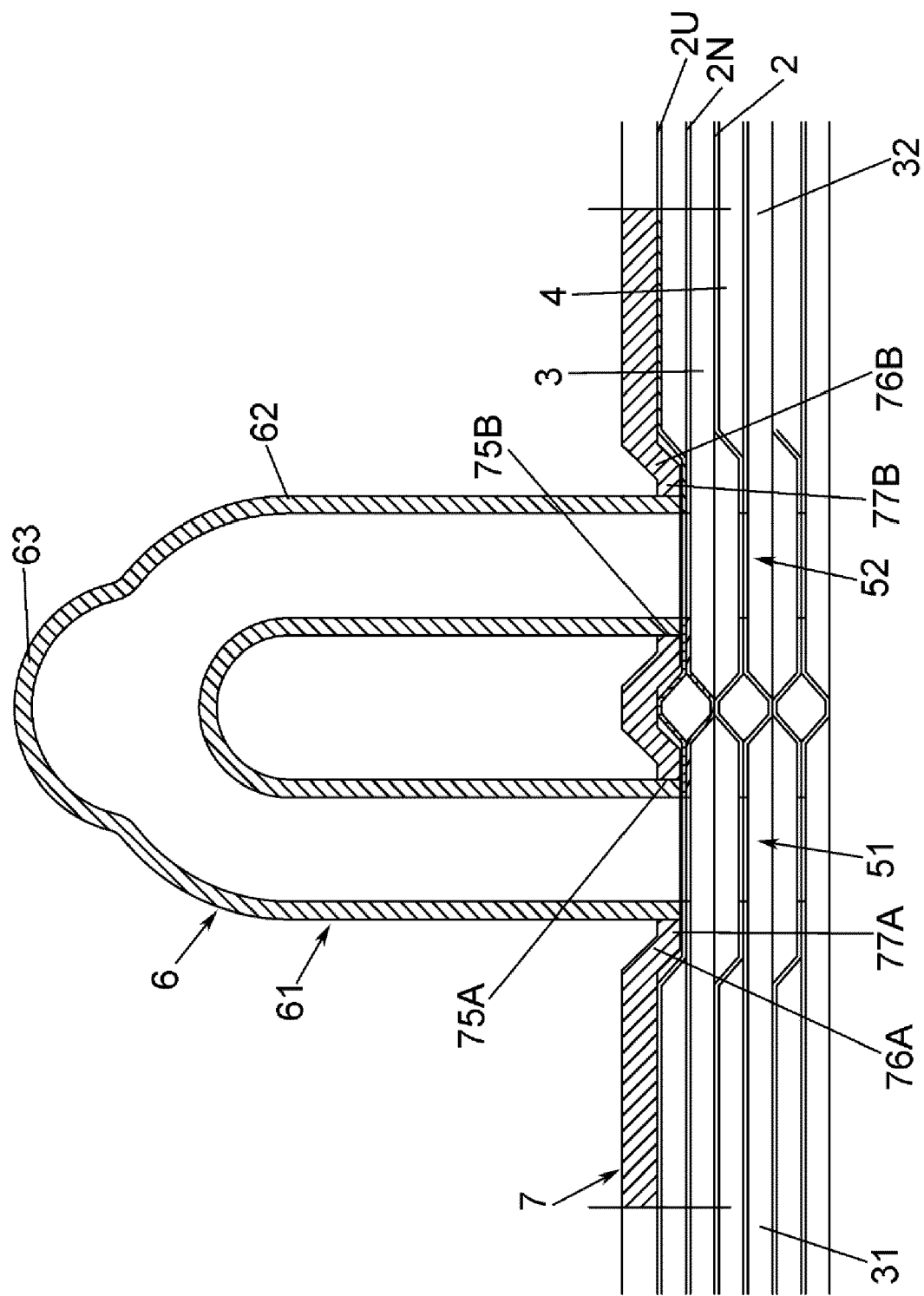


Fig.14



EUROPEAN SEARCH REPORT

Application Number

EP 24 18 7702

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A	KR 2022 0007536 A (HANON SYSTEMS [KR]) 18 January 2022 (2022-01-18) * figures 1-22 *	1	
			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
Munich		27 November 2024	Bloch, Gregor
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