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(54) Title: VASCULAR CLAMP

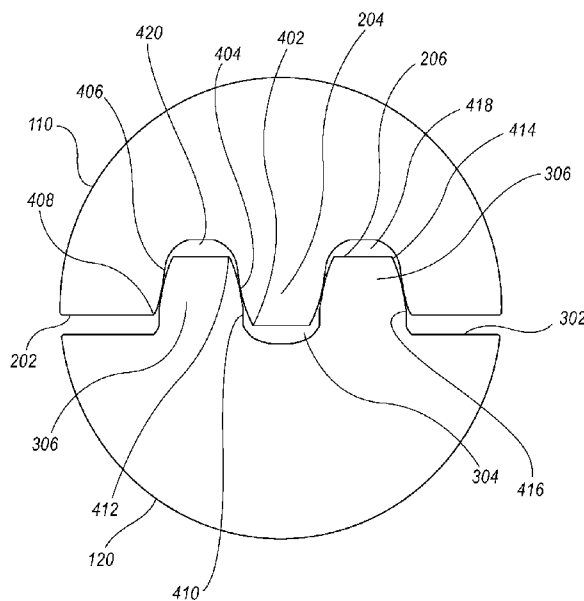


FIG. 4

(57) Abstract: A vascular clamp comprising a first elongated member and a second elongated member. The first elongated member has first distal section and a first proximal section. The first distal section has a first elongated portion and a first clamping member. The second elongated member has a second distal section and a second proximal section. The second distal section comprises a second elongated portion and a second clamping member, the second elongated member pivotably attached to the first elongated member, the first and the second clamping members having a clamped position where the first and the second clamping members are in contact with each other. The first clamping member has a first clamping surface disposed along the first clamping member. The first clamping surface comprises a first protrusion having a first lower portion and a first apex, wherein the first lower portion is wider than the first apex.

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RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH,
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VASCULAR CLAMP

TECHNICAL FIELD

5 The present disclosure relates to vascular clamps used to achieve haemostasis.

BACKGROUND

Vascular clamps are routinely employed by surgeons to manipulate and occlude blood vessels to prevent blood flow to prevent a patient from bleeding out during a surgical procedure.

10 To achieve haemostasis, especially in the case of the great vessels, the jaws of the vascular clamp must deliver significant clamping force and, in the process, can lead to damage to a blood vessel wall. While existing clamps such as The Surtex® Lemole Strong Aortic Clamps or Teleflex® Strong Aorta Clamp both feature jaw profiles that seek to provide a secure hold without damage the wall of the blood vessel, the opportunity for improved clamps that further

15 reduce the possibility of blood vessel damage while maintaining a secure grip on the blood vessel exists.

SUMMARY OF DISCLOSURE

One aspect of the invention is a vascular clamp comprising a first elongated member

20 having a first distal section and a first proximal section, said first distal section comprising a first elongated portion and a first clamping member, a second elongated member having a second distal section and a second proximal section, said second distal section comprising a second elongated portion and a second clamping member, the second elongated member pivotably attached to the first elongated member, the first and the second clamping members

25 having a clamped position where the first and the second clamping members are in contact with each other the first and second proximal section each comprising a linear portion of a predefined length where the first clamping member comprises a first clamping surface disposed along the first clamping member, the first clamping surface comprising a first protrusion, the first protrusion having a first lower portion and a first apex, wherein the first lower portion is

30 wider than the first apex.

Optionally, the first protrusion substantially spans the first clamping surface, the first protrusion disposed between two recesses, the two recesses each having a second lower portion and a second apex wherein the second lower portion is narrower than the second apex.

5 Optionally, the second clamping member comprises a second clamping surface disposed along the second clamping member comprising a first recess, the first recess having a third lower portion and a third apex, wherein the third lower portion is narrower than the third apex, the first recess disposed between two protrusions, each having a fourth base and fourth apex wherein the fourth base is wider than the fourth apex.

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Optionally, when in the clamped position, the first protrusion and the two protrusions are disposed substantially within the first recess and the two recesses respectively.

Optionally, the first clamping member further comprises a plurality of protrusions
15 disposed along the first clamping surface. Optionally, the second clamping member further comprises a plurality of recesses disposed along the second clamping surface such that when in the clamped position, each of the plurality of protrusions are disposed substantially within a corresponding recess of the plurality of recesses. Optionally, the plurality of protrusions are each substantially hemispherical.

20

Optionally, each of the first and second distal sections are joined to their respective first and second proximal sections at a predefined angle. Optionally, the predefined length is in a range from about 8 cm to about 16 cm. Optionally, the predefined length is about 12 cm. Optionally, the predefined angle is more than about 135° and less than about 180°. Optionally,
25 the predefined angle is more than about 150° and less than about 180°.

Optionally, the clamp is to be used for a minimally invasive surgery or MIS. Optionally, the surgery is a coronary artery bypass grafting (or CABG) surgery.

30 Optionally, the vascular clamp is manufactured at least partially from a material comprising a metal, an alloy, a polymer or a composite material. Optionally, the vascular clamp is manufactured at least partially from stainless steel or nitinol.

Optionally, the first and second clamping member are each substantially U-shaped or substantially C-shaped. Optionally, the vascular clamp further comprises a clamp padding disposed on the first and the second clamping surface.

5 Another aspect of the invention is a vascular clamp comprising a first elongated member having a first distal section and a first proximal section, said first distal section comprising a first elongated portion and a first clamping member, a second elongated member having a second distal section and a second proximal section, said second distal section comprising a second elongated portion and a second clamping member, the second elongated
10 member pivotably attached to the first elongated member, the first and the second clamping members having a clamped position where the first and the second clamping members are in contact with each other, the first and second proximal section each comprising a linear portion of a predefined length, the first clamping member comprising a first clamping surface disposed along the first clamping member, the first clamping surface comprising a first protrusion, the
15 first protrusion having a first lower portion and a first apex, wherein the first lower portion is wider than the first apex and a second lower portion extending from the first lower portion to a first base, the second lower portion having a constant width, the first protrusion substantially spanning the first clamping surface, the first protrusion disposed between two recesses, the two recesses having a constant width.

20

Optionally, the second clamping member comprises a second clamping surface disposed along the second clamping member, the second clamping surface comprising a first recess, the first recess having a third lower portion and a third apex, wherein the third lower portion is narrower than the third apex and a fourth lower portion extending from the third
25 lower portion to a second base, the fourth lower portion having a substantially constant width, the first recess disposed between two protrusions, each having a fifth lower portion and fourth apex wherein the fifth lower portion is wider than the fourth apex.

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BRIEF DESCRIPTION OF DRAWINGS

Some non-limiting exemplary embodiments or features of the disclosed subject matter are illustrated in the drawings.

Fig. 1 is a perspective view of a vascular clamp according to some embodiments of the present disclosure.

Fig. 2 depicts the first clamping member according to some embodiments of the present disclosure.

5 Fig. 3 depicts the second clamping member according to some embodiments of the present disclosure.

Fig. 4 depicts a cross sectional view of the first and second clamping member in a clamped position according to some embodiments of the present disclosure.

10 Fig. 5 depicts a cross sectional view of the first and second clamping member in a clamped position according to some embodiments of the present disclosure.

Fig. 6 depicts the first clamping member with a plurality of protrusions according to some embodiments of the present disclosure.

Fig. 7 depicts the second clamping member with a plurality of recesses according to some embodiments of the present disclosure.

15 Fig. 8 depicts a cross sectional view of the first and second clamping member in a clamped position according to some embodiments of the present disclosure.

DETAILED DESCRIPTION

20 Described herein are various non-limiting embodiments and configurations of devices for achieving either partial or occlusion of a blood vessel of interest. The blood vessel of interest may be an artery or a vein.

Referring to Figs. 1 and 2, an aspect of the present disclosure is vascular clamp 100 comprising first elongated member 102 with first distal section 104 and first proximal section 106. The first distal section 104 in turn comprises first clamping member 110 and first elongated portion 108 disposed between the first clamping member 110 and the first proximal section 106.
25

The vascular clamp further comprises second elongated member 112 with second distal section 114 and second proximal section 116. The second distal section 114 in turn comprises

second clamping member 120 and second elongated portion 118 disposed between the second clamping member 114 and the second proximal section 116.

The first elongated member 102 and the second elongated member 112 are pivotably
5 attached to each other by way of hinge mechanism 119, for example, a box lock disposed
between the first elongated portion 108 and the second elongated portion 118. In this manner,
a user, typically a surgeon, can bring the first clamping member 110 and the second clamping
member 120 into contact with each other to achieve a clamped position using optional finger
10 holes 122, disposed at distal ends of each of the first distal section 104 and the second distal
section 114. While the clamped position is described above as contact between the first
clamping member 110 and second clamping member 120, in practice, tissue/organs to be
clamped typically prevent contact. The clamped position can therefore be understood to also
refer to bringing the first clamping member 110 and the second clamping member 120 towards
15 each other such that a desired clamping force is applied to an organ/ tissue of interest. Ratchet
124 allows the user to keep the first clamping member 110 and the second clamping member
120 in a clamped position at varying pressures depending on specific requirements.

The first proximal section 106 and the second proximal section 116 each comprise a
linear portion of a predefined length. In some embodiments, the predefined length is about 8
20 cm to about 16 cm. In some embodiments, the predefined length is about 12cm. In some
embodiments, each of the first distal section 108 and the second distal section 118 are joined
to their respective the first proximal section 106 and the second proximal section 116 at a
predefined angle. The predefined angle may be more than about 135° and less than about 180°
or more than about 150° and less than about 180°. In one embodiment, the vascular clamp may
25 have a combination of any of the predefined lengths and any of the predefined angles as
described above.

Referring to Figs. 2 and 4, the first clamping member 110 comprises first clamping
surface 202 disposed substantially perpendicular to a longitudinal axis of the vascular clamp
30 (100 of Fig. 1) and inwardly towards the second elongated member (112 of Fig. 1). The first
clamping surface 202 spans substantially a length of the first clamping member (110 of Fig. 1).
The first clamping surface 202 comprises first protrusion 204 that may likewise span the length
of the first clamping surface 202. The first protrusion 204 may optionally be serrated for
improved grip. The first protrusion 204 has a first lower portion 404 and a first apex 402. The

first protrusion 204 has angled longitudinal surfaces such that the first lower portion 404 is wider than the first apex 402.

5 The first protrusion 204 may be located between two recesses 206 disposed on either side of the first protrusion 204. Each of the two recesses 206 has second lower portion 406 and second apex 408. Longitudinal surfaces of each of the two recesses 206 follow the angled vertical surfaces of the first protrusion 204 resulting in each of the second lower portion 406 being narrower than each of the second apex 408. Each of the second lower portion 406 may be continuous with the first lower portion 404.

10

Referring to Figs. 3 and 4, the second clamping member 120 has second clamping member surface 302 disposed substantially perpendicular to the longitudinal axis of the vascular clamp 100 and inwardly towards the first elongated member 102. The second clamping surface 302 may span substantially a length of the second clamping member 120.

15 The second clamping surface 302 comprises first recess 304 and similarly, may span the length of the second clamping surface 302. The first recess 304 has third lower portion 410 and third apex 412. The first recess 304 has angled longitudinal surfaces such that the third lower portion 410 is narrower than the third apex 412.

20 The first recess 304 may be located between two protrusions 306 disposed on either side of the first recess 304. Each of the two protrusions 306 has fourth lower portion 416 and fourth apex 414. Like in the case of the first protrusion 204, the two protrusions 306 may optionally be serrated to improve grip. Longitudinal surfaces of each of the two protrusions 306 follow the angled longitudinal surfaces of the first recess 304 resulting in each of the fourth lower portion 416 being wider than the fourth apex 414. Each of the fourth lower portion 416 may be continuous with the third lower portion 410. The lower portions 404, 416 of the first protrusion 204 and each of the two protrusions 306 are where the respective first protrusion 204 and each of the two protrusions 306 are at their widest. A distance from the respective apexes 402, 414 to the respective lower portions 404, 416 span substantially the length of the respective vertical surfaces. In some embodiments, the distance from the respective apexes 402, 414 to the respective lower portions 404, 416 a shorter length of the vertical surfaces and may encompass a tip of the first protrusion 204 or the two protrusions 306. As depicted in Fig

25 30 4, the longitudinal walls from the first lower portion 404 and the fourth lower portion 416 curve

inwardly towards respective bases of the respective first protrusion 204 and the two protrusions 306.

5 The lower portions 406,410 are where the respective two recesses 206 and the first recess 304 are at their narrowest. A distance from the respective apexes 408, 412 to the respective lower portions 406,410 span substantially the length of the respective vertical surfaces. In some embodiments, the distance from the respective apexes 408, 412 to the respective lower portions 406,410 a shorter length of the vertical surfaces and may encompass a tip of the first protrusion 204 or the two protrusions 306. As depicted in Fig 4, the longitudinal
10 walls from the second lower portion 406 and the third lower portion 410 curve towards respective bases of the respective two recesses 206 and the first recess 304.

In some embodiments the respective lower portions 404, 406, 410, 416 may instead of spanning substantially the length of the respective substantially longitudinal surfaces, extend
15 all the way to the base of the respective first protrusion 204, each of the two protrusions 306, the two recesses 206 and the first recess 304.

The first clamping surface 202 and the second clamping surface 302 are aligned such that when the first elongated member 102 and the second elongated member 112 are pivoted
20 to the clamped position, the first protrusion 204 and the two protrusions 306 are disposed substantially within the first recess 304 and the two recesses 206 respectively such that there is a gap 420 between respective apexes of the first protrusion 204 and the two protrusions 306 and respective lower portions of the first recess 304 and the two recesses 206. The gap 420 arises due to a mismatch between the shape of the respective apex and corresponding recess.
25 As depicted in Fig. 4 the respective apexes have a flat profile, while the respective recesses have a curved profile that leads to a void therebetween. The size of the gap 420 is further increased by the angled longitudinal walls. The gap 420 can reduce the atraumacity of the first clamping member 110 and second clamping member 120 while in operable contact with tissue/organs of interest.

30

Alternatively, and in some embodiments, there is little to no apparent gap between respective apexes of the first protrusion and the two protrusions and respective lower portions of the first recess 304 and the two recesses 206 to improve grip.

Referring to Fig. 5, a cross-sectional view of first clamping member 502 and second clamping member 504 according to one embodiment of the present invention is depicted in the clamped position. The first clamping member 502 comprises first protrusion 506 that spans substantially the length of the first clamping member 502. The first protrusion 506 may optionally be serrated for improved grip. The first protrusion 506 comprises first lower portion 508 and first apex 510. The first protrusion 506 has angled longitudinal surfaces spanning from the first apex 510 to the first lower portion 508 such that the first lower portion 508 is wider than the first apex 510. Disposed below the first lower portion 508 is second lower portion 512 with substantially parallel longitudinal walls that extend to first base 514. The substantially parallel longitudinal walls curve as they meet the first base 514. In some embodiments, the substantially parallel longitudinal walls may meet the base at substantially a right angle.

The first protrusion 506 is located between two recesses 516 disposed on either side of the first protrusion 506. Each of the two recesses 516 has third lower portion 520 and second apex 521. The third lower portion 520 extends from the second apex 521 and substantially spans a length of the two recesses 516. Longitudinal walls of the third lower portion 520 follow the substantially parallel longitudinal walls of the first protrusion 506 resulting in the third lower portion 530 having a substantially the same width as the second apex 521.

The second clamping member 504 comprises first recess 518 and similarly, may span the length of the second clamping surface 302. The first recess 518 comprises fourth lower portion 524 and third apex 522. The first recess 518 has angled longitudinal surfaces such that the fourth lower portion 524 is wider than the third apex 522. Disposed below the fourth lower portion 524 is fifth lower portion 512 with substantially parallel longitudinal walls that extend to second base 526. The substantially parallel longitudinal walls curve as they meet the second base 526. In some embodiments, the substantially parallel longitudinal walls may meet the base at substantially a right angle. In some embodiments the recess may have a profile that is a lock and key fit for the first protrusion 506.

Disposed on either side of the first recess are two protrusions 528. Each of the two protrusions 528 has sixth lower portion 530 and fourth apex 532. Each of the two protrusions 528 may optionally be serrated for improved grip. Each of the two protrusions 528 comprise sixth lower portion 530 and fourth apex 532. Each of the two protrusions 528 have angled longitudinal surfaces spanning from the fourth apex 532 to the sixth lower portion 530 such

that the sixth lower portion 530 is wider than the fourth apex 532. As depicted in Fig 5, the longitudinal surfaces from the sixth lower portion 530 curve inwardly towards third base 534.

Referring to Figs. 6, in one embodiment the first clamping member 110 further
5 comprises a plurality of protrusions 602 disposed along the first clamping surface 202. The plurality of protrusions 602 are arranged in a single row spanning substantially the length of the first clamping surface 202. Alternatively, the plurality of protrusions 602 may be arranged in two or more rows. In some embodiments, the plurality of protrusions 602 are disposed throughout the length of the first clamping surface 202 in a disordered manner i.e. without
10 discernible or easily discernible row(s).

Referring to Fig. 7, the second clamping member 120 further comprises a plurality of recesses 702 disposed along the second clamping surface 302. The plurality of recesses 702 are arranged in a single row spanning substantially the length of the first clamping surface 202
15 such that when in the clamped position, each of the plurality of protrusions 602 is disposed substantially within a corresponding recess of the plurality of recesses 702. In some embodiments, the plurality of recesses 702 may each have a profile that is a lock and key fit for each of the plurality of protrusions 602.

20 While Fig. 6 depicts a substantially C-shaped first clamping member 110 and Fig. 7 depicts a substantially U-shaped second clamping member 120, both the first clamping member 110 and the second clamping member may either be substantially U-shaped, substantially C-shaped, or substantially linear.

25 The vascular clamp 100 may further comprise clamp padding (not shown) fitted to the first clamping surface 202 and/or the second clamping surface 302. The clamp padding (not shown) may be made of a resilient material such as but not limited to silicone or a polymer. The clamp padding (not shown) may conform to the protrusions or recesses present on the clamping surface they are fitted to.
30

Referring to Fig. 8, the plurality of protrusions 602 is substantially hemispherical in shape while each of the plurality of protrusions 602 are shaped to allow a lock and key fit between the plurality of protrusions 602 and the plurality of recesses 702. Each of the plurality of recesses 702 are sized such that they are a lock and kit fit with each of the substantially

hemispherical plurality of protrusions 602. Alternatively, the plurality of protrusions 602 are smaller than the plurality of recesses 702 such that there while in the clamped position, a gap (not shown) exists between each of the plurality of protrusions 602 and base 802 of each of the plurality of recesses 702. In some embodiments, the plurality of protrusions 602 may all be substantially hemispherical. In some embodiments, one or more of the plurality of protrusions 602 are hemispherical. In some embodiments, the plurality of protrusions 602 may be a combination of hemispheres and other shapes.

In some embodiments first clamping member 110 and/or the second clamping member 120 may have both a plurality of hemispherical protrusions and recesses on the same clamping member.

The vascular clamp 100 may be manufactured at least partially from a material comprising a metal, an alloy, a polymer or a composite material. Suitable materials include stainless steel and nickel titanium, also known as nitinol.

The corresponding structures, materials, acts, and equivalents of all means or step plus function elements in the claims below are intended to include any structure, material, or act for performing the function in combination with other claimed elements as specifically claimed. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprising", "including" and/or "having" and other conjugations of these terms, when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

The terminology used herein should not be understood as limiting, unless otherwise specified, and is for the purpose of describing embodiments only and is not intended to be limiting of the disclosed subject matter. While certain aspects of the disclosed subject matter have been illustrated and described, it will be clear that the disclosure is not limited to the aspects described herein. Numerous modifications, changes, variations, substitutions and equivalents are not precluded. It will also be appreciated by a person skilled in the art that the

present disclosure is not limited to what has been particularly shown and described hereinabove.

CLAIMS

1. A vascular clamp comprising:
a first elongated member having a first distal section and a first proximal section, said first distal section comprising:
5 a first elongated portion; and
a first clamping member;
a second elongated member having a second distal section and a second proximal section, said second distal section comprising:
a second elongated portion; and
10 a second clamping member;
the second elongated member pivotably attached to the first elongated member, the first and the second clamping members having a clamped position where the first and the second clamping members are in contact with each other;
the first and second proximal section each comprising a linear portion of a predefined
15 length;
wherein the first clamping member comprises a first clamping surface disposed along the first clamping member, the first clamping surface comprising a first protrusion, the first protrusion having a first lower portion and a first apex, wherein the first lower portion is wider than the first apex.
20
2. The vascular clamp according to claim 1, wherein the first protrusion substantially spanning the first clamping surface, the first protrusion disposed between two recesses, the two recesses each having a second lower portion and a second apex wherein the second lower portion is narrower than the second apex.
25
3. The vascular clamp according to claim 2, wherein the second clamping member comprises a second clamping surface disposed along the second clamping member comprising a first recess, the first recess having a third lower portion and a third apex, wherein the third lower portion is narrower than the third apex, the first recess disposed between two protrusions,
30 each having a fourth base and fourth apex wherein the fourth base is wider than the fourth apex.

4. The vascular clamp according to claim 3, wherein in the clamped position, the first protrusion and the two protrusions are disposed substantially within the first recess and the two recesses respectively.
5. The vascular clamp according to claim 4, wherein there is a gap between respective apexes of the first protrusion and the two protrusions and respective bases of the first recess and the two recesses.
6. The vascular clamp according to claim 1, wherein the first clamping member further comprises a plurality of protrusions disposed along the first clamping surface.
7. The vascular clamp according to claim 6, wherein the second clamping member further comprises a plurality of recesses disposed along the second clamping surface such that when in the clamped position, each of the plurality of protrusions are disposed substantially within a corresponding recess of the plurality of recesses.
8. The vascular clamp according to claim 6, wherein the plurality of protrusions are substantially hemispherical.
9. The vascular clamp according to claim 1, wherein each of the first and second distal sections are joined to their respective first and second proximal sections at a predefined angle.
10. The vascular clamp according to claim 1, wherein the predefined length is in a range from about 8 cm to about 16 cm.
11. The vascular clamp according to claim 1, wherein the predefined length is about 12 cm.
12. The vascular clamp according to claim 9, wherein the predefined angle is more than about 135° and less than about 180°.
13. The vascular clamp according to claim 9, wherein the predefined angle is more than about 150° and less than about 180°.
14. The vascular clamp according to claim 1, wherein the clamp is to be used for a minimally invasive surgery or MIS.

15. The vascular clamp according to claim 14, wherein the surgery is a coronary artery bypass grafting (or CABG) surgery.
16. The vascular clamp according to claim 1, wherein the vascular clamp is manufactured at least partially from a material comprising a metal, an alloy, a polymer or a composite material.
17. The vascular clamp according to claim 1, wherein the vascular clamp is manufactured at least partially from stainless steel or nitinol.
18. The vascular clamp according to claim 1, wherein the first and second clamping member are each substantially U-shaped or substantially C-shaped.
19. The vascular clamp according to claim 4, wherein the vascular clamp further comprises a clamp padding disposed on the first and the second clamping surface.
20. A vascular clamp comprising:
a first elongated member having a first distal section and a first proximal section, said first distal section comprising:
a first elongated portion; and
a first clamping member;
a second elongated member having a second distal section and a second proximal section, said second distal section comprising:
a second elongated portion; and
a second clamping member;
the second elongated member pivotably attached to the first elongated member, the first and the second clamping members having a clamped position where the first and the second clamping members are in contact with each other;
the first and second proximal section each comprising a linear portion of a predefined length;
wherein the first clamping member comprises a first clamping surface disposed along the first clamping member, the first clamping surface comprising a first protrusion, the first protrusion having:

a first lower portion and a first apex, wherein the first lower portion is wider than the first apex; and

a second lower portion extending from the first lower portion to a first base, the second lower portion having a substantially constant width;

5 the first protrusion substantially spanning the first clamping surface, the first protrusion disposed between two recesses, the two recesses having a substantially constant width.

21. The vascular clamp according to claim 20, wherein the second clamping member comprises a second clamping surface disposed along the second clamping member, the second
10 clamping surface comprising a first recess, the first recess having:

a third lower portion and a third apex, wherein the third lower portion is narrower than the third apex; and

a fourth lower portion extending from the third lower portion to a second base, the fourth lower portion having a constant width;

15 the first recess disposed between two protrusions, each having a fifth lower portion and fourth apex wherein the fifth lower portion is wider than the fourth apex.

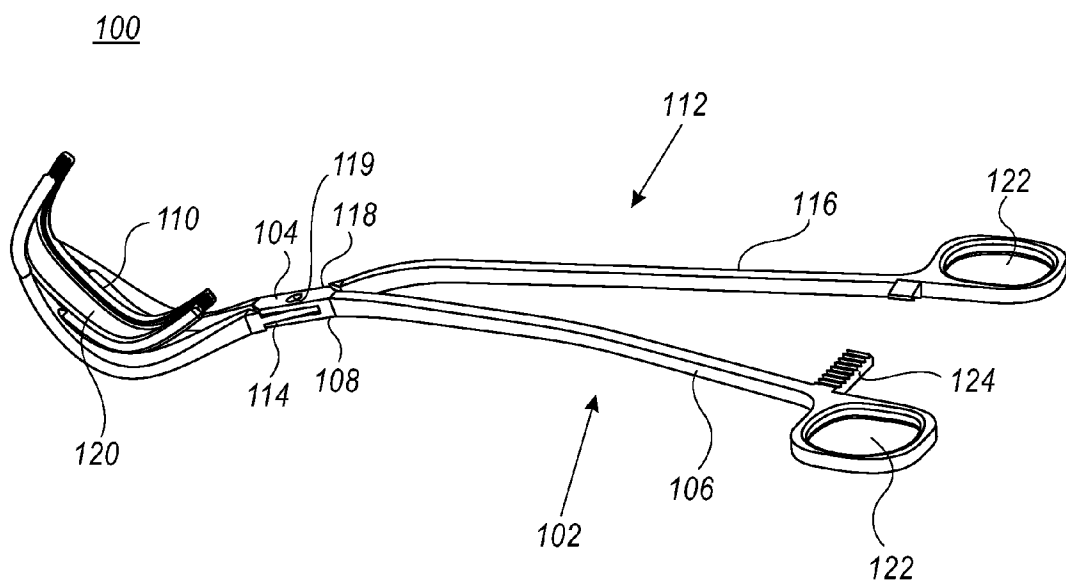


FIG. 1

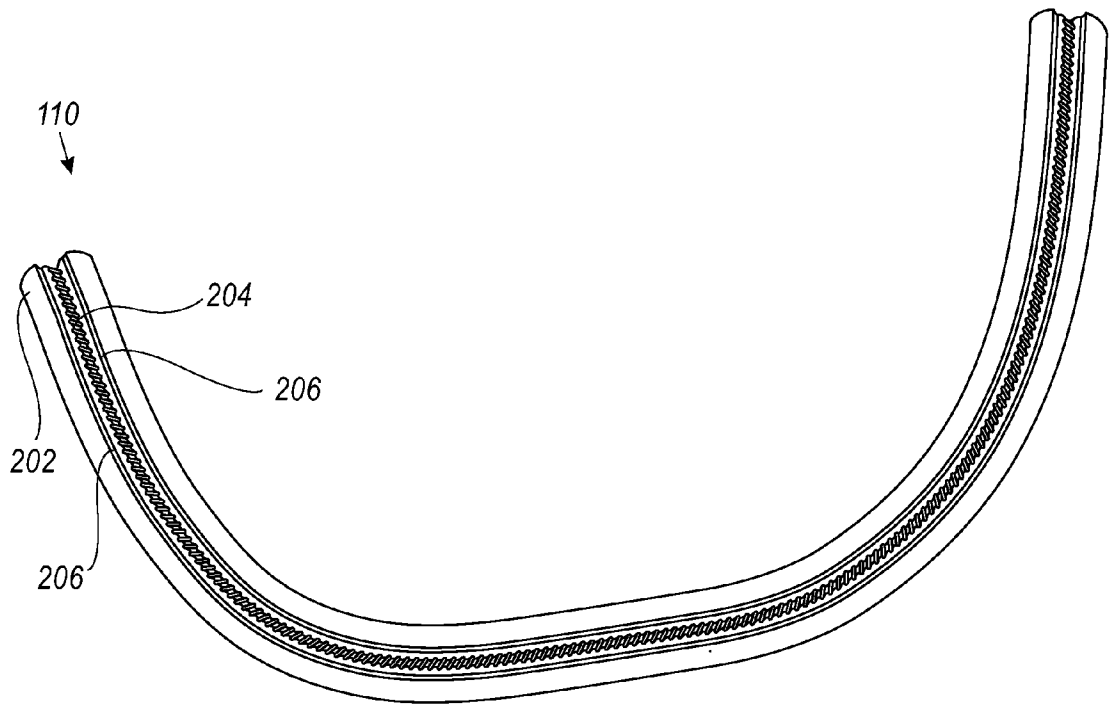


FIG. 2

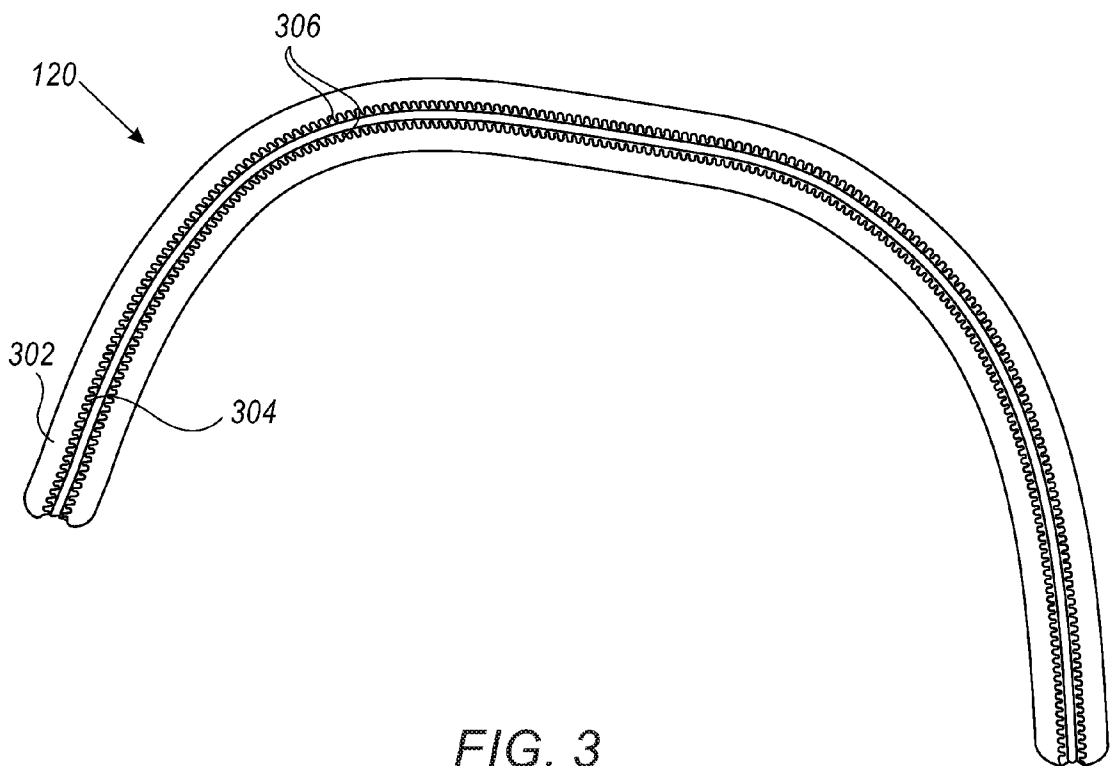


FIG. 3

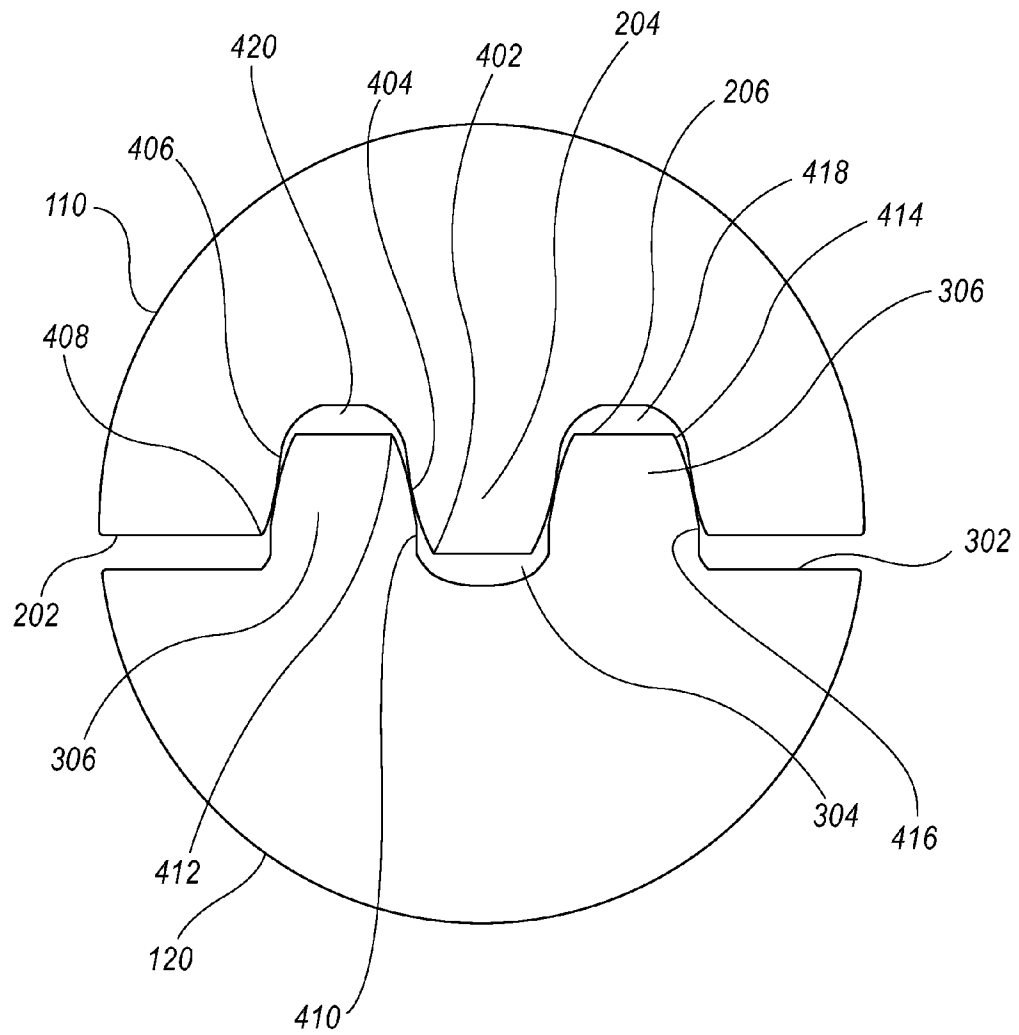


FIG. 4

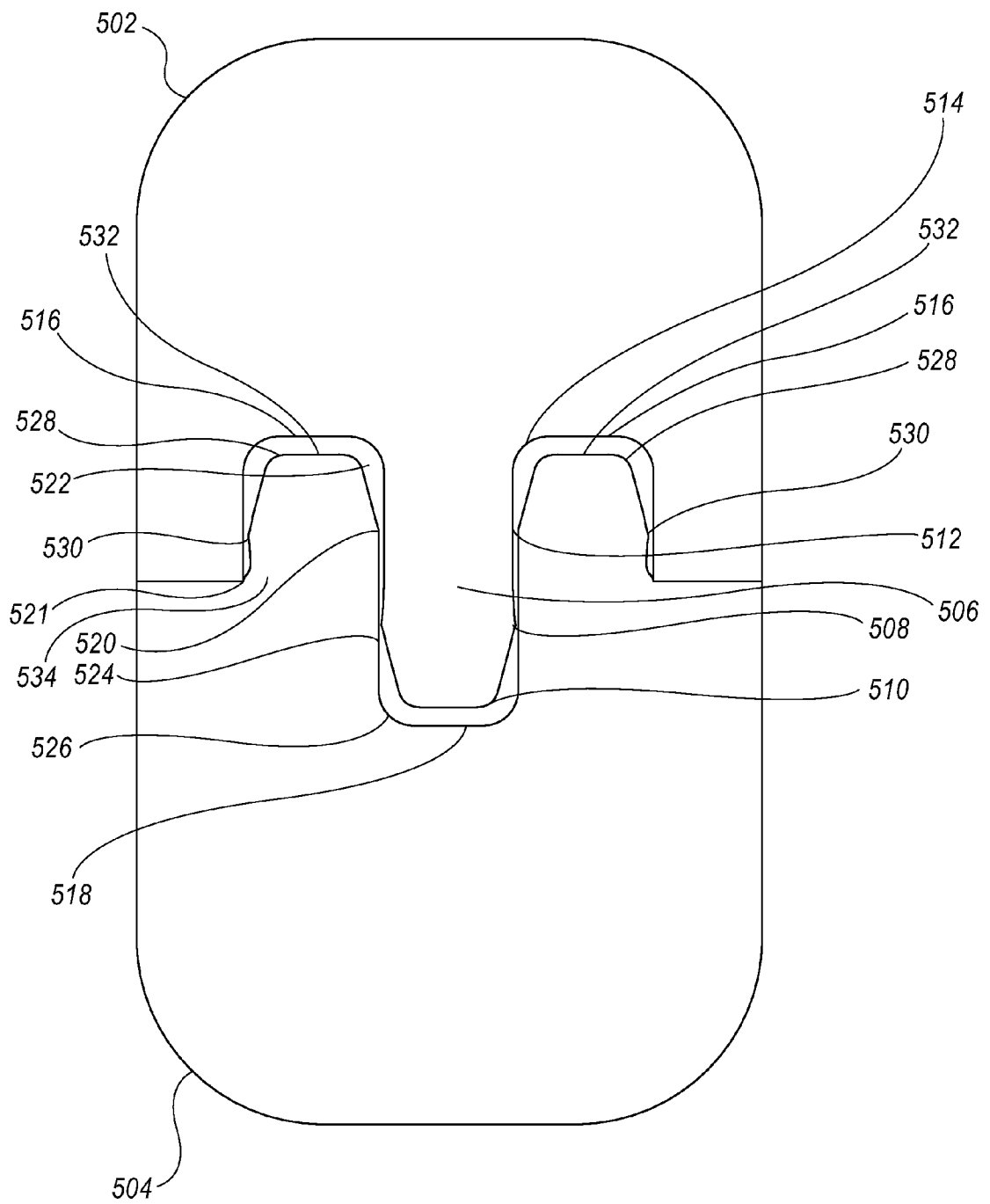


FIG. 5

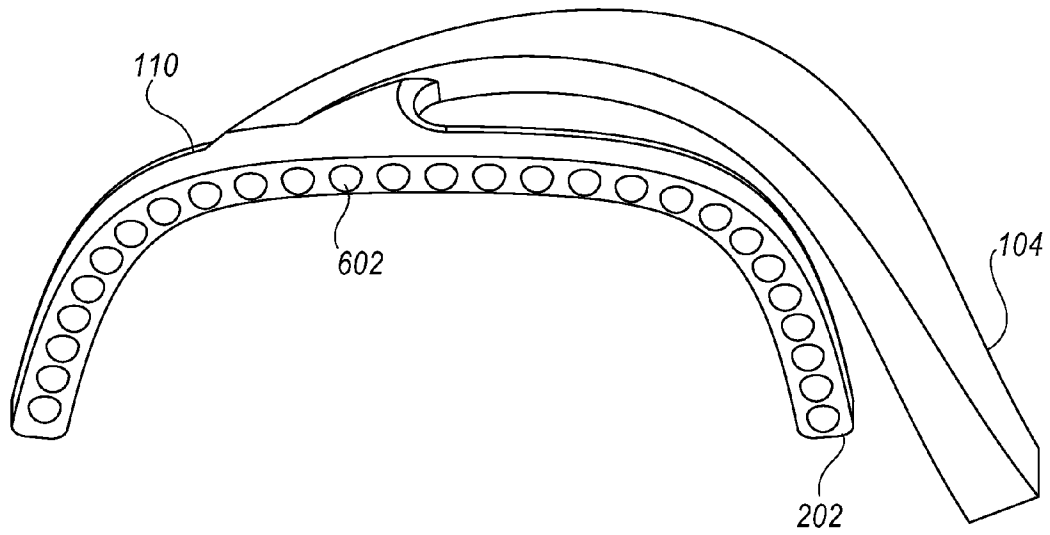


FIG. 6

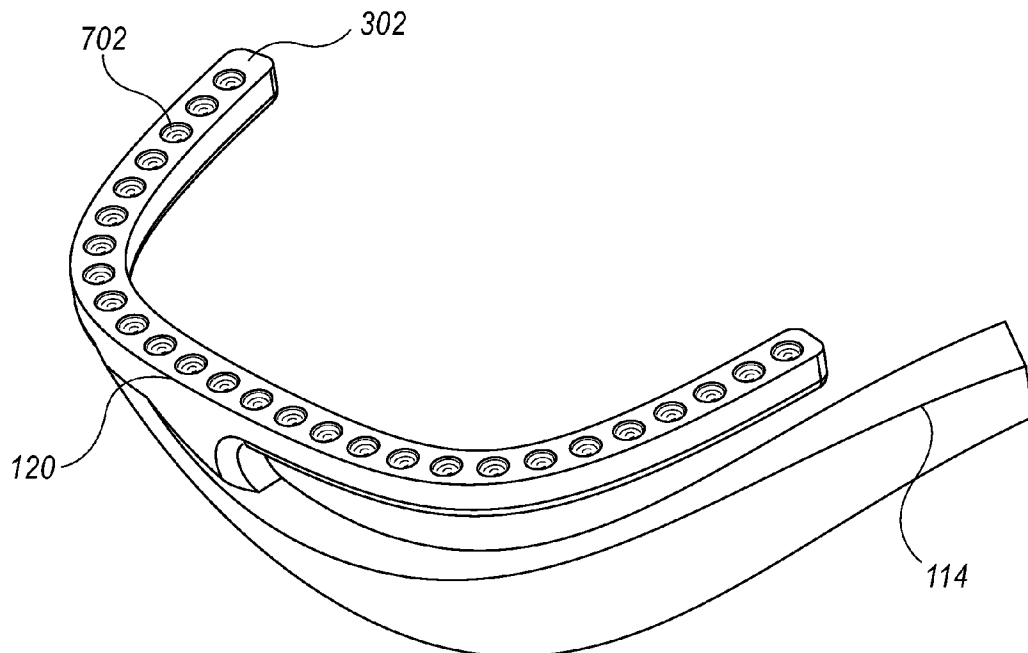


FIG. 7

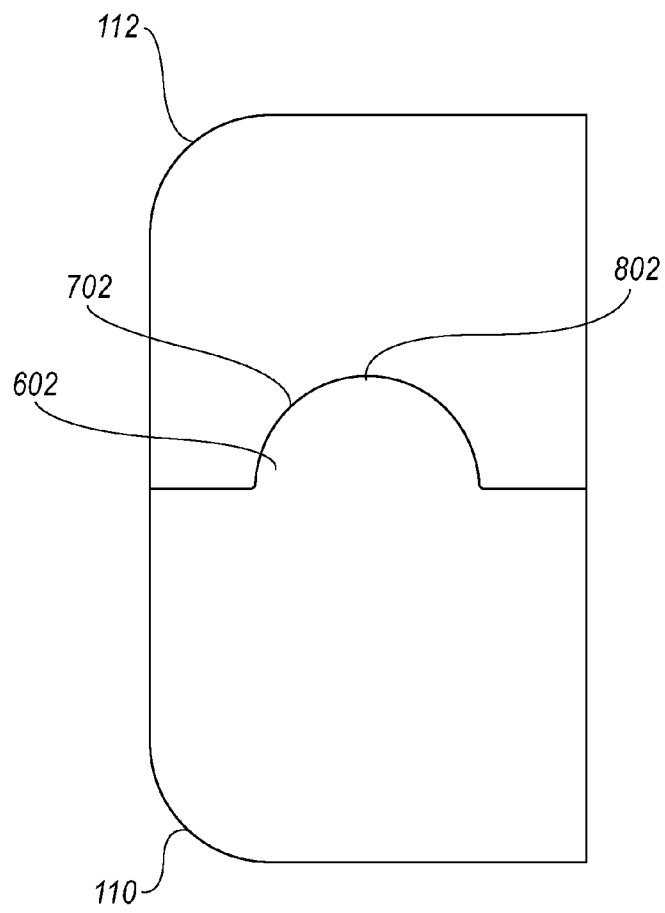


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SG2024/050377

A. CLASSIFICATION OF SUBJECT MATTER**A61B 17/122 (2006.01)**

According to International Patent Classification (IPC)

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A61B

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)

FAMPAT: vascular, vessel, artery, aorta, hemostatic, clamp, forceps, clip, pivot, hinge, tooth, teeth, jaw, protrusion, recess, groove, ridge and like terms

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2002/0183785 A1 (HOWELL THOMAS A, ET AL.) 5 December 2002 fig. 1, 15-19; para.[0009], [0039]	1-21
X	US 2017/0020530 A1 (WILLETT LYNN, ET AL.) 26 January 2017 fig. 16-18, 107, 115-120, 123-124; para.[0007]-[0008], [0176]-[0177], [0296], [0303]	1-21
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