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(54) HEAT EXCHANGE PLATE FOR USE IN PLATE-TYPE HEAT EXCHANGER, AND PLATE-TYPE HEAT EXCHANGER

(57) Disclosed in the embodiments of the present invention are a heat exchange plate for use in a plate-type heat exchanger, and a plate-type heat exchanger having same. The heat exchange plate comprises a heat exchange portion and a port portion; fluids having different temperatures exchange heat with each other by means of the heat exchange portion; an opening used as the port of the heat exchanger is formed in the port portion. The heat exchange plate comprises a first side and a second side in a direction perpendicular to the heat exchange plate; the port portion is provided with a contact portion that is in contact with the port portion of another heat exchange plate at the first side, and a protrusion protruding towards the second side relative to the contact portion. The heat exchange plate and the plate-type heat exchanger of the embodiments of the present invention can, for example, improve the quality of the port portion of the heat exchange plate of the heat exchanger.

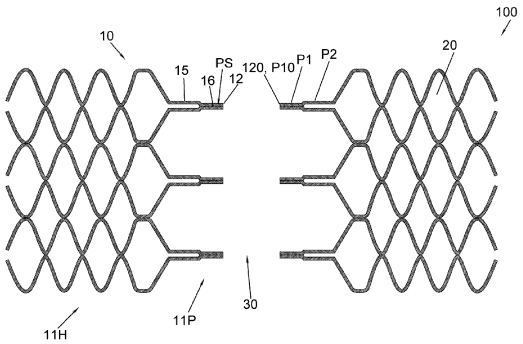

FIG. 3

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Description

Technical Field

[0001] Embodiments of the present invention relate to a heat exchange plate for plate heat exchanger, and a plate heat exchanger.

Background Art

[0002] A plate heat exchanger comprises cover plates, heat exchange plates, connecting pipes, etc.

Summary of the Invention

[0003] An objective of embodiments of the present invention is to provide a heat exchange plate for a plate heat exchanger, and a plate heat exchanger having same, so that the quality of a port portion of the heat exchange plate of the heat exchanger can be improved, for example.

[0004] According to an embodiment of the present invention, a heat exchange plate for a plate heat exchanger is provided, the heat exchange plate comprising: a heat exchange portion and a port portion, wherein fluids having different temperatures exchange heat with each other through the heat exchange portion, and an opening used as a port of the heat exchanger is formed in the port portion, wherein the heat exchange plate comprises a first side and a second side in a direction perpendicular to the heat exchange plate; and the port portion is provided with a contact portion that is in contact with the port portion of another heat exchange plate on the first side, and a protrusion protruding toward the second side relative to the contact portion.

[0005] According to an embodiment of the present invention, the port portion comprises a plurality of protrusions distributed in a circumferential direction around the opening.

[0006] According to an embodiment of the present invention, when viewed in the direction perpendicular to the heat exchange plate, the plurality of protrusions are each in a circular, rectangular or trapezoidal shape.

[0007] According to an embodiment of the present invention, the port portion comprises an annular contact portion and an annular protrusion surrounding the opening, and the annular contact portion and the annular protrusion adjoin each other.

[0008] According to an embodiment of the present invention, the port portion comprises at least two annular protrusions surrounding the opening, and two of the at least two annular protrusions adjoin each other and have different protrusion amounts relative to the contact portion; or two of the at least two annular protrusions are separated by the annular contact portion.

[0009] According to an embodiment of the present invention, the port portion comprises: a first annular portion surrounding the opening, wherein an inner edge of the first annular portion constitutes an edge of the opening; and a second annular portion surrounding the first annular portion and adjoining the first annular portion, wherein at least a part of one of the first annular portion and the second annular portion constitutes the protrusion.

[0010] According to an embodiment of the present invention, a plurality of circumferentially-spaced parts of at least one of the first annular portion and the second annular portion constitute a plurality of protrusions; or one of the first annular portion and the second annular portion constitutes an annular protrusion; or one of the first annular portion and the second annular portion constitutes an annular protrusion, and a plurality of circumferentially-spaced parts of the other of the first annular portion and the second annular portion constitute a plurality of protrusions.

[0011] According to an embodiment of the present invention, the port portion comprises: a first annular portion surrounding the opening, wherein an inner edge of the first annular portion constitutes an edge of the opening; a second annular portion surrounding the first annular portion and adjoining the first annular portion; and a third annular portion surrounding the second annular portion and adjoining the second annular portion, wherein at least a part of at least one of the first annular portion, the second annular portion and the third annular portion constitutes a protrusion.

[0012] According to an embodiment of the present invention, the second annular portion and the third annular portion protrude toward the second side relative to a part of a surface of the port portion to constitute protrusions, at least a part of the first annular portion constitutes a contact portion, and a protrusion amount of the second annular portion relative to the contact portion is less than a protrusion amount of the third annular portion.

[0013] According to an embodiment of the present invention, one of the first annular portion, the second annular portion and the third annular portion constitutes an annular protrusion, and a plurality of circumferentially-spaced parts of a further one of the first annular portion, the second annular portion and the third annular portion constitute a plurality of protrusions.

[0014] According to an embodiment of the present invention, the port portion comprises: a plurality of annular portions surrounding the opening, wherein an inner edge of the innermost annular portion constitutes an edge of the opening, two adjacent annular portions of the plurality of annular portions adjoin each other, and at least a part of at least one of the plurality of annular portions constitutes the protrusion.

[0015] According to an embodiment of the present invention, at least one of the plurality of annular portions protrudes toward the second side relative to a part of a surface of the port portion to constitute an annular protrusion; or a plurality of circumferentially-spaced parts of at least one of the plurality of annular portions protrude toward the second side relative to the part of the surface of the port portion to constitute a plurality of protrusions.

[0016] According to an embodiment of the present invention, a plate heat exchanger is further provided, comprising: a plurality of heat exchange plates, each being the heat exchange plate described above.

[0017] According to an embodiment of the present invention, protrusions of two adjacent heat exchange plates hermetically connected to each other at the port portions thereof protrude in directions away from each other, and a gap between two protrusions is in the range of 0.2-0.3 mm.

[0018] According to an embodiment of the present invention, protrusions of two adjacent heat exchange plates hermetically connected to each other at the port portions thereof protrude in directions away from each other, a gap between two protrusions is in the range of 0.2-0.3 mm, and the gap between the two protrusions is filled with a brazing alloy for brazing the plate heat exchanger, so as to braze the two protrusions together.

[0019] The heat exchange plate and the plate heat exchanger according to the embodiments of the present invention can improve the quality of the port portion of the heat exchange plate of the heat exchanger, for example.

Brief Description of the Drawings

[0020]

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

FIG. 2 is a schematic partial top view of the plate heat exchanger according to the embodiment of the present invention;

FIG. 3 is a schematic partial cross-sectional view of the plate heat exchanger according to the embodiment of the present invention along line AA in FIG. 2;

FIG. 4 is a schematic partial cross-sectional view of a heat exchange plate of a plate heat exchanger according to a first embodiment of the present invention along line AA in FIG. 2;

FIG. 5 is a schematic partial cross-sectional view of a heat exchange plate of a plate heat exchanger according to a second embodiment of the present invention along line AA in FIG. 2;

FIG. 6 is a schematic partial cross-sectional view of a heat exchange plate of a plate heat exchanger according to a third embodiment of the present invention along line AA in FIG. 2;

FIG. 7 is a schematic partial top view of a heat exchange plate of a plate heat exchanger according to a fourth embodiment of the present invention;

FIG. 8A is a schematic partial cross-sectional view of a heat exchange plate of a plate heat exchanger according to a fifth embodiment of the present invention along a plane passing through an axis of a port shown in FIG. 2;

FIG. 8B is a schematic partial cross-sectional view of the heat exchange plate of the plate heat exchanger according to the fifth embodiment of the present invention along another plane passing through the axis of the port shown in FIG. 2;

FIG. 9A is a schematic partial cross-sectional view of a heat exchange plate of a plate heat exchanger according to a sixth embodiment of the present invention along a plane passing through the axis of the port shown in FIG. 2;

FIG. 9B is a schematic partial cross-sectional view of the heat exchange plate of the plate heat exchanger according to the sixth embodiment of the present invention along another plane passing through the axis of the port shown in FIG. 2;

FIG. 10A is a schematic partial cross-sectional view of a heat exchange plate of a plate heat exchanger according to a seventh embodiment of the present invention along a plane passing through the axis of the port shown in FIG. 2;

FIG. 10B is a schematic partial cross-sectional view of the heat exchange plate of the plate heat exchanger according to the seventh embodiment of the present invention along another plane passing through the axis of the port shown in FIG. 2;

FIG. 11A is a schematic partial cross-sectional view of a heat exchange plate of a plate heat exchanger according to an eighth embodiment of the present invention along a plane passing through the axis of the port shown in FIG. 2;

FIG. 11B is a schematic partial cross-sectional view of the heat exchange plate of the plate heat exchanger according to the eighth embodiment of the present invention along another plane passing through the axis of the port shown in FIG. 2;

FIG. 12A is a schematic partial top view of a plate heat exchanger according to a ninth embodiment of the present invention; and

FIG. 12B is a schematic partial cross-sectional view of the heat exchange plate of the plate heat exchanger according to the ninth embodiment of the present invention along line BB shown in FIG. 12A.

Detailed Description of Embodiments

[0021] The present invention will be further described below in conjunction with the accompanying drawings and specific implementations.

[0022] As shown in FIGS. 1 to 3, a plate heat exchanger 100 according to an embodiment of the present invention comprises: a plurality of heat exchange plates 10; heat exchange spaces 20 formed between adjacent heat exchange plates 10 of the plurality of heat exchange plates 10; and ports 30 formed in the heat exchange plates 10. Each of the ports 30 is configured to distribute a refrigerant to some heat exchange spaces 20 of the heat exchange spaces 20.

[0023] Referring to FIGS. 1 to 12B, the heat exchange plate 10 for the plate heat exchanger 100 according to

embodiments of the present invention comprises: a heat exchange portion 11H and a port portion 11P; and an opening 12 formed in the port portion 11P and configured to form a port 30 of the heat exchanger 100. The heat exchange portion 11H is provided with a corrugated structure, so that fluids having different temperatures exchange heat with each other on two sides of the heat exchange portion 11H. The port portions 11P are substantially fitted together. The heat exchange plate 10 comprises a first side and a second side (e.g., an upper side and a lower side of each of the heat exchange plates 10 in FIGS. 3, 4, 5, 6, 8A, 8B, 9A, 9B, 10A, 10B, 11A, 11B, and 12B) in a direction perpendicular to the heat exchange plate 10; and the port portion 11P is provided with a contact portion 16 that is in contact with the port portion 11P of another heat exchange plate 10 on the first side, and a protrusion 15 protruding toward the second side relative to the contact portion 16. For example, the port portion 11P has a surface PS on the first side, and a part of the surface PS of the port portion 11P is in contact with the port portion 11P of another heat exchange plate 10.

[0024] In some embodiments of the present invention, referring to FIGS. 7, 8A, 8B, 9A, 9B, 10A, 10B, 12A, and 12B, the port portion 11P comprises a plurality of protrusions 15 distributed in a circumferential direction around the opening 12. For example, referring to FIGS. 7 and 12A, when viewed in the direction perpendicular to the heat exchange plate 10, the plurality of protrusions 15 are each in a circular, rectangular or trapezoidal shape.

[0025] In some embodiments of the present invention, referring to FIGS. 3, 4, 5, 6, 8A, 8B, 10A, 10B, 11A, and 11B, the port portion 11P comprises an annular contact portion 16 and an annular protrusion 15 surrounding the opening 12, and the annular contact portion 16 and the annular protrusion 15 adjoin each other. For example, referring to FIG. 5, the port portion 11P comprises at least two annular protrusions 15 surrounding the opening 12, and two annular protrusions 15 of the at least two annular protrusions 15 adjoin each other and have different protrusion amounts relative to the contact portion 16; or two annular protrusions 15 of the at least two annular protrusions 15 are separated by the annular contact portion 16.

[0026] In some embodiments of the present invention, referring to FIGS. 3 to 12B, the port portion 11P comprises: a first annular portion P1 surrounding the opening 12, wherein an inner edge P10 of the first annular portion P1 constitutes an edge 120 of the opening 12; and a second annular portion P2 surrounding the first annular portion P1 and adjoining the first annular portion P1, wherein at least a part of at least one of the first annular portion P1 and the second annular portion P2 (e.g., one of the first annular portion P1 and the second annular portion P2) protrudes toward the second side to constitute a protrusion 15. For example, one of the first annular portion P1 and the second annular portion P2 protrudes toward the second side to constitute a protrusion 15.

[0027] Each of the first annular portion P1 and the second annular portion P2 has a predetermined width, and may be in a circular ring shape or other suitable shapes according to the shape of the opening 12.

[0028] In some embodiments of the present invention, referring to FIGS. 7, 8A, 8B, 9A, 9B, 10A, 10B, 12A, and 12B, a plurality of circumferentially-spaced parts of at least one of the first annular portion P1 and the second annular portion P2 (e.g., one of the first annular portion P1 and the second annular portion P2) protrude toward the second side to constitute a plurality of protrusions 15. A plurality of stepped reinforcing structures are uniformly arranged in a circumferential direction of the annular portion around the opening 12 of the heat exchange plate 10. For example, referring to FIG. 7, no protrusion 15 is provided in a region A and a protrusion 15 is provided in a region B. This structure can be modified according to the size of the opening and the size of the heat exchange portion.

[0029] In some embodiments of the present invention, referring to FIGS. 3, 4, 5, 6, 8A, 8B, 10A, 10B, 11A, and 11B, the first annular portion P1 protrudes toward the second side to constitute an annular protrusion 15; or the second annular portion P2 protrudes toward the second side to constitute an annular protrusion 15.

[0030] In some embodiments of the present invention, referring to FIGS. 7, 8A, and 8B, one of the first annular portion P1 and the second annular portion P2 protrudes toward the second side to constitute an annular protrusion 15, and a plurality of circumferentially-spaced parts of the other of the first annular portion P1 and the second annular portion P2 protrude toward the second side to constitute a plurality of protrusions 15.

[0031] In some embodiments of the present invention, referring to FIGS. 5, 10A, 10B, 11A, 11B, 12A, and 12B, the port portion 11P comprises: a first annular portion P1 surrounding the opening 12, wherein an inner edge P10 of the first annular portion P1 constitutes an edge 120 of the opening 12; a second annular portion P2 surrounding the first annular portion P1 and adjoining the first annular portion P1; and a third annular portion P3 surrounding the second annular portion P2 and adjoining the second annular portion P2, wherein at least a part of at least one of the first annular portion P1, the second annular portion P2 and the third annular portion P3 protrudes toward the second side to constitute a protrusion 15.

[0032] In some embodiments of the present invention, referring to FIG. 5, the second annular portion P2 and the third annular portion P3 protrude toward the second side to constitute protrusions 15, at least a part of the first annular portion P1 constitutes a contact portion 16, and a protrusion amount of the second annular portion P2 relative to the contact portion 16 is less than a protrusion amount of the third annular portion P3.

[0033] In some embodiments of the present invention, referring to FIGS. 10A, 10B, 11A, and 11B, one of the first annular portion P1, the second annular portion P2 and the third annular portion P3 protrudes toward the second side to constitute an annular protrusion 15, and

a plurality of circumferentially-spaced parts of a further one of the first annular portion P1, the second annular portion P2 and the third annular portion P3 protrude toward the second side to constitute a plurality of protrusions 15.

[0034] In some embodiments of the present invention, referring to FIGS. 10A, 10B, 11A, and 11B, one of the first annular portion P1 and the second annular portion P2 protrudes toward the second side to constitute an annular protrusion 15, and a plurality of circumferentially-spaced parts of the third annular portion P3 protrude toward the second side to constitute a plurality of protrusions 15.

[0035] In some embodiments of the present invention, referring to FIGS. 7, 8A, 8B, 9A, 9B, 10A, 10B, 12A, and 12B, the plurality of protrusions 15 are arranged at equal intervals in the circumferential direction.

[0036] In some embodiments of the present invention, referring to FIGS. 7 and 12A, when viewed in the direction perpendicular to the heat exchange plate 10, the plurality of protrusions 15 are each in a circular, rectangular or trapezoidal shape.

[0037] In some embodiments of the present invention, referring to FIGS. 3 to 12B, the port portion 11P comprises: a plurality of annular portions surrounding the opening 12, wherein an inner edge P10 of the innermost annular portion constitutes an edge 120 of the opening 12, two adjacent annular portions of the plurality of annular portions adjoin each other, and at least a part of at least one of the plurality of annular portions protrudes toward the second side to constitute the protrusion 15.

[0038] In some embodiments of the present invention, referring to FIGS. 3 to 12B, at least one of the plurality of annular portions protrudes toward the second side to constitute an annular protrusion 15; or a plurality of circumferentially-spaced parts of at least one of the plurality of annular portions protrude toward the second side to constitute a plurality of protrusions 15.

[0039] In some embodiments of the present invention, referring to FIGS. 5, 10A, 10B, 11A, 11B, 12A, and 12B, the port portion 11P comprises: at least three annular portions surrounding the opening 12, wherein an inner edge P10 of the innermost annular portion constitutes an edge 120 of the opening 12, two adjacent annular portions of the at least three annular portions adjoin each other, and at least a part of each of at least two of the at least three annular portions protrudes toward the second side to constitute the protrusion 15.

[0040] In some embodiments of the present invention, referring to FIGS. 5, 10A, 10B, 11A, 11B, 12A, and 12B, a protrusion amount of at least a part of one of the at least two annular portions is different from a protrusion amount of at least a part of the other of the at least two annular portions; or a protrusion amount of at least a part of one of the at least two annular portions is the same as a protrusion amount of at least a part of the other of the at least two annular portions.

[0041] In some embodiments of the present invention, referring to FIGS. 5, 10A, 10B, 11A, 11B, 12A, and 12B, each of at least two of the at least three annular portions protrudes toward the second side to constitute an annular protrusion 15; a plurality of circumferentially-spaced parts of each of at least two of the at least three annular portions protrude toward the second side to constitute a plurality of protrusions 15; or a plurality of circumferentially-spaced parts of one of at least two of the at least three annular portions protrude toward the second side to constitute a plurality of protrusions 15, and the other of the at least two of the at least three annular portions protrudes toward the second side to constitute an annular protrusion 15.

[0042] In some embodiments of the present invention, referring to FIGS. 3, 4, 5, 6, 8A, 8B, 9A, 9B, 10A, 10B, 11A, 11B, and 12B, protrusions 15 of two adjacent heat exchange plates 10 hermetically connected to each other at the port portions 11P thereof protrude in directions away from each other, and a gap between two protrusions 15 is in the range of 0.2-0.3 mm.

[0043] In some embodiments of the present invention, referring to FIGS. 3, 4, 5, 6, 8A, 8B, 9A, 9B, 10A, 10B, 11A, 11B, and 12B, protrusions 15 of two adjacent heat exchange plates 10 hermetically connected to each other at the port portions 11P thereof protrude in directions away from each other, a gap between two protrusions 15 is in the range of 0.2-0.3 mm, and the gap between the two protrusions 15 is filled with a brazing alloy for brazing the plate heat exchanger, so as to braze the two protrusions 15 together. In this way, the protrusions 15 can further reinforce the port portion 11P, for example.

[0044] In some embodiments of the present invention, the heat exchange plate 10 is formed from a plate, such as by stamping. After the heat exchange plate 10 is formed, the plate has an undeformed portion that is not deformed toward the first side or the second side. The undeformed portion is in an initial plane, i.e., an undeformed plane in which the plate lies before being machined (e.g., stamped). Protrusions 15 protrude from the initial plane toward the second side, and at least one of a plurality of annular portions is not provided with a protrusion, i.e., is located in the initial plane.

[0045] According to embodiments of the present invention, referring to FIGS. 3 to 12B, the height, shape and size, etc. of each protrusion 15 can be adjusted according to the size of a corrugated structure in a heat exchange region, and the number of protrusions 15 around each opening can also be adjusted accordingly. The height of each protrusion is less than that of each peak of the corrugated structure.

[0046] According to an embodiment of the present invention, when the size of a port of each heat exchange plate is larger and a larger number of heat exchange plates are stacked, a risk of warpage of the heat exchange plates can be significantly reduced, a product pass rate can be improved, and the flatness of the formed heat exchange plate in the vicinity of the opening for forming the port can be improved.

[0047] According to an embodiment of the present invention, a stepped structure is provided in the vicinity of the opening of the heat exchange plate, i.e., the original entire plane is reconfigured as two or more planes with different heights, so that the structure can improve the flatness of the heat exchange plate. In addition, this structure can significantly enhance the strength of the formed heat exchange plate in the vicinity of the opening and prevent the occurrence of warpage.

[0048] According to an embodiment of the present invention, warpage deformation that may occur if a large number of heat exchange plates are stacked or an opening of each heat exchange plate is larger is eliminated, the flatness of the heat exchange plate in the vicinity of the opening is improved, the brazing quality of the heat exchange plates is improved, and the strength of the entire structure of the heat exchanger is finally increased. In addition, the product pass rate is improved.

[0049] It should be noted that the features in one or more of the above embodiments can be combined into new embodiments. The features in an embodiment can be used in a further embodiment unless the features in the embodiment conflict with the technical solution of the further embodiment.

Claims

1. A heat exchange plate for a plate heat exchanger, the heat exchange plate comprising:

a heat exchange portion and a port portion, wherein fluids having different temperatures exchange heat with each other through the heat exchange portion, and an opening used as a port of the heat exchanger is formed in the port portion,
wherein the heat exchange plate comprises a first side and a second side in a direction perpendicular to the heat exchange plate; and the port portion is provided with a contact portion that is in contact with the port portion of another heat exchange plate on the first side, and a protrusion protruding toward the second side relative to the contact portion.

2. The heat exchange plate for a plate heat exchanger as claimed in claim 1, wherein
the port portion comprises a plurality of protrusions distributed in a circumferential direction around the opening.

3. The heat exchange plate for a plate heat exchanger as claimed in claim 2, wherein
when viewed in the direction perpendicular to the heat exchange plate, the plurality of protrusions are each in a circular, rectangular or trapezoidal shape.

4. The heat exchange plate for a plate heat exchanger as claimed in claim 1, wherein
the port portion comprises an annular contact portion and an annular protrusion surrounding the opening, and the annular contact portion and the annular protrusion adjoin each other.

5. The heat exchange plate for a plate heat exchanger as claimed in claim 4, wherein
the port portion comprises at least two annular protrusions surrounding the opening, and two of the at least two annular protrusions adjoin each other and have different protrusion amounts relative to the contact portion; or two of the at least two annular protrusions are separated by the annular contact portion.

6. The heat exchange plate for a plate heat exchanger as claimed in claim 1, wherein
the port portion comprises: a first annular portion surrounding the opening, wherein an inner edge of the first annular portion constitutes an edge of the opening; and a second annular portion surrounding the first annular portion and adjoining the first annular portion, wherein at least a part of one of the first annular portion and the second annular portion constitutes the protrusion.

7. The heat exchange plate for a plate heat exchanger as claimed in claim 6, wherein

a plurality of circumferentially-spaced parts of at least one of the first annular portion and the second annular portion constitute a plurality of protrusions; or
one of the first annular portion and the second annular portion constitutes an annular protrusion; or
one of the first annular portion and the second annular portion constitutes an annular protrusion, and a plurality of circumferentially-spaced parts of the other of the first annular portion and the second annular portion constitute a plurality of protrusions.

8. The heat exchange plate for a plate heat exchanger as claimed in claim 1, wherein
the port portion comprises: a first annular portion surrounding the opening, wherein an inner edge of the first annular portion constitutes an edge of the opening; a second annular portion surrounding the first annular portion and adjoining the first annular portion; and a third annular portion surrounding the second annular portion and adjoining the second annular portion, wherein at least a part of at least one of the first annular portion, the second annular portion and the third annular portion constitutes a protrusion.

9. The heat exchange plate for a plate heat exchanger as claimed in claim 8, wherein

the second annular portion and the third annular portion protrude toward the second side relative to a part of a surface of the port portion to constitute protrusions, at least a part of the first annular portion constitutes a contact portion, and a protrusion amount of the second annular portion relative to the contact portion is less than a protrusion amount of the third annular portion.

10. The heat exchange plate for a plate heat exchanger as claimed in claim 8, wherein
one of the first annular portion, the second annular portion and the third annular portion constitutes an annular protrusion, and a plurality of circumferentially-spaced parts of a further one of the first annular portion, the second annular portion and the third annular portion constitute a plurality of protrusions.

11. The heat exchange plate for a plate heat exchanger as claimed in claim 1, wherein
the port portion comprises: a plurality of annular portions surrounding the opening, wherein an inner edge of the innermost annular portion constitutes an edge of the opening, two adjacent annular portions of the plurality of annular portions adjoin each other, and at least a part of at least one of the plurality of annular portions constitutes the protrusion.

12. The heat exchange plate for a plate heat exchanger as claimed in claim 11, wherein
at least one of the plurality of annular portions protrudes toward the second side relative to a part of a surface of the port portion to constitute an annular protrusion; or a plurality of circumferentially-spaced parts of at least one of the plurality of annular portions protrude toward the second side relative to the part of the surface of the port portion to constitute a plurality of protrusions.

13. A plate heat exchanger, comprising:
a plurality of heat exchange plates, each being the heat exchange plate as claimed in any one of claims 1 to 12.

14. The plate heat exchanger as claimed in claim 13, wherein
protrusions of two adjacent heat exchange plates hermetically connected to each other at the port portions thereof protrude in directions away from each other, and a gap between two protrusions is in the range of 0.2-0.3 mm.

15. The plate heat exchanger as claimed in claim 13, wherein
protrusions of two adjacent heat exchange plates hermetically connected to each other at the port portions thereof protrude in directions away from each other, a gap between two protrusions is in the range of 0.2-0.3 mm, and the gap between the two protrusions is filled with a brazing alloy for brazing the plate heat exchanger, so as to braze the two protrusions together.

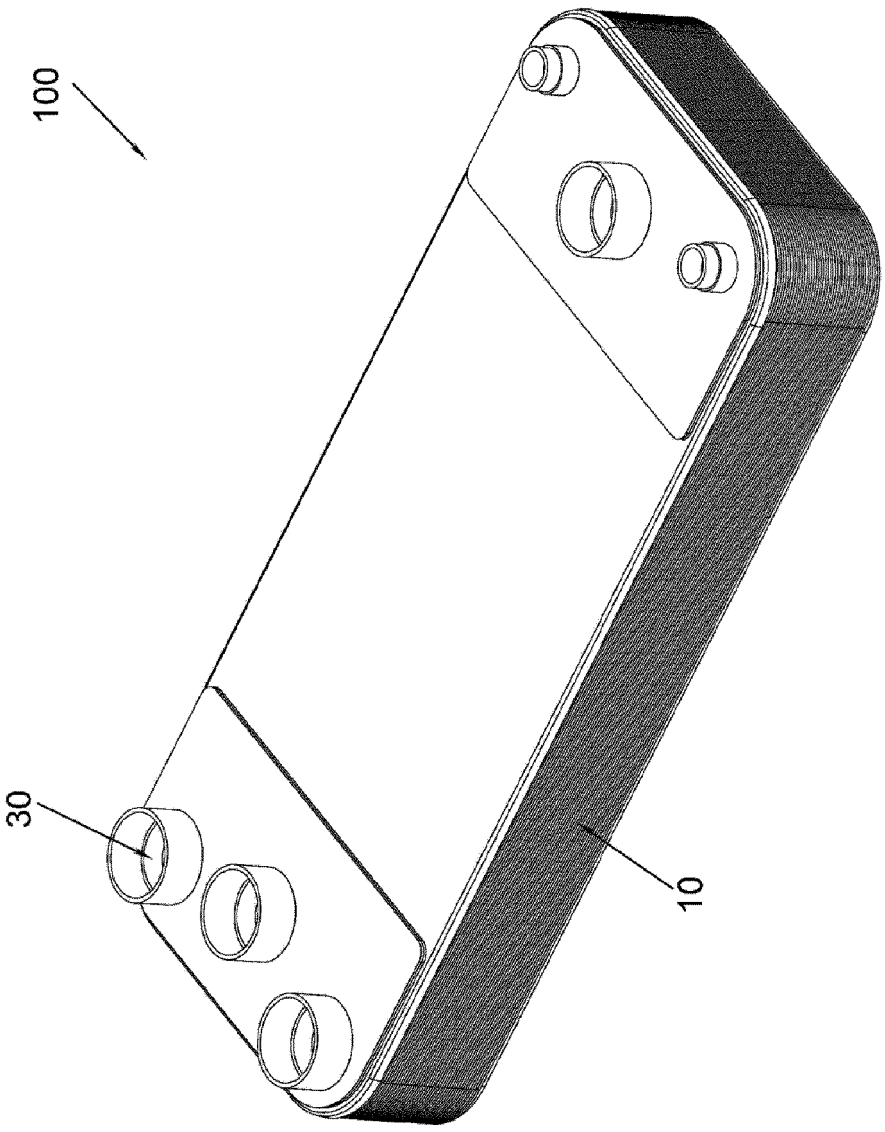

FIG. 1

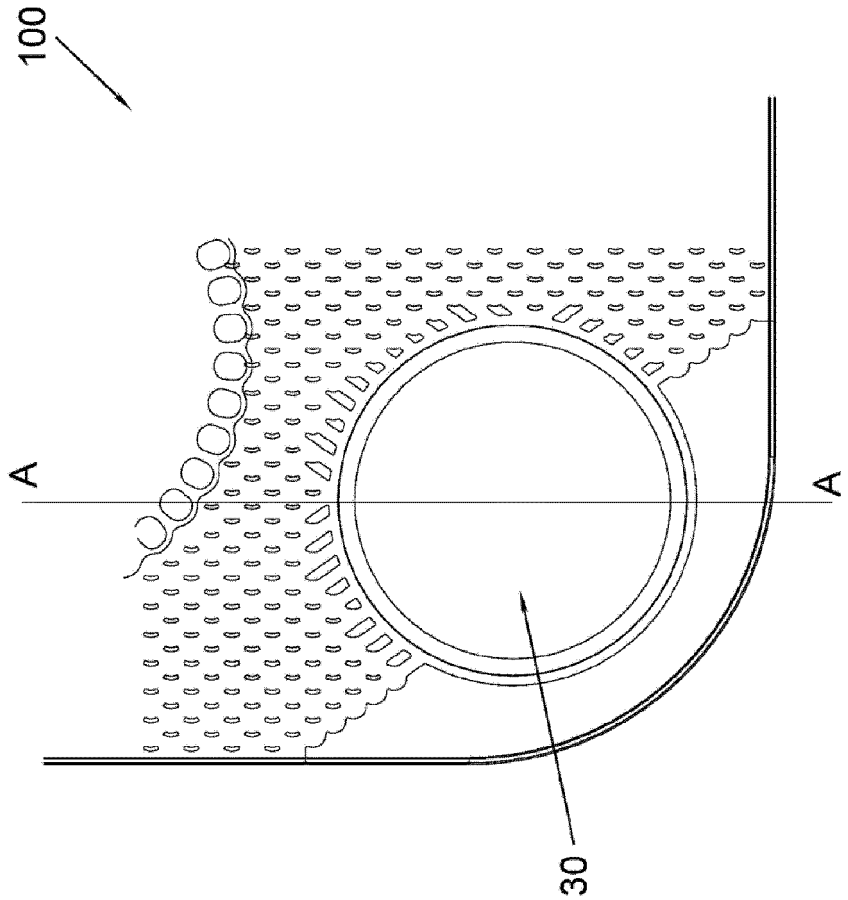

FIG. 2

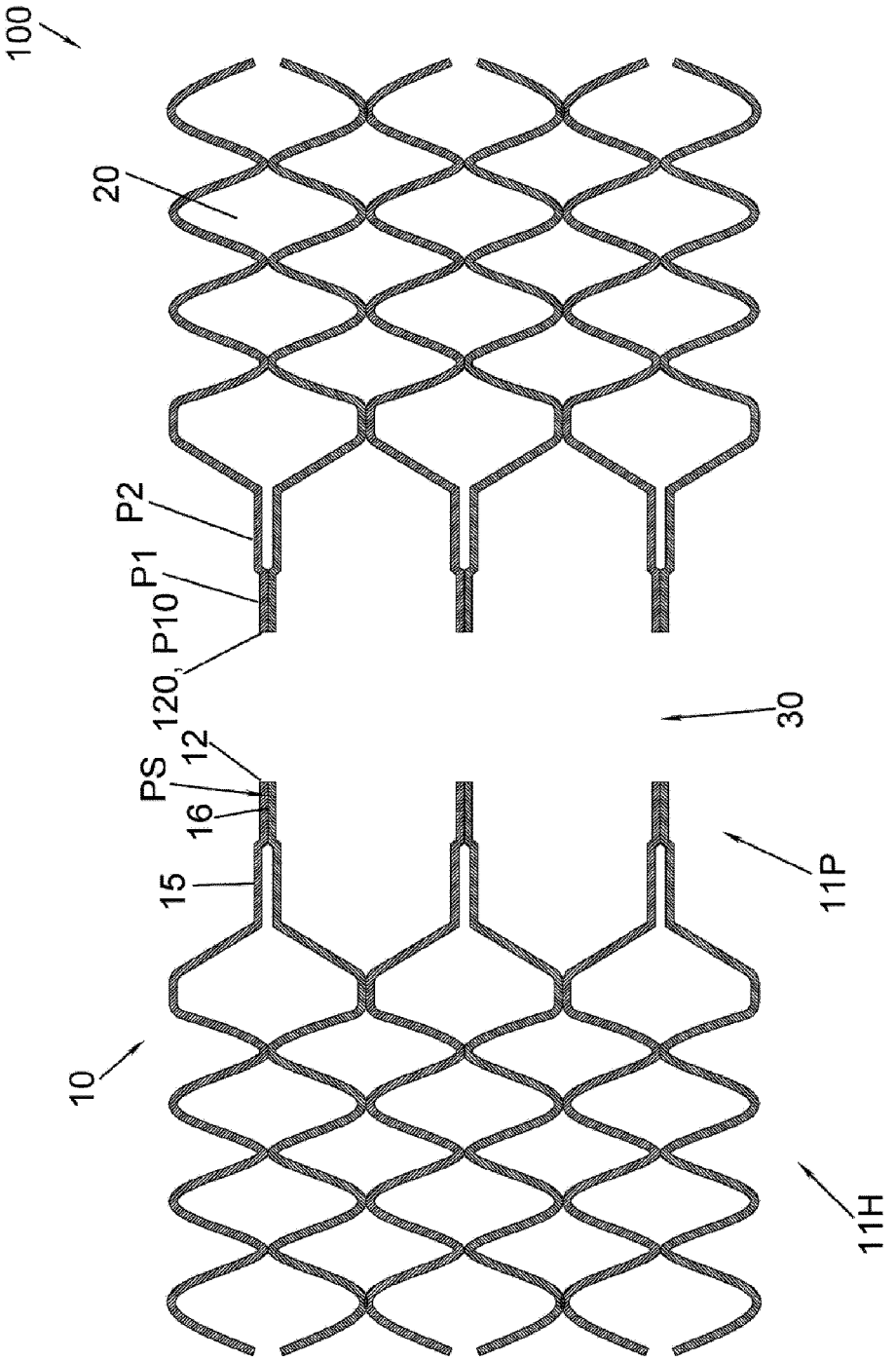

FIG. 3

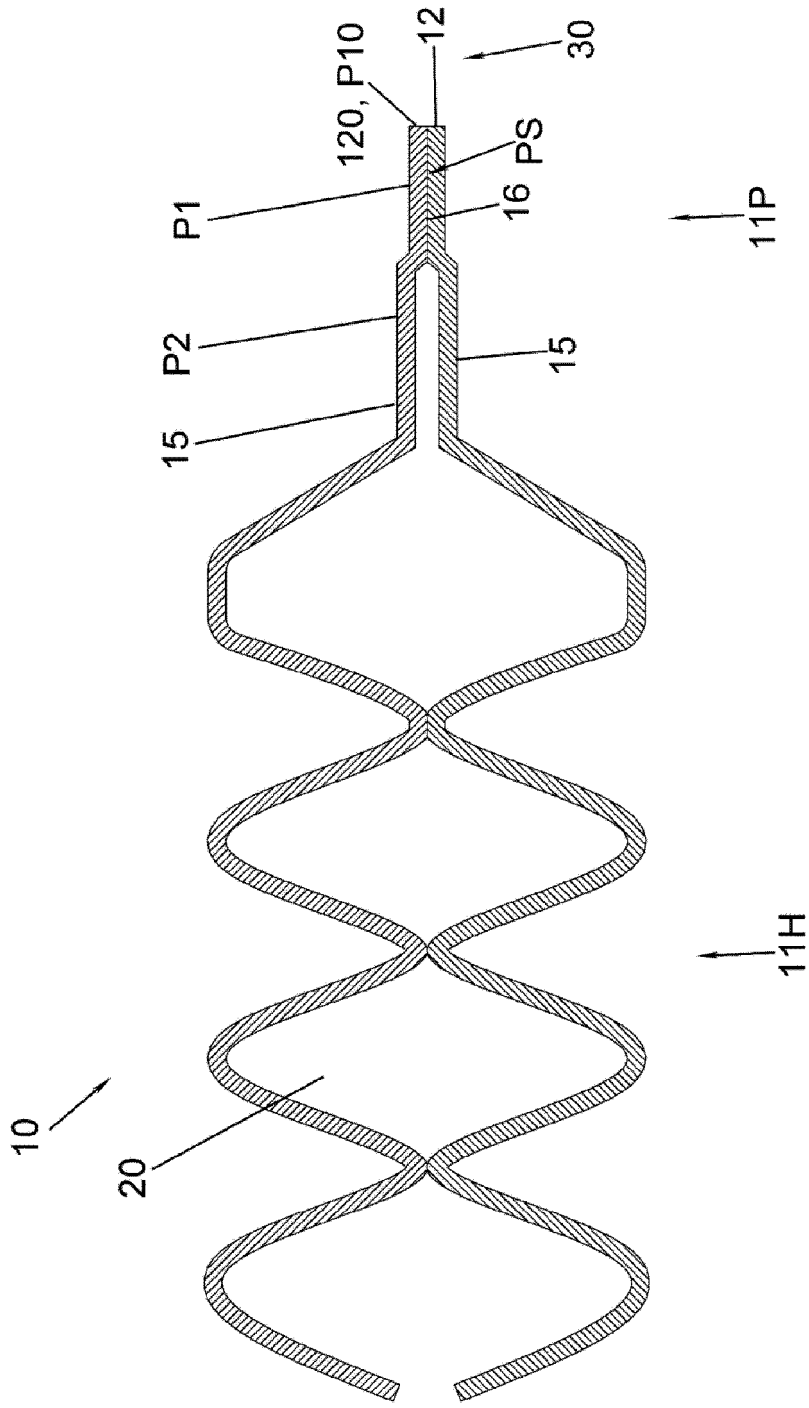

FIG. 4

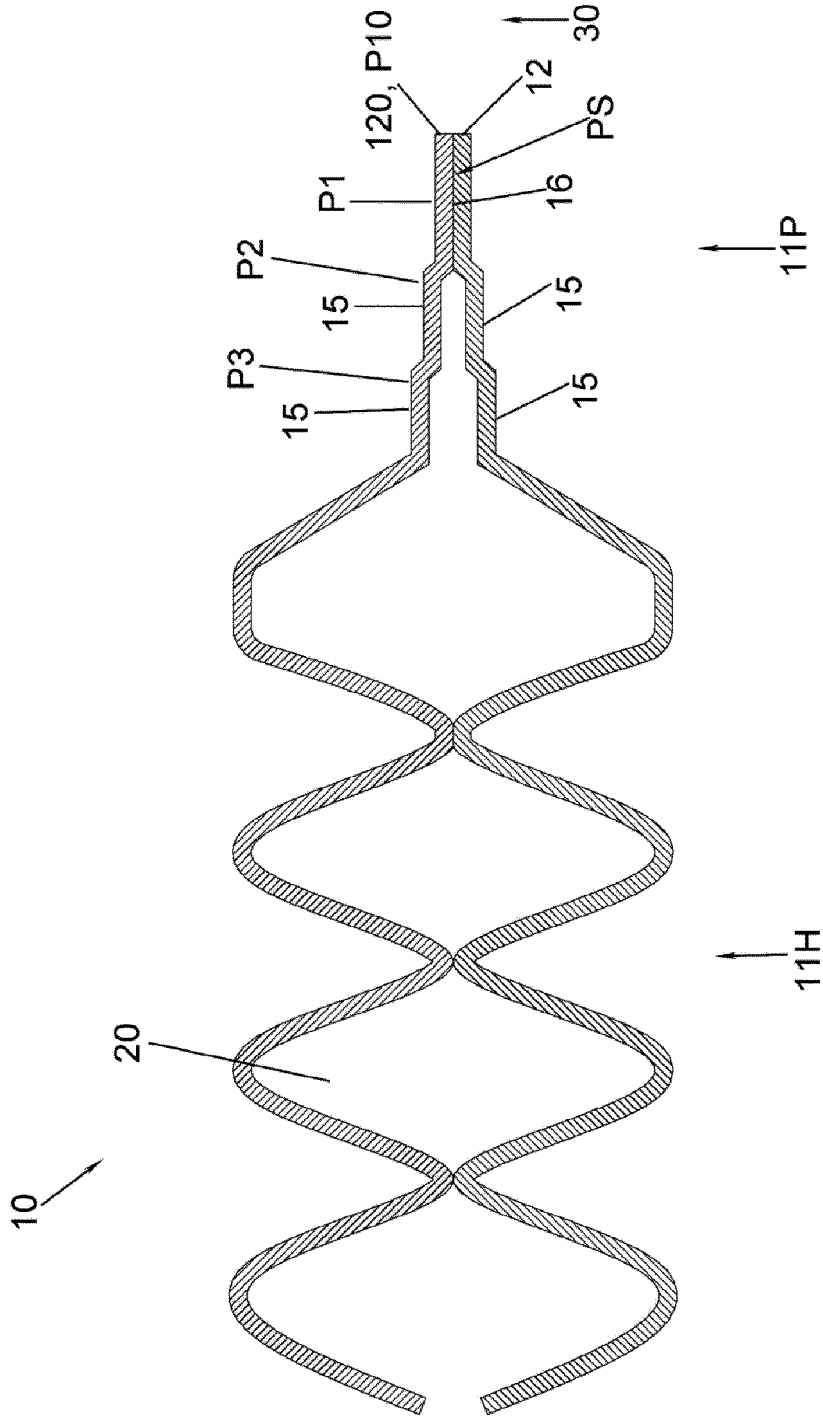

FIG. 5

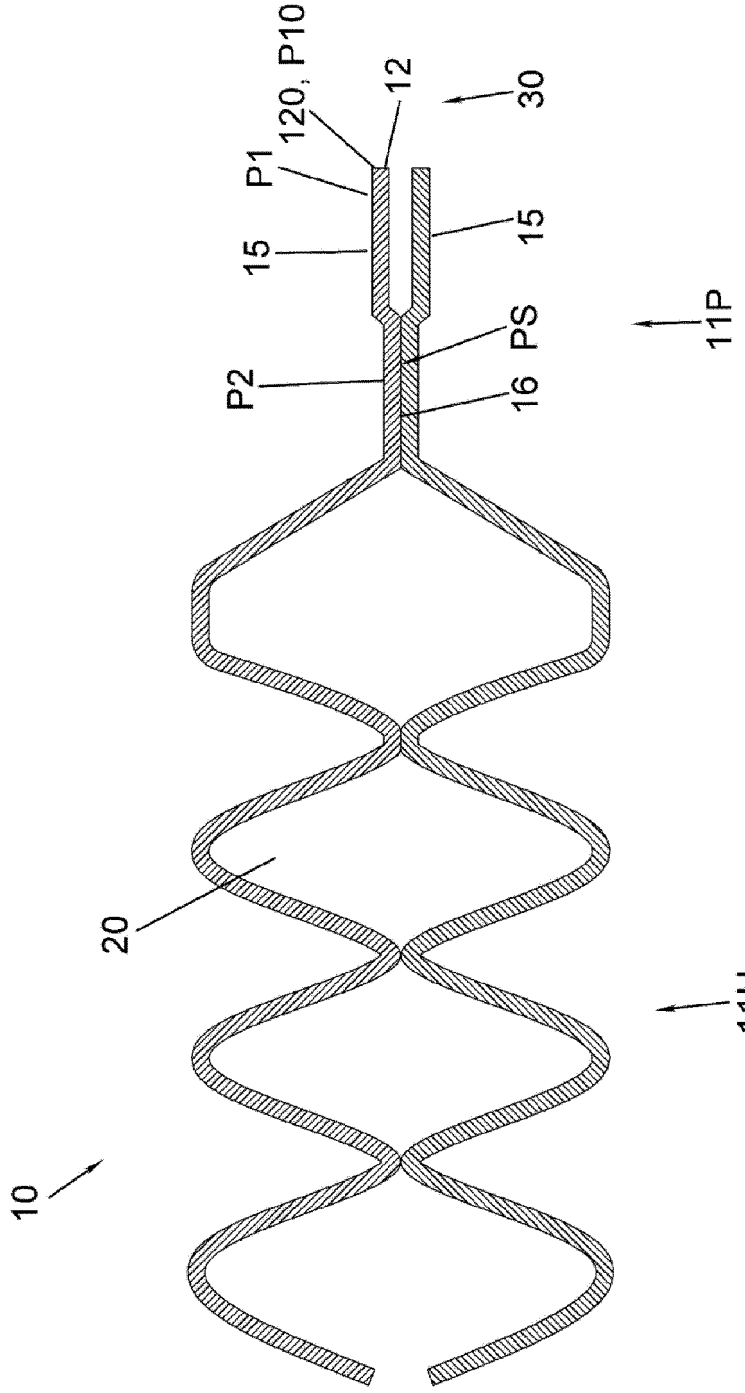

FIG. 6

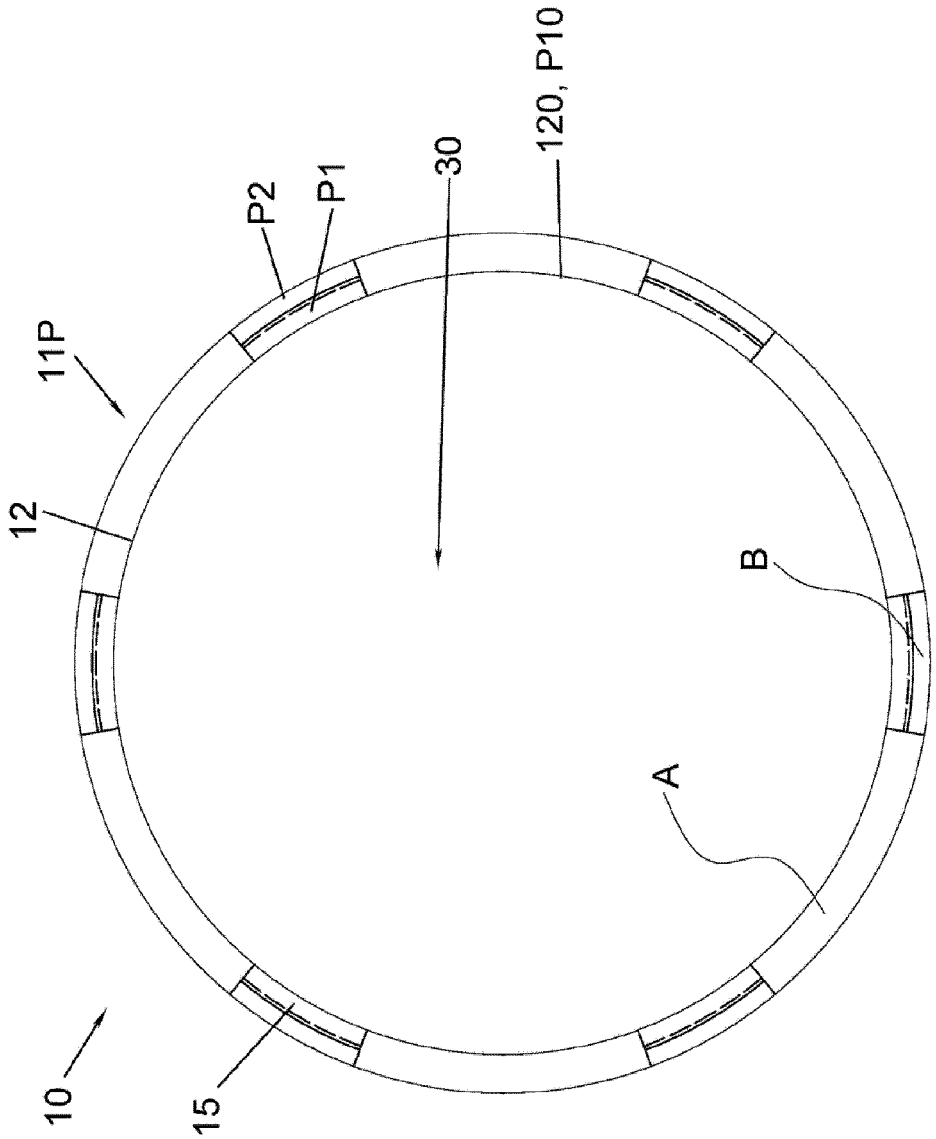

FIG. 7

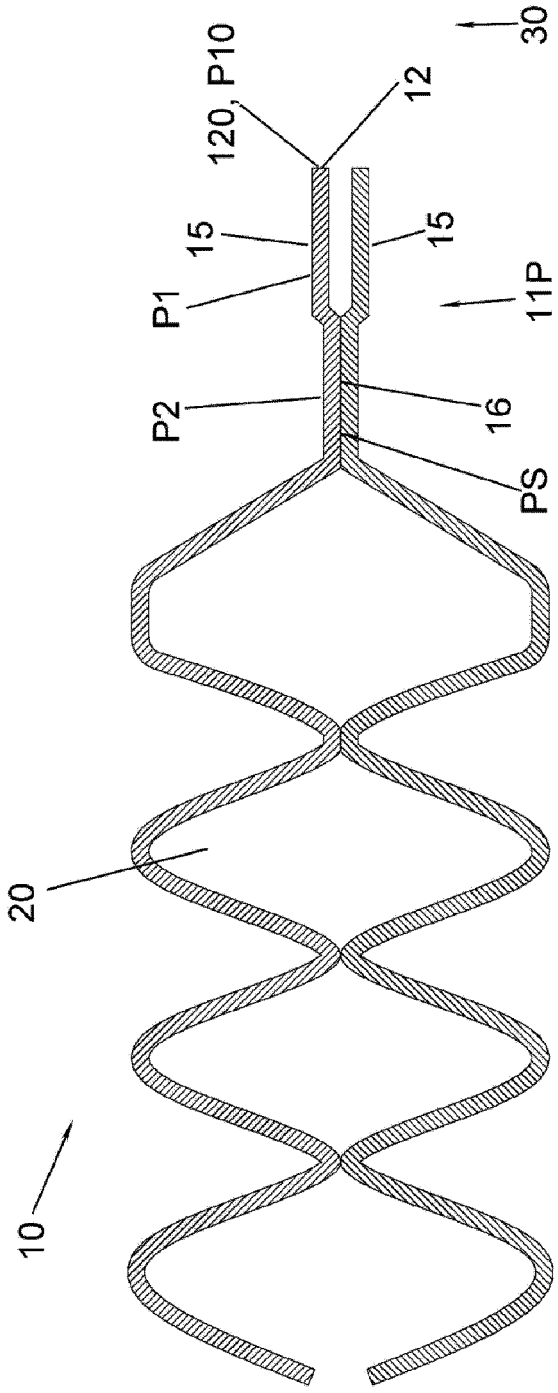

FIG. 8A

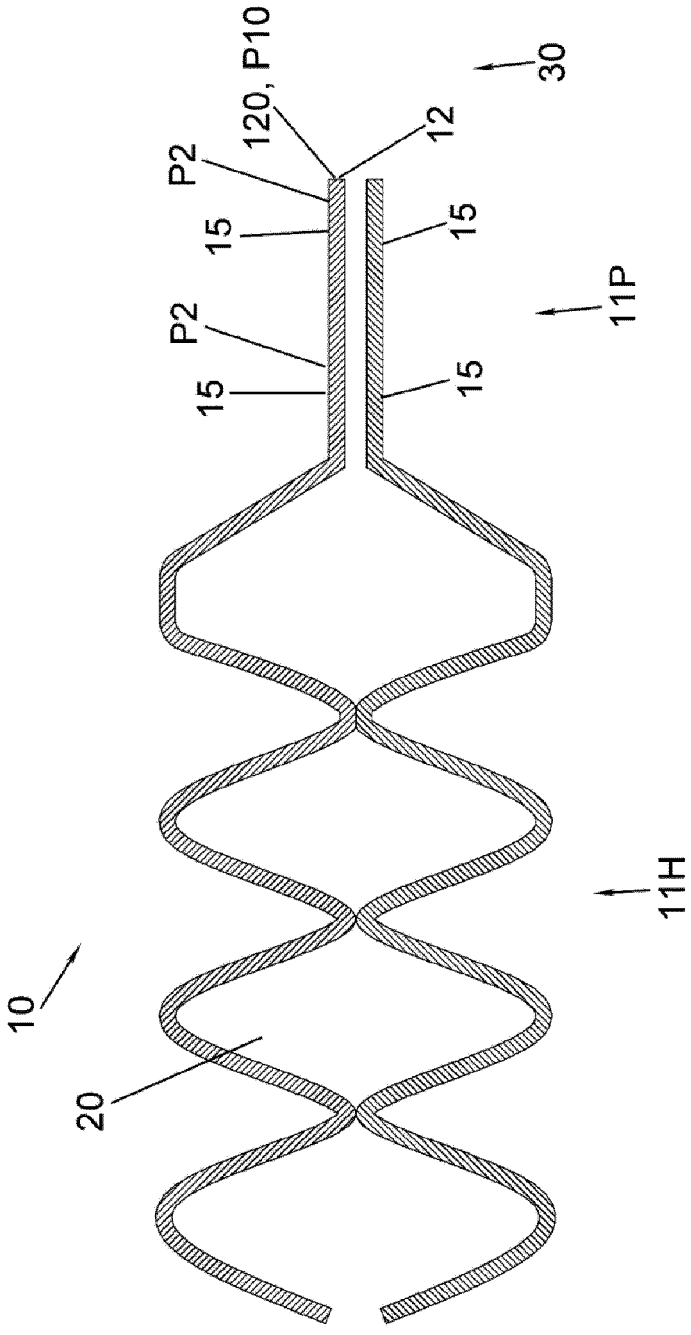

FIG. 8B

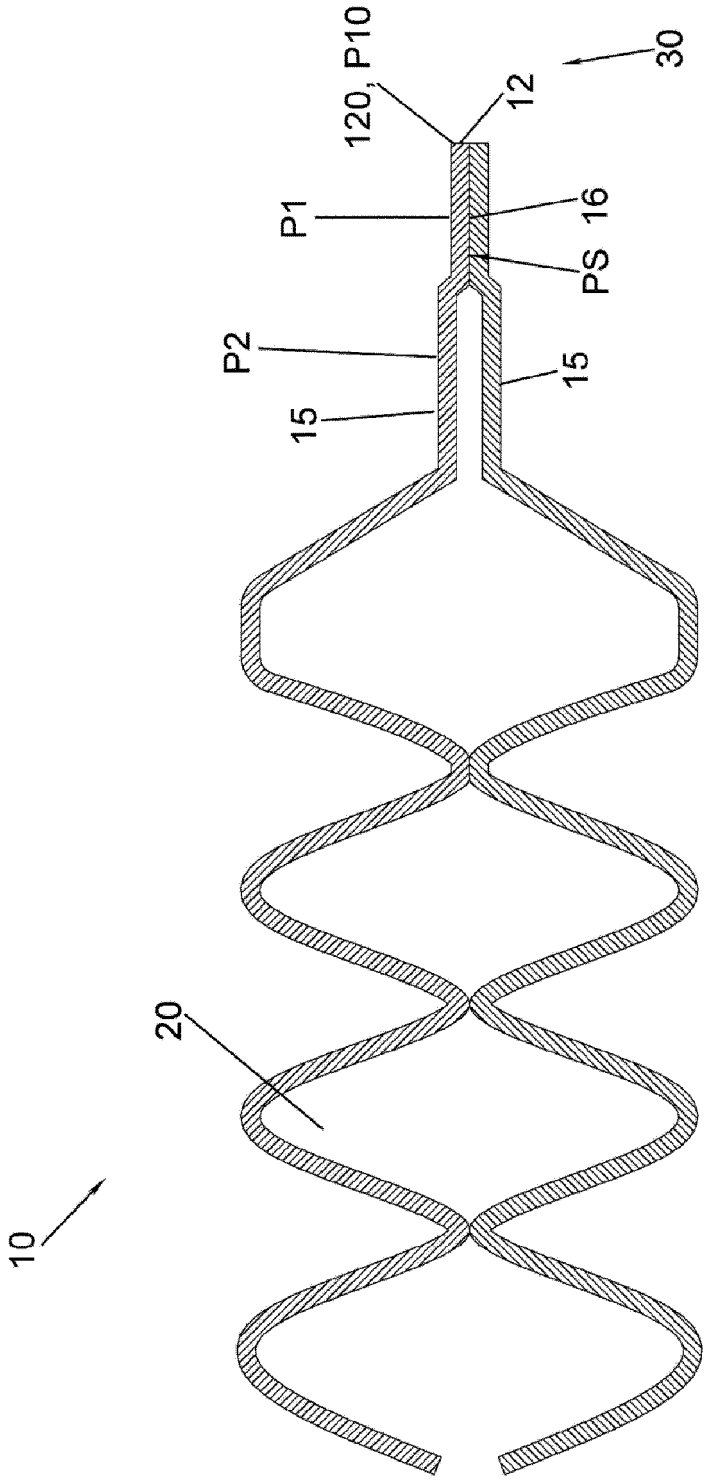

FIG. 9A

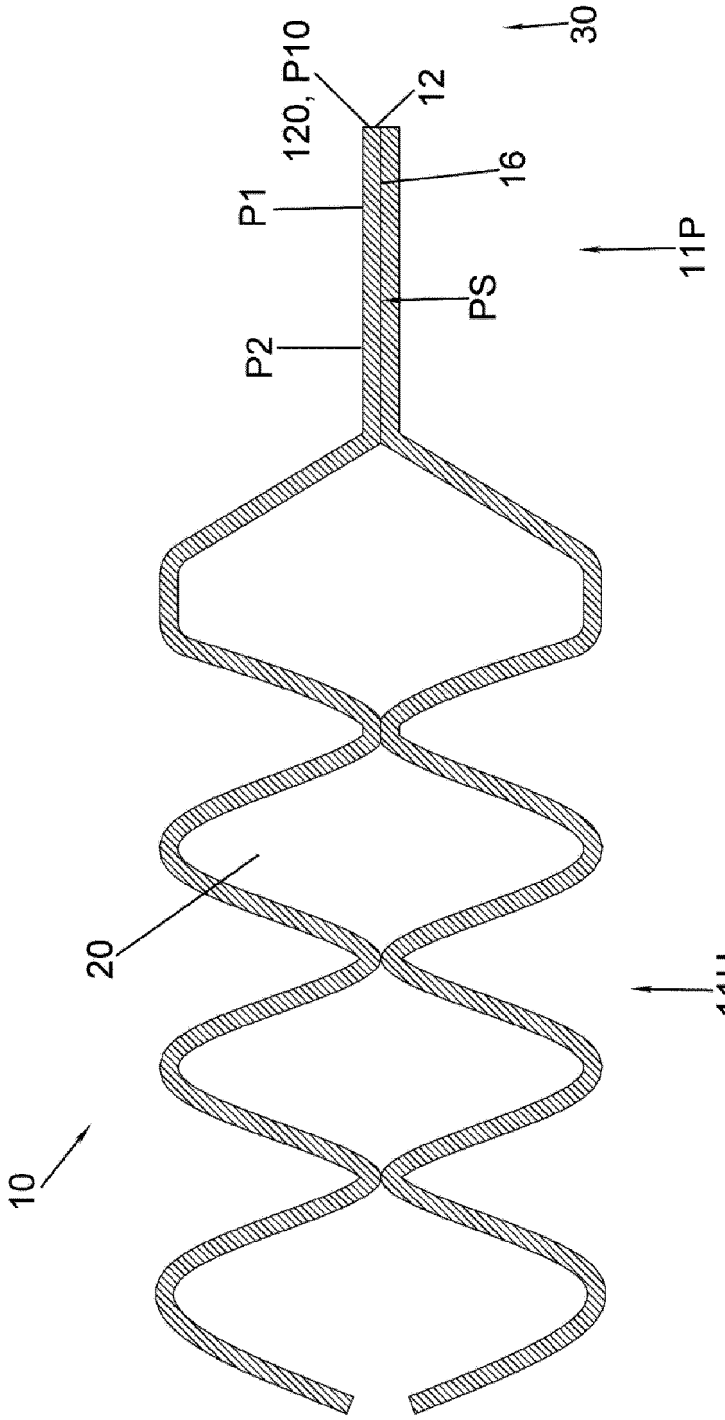

FIG. 9B

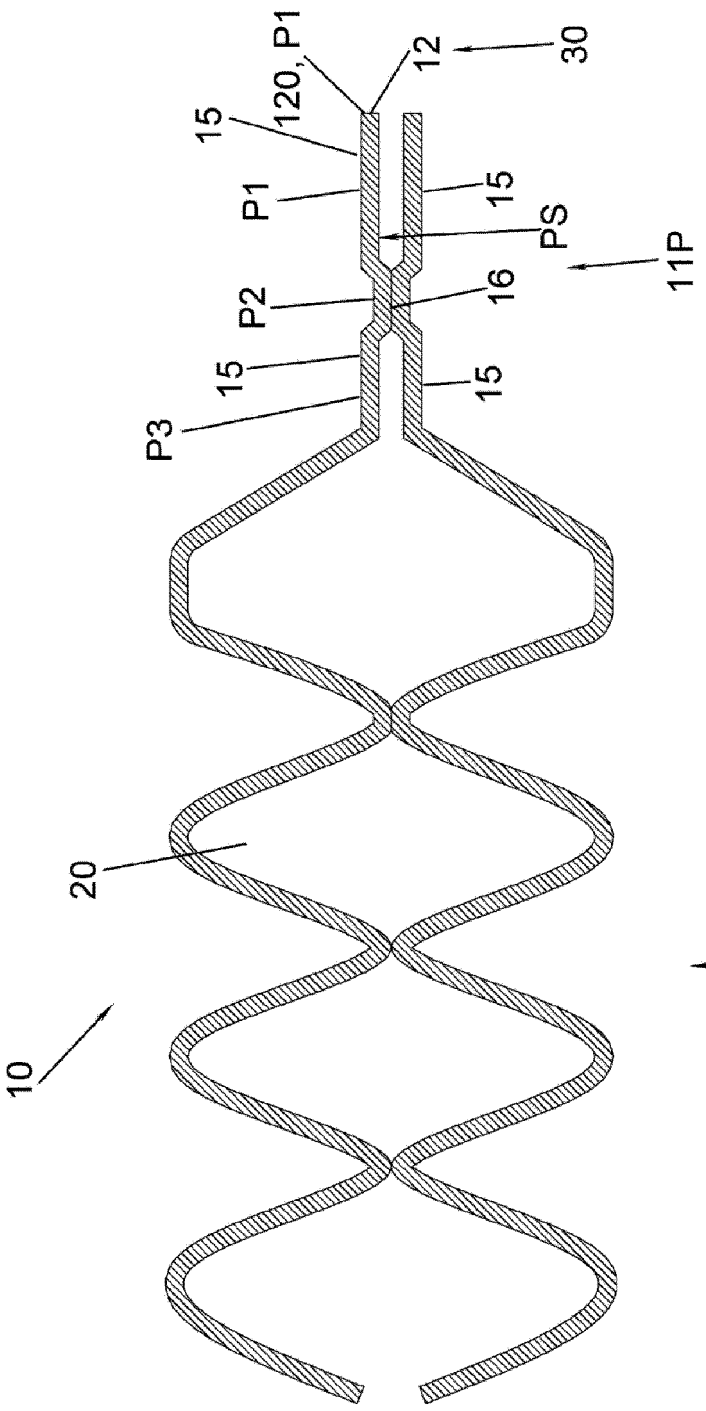

FIG. 10A

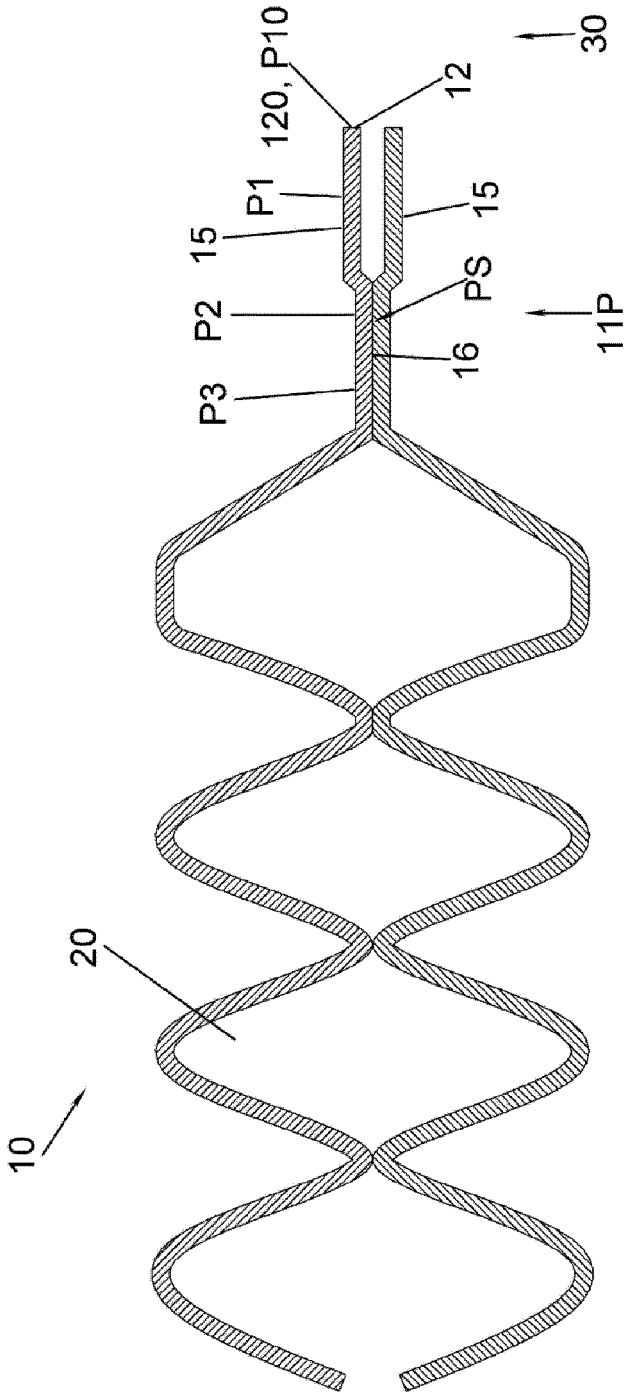

FIG. 10B

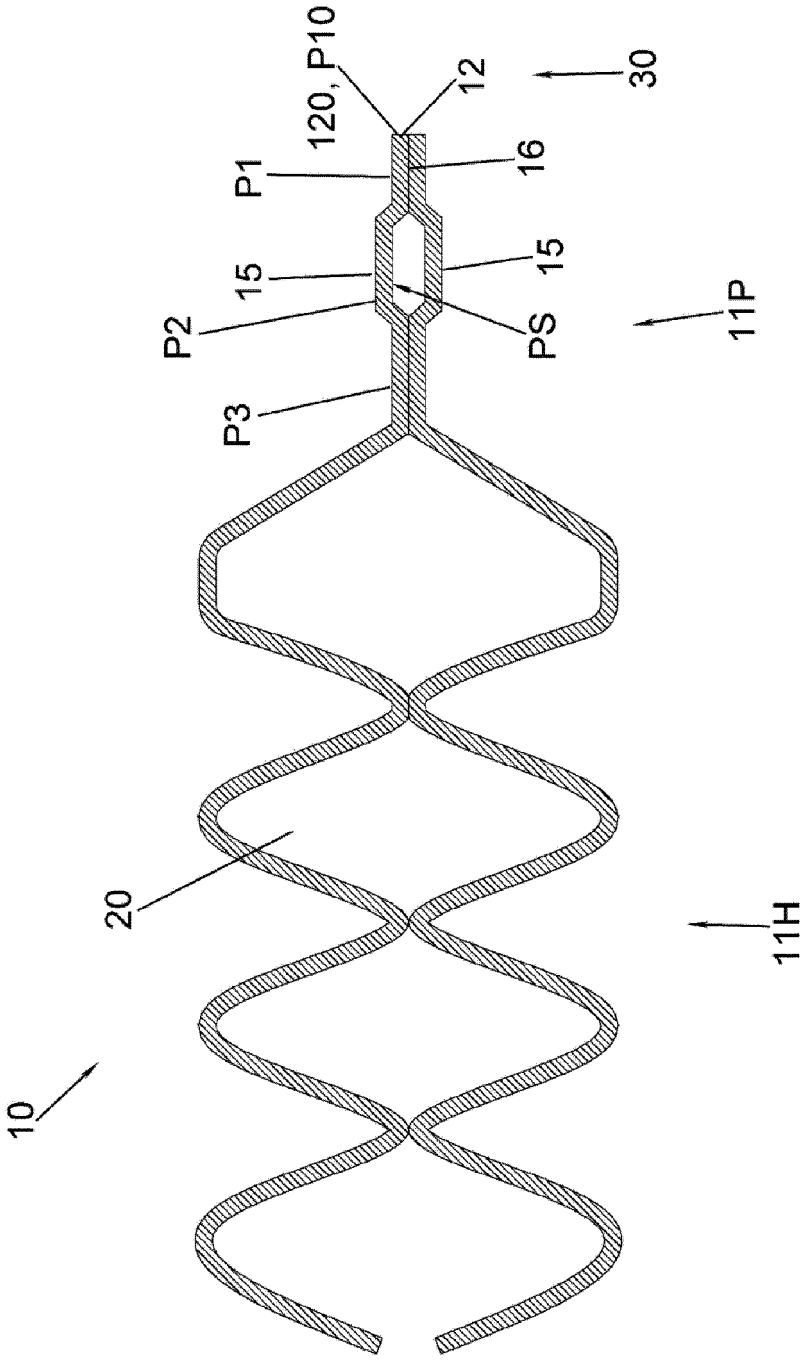

FIG. 11A

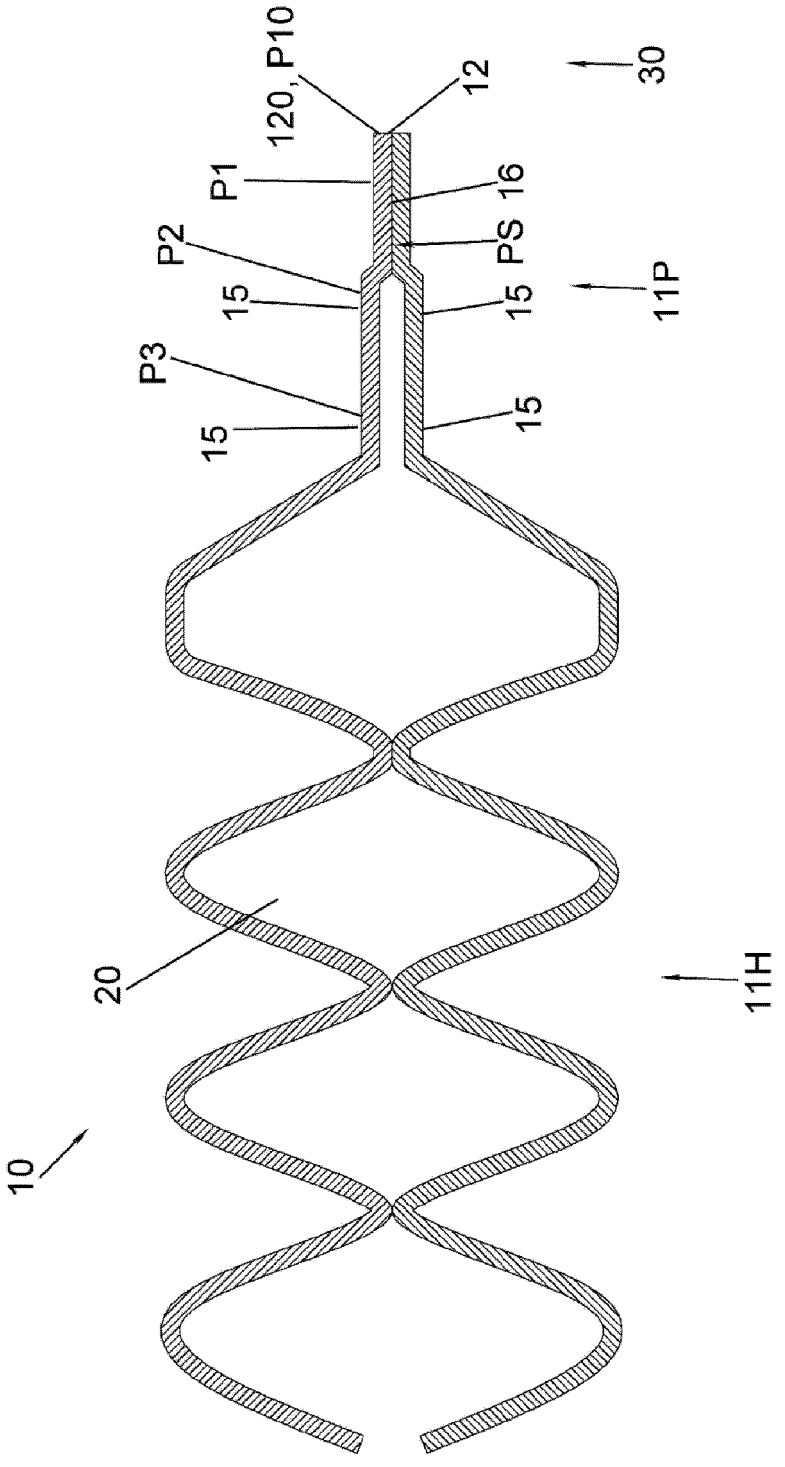

FIG. 11B

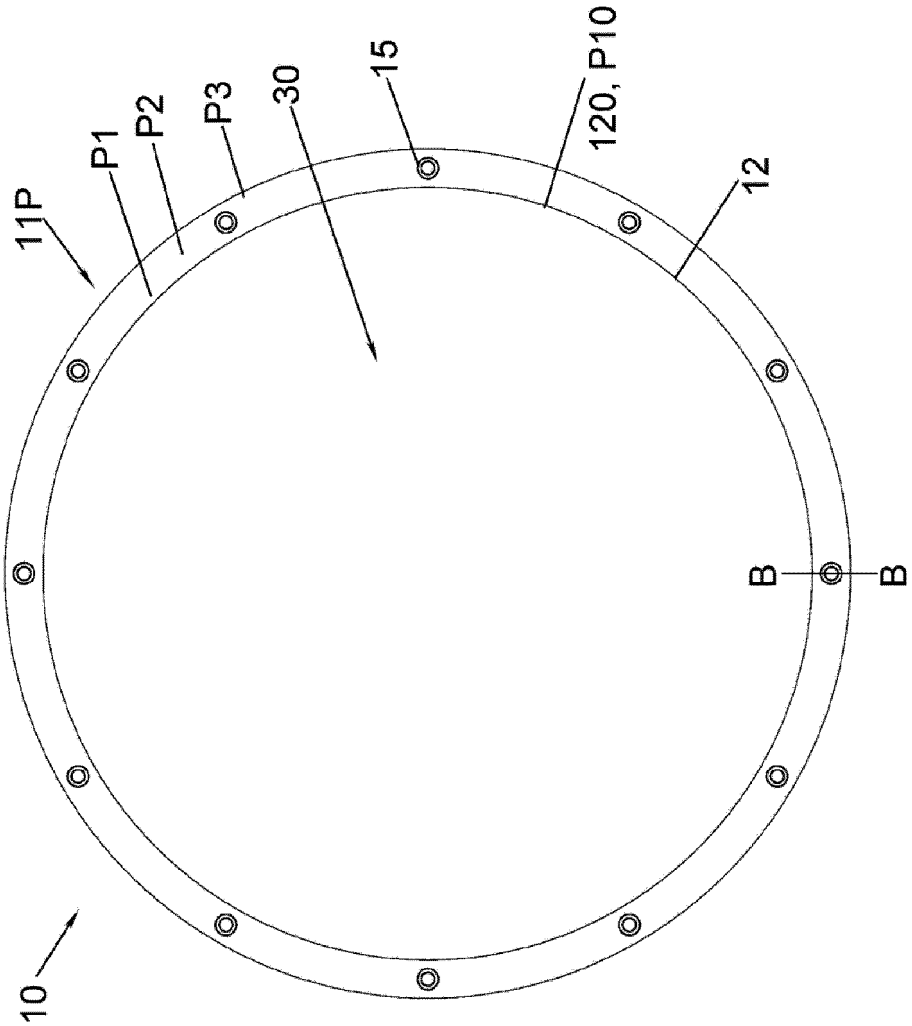

FIG. 12A

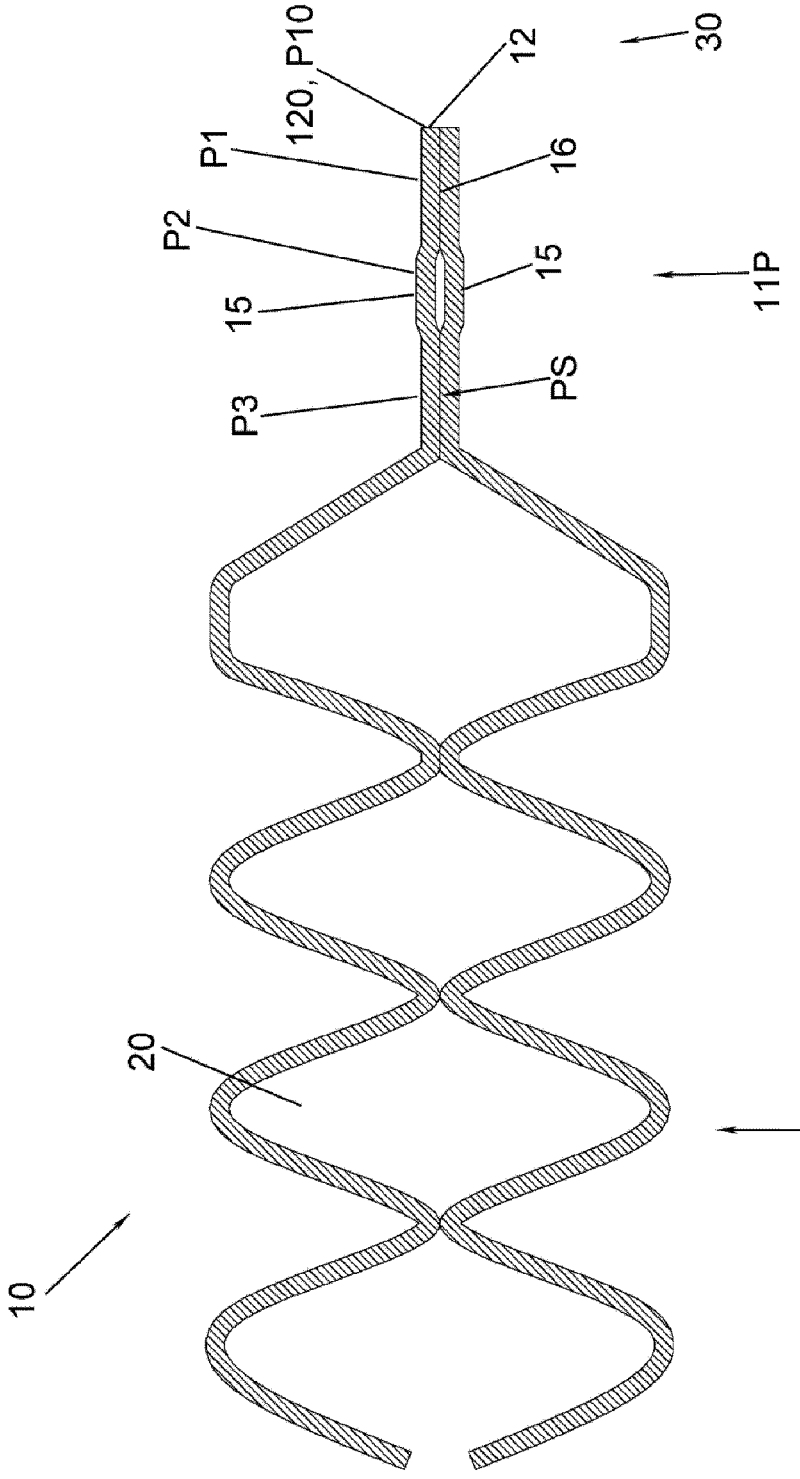

FIG. 12B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2020/124321

A. CLASSIFICATION OF SUBJECT MATTER

F28F 3/08(2006.01)i; F28D 9/04(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F28F; F28D; F25B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNABS, VEN, CNKI: 丹佛斯有限公司, 换热器, 板式换热器, 突起, 端口, 板式, 热交换器, 凸起, 板, 接触, heat exchang+, plate, panel, board, sheet, port, protrude, convex, bulge, touch

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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) description, paragraphs [0043]-[0059], and figures 1-12	1-4, 13
X	CN 106403666 A (MAHLE FILTER SYSTEMS JAPAN CORPORATION) 15 February 2017 (2017-02-15) description, paragraphs [0045]-[0075], and figures 1-12	1-15
X	CN 103162473 A (HYUNDAI MOTOR COMPANY) 19 June 2013 (2013-06-19) description, paragraphs [0043]-[0117], and figures 1-4	1-15
X	CN 104380022 A (ALFA LAVAL CORPORATE AB) 25 February 2015 (2015-02-25) description, paragraphs [0042]-[0068], and figures 1-13	1-4, 13
X	CN 109073325 A (ALFA LAVAL CORPORATE AB) 21 December 2018 (2018-12-21) description, paragraphs [0045]-[0084], and figures 1-5	1-4, 13
A	CN 109154475 A (ALFA LAVAL CORPORATE AB) 04 January 2019 (2019-01-04) entire document	1-15
A	US 5307869 A (ALFA LAVAL THERMAL) 03 May 1994 (1994-05-03) entire document	1-15

☑ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* 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
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"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
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"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

Date of the actual completion of the international search	Date of mailing of the international search report
23 December 2020	**07 January 2021**
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** Facsimile No. **(86-10)62019451**	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2020/124321

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	CN 206787364 U (JIANGSU FEKS HEAT TRANSFER TECHNOLOGY CO., LTD.) 22 December 2017 (2017-12-22) entire document	1-15

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Information on patent family members

International application No.
PCT/CN2020/124321

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International application No.
PCT/CN2020/124321

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