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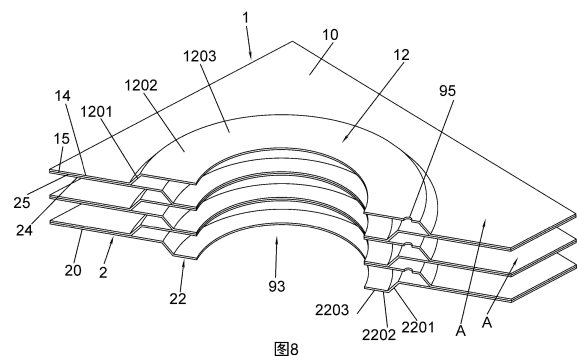
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(54) **PLATE HEAT EXCHANGER**

(57) Disclosed in the embodiments of the present application is a plate heat exchanger. The plate heat exchanger comprises heat exchange plates and a port, and the port communicates with a predetermined heat exchange space of a plurality of heat exchange spaces. The heat exchange plates of the plate heat exchanger comprise a plurality of first heat exchange plates and a plurality of second heat exchange plates. The first heat exchange plate comprises: a first heat exchange plate main body; a first opening formed in the first heat exchange plate main body for forming the port; and a first annular protrusion surrounding the first opening, adjoining the first opening and protruding from the first heat exchange plate main body toward a first side in a stacking direction. The second heat exchange plate comprises: a second heat exchange plate main body; a second opening formed in the second heat exchange plate main body for forming the port; and a second annular protrusion surrounding the second opening, adjoining the second opening and protruding from the second heat exchange plate main body toward a second side opposite the first side in the stacking direction. The plate heat exchanger according to the embodiments of the present invention can simplify the manufacturing process of the plate heat exchanger, for example.



EP 4 095 478 A1

Description

Cross-reference to Related Application

[0001] The present application claims the benefit of the Chinese Patent Application No. 202010073885.3 filed with the Patent Office of China on January 22, 2020, the entire disclosure of which is incorporated herein by reference.

Technical Field

[0002] The embodiments of the present invention relate to a plate heat exchanger.

Background

[0003] A plate heat exchanger comprises cover plates, heat exchange plates, ports, distributors, connecting pipes, etc.

Summary of the Invention

[0004] An objective of the embodiments of the present invention is to provide a plate heat exchanger, which can thus simplify the manufacturing process of the plate heat exchanger, for example.

[0005] According to an embodiment of the present invention, there is provided a plate heat exchanger comprising: a plurality of heat exchange plates, the plurality of heat exchange plates being arranged in a stacking direction to form a plurality of heat exchange spaces, and the plurality of heat exchange plates comprising a plurality of first heat exchange plates and a plurality of second heat exchange plates; and a port formed in the heat exchange plates, the port communicating with a predetermined heat exchange space of the plurality of heat exchange spaces, wherein the first heat exchange plate comprises: a first heat exchange plate main body; a first opening formed in the first heat exchange plate main body for forming the port; and a first annular protrusion surrounding the first opening, adjoining the first opening and protruding from the first heat exchange plate main body toward a first side in the stacking direction; and the second heat exchange plate comprises: a second heat exchange plate main body; a second opening formed in the second heat exchange plate main body for forming the port; and a second annular protrusion surrounding the second opening, adjoining the second opening and protruding from the second heat exchange plate main body toward a second side opposite to the first side in the stacking direction.

[0006] According to an embodiment of the present invention, the plate heat exchanger further comprises: a communicating hole formed in at least some of the first heat exchange plates and/or at least some of the second heat exchange plates, wherein the port communicates with the predetermined heat exchange space through

the communicating hole.

[0007] According to an embodiment of the present invention, the first annular protrusion of the first heat exchange plate comprises: an annular first portion extending from the first heat exchange plate main body toward the first side; and an annular second portion extending inwardly from the annular first portion, the second portion of the first annular protrusion having a surface facing the first side; the second annular protrusion of the second heat exchange plate comprises: an annular first portion extending from the second heat exchange plate main body toward the second side; and an annular second portion extending inwardly from the annular first portion of the second annular protrusion of the second heat exchange plate, the second portion of the second annular protrusion having a surface facing the second side; and the surface of the second portion of the first annular protrusion and the surface of the second portion of the second annular protrusion are in at least partial contact to form a seal over at least one part of a circumferential length of the surface of the second portion of the first annular protrusion and the surface of the second portion of the second annular protrusion.

[0008] According to an embodiment of the present invention, projections of the second portion of the first annular protrusion and the second portion of the second annular protrusion on a plane perpendicular to the stacking direction have an annular inner overlapping portion, and a projection of the communicating hole on the plane perpendicular to the stacking direction is outside the annular inner overlapping portion. According to an embodiment of the present invention, at least one part of the projection of the second portion of the first annular protrusion on the plane perpendicular to the stacking direction is outside the projection of the second portion of the second annular protrusion in the plane perpendicular to the stacking direction.

[0009] According to an embodiment of the present invention, the first heat exchange plate further comprises an annular portion surrounding the first annular protrusion, the annular portion of the first heat exchange plate has a surface facing the second side, the second heat exchange plate further comprises an annular portion surrounding the second annular protrusion, the annular portion of the second heat exchange plate has a surface facing the first side, and the surface of the annular portion of the first heat exchange plate and the surface of the annular portion of the second heat exchange plate adjacent to each other are in at least partial contact to form a seal.

[0010] According to an embodiment of the present invention, projections of the annular portion of the first heat exchange plate and the annular portion of the second heat exchange plate on the plane perpendicular to the stacking direction have an annular outer overlapping portion, and the projection of the communicating hole on the plane perpendicular to the stacking direction is inside the annular outer overlapping portion.

[0011] According to an embodiment of the present invention, at least one part of the projection of the annular portion of the second heat exchange plate on the plane perpendicular to the stacking direction is inside the projection of the annular portion of the first heat exchange plate in the plane perpendicular to the stacking direction.

[0012] According to an embodiment of the present invention, the communicating hole is in the annular second portions of the first annular protrusions of at least some of the first heat exchange plates and/or the communicating hole is in the annular portions of at least some of the second heat exchange plates.

[0013] According to an embodiment of the present invention, the first annular protrusion of the first heat exchange plate has a circular annular shape, the second annular protrusion of the second heat exchange plate has a circular annular shape, and an outer diameter of the first annular protrusion of the first heat exchange plate is larger than an outer diameter of the second annular protrusion of the second heat exchange plate.

[0014] According to an embodiment of the present invention, the annular portion of the first heat exchange plate has a circular annular shape, the annular portion of the second heat exchange plate has a circular annular shape, and an inner diameter of the annular portion of the second heat exchange plate is smaller than an inner diameter of the annular portion of the first heat exchange plate.

[0015] According to an embodiment of the present invention, the annular portion of the first heat exchange plate adjoins the first portion of the first annular protrusion of the first heat exchange plate, and the annular portion of the second heat exchange plate adjoins the first portion of the second annular protrusion of the second heat exchange plate.

[0016] According to an embodiment of the present invention, the first annular protrusion of the first heat exchange plate comprises an annular protrusion main body and a communicating protrusion extending outwardly from the annular protrusion main body; and at least one part of a projection of the communicating protrusion of the first annular protrusion on the plane perpendicular to the stacking direction is outside the projection of the second portion of the second annular projection on the plane perpendicular to the stacking direction, and the projection of the communicating hole on the plane perpendicular to the stacking direction is in the at least one part of the projection of the communicating protrusion of the first annular protrusion.

[0017] According to an embodiment of the present invention, the annular protrusion main body of the first annular protrusion of the first heat exchange plate has a circular annular shape, the second annular protrusion of the second heat exchange plate has a circular annular shape, and an outer diameter of the annular protrusion main body of the first annular protrusion of the first heat exchange plate is substantially equal to an outer diameter of the second annular protrusion of the second heat ex-

change plate; and the projection of the communicating protrusion of the first annular protrusion on the plane perpendicular to the stacking direction is outside the projection of the second portion of the second annular protrusion on the plane perpendicular to the stacking direction, and the projection of the communicating hole on the plane perpendicular to the stacking direction is in the projection of the communicating protrusion of the first annular protrusion.

[0018] According to an embodiment of the present invention, the communicating hole is a plurality of communicating holes, and the communicating protrusion is a plurality of spaced communicating protrusions.

[0019] According to an embodiment of the present invention, a surface of the second annular protrusion of the second heat exchange plate facing the second side has a second recessed portion, and the second recessed portion forms the communicating hole.

[0020] According to an embodiment of the present invention, the first annular protrusion of the first heat exchange plate has a circular annular shape, the second protrusion of the second heat exchange plate has a circular annular shape, and an outer diameter of the first annular protrusion of the first heat exchange plate is substantially equal to an outer diameter of the second annular protrusion of the second heat exchange plate.

[0021] According to an embodiment of the present invention, an annular first portion of the first annular protrusion of the first heat exchange plate extends obliquely from the first heat exchange plate main body toward the first side, and an annular second portion of the first annular protrusion of the first heat exchange plate extends inwardly from the annular first portion of the first annular protrusion of the first heat exchange plate substantially parallel to the first heat exchange plate main body; and an annular first portion of the second annular protrusion of the second heat exchange plate extends obliquely from the second heat exchange plate main body toward the second side, and an annular second portion of the second annular projection of the second heat exchange plate extends inwardly from the annular first portion of the second annular projection of the second heat exchange plate substantially parallel to the second heat exchange plate main body.

[0022] According to an embodiment of the present invention, the annular second portion of the first annular protrusion of the first heat exchange plate adjoins the first opening, and the annular second portion of the second annular projection of the second heat exchange plate adjoins the second opening.

[0023] According to an embodiment of the present invention, the plurality of first heat exchange plates and the plurality of second heat exchange plates are alternately arranged in the stacking direction.

[0024] According to an embodiment of the present invention, the communicating hole is formed in the first heat exchange plates and/or the second heat exchange plates.

[0025] The plate heat exchanger according to the embodiments of the present invention can simplify the manufacturing process of the plate heat exchanger, for example.

Brief Description of the Drawings

[0026]

Fig. 1 is a schematic top view of a port portion of a first heat exchange plate of a plate heat exchanger according to an embodiment of the present invention;

Fig. 2 is a schematic top view of a port portion of a second heat exchange plate of the plate heat exchanger according to the embodiment of the present invention;

Fig. 3 is a schematic perspective view of a port portion of the plate heat exchanger according to the embodiment of the present invention;

Fig. 4 is a schematic cross-sectional perspective view of the port portion of the plate heat exchanger according to the embodiment of the present invention;

Fig. 5 is a schematic top view of a port portion of a first heat exchange plate of a plate heat exchanger according to another embodiment of the present invention;

Fig. 6 is a schematic top view of a port portion of a second heat exchange plate of the plate heat exchanger according to the other embodiment of the present invention;

Fig. 7 is a schematic perspective view of a port portion of the plate heat exchanger according to the other embodiment of the present invention;

Fig. 8 is a schematic cross-sectional perspective view of the port portion of the plate heat exchanger according to the other embodiment of the present invention;

Fig. 9 is a schematic top view of a port portion of a first heat exchange plate of a plate heat exchanger according to yet another embodiment of the present invention;

Fig. 10 is a schematic top view of a port portion of a second heat exchange plate of the plate heat exchanger according to the yet another embodiment of the present invention;

Fig. 11 is a schematic perspective view of a port portion of the plate heat exchanger according to the yet another embodiment of the present invention;

Fig. 12 is a schematic cross-sectional perspective view of the port portion of the plate heat exchanger according to the yet another embodiment of the present invention;

Fig. 13 is a schematic perspective view of a plate heat exchanger according to an embodiment of the present invention;

Fig. 14 is a schematic cross-sectional view of a port

portion of the plate heat exchanger according to the embodiment of the present invention;

Fig. 15 is a schematic enlarged cross-sectional view of the port portion of the plate heat exchanger shown in Fig. 14;

Fig. 16 is a schematic perspective view of a plate heat exchanger according to another embodiment of the present invention; and

Fig. 17 is a schematic cross-sectional view of a port portion of the plate heat exchanger according to the other embodiment of the present invention.

Detailed Description of the Invention

[0027] The present invention is explained further below in conjunction with the accompanying drawing and specific implementations.

[0028] Referring to Figs. 1 to 17, a plate heat exchanger 100 according to an embodiment of the present invention comprises a plurality of heat exchange plates 1, 2, 3, 4 (Fig. 17) and a port 93 formed in the heat exchange plates 1, 2, 3, 4. The plurality of heat exchange plates 1, 2, 3, 4 are arranged in a stacking direction to form a plurality of heat exchange spaces A, B and C (Fig. 17), the plurality of heat exchange plates 1, 2, 3, 4 comprising a plurality of first heat exchange plates 1 and a plurality of second heat exchange plates 2; and the port 93 communicates with a predetermined heat exchange space A of the plurality of heat exchange spaces A, B and C to distribute a heat exchange medium for the predetermined heat exchange space A. In the embodiments shown in Figs. 1 to 15, the plurality of first heat exchange plates 1 and the plurality of second heat exchange plates 2 are alternately arranged in the stacking direction to form alternately arranged first heat exchange spaces A and second heat exchange spaces B. In the embodiments shown in Figs. 16 and 17, the plurality of heat exchange plates 1, 2, 3, 4 comprise a plurality of first heat exchange plates 1, a plurality of second heat exchange plates 2, a plurality of third heat exchange plates 3 and a plurality of fourth heat exchange plates 4, and the first heat exchange plate 1, the second heat exchange plate 2, the third heat exchange plate 3 and the fourth heat exchange plate 4 constitute one repeating unit. The plate heat exchanger 100 comprises a plurality of repeating units. The plurality of heat exchange spaces A, B and C comprise a first heat exchange space A, a second heat exchange space B and a third heat exchange space C which are separated from each other. The first heat exchange plate 1 comprises: a first heat exchange plate main body 10; a first opening 11 formed in the first heat exchange plate main body 10 for forming the port 93; and a first annular protrusion 12 surrounding the first opening 11, adjoining the first opening 11 and protruding from the first heat exchange plate main body 10 toward a first side in the stacking direction. The second heat exchange plate 2 comprises: a second heat exchange plate main body 20; a second opening 21 formed in the second heat exchange

plate main body 20 for forming the port 93; and a second annular protrusion 22 surrounding the second opening 21, adjoining the second opening 21 and protruding from the second heat exchange plate main body 20 toward a second side opposite to the first side in the stacking direction. The sum of heights of the first annular protrusion 12 and the second annular protrusion 22 is equal to a height of the heat exchange space. For example, the heights of the first annular protrusion 12 and the second annular protrusion 22 are equal to half of the height of the heat exchange space.

[0029] In some embodiments of the present invention, with reference to Figs. 13 and 14, in addition to the port 93 serving as a first heat exchange medium inlet port, the plate heat exchanger 100 further comprises a first heat exchange medium outlet 93A, a second heat exchange medium inlet 93B, and a second heat exchange medium outlet 93C.

[0030] In other embodiments of the present invention, with reference to Figs. 16 and 17, in addition to the port 93 serving as the first heat exchange medium inlet port, the plate heat exchanger 100 further comprises a first heat exchange medium outlet 93A, a second heat exchange medium inlet 93B, a second heat exchange medium outlet 93C, a third heat exchange medium inlet 93D, and a third heat exchange medium outlet 93E. The plurality of heat exchange plates 1, 2, 3, 4 comprise a plurality of first heat exchange plates 1, a plurality of second heat exchange plates 2, a plurality of third heat exchange plates 3 and a plurality of fourth heat exchange plates 4, and the first heat exchange plate 1, the second heat exchange plate 2, the third heat exchange plate 3 and the fourth heat exchange plate 4 constitute one repeating unit. The plate heat exchanger 100 may form three loops. The first heat exchange space A, the second heat exchange space B and the third heat exchange space C are separated from each other. A first heat exchange medium may be a refrigerant, a second heat exchange medium may be water, and a third heat exchange medium may be a refrigerant. The first heat exchange plate 1 and the third heat exchange plate 3 may be the same in the port portion except that one of them has a communicating hole 95 and the other does not have the communicating hole 95. The second heat exchange plate 2 and the fourth heat exchange plate 4 may be the same in the port portion. If the communicating hole 95 is formed in one of the second heat exchange plate 2 and the fourth heat exchange plate 4, the first heat exchange plate 1 and the third heat exchange plate 3 may be the same at the port portion. The first heat exchange plate 1 and the third heat exchange plate 3 may be the same or different in the heat exchange portion, and the second heat exchange plate 2 and the fourth heat exchange plate 4 may be the same or different in the heat exchange portion. The third heat exchange plate 3 may be considered as the first heat exchange plate 1, but has a heat exchange portion that is the same as or different from that of the first heat exchange plate 1, and may or may not have

communicating hole 95, regardless of whether the first heat exchange plate 1 has the communicating hole 95 or not. The fourth heat exchange plate 4 may be considered as the second heat exchange plate 2, but has a heat exchange portion that is the same as or different from that of the second heat exchange plate 2, and may or may not have the communicating hole 95, regardless of whether the second heat exchange plate 2 has the communicating hole 95 or not. The port portion comprises annular portions 14, 24 and portions inside the annular portions 14, 24, and the heat exchange portion is a portion where the heat exchange space is located, and is outside the annular portions 14, 24.

[0031] In some embodiments of the present invention, with reference to Figs. 1, 3, 4, 5, 7, 8, 11, 12, 14, 15 and 17, the first annular protrusion 12 of the first heat exchange plate 1 comprises: an annular first portion 1201 extending from the first heat exchange plate main body 10 toward the first side; and an annular second portion 1202 extending inwardly from the annular first portion 1201, the second portion 1202 of the first annular protrusion 12 having a surface 1203 facing the first side. The second annular protrusion 22 of the second heat exchange plate 2 comprises: an annular first portion 2201 extending from the second heat exchange plate main body 20 toward the second side; and an annular second portion 2202 extending inwardly from the annular first portion 2201 of the second annular protrusion 22 of the second heat exchange plate 2, the second portion 2202 of the second annular protrusion 22 having a surface 2203 facing the second side. The surface 1203 of the second portion 1202 of the first annular protrusion 12 and the surface 2203 of the second portion 2202 of the second annular protrusion 22 adjacent to each other are in at least partial contact to form a seal over at least one part of a circumferential length of the surface 1203 of the second portion 1202 of the first annular protrusion 12 and the surface 2203 of the second portion 2202 of the second annular protrusion 22. Thus, a heat exchange medium from the port 93 does not flow into a predetermined heat exchange space A between the entire surface 1203 of the second portion 1202 of the first annular protrusion 12 and the surface 2203 of the second portion 2202 of the second annular protrusion 22, but only flows into the predetermined heat exchange space A through the communicating hole 95.

[0032] Referring to Figs. 1, 3, 4, 5, 7, 8, 11, 12, 14, 15 and 17, according to an example of the present invention, the annular first portion 1201 of the first annular protrusion 12 of the first heat exchange plate 1 extends obliquely from the first heat exchange plate main body 10 toward the first side, and the annular second portion 1202 of the first annular protrusion 12 of the first heat exchange plate 1 extends inwardly from the annular first portion 1201 of the first annular protrusion 12 of the first heat exchange plate 1 substantially parallel to the first heat exchange plate main body 10. The annular first portion 2201 of the second annular protrusion 22 of the second

heat exchange plate 2 extends obliquely from the second heat exchange plate main body 20 toward the second side, and the annular second portion 2202 of the second annular projection 22 of the second heat exchange plate 2 extends inwardly from the annular first portion 2201 of the second annular projection 22 of the second heat exchange plate 2 substantially parallel to the second heat exchange plate main body 20. For example, the annular second portion 1202 of the first annular protrusion 12 of the first heat exchange plate 1 adjoins the first opening 11, and the annular second portion 2022 of the second annular protrusion 22 of the second heat exchange plate 2 adjoins the second opening 21.

[0033] In some embodiments of the present invention, with reference to Figs. 1, 3, 4, 5, 7, 8, 11, 12, 14, 15 and 17, the first heat exchange plate 1 further comprises an annular portion 14 surrounding the first annular protrusion 12, the annular portion 14 of the first heat exchange plate 1 has a surface 15 facing the second side, the second heat exchange plate 2 further comprises an annular portion 24 surrounding the second annular protrusion 22, the annular portion 24 of the second heat exchange plate 2 has a surface 25 facing the first side, and the surface 15 of the annular portion 14 of the first heat exchange plate 1 and the surface 25 of the annular portion 24 of the second heat exchange plate 2 adjacent to each other are in at least partial contact to form a seal. Thus, the heat exchange medium from the port 93 does not flow into other heat exchange spaces B and C other than the predetermined heat exchange space A.

[0034] In some embodiments of the present invention, with reference to Figs. 1, 3, 4, 5, 7, 8, 11, 12, 15 and 17, the plate heat exchanger further comprises a communicating hole 95 formed in at least some of the first heat exchange plates 1 and/or at least some of the second heat exchange plates 2, wherein the port 93 communicates with the predetermined heat exchange space A through the communicating hole 95. The communicating hole 95 may have any suitable shape, such as a circular shape, a semi-circular shape, an oval shape, a quadrangular shape or the like.

[0035] In some embodiments of the present invention, with reference to Figs. 4, 8, 14, 15 and 17, projections of the second portion 1202 of the first annular protrusion 12 and the second portion 2202 of the second annular protrusion 22 on a plane perpendicular to the stacking direction have an annular inner overlapping portion (e.g., a radially inner overlapping portion), and a projection of the communicating hole 95 on the plane perpendicular to the stacking direction is outside (e.g., radially outside) the annular inner overlapping portion. For example, at least one part of the projection of the second portion 1202 of the first annular protrusion 12 on the plane perpendicular to the stacking direction is outside (e.g., radially outside) the projection of the second portion 2202 of the second annular protrusion 22 on the plane perpendicular to the stacking direction.

[0036] In some embodiments of the present invention,

referring to Figs. 4, 8, 14 and 16, projections of the annular portion 14 of the first heat exchange plate 1 and the annular portion 24 of the second heat exchange plate 2 on the plane perpendicular to the stacking direction have an annular outer overlapping portion (e.g., a radially outer overlapping portion), and the projection of the communicating hole 95 on the plane perpendicular to the stacking direction is inside (e.g., radially inside) the annular outer overlapping portion. For example, at least one part of the projection of the annular portion 24 of the second heat exchange plate 2 on the plane perpendicular to the stacking direction is inside (e.g., radially inside) the projection of the annular portion 14 of the first heat exchange plate 1 on the plane perpendicular to the stacking direction. For example, the annular portion 14 of the first heat exchange plate 1 has a circular annular shape, the annular portion 24 of the second heat exchange plate 2 has a circular annular shape, and an inner diameter of the annular portion 24 of the second heat exchange plate 2 is smaller than an inner diameter of the annular portion 14 of the first heat exchange plate 1. The annular portion 14 of the first heat exchange plate 1 may adjoin the first portion 1201 of the first annular protrusion 12 of the first heat exchange plate 1, and the annular portion 24 of the second heat exchange plate 2 may adjoin the first portion 2201 of the second annular protrusion 22 of the second heat exchange plate 2.

[0037] In some embodiments of the present invention, with reference to Figs. 4, 8, 14, 15 and 17, the communicating hole 95 is in the annular second portions 1202 of the first annular protrusions 12 of at least some of the first heat exchange plates 1 and/or the communicating hole 95 is in the annular portions 24 of at least some of the second heat exchange plates 2. Thus, it is easy to machine the communicating hole 95 with high accuracy, and it is not easily blocked. For example, in the embodiment shown in Fig. 14, the communicating hole 95 is formed in the first heat exchange plate 1 and/or the second heat exchange plate 2.

[0038] In some embodiments of the present invention, with reference to Figs. 4, 8, 14, 15 and 17, the communicating hole 95 is in the annular first portions 1201 of the first annular protrusions 12 of at least some of the first heat exchange plates 1 and/or the communicating hole 95 is in the annular first portions 2201 of at least some of the second heat exchange plates 2. Thus, the first annular protrusion 12 and the second annular protrusion 22 may have the same shape and the same size.

[0039] Although it is shown in Figs. 1, 3, 4, 5, 7 and 8 that the communicating hole 95 is formed in the first heat exchange plate 1, the communicating hole 95 may be formed in the second heat exchange plate 2, or the communicating hole 95 may be formed in each of the first heat exchange plate 1 and the second heat exchange plate 2. In addition, although it is shown in Figs. 1, 3, 4, 5, 7 and 8 that one communicating hole 95 is formed in the first heat exchange plate 1, but a plurality of communicating holes 95 may be formed in the first heat ex-

change plate 1, a plurality of communicating holes 95 are formed in the second heat exchange plate 2, or a plurality of communicating holes 95 are formed in each of the first heat exchange plate 1 and the second heat exchange plate 2.

[0040] In some embodiments of the present invention, referring to Fig. 8, the first annular protrusion 12 of the first heat exchange plate 1 has a circular annular shape, the second annular protrusion 22 of the second heat exchange plate 2 has a circular annular shape, and an outer diameter of the first annular protrusion 12 of the first heat exchange plate 1 is larger than an outer diameter of the second annular protrusion 22 of the second heat exchange plate 2. When viewed in the stacking direction, the first annular protrusion 12 of the first heat exchange plate 1 and the second annular protrusion 22 of the second heat exchange plate 2 may be substantially concentric.

[0041] In some embodiments of the present invention, referring to Fig. 4, the first annular protrusion 12 of the first heat exchange plate 1 comprises an annular protrusion main body 120 and a communicating protrusion 121 extending outwardly (e.g., radially outwardly in a direction away from the center of the annular protrusion main body 120) from the annular protrusion main body 120, and at least one part of a projection of the communicating protrusion 121 of the first annular protrusion 12 on the plane perpendicular to the stacking direction is outside (e.g., radially outside) the projection of the second portion 2202 of the second annular projection 22 on the plane perpendicular to the stacking direction, and the projection of the communicating hole 95 on the plane perpendicular to the stacking direction is in the at least one part of the projection of the communicating protrusion 121 of the first annular protrusion 12. Although it is shown in Figs. 1, 3 and 4 that the communicating hole 95 is formed in the communicating protrusion 121 of the first heat exchange plate 1, the communicating hole 95 may be formed in the second heat exchange plate 2, or the communicating hole 95 may be formed in each of the communicating protrusion 121 of the first heat exchange plate 1 and the second heat exchange plate 2. In addition, although it is shown in Figs. 1, 3 and 4 that one communicating hole 95 is formed in the communicating protrusion 121 of the first heat exchange plate 1, a plurality of communicating protrusions 121 may also be provided. Thus, a plurality of communicating holes 95 are formed in the plurality of communicating protrusions 121 of the first heat exchange plate 1, respectively, or a plurality of communicating holes 95 are formed in the second heat exchange plate 2, or a plurality of communicating holes 95 are formed in each of the plurality of communicating protrusions 121 of the first heat exchange plate 1 and the second heat exchange plate 2.

[0042] In some embodiments of the present invention, with reference to Figs. 1 to 4, the annular protrusion main body 120 of the first annular protrusion 12 of the first heat exchange plate 1 has a circular annular shape, the sec-

ond annular protrusion 22 of the second heat exchange plate 2 has a circular annular shape, and an outer diameter of the annular protrusion main body 120 of the first annular protrusion 12 of the first heat exchange plate 1 is substantially equal to an outer diameter of the second annular protrusion 22 of the second heat exchange plate 2. Moreover, the projection of the communicating protrusion 121 of the first annular protrusion 12 on the plane perpendicular to the stacking direction is outside (e.g., radially outside) the projection of the second portion 2202 of the second annular protrusion 22 on the plane perpendicular to the stacking direction, and the projection of the communicating hole 95 on the plane perpendicular to the stacking direction is in the projection of the communicating protrusion 121 of the first annular protrusion 12.

[0043] In some embodiments of the present invention, with reference to Figs. 1 to 4, the communicating hole 95 is a plurality of communicating holes 95, and the communicating protrusion 121 is a plurality of spaced communicating protrusions 121.

[0044] In some embodiments of the present invention, with reference to Figs. 11 and 12, a surface 2203 of the second annular protrusion 22 of the second heat exchange plate 2 facing the second side has a recessed portion 2206, which forms a communicating hole 95. Thus, it is only necessary to machine a recessed portion on one side of the second heat exchange plate 2, which is convenient for machining with high accuracy. Optionally, the surface 1203 of the first annular protrusion 12 of the first heat exchange plate 1 facing the first side has a recessed portion, which forms the communicating hole 95. Alternatively, the surface 1203 of the first annular protrusion 12 of the first heat exchange plate 1 facing the first side has a recessed portion, the surface 2203 of the second annular protrusion 22 of the second heat exchange plate 2 facing the second side has a recessed portion 2206, and the recessed portion of the surface 1203 of the first annular protrusion 12 of the first heat exchange plate 1 facing the first side and the recessed portion 2206 of the surface 2203 of the second annular protrusion 22 of the second heat exchange plate 2 facing the second side are aligned in the stacking direction to form a communicating hole 95, or are misaligned to form communicating holes 95, respectively. According to an example of the present invention, an insert with a hole may be placed in the recessed portion to ensure the accuracy of the communicating hole. For example, the first annular protrusion 12 of the first heat exchange plate 1 has a circular annular shape, the second protrusion of the second heat exchange plate 2 has a circular annular shape, and an outer diameter of the first annular protrusion 12 of the first heat exchange plate 1 is substantially equal to an outer diameter of the second annular protrusion 22 of the second heat exchange plate 2.

[0045] The concepts according to the embodiments of the present invention can be applied to any plate heat exchanger, not limited to the heat exchangers shown in the figures. That is, the port portion of the heat exchange

plate of the plate heat exchanger according to the embodiments of the present invention can be applied to any plate heat exchanger.

[0046] The plate heat exchanger according to the embodiments of the present invention can simplify the manufacturing process of the plate heat exchanger, for example. A separate distributor may be omitted for the plate heat exchanger. In addition, the use of the plate heat exchanger according to the embodiments of the present invention can reduce the cost.

[0047] According to the plate heat exchanger of the embodiments of the present invention, an integrated distributor is formed on the heat exchange plate by means of stamping.

[0048] It must be explained that features in one or more of the embodiments above may be combined to form new embodiments. A feature in one embodiment may be used in another embodiment, unless the feature in one embodiment clashes with the technical solution of the other embodiment.

Claims

1. A plate heat exchanger, comprising:

a plurality of heat exchange plates, the plurality of heat exchange plates being arranged in a stacking direction to form a plurality of heat exchange spaces, and the plurality of heat exchange plates comprising a plurality of first heat exchange plates and a plurality of second heat exchange plates; and

a port formed in the heat exchange plates, the port communicating with a predetermined heat exchange space of the plurality of heat exchange spaces, wherein

the first heat exchange plate comprises: a first heat exchange plate main body; a first opening formed in the first heat exchange plate main body for forming the port; and a first annular protrusion surrounding the first opening, adjoining the first opening and protruding from the first heat exchange plate main body toward a first side in the stacking direction; and

the second heat exchange plate comprises: a second heat exchange plate main body; a second opening formed in the second heat exchange plate main body for forming the port; and a second annular protrusion surrounding the second opening, adjoining the second opening and protruding from the second heat exchange plate main body toward a second side opposite to the first side in the stacking direction.

2. The plate heat exchanger as claimed in claim 1, further comprising:

a communicating hole formed in at least some of the

first heat exchange plates and/or at least some of the second heat exchange plates, wherein the port communicates with the predetermined heat exchange space through the communicating hole.

3. The plate heat exchanger as claimed in claim 2, wherein:

the first annular protrusion of the first heat exchange plate comprises: an annular first portion extending from the first heat exchange plate main body toward the first side; and an annular second portion extending inwardly from the annular first portion, the second portion of the first annular protrusion having a surface facing the first side;

the second annular protrusion of the second heat exchange plate comprises: an annular first portion extending from the second heat exchange plate main body toward the second side; and an annular second portion extending inwardly from the annular first portion of the second annular protrusion of the second heat exchange plate, the second portion of the second annular protrusion having a surface facing the second side; and

the surface of the second portion of the first annular protrusion and the surface of the second portion of the second annular protrusion adjacent to each other are in at least partial contact to form a seal over at least one part of a circumferential length of the surface of the second portion of the first annular protrusion and the surface of the second portion of the second annular protrusion.

4. The plate heat exchanger as claimed in claim 3, wherein:

projections of the second portion of the first annular protrusion and the second portion of the second annular protrusion on a plane perpendicular to the stacking direction have an annular inner overlapping portion, and

a projection of the communicating hole on the plane perpendicular to the stacking direction is outside the annular inner overlapping portion.

5. The plate heat exchanger as claimed in claim 4, wherein:

at least one part of the projection of the second portion of the first annular protrusion on the plane perpendicular to the stacking direction is outside the projection of the second portion of the second annular protrusion in the plane perpendicular to the stacking direction.

6. The plate heat exchanger as claimed in claim 4,

wherein:

the first heat exchange plate further comprises an annular portion surrounding the first annular protrusion, the annular portion of the first heat exchange plate has a surface facing the second side, the second heat exchange plate further comprises an annular portion surrounding the second annular protrusion, the annular portion of the second heat exchange plate has a surface facing the first side, and the surface of the annular portion of the first heat exchange plate and the surface of the annular portion of the second heat exchange plate adjacent to each other are in at least partial contact to form a seal.

7. The plate heat exchanger as claimed in claim 6, wherein:

projections of the annular portion of the first heat exchange plate and the annular portion of the second heat exchange plate on the plane perpendicular to the stacking direction have an annular outer overlapping portion, and the projection of the communicating hole on the plane perpendicular to the stacking direction is inside the annular outer overlapping portion.

8. The plate heat exchanger as claimed in claim 6, wherein:

at least one part of the projection of the annular portion of the second heat exchange plate on the plane perpendicular to the stacking direction is inside the projection of the annular portion of the first heat exchange plate in the plane perpendicular to the stacking direction.

9. The plate heat exchanger as claimed in claim 6, wherein:

the communicating hole is in the annular second portions of the first annular protrusions of at least some of the first heat exchange plates and/or the communicating hole is in the annular portions of at least some of the second heat exchange plates.

10. The plate heat exchanger as claimed in claim 3 or 4, wherein:

the first annular protrusion of the first heat exchange plate has a circular annular shape, the second annular protrusion of the second heat exchange plate has a circular annular shape, and an outer diameter of the first annular protrusion of the first heat exchange plate is larger than an outer diameter of the second annular protrusion of the second heat exchange plate.

11. The plate heat exchanger as claimed in claim 6 or 7, wherein:

the annular portion of the first heat exchange plate

has a circular annular shape, the annular portion of the second heat exchange plate has a circular annular shape, and an inner diameter of the annular portion of the second heat exchange plate is smaller than an inner diameter of the annular portion of the first heat exchange plate.

12. The plate heat exchanger as claimed in claim 11, wherein:

the annular portion of the first heat exchange plate adjoins the first portion of the first annular protrusion of the first heat exchange plate, and the annular portion of the second heat exchange plate adjoins the first portion of the second annular protrusion of the second heat exchange plate.

13. The plate heat exchanger as claimed in claim 4, wherein:

the first annular protrusion of the first heat exchange plate comprises an annular protrusion main body and a communicating protrusion extending outwardly from the annular protrusion main body; and

at least one part of a projection of the communicating protrusion of the first annular protrusion on the plane perpendicular to the stacking direction is outside the projection of the second portion of the second annular projection on the plane perpendicular to the stacking direction, and the projection of the communicating hole on the plane perpendicular to the stacking direction is in the at least one part of the projection of the communicating protrusion of the first annular protrusion.

14. The plate heat exchanger as claimed in claim 13, wherein:

the annular protrusion main body of the first annular protrusion of the first heat exchange plate has a circular annular shape, the second annular protrusion of the second heat exchange plate has a circular annular shape, and an outer diameter of the annular protrusion main body of the first annular protrusion of the first heat exchange plate is substantially equal to an outer diameter of the second annular protrusion of the second heat exchange plate; and

the projection of the communicating protrusion of the first annular protrusion on the plane perpendicular to the stacking direction is outside the projection of the second portion of the second annular protrusion on the plane perpendicular to the stacking direction, and the projection of the communicating hole on the plane perpendicular to the stacking direction is in the projection of the communicating protrusion of the first

annular protrusion.

15. The plate heat exchanger as claimed in claim 13 or 14, wherein:

the communicating hole is a plurality of communicating holes, and the communicating protrusion is a plurality of spaced communicating protrusions.

16. The plate heat exchanger as claimed in claim 2, wherein:

a surface of the second annular protrusion of the second heat exchange plate facing the second side has a second recessed portion, and the second recessed portion forms the communicating hole.

17. The plate heat exchanger as claimed in claim 16, wherein: the first annular protrusion of the first heat exchange plate has a circular annular shape, the second protrusion of the second heat exchange plate has a circular annular shape, and an outer diameter of the first annular protrusion of the first heat exchange plate is substantially equal to an outer diameter of the second annular protrusion of the second heat exchange plate.

18. The plate heat exchanger as claimed in claim 1, wherein:

an annular first portion of the first annular protrusion of the first heat exchange plate extends obliquely from the first heat exchange plate main body toward the first side, and an annular second portion of the first annular protrusion of the first heat exchange plate extends inwardly from the annular first portion of the first annular protrusion of the first heat exchange plate substantially parallel to the first heat exchange plate main body; and

an annular first portion of the second annular protrusion of the second heat exchange plate extends obliquely from the second heat exchange plate main body toward the second side, and an annular second portion of the second annular projection of the second heat exchange plate extends inwardly from the annular first portion of the second annular projection of the second heat exchange plate substantially parallel to the second heat exchange plate main body.

19. The plate heat exchanger as claimed in claim 18, wherein:

the annular second portion of the first annular protrusion of the first heat exchange plate adjoins the first opening, and the annular second portion of the second annular projection of the second heat exchange plate adjoins the second opening.

20. The plate heat exchanger as claimed in claim 1,

wherein:

the plurality of first heat exchange plates and the plurality of second heat exchange plates are alternately arranged in the stacking direction.

21. The plate heat exchanger as claimed in claim 2, wherein:

the communicating hole is formed in the first heat exchange plates and/or the second heat exchange plates.

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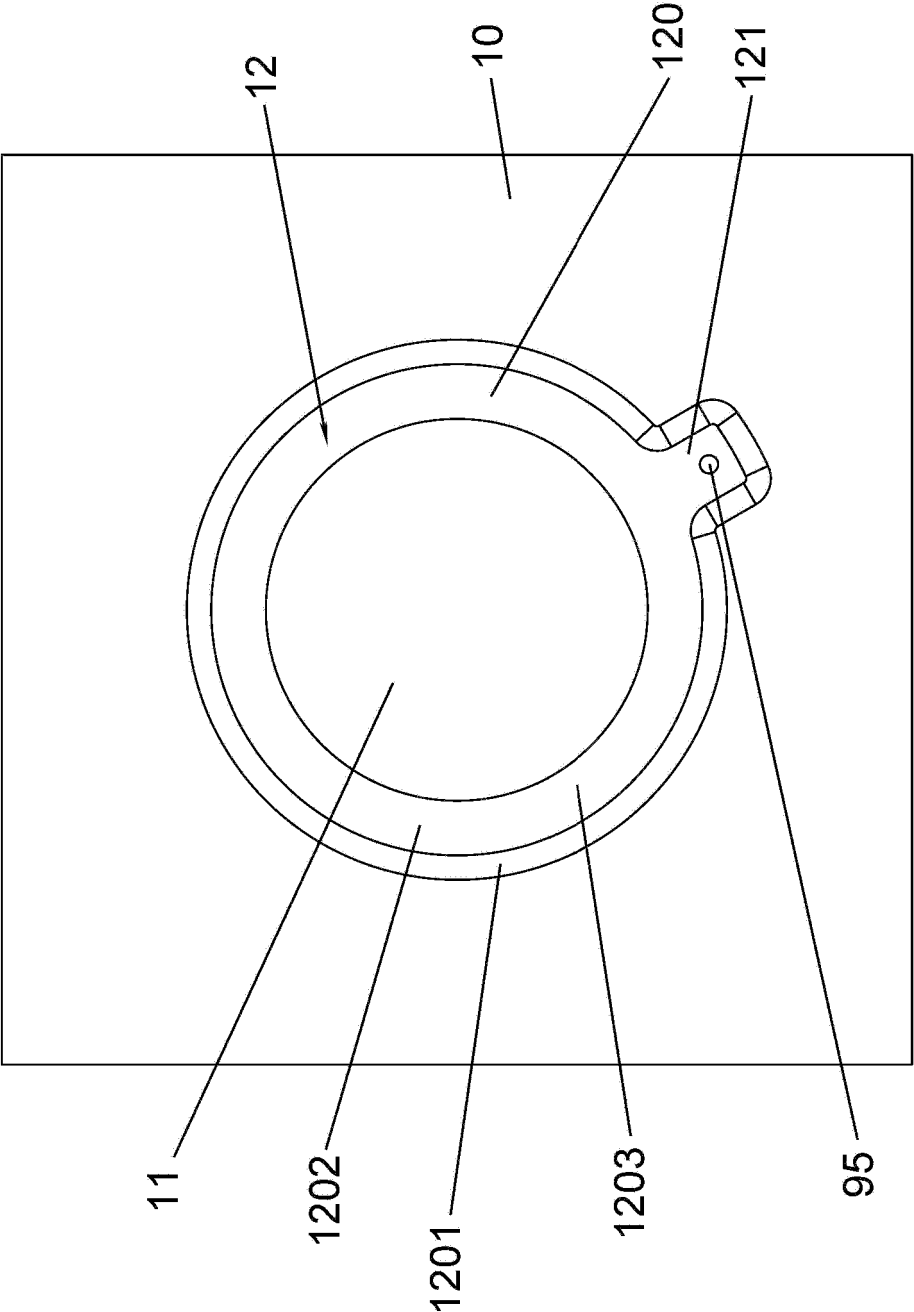


图1

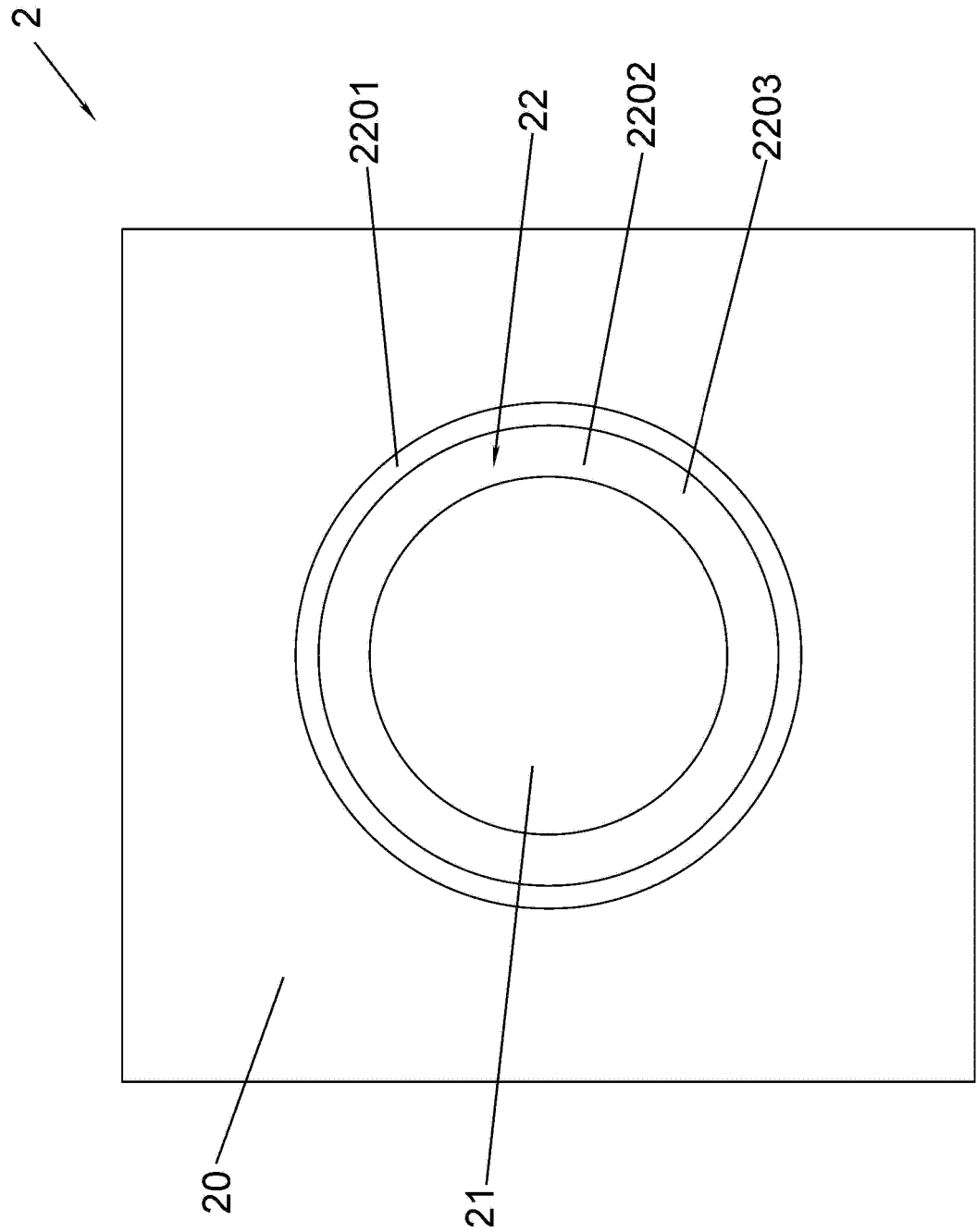


图2

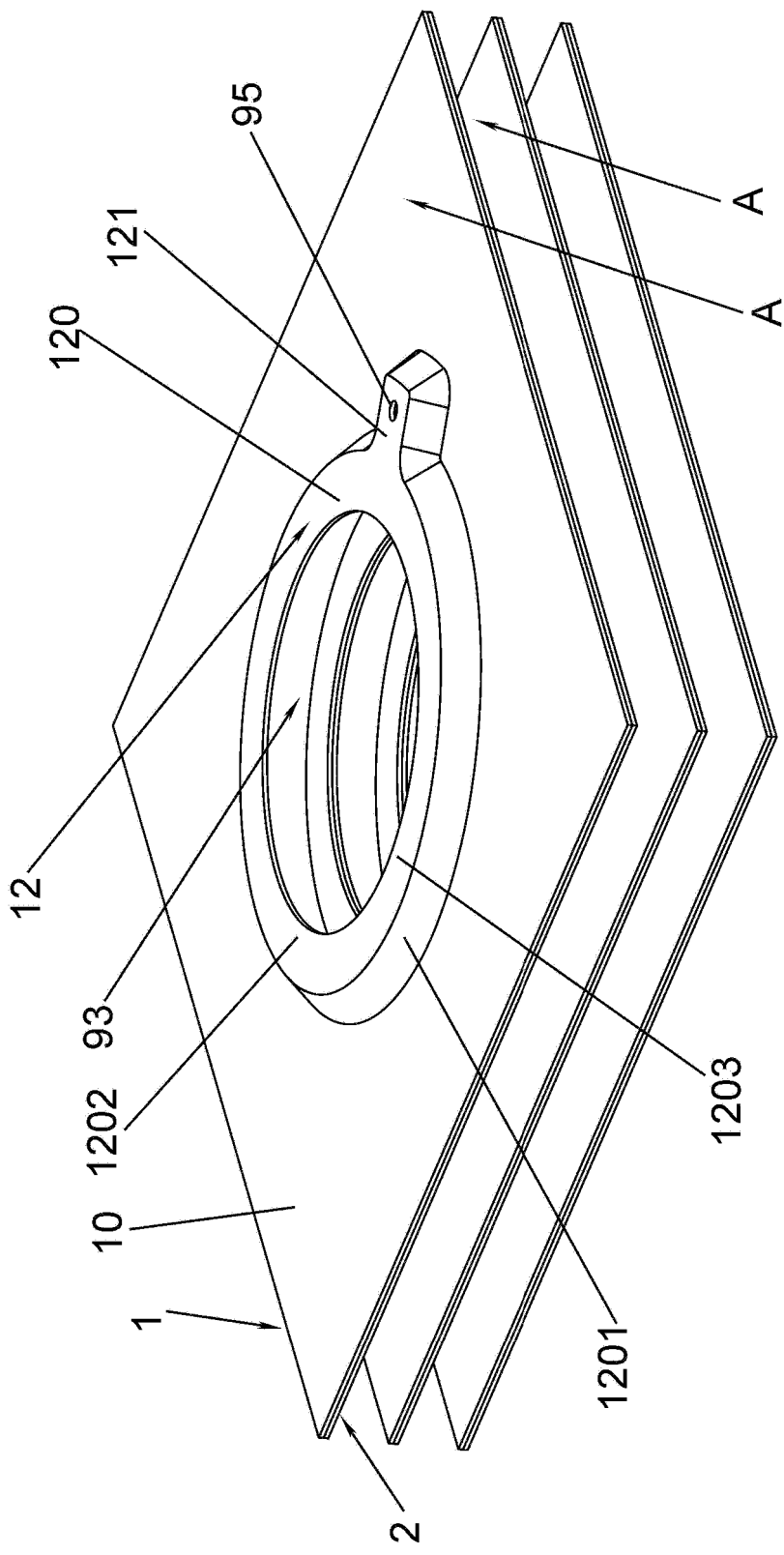


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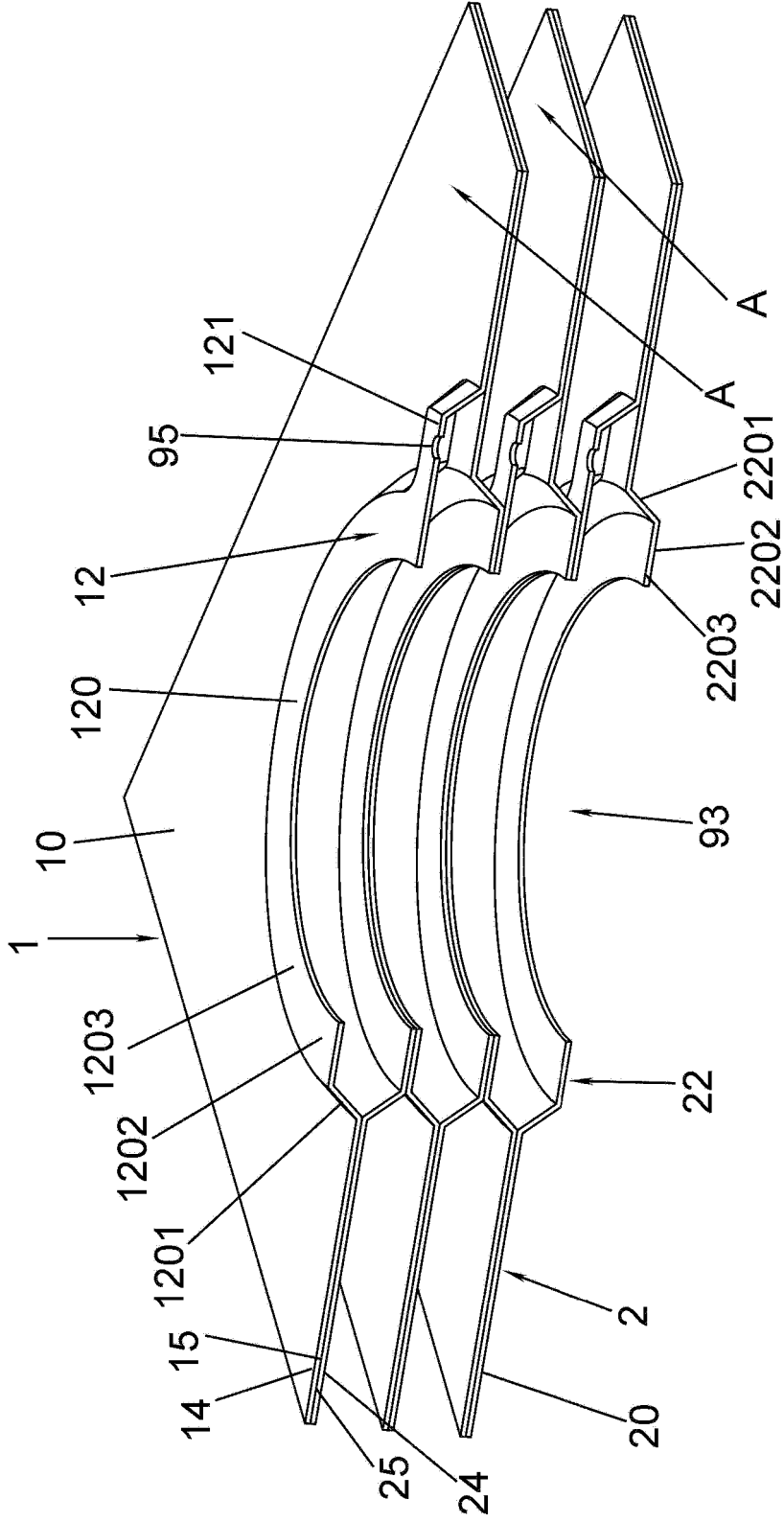


图4

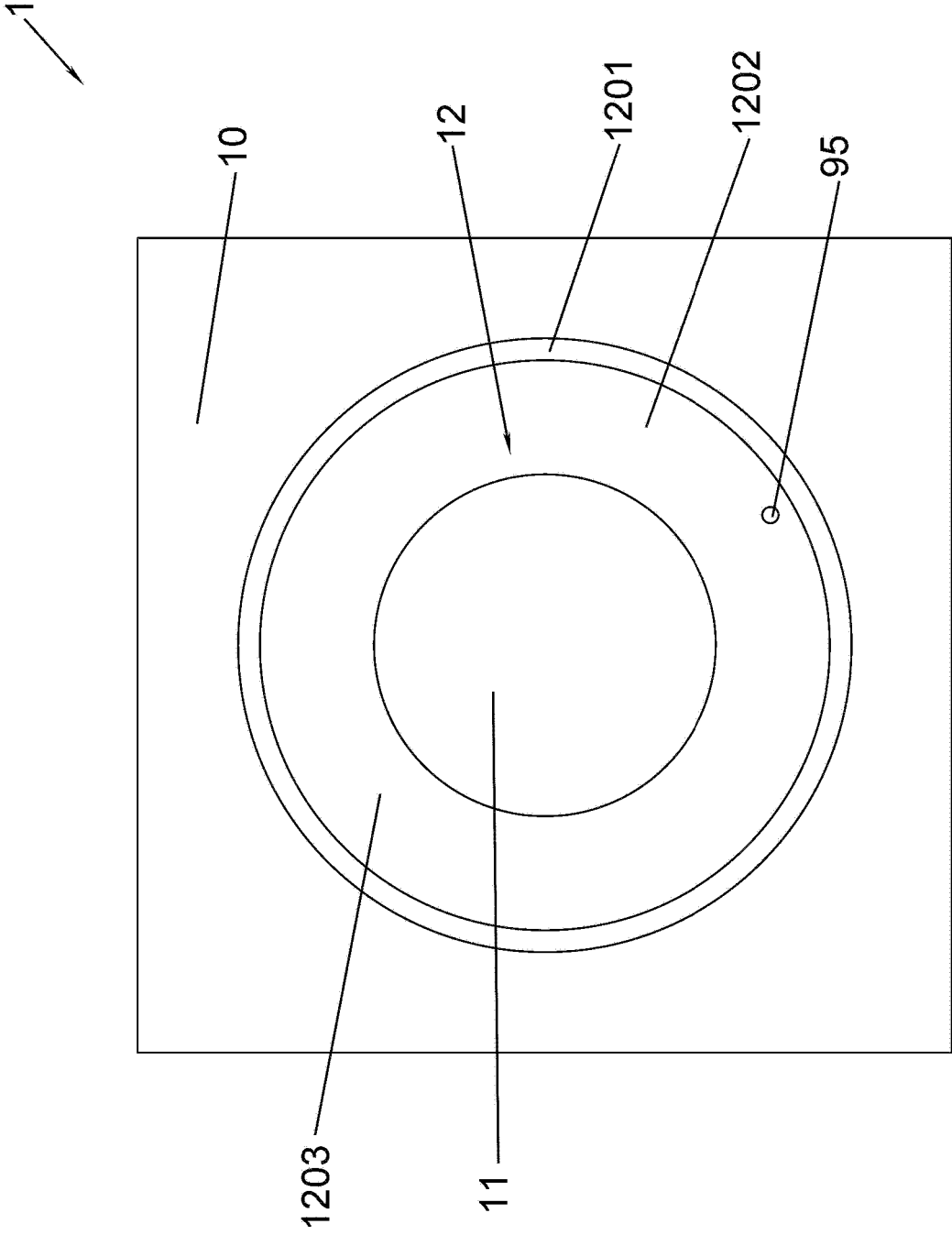


图5

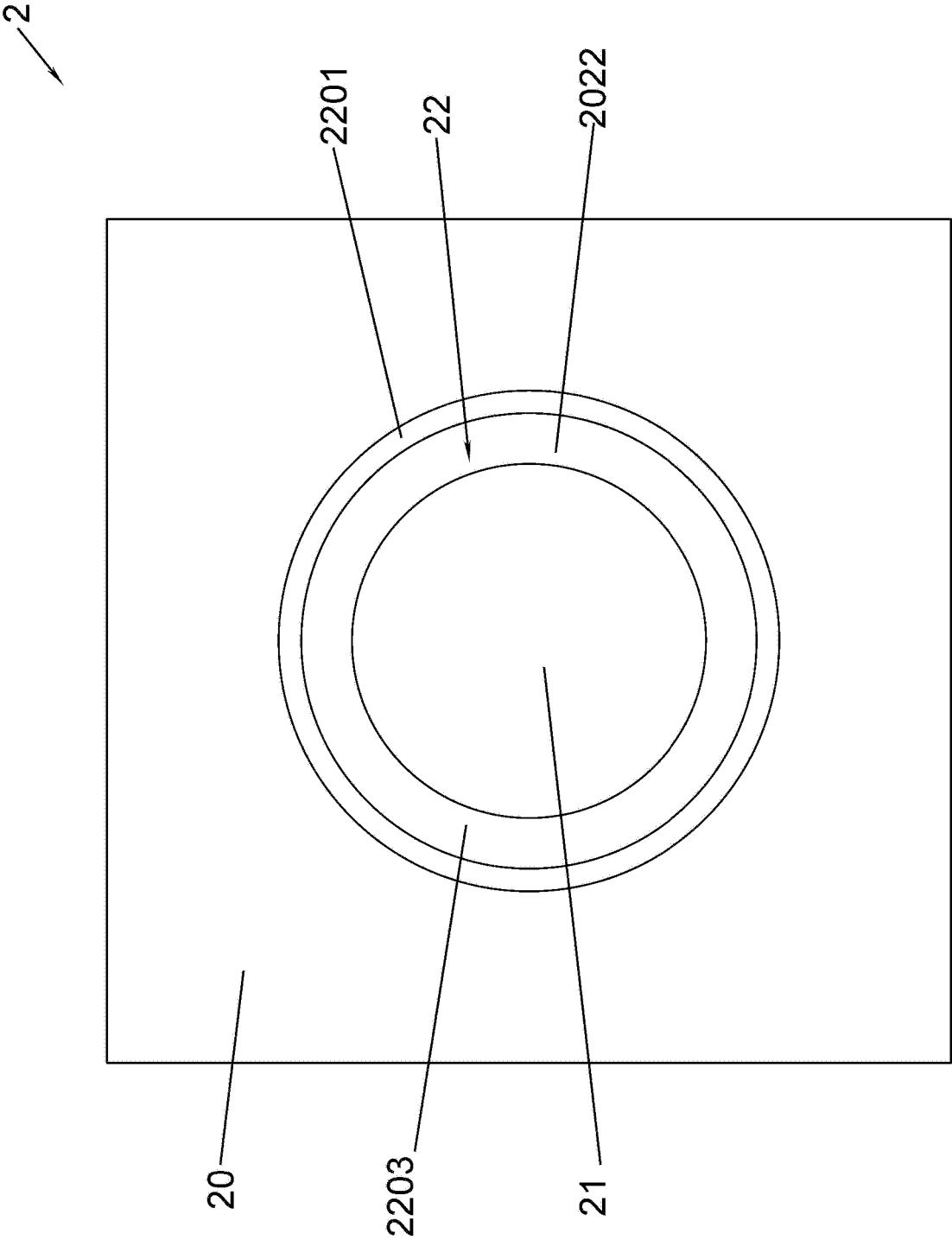
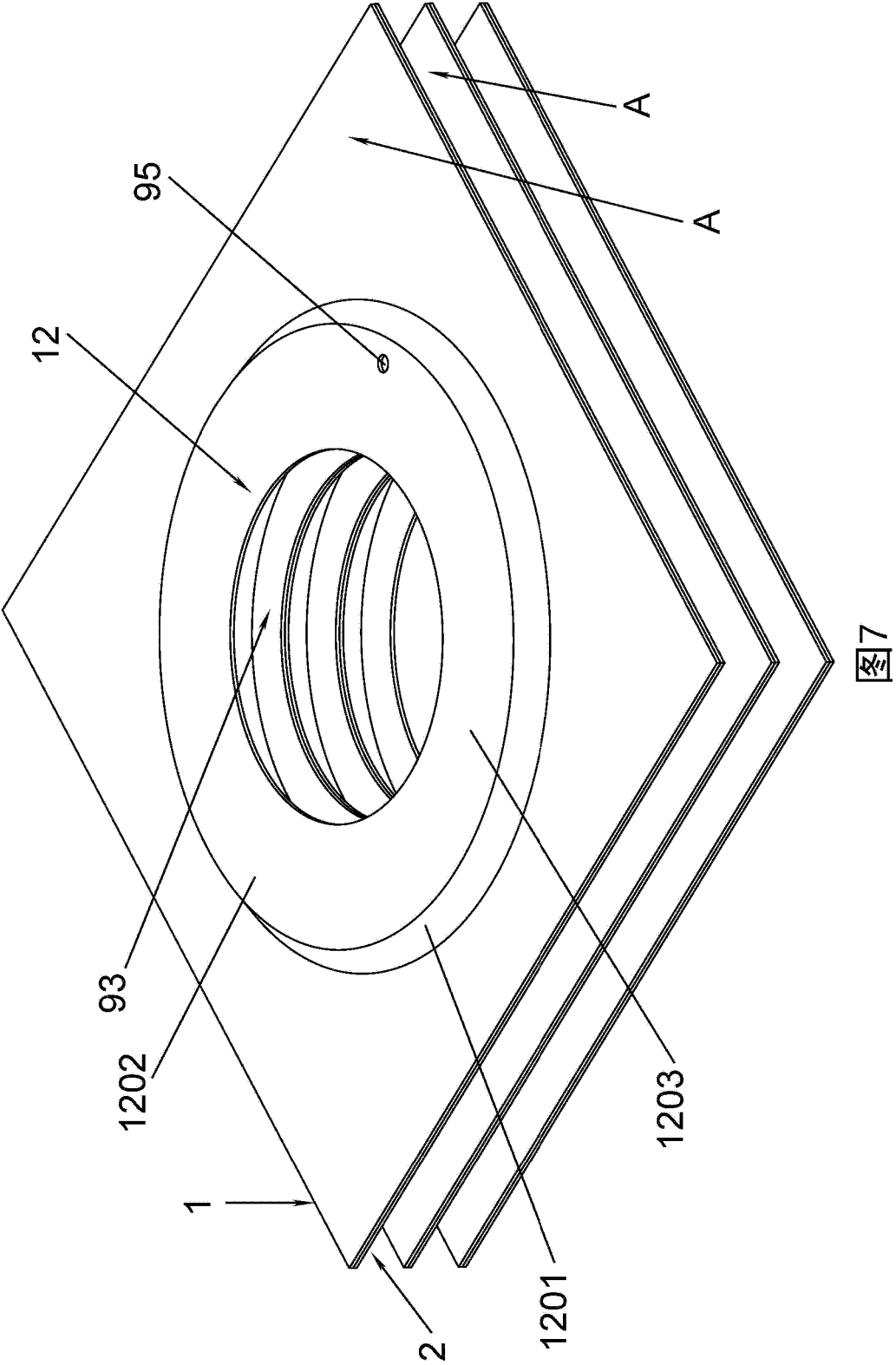


图 6



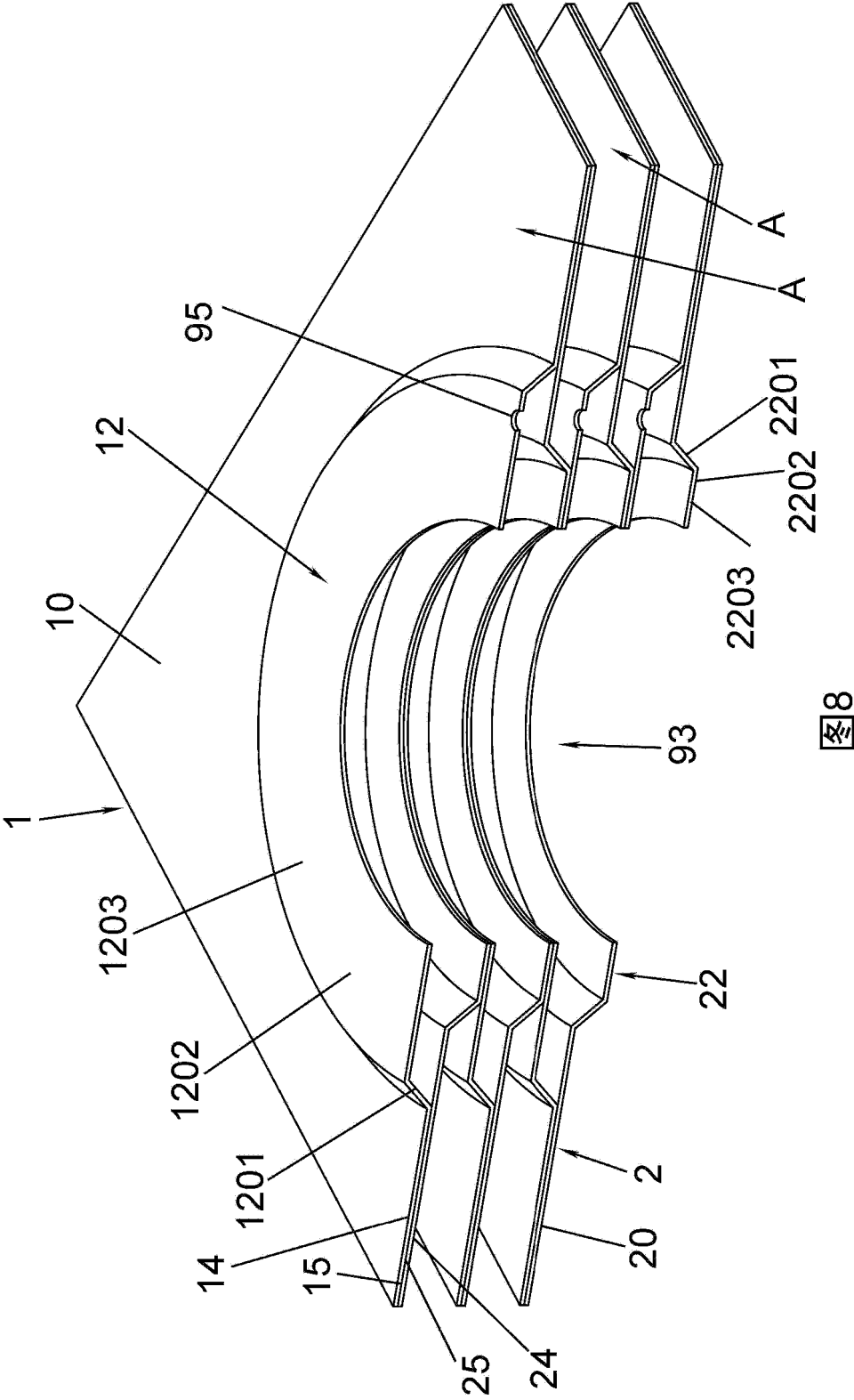


图8

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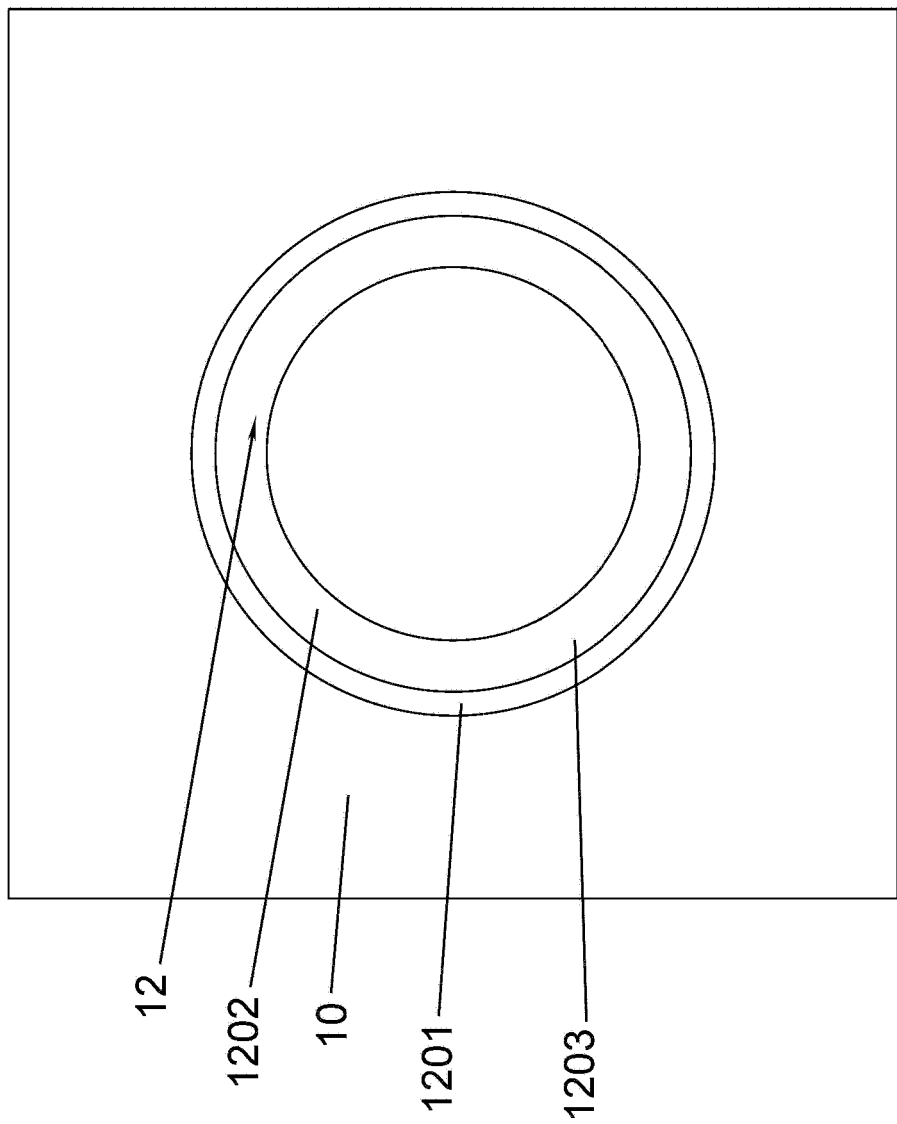


图9

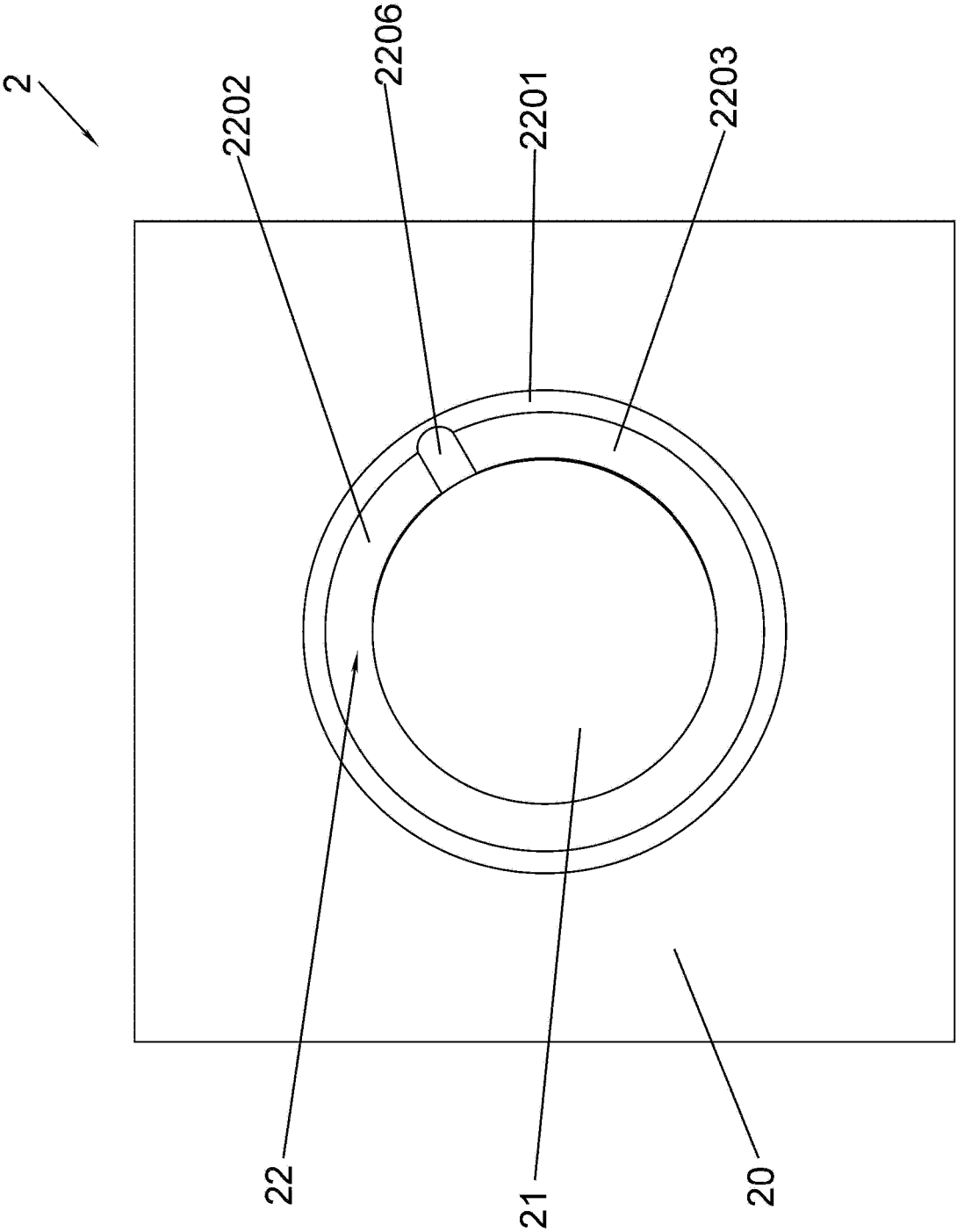


图10

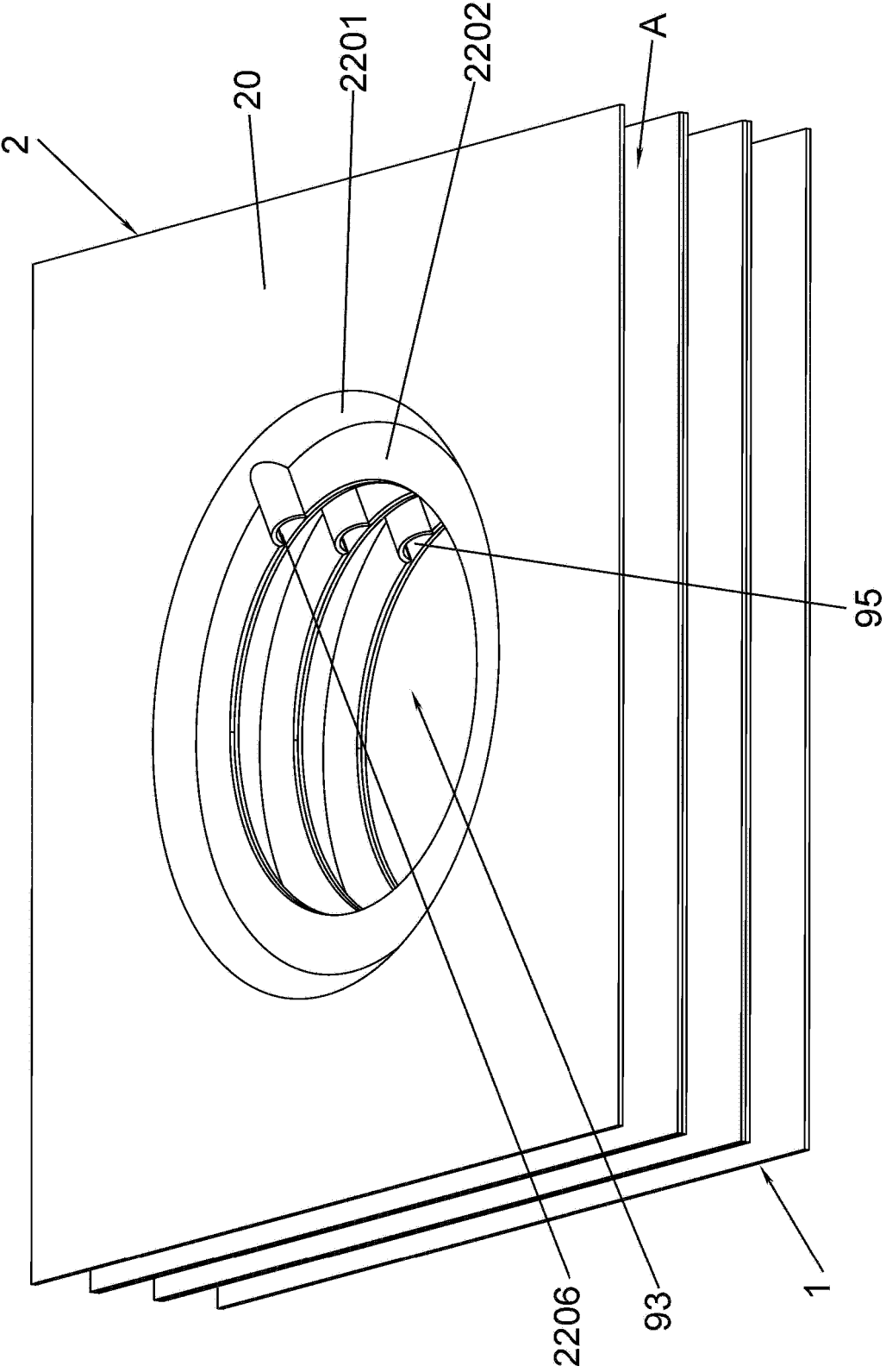


图11

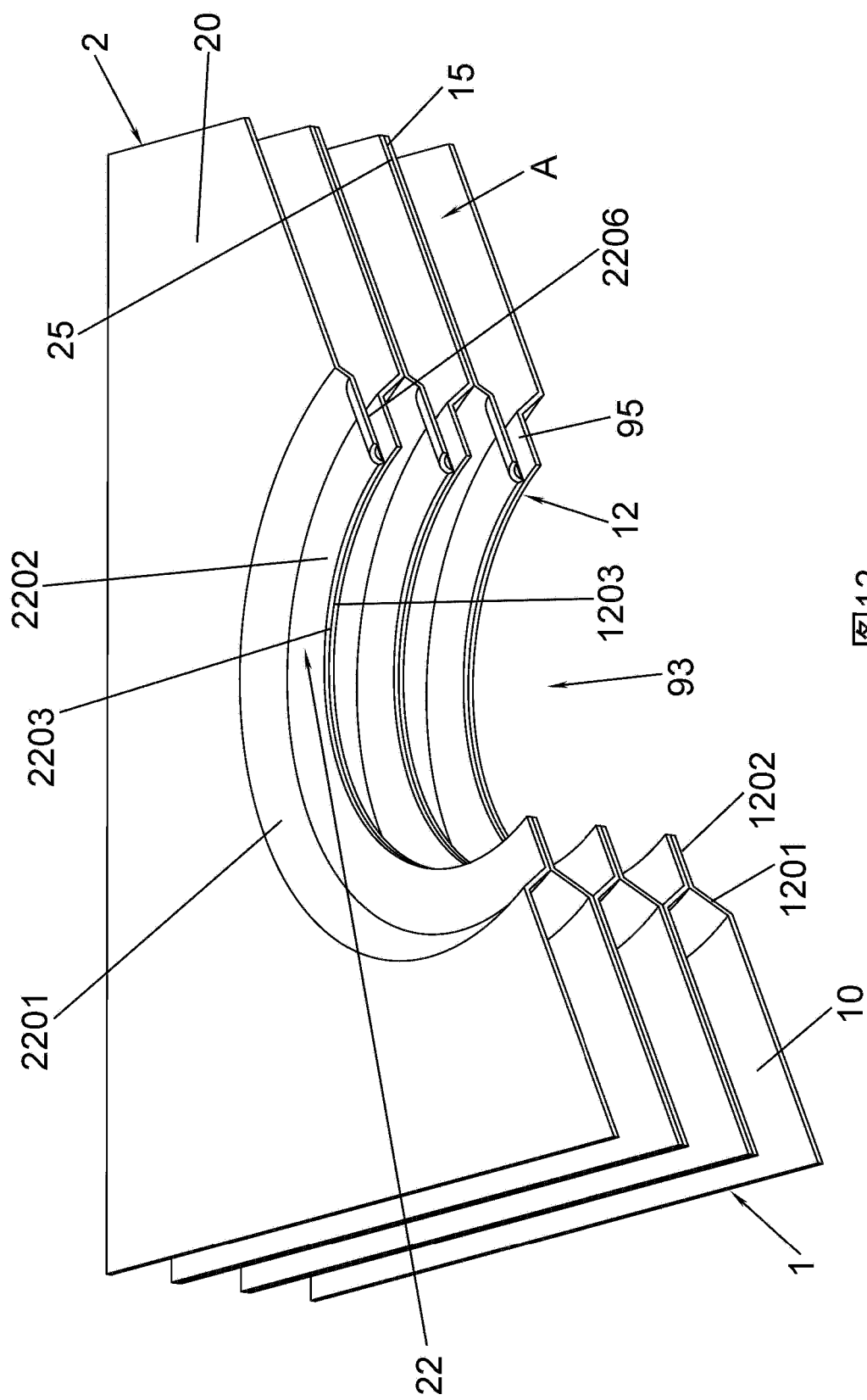


图 12

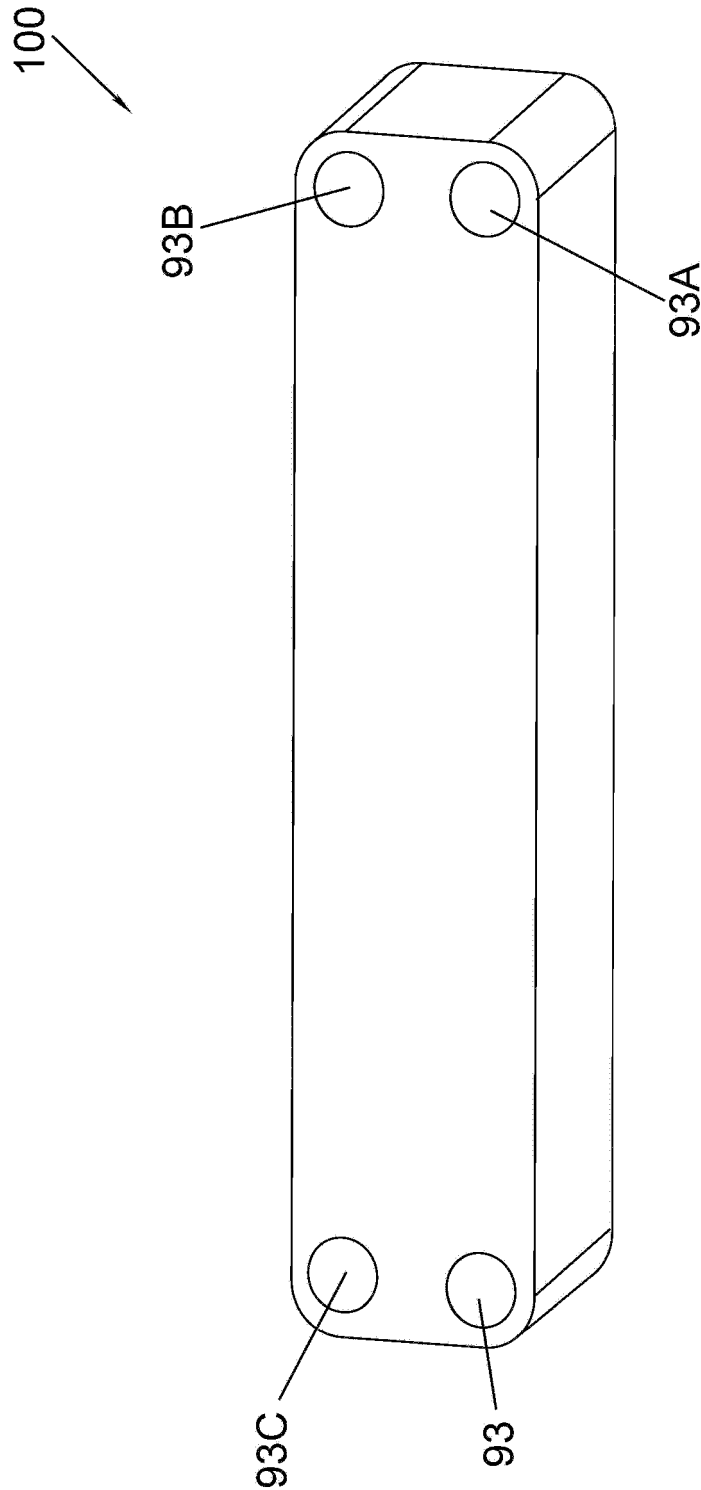


图13

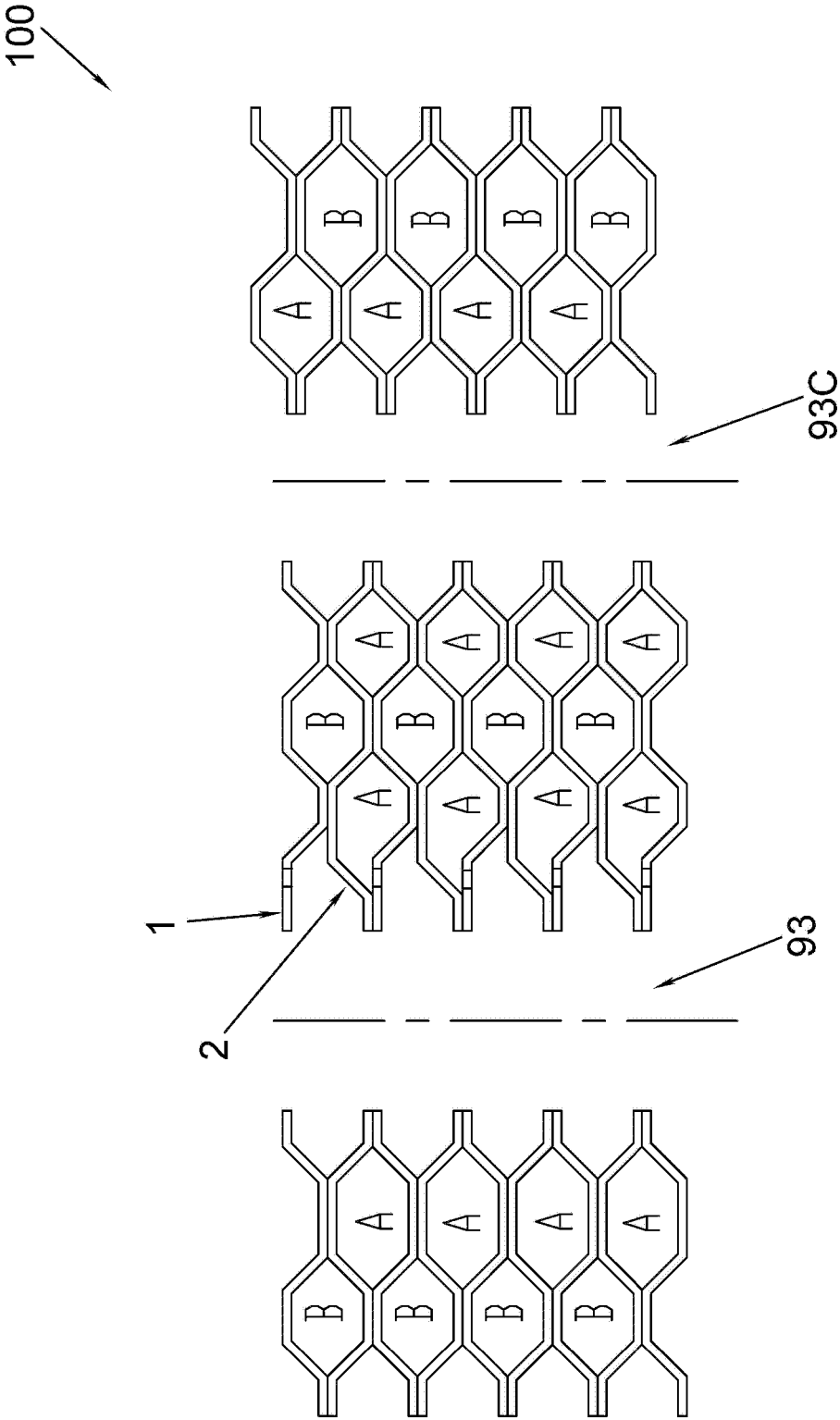


图14

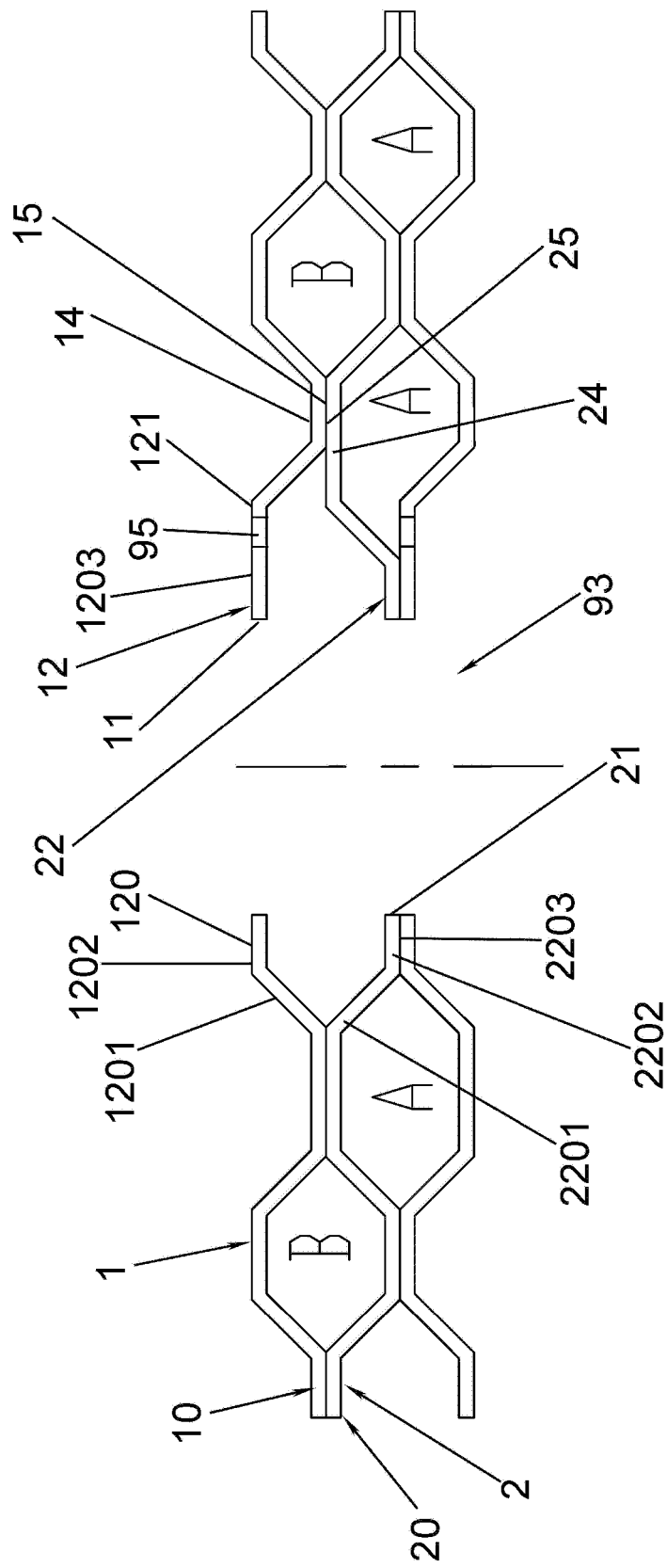


图15

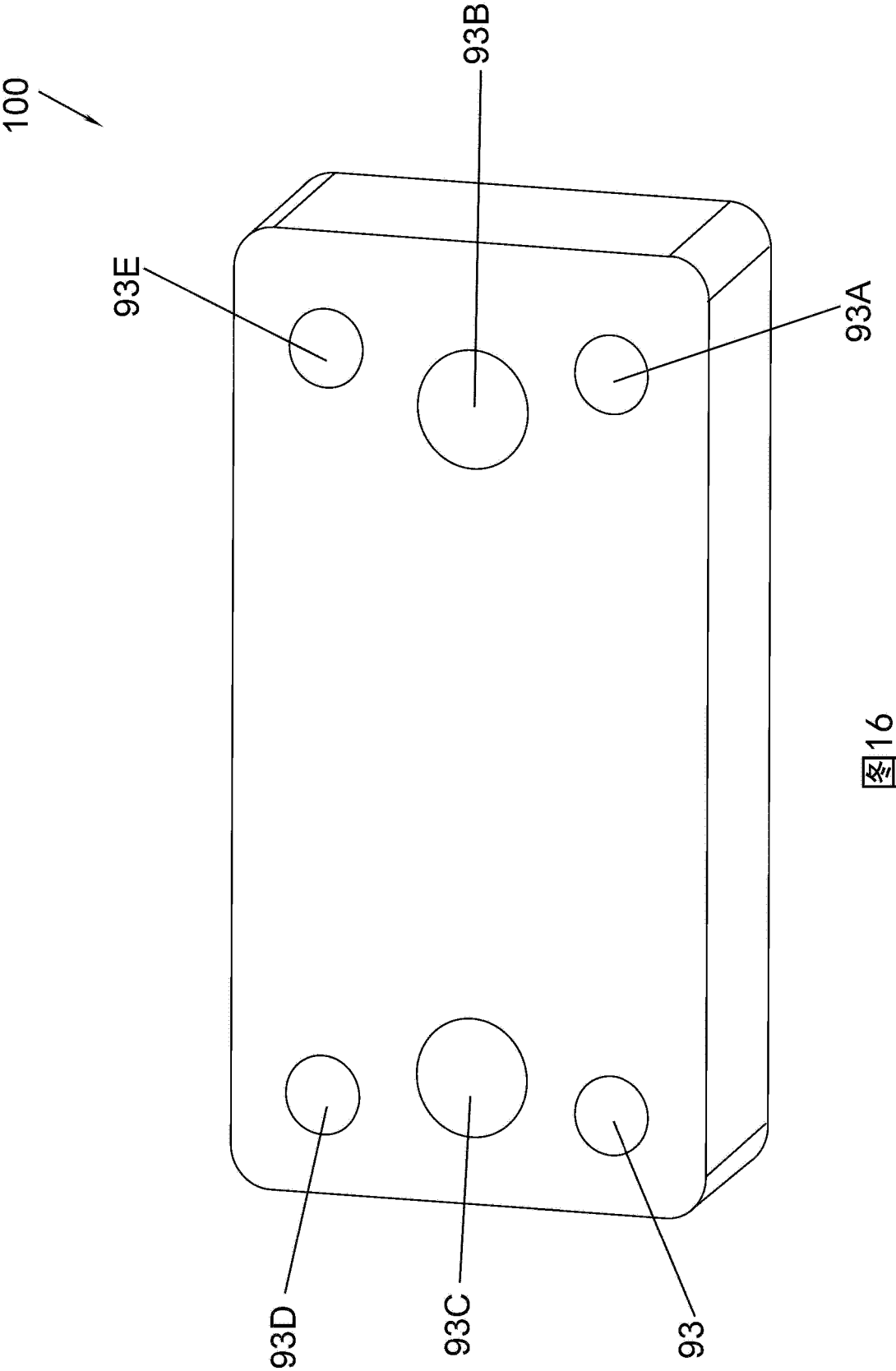


图16

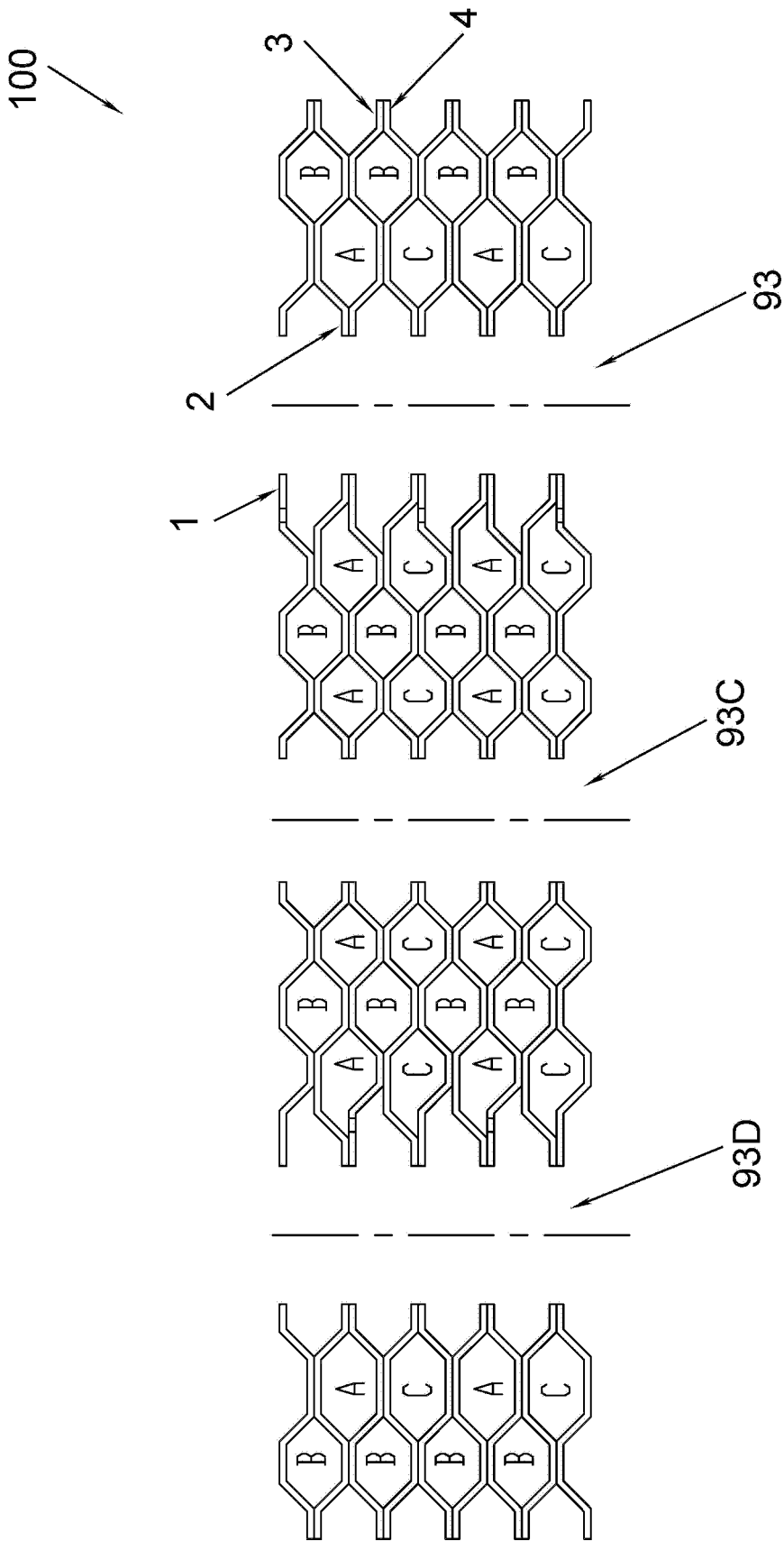


图17

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2020/128673

5	A. CLASSIFICATION OF SUBJECT MATTER F28F 9/22(2006.01)i		
	According to International Patent Classification (IPC) or to both national classification and IPC		
10	B. FIELDS SEARCHED		
	Minimum documentation searched (classification system followed by classification symbols) F28D, F28F		
	Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
15	Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) VEN; CNABS; CNTXT; CNKI: 板式, 换热器, 层, 叠, 分配, 孔, 口, 端口, 进口, 出口, 一体, 冲压, plate, laminat+, heat, exchange +, stack+, distribut+, apertur+, open+, pore, hole, port, inlet, outlet, integrat+, stamp+, punch+		
	C. DOCUMENTS CONSIDERED TO BE RELEVANT		
20	Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	PX	CN 211575949 U (DANFOSS AS) 25 September 2020 (2020-09-25) claims 1-21	1-21
	X	CN 104755873 A (ALFA LAVAL CORPORATE AB) 01 July 2015 (2015-07-01) description, paragraphs [0046]-[0089], and figures 1-12	1-14, 18-21
25	Y	CN 104755873 A (ALFA LAVAL CORPORATE AB) 01 July 2015 (2015-07-01) description, paragraphs [0046]-[0089], and figures 1-12	15-17
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35	A	CN 101160503 A (ALFA LAVAL CORPORATE AB) 09 April 2008 (2008-04-09) entire document	1-21
	☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
40	* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed		"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family
45	Date of the actual completion of the international search 03 February 2021		Date of mailing of the international search report 18 February 2021
50	Name and mailing address of the ISA/CN China National Intellectual Property Administration (ISA/CN) No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088 China		Authorized officer
55	Facsimile No. (86-10)62019451		Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.

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A	CN 204438867 U (ZHEJIANG FORWON PLATE HEAT EXCHANGER CO., LTD.) 01 July 2015 (2015-07-01) entire document	1-21
A	CN 101178294 A (DANFOSI QINBAO (HANGZHOU) REFRIGERATOR CO., LTD.) 14 May 2008 (2008-05-14) entire document	1-21

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International application No.

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