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(54) ULTRASONIC SURGICAL BLADE WITH IMPROVED HEEL PORTION

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Description

INTRODUCTION

[0001] The present disclosure is related generally to ultrasonic blades for use in surgical instruments. In particular, the present disclosure is related to ultrasonic surgical blades for use in surgical instruments and, more particularly, to an ultrasonic surgical blade with improved cutting and coagulation features.

BACKGROUND

[0002] Ultrasonic instruments, including both hollow core and solid core instruments, are used for the safe and effective treatment of many medical conditions. Ultrasonic instruments, and particularly solid core ultrasonic instruments, are advantageous because they may be used to cut and/or coagulate organic tissue using energy in the form of mechanical vibrations transmitted to a surgical end-effector at ultrasonic frequencies. Ultrasonic vibrations, when transmitted to organic tissue at suitable energy levels and using a suitable end-effector, may be used to cut, dissect, or cauterize tissue. Ultrasonic instruments utilizing solid core technology are particularly advantageous because of the amount of ultrasonic energy that may be transmitted from the ultrasonic transducer, through the waveguide, to the surgical end-effector. Such instruments may be used for open procedures or minimally invasive procedures, such as endoscopic or laparoscopic procedures, wherein the end-effector is passed through a trocar to reach the surgical site.

[0003] Activating the end-effector (e.g., cutting blade) of such instruments at ultrasonic frequencies induces longitudinal vibratory movement that generates localized heat within adjacent tissue, facilitating both cutting and coagulation. Because of the nature of ultrasonic instruments, a particular ultrasonically actuated end-effector may be designed to perform numerous functions, including, for example, cutting and coagulation. The structural stress induced in such end-effectors by vibrating the blade at ultrasonic frequencies may have a number of undesirable effects. Such undesirable effects may include, for example, transverse motion in the instrument waveguide that may lead to, for example, excess heat generation in the waveguide or premature stress failure.

[0004] Although ultrasonic surgical instruments have been eminently successful, some areas of improvement still remain. For example, it would be desirable for improved ultrasonic blades to remove the gall bladder from the liver bed and for coagulation to facilitate the procedure. An ultrasonic blade that enables efficient dissection of the gall bladder from the liver bed using proximal and distal surfaces facilitates the surgical technique. An ultrasonic blade which has a hook or right angle, or near right angle, bend near the distal end with a plow member, or ridge cutting edge, at the distal end would provide advantages for access and visibility. The challenges to providing such a configuration have been stress and balance related. An ultrasonic blade with such a configuration must be behave in a balanced manner and be sufficiently strong to endure the added stresses. It would, therefore, be desirable to design an improved ultrasonic surgical blade. It would further be advantageous to provide an ultrasonic surgical blade that cuts faster, while maintaining hemostasis desired by the surgeon. It would also be advantageous to provide an ultrasonic surgical blade that is more controllable and precise, to providing cutting where needed with significant control.

[0005] Additionally, surgeons may utilize the leading, or distal, portion of the ultrasonic surgical blade, also referred to as the heel of the blade, when dissecting the gall bladder from the liver bed for cutting tissue as well as efficiently advancing the blade between the gall bladder and the liver bed. Thus, it would be advantageous to provide an ultrasonic surgical blade with an improved heel portion to optimize heel dissection. It would also be advantageous to provide an improved heel configuration to allow a surgeon to more easily enter the tissue plane between the gall bladder and the liver bed.

[0006] An ultrasonic surgical instrument is described with improved cutting and coagulation features to provide these advantages and overcome the disadvantages of previous instruments.

[0007] US 2015/088181 (A1) discloses a method for ultrasonically treating tissue that includes accessing a surgical site with an ultrasonic surgical instrument, dissecting tissue with a first portion of the blade, and sealing tissue with a second portion of the blade. The instrument includes a blade that defines a longitudinal axis. The blade is configured to oscillate along the longitudinal axis to ultrasonically treat tissue.

[0008] US 2008/009848 (A1) discloses an ultrasonic surgical blade having a blade body and a shank. The shank is fixed at one end to the blade body and is operatively connectable at an opposite end to a source of ultrasonic vibrations. The shank has a longitudinal axis. The blade body is eccentrically disposed relative to the axis.US 5,318,570 discloses a surgical instrument comprising a plow blade formed on the distal end of a shank.

SUMMARY

[0009] In one aspect, an ultrasonic surgical blade is disclosed. According to the present invention, an ultrasonic surgical blade comprises a solid body; a longitudinal portion having a proximal end configured to couple to an ultrasonic transmission waveguide and a distal end configured to dissect and coagulate tissue, the longitudinal portion comprising: a substantially planar longitudinal surface; and a distal hemostasis surface located opposite of the substantially planar longitudinal surface; a transverse portion extending crosswise from the distal end of the longitudinal portion, the transverse portion defining a hook having a free end configured to pull and dissect tissue, the transverse portion comprising: a

curved section extending from a distal end of the substantially planar longitudinal surface; a tip surface defined at the free end; a substantially planar proximal inner surface extending from the curved section to the tip surface; and a plow member extending from the tip surface to the distal hemostasis surface, the plow member comprising first and second lateral surfaces extending from a surface inflection defining a cutting edge; and a distal dissection edge defined at a surface inflection of the first and second lateral surfaces and the distal hemostasis surface.

[0010] In another example, the distal dissection edge of the ultrasonic surgical blade comprises a distal-most vertex defined by the plow member and the distal hemostasis surface.

[0011] In another example, the plow member of the ultrasonic surgical blade is concave.

[0012] In another example the ultrasonic surgical blade further comprises a leading, angular tip surface extending from the tip surface to the first and second lateral surfaces.

[0013] In another example, the first and second lateral surfaces of the ultrasonic surgical blade each comprises a surface section, and wherein each surface section is concave.

[0014] In another example, the longitudinal portion of ultrasonic surgical blade comprises a proximal hemostasis surface located opposite of the substantially planar longitudinal surface. In another example, the ultrasonic surgical blade further comprising first and second proximal lateral surfaces extending from the body to the proximal hemostasis surface defining first and second lateral cutting edges defined at first and second surface inflections between the first and second proximal lateral surfaces and the proximal hemostasis surface.

[0015] In another example, the ultrasonic surgical blade further comprises a beveled edge defined between the tip surface and the substantially planar proximal inner surface.

[0016] Further described herein is an ultrasonic surgical blade comprising a solid body; a longitudinal portion having a proximal end and a distal end, the longitudinal portion comprising: a substantially planar longitudinal surface; and a distal hemostasis surface located opposite of the substantially planar longitudinal surface; a transverse portion extending crosswise from the distal end of the longitudinal portion, the transverse portion defining a hook having a free end, the transverse portion comprising: a curved section extending from a distal end of the substantially planar longitudinal surface; a tip surface defined at the free end; a proximal inner surface extending from the curved surface to the tip surface; and a tissue diverting portion extending from the tip surface to the distal hemostasis surface, the tissue diverting portion comprising a tissue diverting edge.

[0017] The tissue diverting edge of the ultrasonic surgical blade may be concave.

[0018] The ultrasonic surgical blade may further comprise a distal-most vertex defined by the tissue diverting portion and the distal hemostasis surface.

[0019] The ultrasonic surgical blade may further comprise a distal dissection edge defined by a surface inflection of the distal hemostasis surface and the tissue diverting portion, and wherein the distal dissection edge and the tissue diverting edge comprises a substantially T-like configuration.

[0020] The longitudinal portion of the ultrasonic surgical blade may comprise a proximal hemostasis surface located opposite of the substantially planar longitudinal surface. The ultrasonic surgical blade may comprise first and second lateral surfaces extending from the body to the proximal hemostasis surface defining first and second cutting edges defined at first and second surface inflections between the first and second lateral surfaces and the proximal hemostasis surface.

[0021] Further described herein is an ultrasonic surgical bladecomprising a hook portion having a free end portion and a distal end; and a plow member defined by the distal end of the hook portion, the plow member comprising first and second lateral surfaces extending from a surface inflection defining a cutting edge.

[0022] The plow member of the ultrasonic surgical blade may be configured to divert tissue upon interaction therewith.

[0023] The plow cutting edge of the ultrasonic surgical blade may be concave.

[0024] The cutting edge of the ultrasonic surgical blade may extend from a vertex defined at a first end of the cutting edge to a tip surface defined at a second end of the cutting edge.

[0025] The ultrasonic surgical blade may further comprise an angular tip surface defined by the free end portion of the hook portion.

[0026] The first and second lateral surfaces of the ultrasonic surgical blade may be curved.

[0027] The foregoing summary is illustrative only and is not intended to be in any way limiting. In addition to the illustrative aspects, and features described above, further aspects, and features will become apparent by reference to the drawings and the following detailed description.

FIGURES

[0028] The features of the aspects described herein are set forth with particularity in the appended claims. The aspects, however, both as to organization and methods of operation may be better understood by reference to the following description, taken in conjunction with the accompanying drawings as follows.

FIG. 1 is an illustration of an ultrasonic instrument according to one aspect.

FIG. 2 is an illustration of the ultrasonic instrument shown in FIG. 1, with the outer sheath removed to reveal the underlying ultrasonic transmission waveguide.

FIG. 3 is an illustration of the ultrasonic surgical instrument shown in FIG. 1 with the right and left shrouds removed.

FIG. 4 is an illustration of the handle assembly of the ultrasonic surgical instrument shown in FIG. 1 with the left shroud, the shaft assembly, and the nose cone removed.

FIG. 5 is a front view of the ultrasonic surgical instrument shown in FIG. 1 with the nose cone removed to show the underlying activation button assembly, the clutch plate, retainer, and support bushing.

FIG. 6 is a graphical representation of displacement (microns) along the vertical axis of the ultrasonic surgical blade shown in FIGS. 1-5 versus distance (in inches, wherein 1 inch corresponds to approx. 2.54 cm) along the ultrasonic surgical blade along the horizontal axis, according to one aspect.

FIG. 7 illustrates another aspect of a surgical end effector integrally formed with an ultrasonic transmission waveguide.

FIG. 8 is a perspective view of an ultrasonic surgical blade of the surgical end effector of FIG. 7.

FIG. 9 is a side view of the ultrasonic surgical blade of FIG. 8.

FIG. 10 is a perspective view of the ultrasonic surgical blade of FIG. 8.

FIG. 11 is a bottom view of the ultrasonic surgical blade of FIG. 8, wherein the ultrasonic surgical blade comprises a distal and proximal hemostasis surface.

FIG. 12 is another side view of the ultrasonic surgical blade of FIG. 8.

FIG. 13 is cross-sectional view of the ultrasonic surgical blade of FIG. 8 taken along line 13-13 shown in FIG. 12.

FIG. 14 is another cross-sectional view of the ultrasonic surgical blade of FIG. 8 taken along line 14-14 shown in FIG. 12.

FIG. 15 is a top view of the ultrasonic surgical blade of FIG. 8.

FIG. 16 is a cross-sectional view of the ultrasonic surgical blade of FIG. 8 taken along line 16-16 shown in FIG. 15.

FIG. 17 is a front view of the ultrasonic surgical blade of FIG. 8.

DESCRIPTION

[0029] In the following detailed description, reference is made to the accompanying drawings, which form a part hereof. In the drawings, similar symbols and reference characters typically identify similar components throughout the several views, unless context dictates otherwise. The illustrative aspects described in the detailed description and drawings are not meant to be limiting. Other aspects may be utilized, and other changes may be made, without departing from the scope of the claims presented here.

[0030] The following description of certain examples of the technology should not be used to limit its scope. Other examples, features, aspects, aspects, and advantages of the technology will become apparent to those skilled in the art from the following description, which is by way of illustration, one of the best modes contemplated for carrying out the technology. As will be realized, the technology described herein is capable of other different and obvious aspects, all without departing from the technology. Accordingly, the drawings and descriptions should be regarded as illustrative in nature and not restrictive.

[0031] It is further understood that any one or more of the teachings, expressions, aspects, examples, etc. described herein may be combined with any one or more of the other teachings, expressions, aspects, examples, etc. that are described herein. The following-described teachings, expressions, aspects, examples, etc. should therefore not be viewed in isolation relative to each other. Various suitable ways in which the teachings herein may be combined will be readily apparent to those of ordinary skill in the art in view of the teachings herein. Such modifications and variations are intended to be included within the scope of the claims.

[0032] In the following description, it is to be understood that terms such as front, back, inside, outside, top, bottom and the like are words of convenience and are not to be construed as limiting terms. Terminology used herein is not meant to be limiting insofar as devices described herein, or portions thereof, may be attached or utilized in other orientations. The various aspects will be described in more detail with reference to the drawings. Several examples of ultrasonic blades and instruments are disclosed in U.S. Patent Application Serial No. 14/789,744, entitled ULTRASONIC SURGICAL BLADE WITH IMPROVED CUTTING AND COAGULATION FEATURES, filed July 1, 2015.

[0033] The present disclosure provides an ultrasonic instrument comprising an ultrasonic blade with improved cutting and coagulation features. FIG. 1 is an illustration of an ultrasonic instrument 100 according to one aspect. The ultrasonic instrument 100 comprises a handle assembly 102, a shaft assembly 104, and a surgical end-effector 106. The handle assembly 102 comprises right and left shrouds 108a, 108b, an activation button assembly 110, and a nose cone 112. The activation button assembly 110 comprises a plurality of activation buttons. Turning briefly to FIG. 5, which is a front view of the ultrasonic instrument, it can be seen that in one aspect, the activation button assembly 110 comprises eight activation buttons 110a, 110b, 110c, 110d, 110e, 110f, 110g, 110h distributed about the handle assembly 102. Turning back to FIG. 1, the shaft assembly 104 comprises an outer sheath 114. The surgical end-effector 106 comprises an ultrasonic surgical blade 116 with improved cutting and coagulation features. For example, the ultrasonic blade 116 comprises a plow member, or ridge cutting edge, 591 to separate tissue. The ultrasonic surgical blade 116 and ultrasonic transmission waveguide is iso-

lated from the outer sheath 114 with multiple isolation spacers 118, which can be overmolded over the ultrasonic transmission waveguide.

[0034] The handle assembly 102 also comprises an ultrasonic transducer acoustically coupled to an ultrasonic transmission waveguide which is acoustically coupled to the surgical end-effector 106. The handle assembly 102 is electrically connected to an ultrasonic energy generator, which can be activated by one of the plurality of activation buttons 110a-110h, for example the activation button 110a. Depressing the activation button 110a activates the ultrasonic generator, and delivers electrical energy to an ultrasonic transducer located in the handle assembly 102. The ultrasonic transducer in the handle assembly 102 converts the electrical energy to ultrasonic motion, which is acoustically coupled to the ultrasonic transmission assembly and the treatment region of the surgical end-effector 106. The treatment region vibrates at an excursion magnitude of 20 micrometers to 150 micrometers, and at a frequency of approximately 55.5 kilohertz, although other frequencies may be employed, without departing from the scope of the present disclosure.

[0035] FIG. 2 is an illustration of the ultrasonic instrument 100 shown in FIG. 1, with the outer sheath 114 (FIG. 1) removed to reveal the underlying ultrasonic transmission waveguide 120. As shown, isolation spacers 118 are disposed over the ultrasonic transmission waveguide 120 to acoustically isolate the outer sheath 114 from the ultrasonic transmission waveguide 120. Accordingly, the plurality of isolation spacers 118 are located on respective nodes along the ultrasonic transmission waveguide 120 to minimize the vibrations acoustically coupled to the outer sheath 114. In one aspect, the isolation spacers 118 may be overmolded over the ultrasonic transmission waveguide 120.

[0036] FIG. 3 is an illustration of the ultrasonic surgical instrument 100 shown in FIG. 1 with the right and left shrouds 108a, 108b removed. The handle assembly 102 includes a support base 122 located proximal to the activation button assembly 110.

[0037] FIG. 4 is an illustration of the handle assembly 102 of the ultrasonic surgical instrument 100 shown in FIG. 1 with the left shroud 108b (FIG. 1), the shaft assembly 102 (FIG. 1), and the nose cone 112 removed. As shown in FIG. 4, below the nose cone 112 is a bridge guide 132 operatively coupled to the activation button assembly 110. A clutch plate 134 and clutch spring 136 are disposed between the bridge guide 132 and a retainer 138. A support bushing 140 supports the shaft assembly 102.

[0038] FIG. 5 is a front view of the ultrasonic surgical instrument 100 shown in FIG. 1 with the nose cone 112 removed to show the underlying activation button assembly 110, the clutch plate 134, retainer 138, and support bushing 140. The activation button assembly 110 comprises a plurality activation buttons 110a-110h, that are individually programmable to perform a particular function. For example, the activation 110a is electrically coupled to the ultrasonic generator and is used to energize the ultrasonic transducer to activate the surgical end-effector 106.

[0039] FIG. 6 is a graphical representation 162 of displacement (microns) along the vertical axis of the ultrasonic surgical blade 116 shown in FIGS. 1-5 versus distance (in) along the ultrasonic surgical blade 116 along the horizontal axis, according to one aspect. The distance along the blade indicated as 0.000 in. corresponds to the most proximal location where the ultrasonic transmission waveguide 120 and the distance along the blade indicated as 35.56 cm (14.000 inches) corresponds to the most distal location 166 where the ultrasonic tip 144 of the ultrasonic surgical blade 116 is displaced. With reference now also to FIG. 6, the blade displacement waveform 164 represented by the solid line is a standing waveform set up in the ultrasonic transmission waveguide and end effector ultrasonic surgical blade 116 along the longitudinal axil L as shown in FIG. 6. The displacement waveform 164 includes periodic nodes 174 and antinodes 176, 176' at locations along the longitudinal axis L. The nodes 174 are locations along the standing waveform 164 where there is no displacement and antinodes 176 are locations where displacement is maximum positive, and antinodes 176' where displacement is maximum negative. In accordance with the periodic nature of the ultrasonic vibrations and the properties of a standing wave 164, the nodes 174 and antinodes 176, 176' are located at a distance equal to one quarter wavelength $\frac{\lambda}{4}$, where the wavelength λ proportional to the frequency of vibrations f_o and the speed c of sound in the material of the transmission waveguide and the ultrasonic surgical blade 116 according to the following relationship $f_o = \frac{2\pi\lambda}{c}$. . Due to the design of the ultrasonic surgical blade 116, it can be seen that the absolute maximum displacement occurs at the distal antinode 178, which corresponds to the location of the antinode AN in FIG. 6.

[0040] FIGS. 7-17 illustrate one aspect of an ultrasonic surgical blade 516 configured with edges and surfaces to optimize hemostasis and dissection. Specifically, a heel portion 517 of the blade 516 provides a user with a configuration that permits the blade 516 to be navigated within the tissue plane more efficiently when dissecting the gall bladder from the liver bed, for example. A distal cutting edge 591 defines a configuration resembling a plow member, or ridge, to facilitate tissue diversion when navigating the blade 516 between tissue mediums. Edges and features such as a distal-most vertex, disposed on the distal portion of the ultrasonic surgical blade 516 can provide more efficient heel dissection.

[0041] FIG. 7 is a perspective view of one aspect of an ultrasonic surgical instrument 500 comprising an end effector 506 integrally formed with an ultrasonic transmission waveguide 520. The ultrasonic surgical instrument

500 is similar in many respects to the ultrasonic surgical instrument 100. The surgical end effector 506 comprises an ultrasonic surgical blade 516 having a neck 542 coupled to the ultrasonic transmission waveguide 520. The ultrasonic transmission waveguide 520 is a component of a shaft assembly 504 and may be acoustically isolated from other components of the shaft assembly 504, such as the outer sheath 514 (FIG. 12), by an isolation spacer. As previously discussed in connection with FIG. 15, the isolation spacers are located at the nodes of the ultrasonic transmission waveguide where vibrations are at a minimum or zero amplitude. The ultrasonic surgical blade 516 is configured to vibrate in response to ultrasonic energy applied thereto via the ultrasonic transmission waveguide 520. A balance feature 543 is defined as a cutout section in the ultrasonic transmission waveguide 520 to facilitate the expansion and contraction of the ultrasonic transmission waveguide 520 during the vibratory process.

[0042] FIG. 8 is a perspective view of one aspect of the ultrasonic surgical blade 516. The distal portion of the ultrasonic surgical blade 516 has a curved or angular shape that defines a blade hook 550 having a free end configured for pulling and cutting tissue during use. The ultrasonic surgical blade 516 comprises a longitudinal portion 541 extending distally from the neck 542, where it couples to ultrasonic vibrations and a transverse portion 547 extending from a distal end of the longitudinal portion 541. The transverse portion 547 of the ultrasonic surgical blade 516 defines the blade hook 550 and a tissue-plow configuration 590. At the end of the transverse portion 547, the blade hook 550 defines a tip surface 544 optimized to access tissue planes. From the tip surface 544, extending outwardly and toward the distal cutting edge configuration 590, the tip surface 544 transitions at a surface inflection 539 to a leading, angular tip surface 545. In various instances the tip surface 545 comprises a convex profile. In various other instances, the tip surface 545 comprises a substantially flat or concave profile. The tip surface 545 can be oblique and/or triangular-like. The tip surface 545 comprises a distal vertex 545V defining the distal cutting edge 591 which resembles a plow member or ridge. The plow edge, or sharp vertical ridge, of the distal cutting edge 591 comprises a concave radius of curvature. In various instances, the distal cutting edge 591 can comprise portions that are not curved as well as portions that are curved. Extending from the tip surface 545 at a pair of surface inflections, or edges, 553A and 553B, the blade hook 550 defines a pair lateral distal surfaces 552 which share a common edge 591 defining the distal cutting edge. The distal cutting edge 591 is also referred to as a plow edge, or a ridge feature. The tissue plow configuration 590 is configured to facilitate access to tissue planes by diverting the tissue with the plow edge 591. In various instances, the surfaces 552 define concave radii of curvatures. In various other instances, the surfaces 552 are substantially flat and are comprised of multiple substantially flat portions meeting a surface inflection. In various instances, the surfaces 552 comprise curved and flat surfaces.

[0043] Extending from the distal lateral surfaces 552 through yet another surface inflection is a distal hemostasis surface 548 defining a larger surface area. The distal hemostasis surface 548 has a convex radius of curvature. A dissection edge 546 is defined at the surface inflection between the lateral surfaces 552 and the distal hemostasis surface 548. The dissection edge 546 is configured to improve the dissection or cutting speed using the heel portion 517 of the ultrasonic surgical blade 516. The plow configuration 590 comprises a distal-most vertex 592 disposed along the dissection edge 546 and is configured to lead the ultrasonic surgical blade into the tissue planes. The concave profile of the plow edge 591 extends distally at the surface inflection defining the dissection edge 546 such that the transverse portion 547 of the hook 550 is tapered from the dissection edge 546 to the tip surface 545. From the surface inflections 553A, 553B, the tip surface 545 extends at an angle to the tip surface 544.

[0044] The inner, proximal, portion of the blade hook 550 defines a substantially planar inner surface 549 on the proximal side of the blade hook 550 that extends along the transverse portion 547 from a beveled edge 582 of the tip surface 544 to a curved surface 551 having a concave radius of curvature r_1. The depth d_1 of the transverse portion 547 measured from the tip surface 544 to the planar longitudinal surface 561 may be optimized to pull tissue of various types. A proximal hemostasis surface 554 is provided on the longitudinal portion 541 of the ultrasonic surgical blade 516 and is sized to deliver suitable hemostasis while minimizing mass.

[0045] FIG. 9 is a side view of the ultrasonic surgical blade 516 shown in FIGS. 7 and 8. The ultrasonic surgical blade 516 further comprises additional surfaces designed to acoustically balance the ultrasonic surgical blade 516. These surfaces include a first lateral surface 556, a second lateral surface 558, and a third lateral surface 560 located on one side of the ultrasonic surgical blade 516 and corresponding lateral surfaces on the other side of the ultrasonic surgical blade 516, which are labeled by a prime (') (FIG. 12). The lateral surfaces 560, 560' are oblique and extend from a proximal body portion 559 of the blade 516 to the proximal hemostasis surface 554. Cutting edges 565, 565' are defined at the surface inflections of the proximal hemostasis surface 554 and the oblique lateral surfaces 560, 560'. The lateral surfaces 556, 556', 558, 558', 560, 560' are produced by removing mass from the blade body 559 and are contoured to balance the ultrasonic surgical blade 516 to provide stable ultrasonic vibrations when energized. The substantially planar longitudinal surface 561 is part of the longitudinal portion 541 of the ultrasonic surgical blade 516 extending from the neck 542 toward the curved surface 551 of the transverse portion 547 of the blade hook 550.

[0046] FIG. 10 is another perspective view of the ultra-

sonic surgical blade 516 shown in FIGS. 7-9. The view illustrated in FIG. 10 shows the surface areas of each surface 548, 554. The sizes of the distal and proximal hemostasis surfaces 548, 554 are dimensioned to deliver suitable hemostasis while minimizing mass. The surface inflection 565' of the proximal hemostasis surface 554 and the lateral surface 560' define a cutting edge. The proximal hemostasis surface also defines a cutting edge 570'. Discussed in greater detail below, a cutting edge 572' is disposed on the heel portion 517 of the blade 516.

[0047] FIG. 11 is a partial, bottom view of the ultrasonic surgical blade 516 shown in FIGS. 7-10. The distal hemostasis surface 548 defines a distal dissection edge 546 and lateral sharp cutting edges 572, 572'. The cutting edges 572, 572' share the vertex 592. The cutting edge 572 comprises a first concave portion and a second concave portion sharing an intermediate vertex. Similarly, the cutting edge 572' comprises a first concave portion and a second concave portion sharing an intermediate vertex. The distal hemostasis surface 548 has an effective surface area S1 of approximately 3.25 mm^2 and may vary over a range of 3.25 mm^2 to 6.0 mm^2 (0.0053 in^2 to 0.0093 in^2). The proximal hemostasis surface 554 defines lateral sharp cutting edges 570, 570'. The proximal hemostasis surface 554 has an effective surface area S2 of approximately 9.675 mm^2 and may vary over a range of 6.45 mm^2 to 12.90 mm^2 (0.01 in^2 to 0.02 in^2).

[0048] FIG. 12 is another side view of the ultrasonic surgical blade 516 shown in FIGS. 7-11. Similar to FIG. 9, the view shown in FIG. 12 illustrates the corresponding lateral surfaces labeled by a prime ('). These surfaces include a first lateral surface 556', a second lateral surface 558', and a third lateral surface 560' located on the other side of the ultrasonic surgical blade 516. The lateral surfaces 560, 560' are oblique and extend from a proximal body portion 559 of the blade 516 to the proximal hemostasis surface 554. Cutting edges 565, 565' are defined at the surface inflections of the proximal hemostasis surface 554 and the oblique lateral surfaces 560, 560'. The lateral surfaces 556, 556', 558, 558', 560, 560' are produced by removing mass from the blade body 559 and are contoured to balance the ultrasonic surgical blade 516 to provide stable ultrasonic vibrations when energized. The substantially planar longitudinal surface 561 is part of the longitudinal portion 541 of the ultrasonic surgical blade 516 extending from the neck 542 toward the curved surface 551 of the transverse portion 547 of the blade hook 550. The neck 542 extends distally from the sheath 514 and transitions into the body portion 559.

[0049] FIG. 13 is a cross-sectional view of the ultrasonic surgical blade 516 shown in FIGS. 7-12 taken along section line 12-12 in FIG. 12. Also shown is the longitudinal extending portion 541 of the blade hook 550.

[0050] FIG. 14 is a cross-sectional view of the ultrasonic surgical blade 516 shown in FIGS. 7-13 taken along section line 14-14 in FIG. 12. The surfaces 552 comprise curved, or plow surface, sections 552'. The curved profile of the sections 552' provide the ridge 591 with its concave radius of curvature. As discussed above, the surfaces 552 can comprise flat and curved sections, thus, the ridge, or edge, 591 can comprise flat and/or curved sections.

[0051] FIGS. 15-17 provide additional views of the ultrasonic surgical blade 516 shown in FIGS. 7-14. FIG. 15 is a top view of the ultrasonic surgical blade 516. From left to right, the neck 542 extends distally from the outer tube / sheath 514 and transitions into the blade body portion 559 at surface inflection 586. The blade body 559 defines several surfaces for cutting and / or pulling tissue, applying hemostasis to the tissue, and / or acoustically balancing the ultrasonic surgical blade 516. Additionally, the blade body 559 comprises a heel portion 517 configured to allow a surgeon to dissect tissue with a distal portion of the blade 516 as well as more easily navigate the blade 516 into tissue planes. The planar longitudinal surface 561 extends from a proximal end of the blade body 559 to the curved surface 551 of the blade hook 550. The inner surface 549 of the blade hook 550 extends from the curved surface 551 to the beveled surface 582 of the tip surface 544. The tip surface 544 transitions to the tip surface 545 at surface inflection 539. In various instances, the tip surface 545 comprises a substantially triangular configuration defining the edges 553A, 553B wherein the distal lateral surfaces 552 extend from the edges 553A, 553B to the dissection edge 546, defining a distal, prism-like structure disposed on a distal portion of the blade 516. The most distal portion of the distal surfaces 552 defines the dissection edge 546 which is also the surface inflection between the distal surface 552 and the distal hemostasis surface 548 (FIG. 17). The most distal portion of the dissection edge 546 is the vertex 592 where the sharp distal ridge 591 and the dissection edge 546 meet, or intersect.

[0052] FIG. 16 is a cross-sectional view of the ultrasonic surgical blade 516 taken along section line 16-16 shown in FIG. 15. This sectional view is taken along a longitudinal centerline to show various features of the ultrasonic surgical blade 516 previously described. From right to left, as the blade body 559 extends from the blade neck 542, the ultrasonic surgical blade 516 defines a first surface inflection 568 between the blade body 559 and the planar longitudinal surface 561. The hook portion 550 is defined in part by the curved surface 551 and the inner surface 549 up to the beveled surface 582. The tip surface 544 transitions to the tip surface 545 at surface inflection 539. The tip surface 545 transitions to the distal surfaces 552 at surface inflections 553A, 553B. The distal surfaces 552 share the distal ridge 591 and transition to the distal hemostasis surface 548 at the surface inflection 546, which also defines the dissection edge 546. In various instances, the distal cutting edge 591 is concave. The distal cutting edge 591 defined by the plow member extends from the tip surface 545 to a distal-most vertex 592 of the dissection edge 546. For purposes of the present disclosure, the surface inflection 546 and the dissection edge 546 refer to the same elements. The distal

hemostasis surface 548 transitions to the proximal hemostasis surface 554 at surface inflection 555. The proximal hemostasis surface 554 transitions to the blade body 559 at surface inflection 565.

[0053] FIG. 17 is an end view of the ultrasonic surgical blade 516. As shown, the transverse portion 547 of the ultrasonic surgical blade 516 comprises a tip surface 544 that transitions into the tip surface 545 at surface inflection 539. The distal surfaces 552 extend from the tip surface 545 at surface inflections 553A, 553B. In various instances, the distal surfaces 552 are oriented at a 45 degree angle with respect to a longitudinal axis defined by the shaft assembly 504, for example. In other instances, the distal surfaces 552 are oriented at angles other than 45 degrees. The configuration of the surfaces 552 permit this plow-like configuration to divert tissue upon entry into a tissue plane, for example. The surfaces 552 and/or 552' can be referred to as tissue diverting portions. Steeper profiles for the tissue plow configuration 590 are contemplated. For example, the angle between the inflections 553A, 553B can be acute which would provide a sharper profile for the plow 590. In various other instances, the angle between the inflections 553A, 553B can be obtuse which would provide a less sharp, or less steep, profile for the plow 590. The distal surfaces 552 define the dissection edge 546 between the distal hemostasis surface 554 and the distal surfaces 552.

[0054] Referring still to FIG. 17, the ridge 591 and the dissection edge 546 comprise a substantially T-like configuration, or profile. This T-like configuration, along with the distal-most vertex 592 can provide the ultrasonic surgical blade 516 with horizontal heel dissection and vertical heel dissection. This configuration also maintains a distal hemostasis surface increasing the versatility of the heel portion 517 of the ultrasonic surgical blade 516. Tissue can be quickly and more efficiently incised and/or diverted with the plow configuration 590.

[0055] As discussed herein, any reference to "one aspect" or "an aspect" means that a particular feature, structure, or characteristic described in connection with the aspect is included in at least one aspect. Thus, appearances of the phrases "in one aspect" or "in an aspect" in various places throughout the specification are not necessarily all referring to the same aspect. Furthermore, the particular features, structures or characteristics may be combined in any suitable manner in one or more aspects.

[0056] Although various aspects have been described herein, many modifications, variations, substitutions, changes, and equivalents to those aspects may be implemented and will occur to those skilled in the art. Also, where materials are disclosed for certain components, other materials may be used.

Claims

1. An ultrasonic surgical blade (516), comprising:

a solid body;

a longitudinal portion (541) having a proximal end configured to couple to an ultrasonic transmission waveguide and a distal end configured to dissect and coagulate tissue, the longitudinal portion comprising:

a substantially planar longitudinal surface (561); and

a distal hemostasis surface (548) located opposite of the substantially planar longitudinal surface;

a transverse portion (547) extending crosswise from the distal end of the longitudinal portion (541), the transverse portion (547) defining a hook (550) having a free end configured to pull and dissect tissue, the transverse portion (547) comprising:

a curved section (551) extending from a distal end of the substantially planar longitudinal surface;

a tip surface (544) defined at the free end;

a substantially planar proximal inner surface (549) extending from the curved section (551) to the tip surface (544); and

a plow member (590) extending from the tip surface (544) to the distal hemostasis surface (548), the plow member (590) comprising first and second lateral surfaces (552) extending from a surface inflection defining a cutting edge (591); and

a distal dissection edge (546) defined at a surface inflection of the first and second lateral surfaces (552) and the distal hemostasis surface (548).

2. The ultrasonic surgical blade of Claim 1, wherein the distal dissection edge (546) comprises a distal-most vertex (592) defined by the plow member (590) and the distal hemostasis surface (548).

3. The ultrasonic surgical blade of Claim 1, wherein the plow member (590) is concave.

4. The ultrasonic surgical blade of Claim 1, further comprising a leading, angular tip surface (545) extending from the tip surface (544) to the first and second lateral surfaces (552).

5. The ultrasonic surgical blade of Claim 1, wherein the first and second lateral surfaces (552) each comprises a surface section (552'), and wherein each surface section is concave.

6. The ultrasonic surgical blade of Claim 1, wherein the

longitudinal portion (541) comprises a proximal hemostasis surface (554) located opposite of the substantially planar longitudinal surface (561).

7. The ultrasonic surgical blade of Claim 6, further comprising first and second proximal lateral surfaces (560, 560') extending from the solid body to the proximal hemostasis surface (554) defining first and second lateral cutting edges (565, 565') defined at first and second surface inflections between the first and second proximal lateral surfaces (560, 560') and the proximal hemostasis surface (554).

8. The ultrasonic surgical blade of Claim 1, further comprising a beveled edge (582) defined between the tip surface (544) and the substantially planar proximal inner surface (549).

Patentansprüche

1. Chirurgische Ultraschallklinge (516), umfassend:

einen festen Körper;
einen Längsabschnitt (541) mit einem proximalen Ende, das dazu ausgelegt ist, an einen Ultraschallübertragungswellenleiter zu koppeln, und einem distalen Ende, das dazu ausgelegt ist, Gewebe zu dissektieren und zu koagulieren, wobei der Längsabschnitt umfasst:

eine im Wesentlichen ebene Längsfläche (561); und
eine distale Hämostasefläche (548), die sich gegenüber der im Wesentlichen ebenen Längsfläche befindet;

einen Querabschnitt (547), der sich quer von dem distalen Ende des Längsabschnitts (541) erstreckt, wobei der Querabschnitt (547) einen Haken (550) definiert, der ein freies Ende aufweist, das dazu ausgelegt ist, Gewebe zu ziehen und zu dissektieren, wobei der Querabschnitt (547) umfasst:

einen gekrümmten Abschnitt (551), der sich von einem distalen Ende der im Wesentlichen ebenen Längsfläche erstreckt;
eine Spitzenfläche (544), die an dem freien Ende definiert ist;
eine im Wesentlichen ebene proximale Innenfläche (549), die sich von dem gekrümmten Abschnitt (551) bis zur Spitzenfläche (544) erstreckt; und
ein Pflugelement (590), das sich von der Spitzenfläche (544) bis zu der distalen Hämostasefläche (548) erstreckt, wobei das Pflugelement (590) eine erste und eine zweite Seitenfläche (552) umfasst, die sich von einer Oberflächenbeugung erstrecken, die eine Schneidkante (591) definiert; und

eine distale Dissektionskante (546), die an einer Oberflächenbeugung der ersten und der zweiten Seitenfläche (552) und der distalen Hämostasefläche (548) definiert ist.

2. Chirurgische Ultraschallklinge nach Anspruch 1, wobei die distale Dissektionskante (546) einen am weitesten distal gelegenen Scheitelpunkt (592) umfasst, der durch das Pflugelement (590) und die distale Hämostasefläche (548) definiert ist.

3. Chirurgische Ultraschallklinge nach Anspruch 1, wobei das Pflugelement (590) konkav ist.

4. Chirurgische Ultraschallklinge nach Anspruch 1, ferner umfassend eine vordere, winkelförmige Spitzenfläche (545), die sich von der Spitzenfläche (544) bis zu der ersten und der zweiten Seitenfläche (552) erstreckt.

5. Chirurgische Ultraschallklinge nach Anspruch 1, wobei die erste und die zweite Seitenfläche (552) jeweils einen Flächenabschnitt (552') umfassen, und wobei jeder Flächenabschnitt konkav ist.

6. Chirurgische Ultraschallklinge nach Anspruch 1, wobei der Längsabschnitt (541) eine proximale Hämostasefläche (554) umfasst, die sich gegenüber der im Wesentlichen ebenen Längsfläche befindet (561).

7. Chirurgische Ultraschallklinge nach Anspruch 6, ferner umfassend eine erste und eine zweite proximale Seitenfläche (560, 560'), die sich von dem festen Körper bis zu der proximalen Hämostasefläche (554) erstreckt, die eine erste und eine zweite Schneidkante (565, 565') definiert, die an einer ersten und einer zweiten Oberflächenbeugung zwischen der ersten und der zweiten proximalen Seitenfläche (560, 560') und der proximalen Hämostasefläche (554) definiert sind.

8. Chirurgische Ultraschallklinge nach Anspruch 1, ferner umfassend eine abgeschrägte Kante (582), die zwischen der Spitzenfläche (544) und der im Wesentlichen ebenen proximalen Innenfläche (549) definiert ist.

Revendications

1. Lame chirurgicale à ultrasons (516) comprenant :

un corps solide ;

une partie longitudinale (541) ayant une extrémité proximale configurée pour être couplée à un guide d'onde à transmission par ultrasons et une extrémité distale configurée pour disséquer et coaguler un tissu, la partie longitudinale comprenant :

une surface longitudinale sensiblement plane (561) ; et
une surface d'hémostase distale (548) située à l'opposé de la surface longitudinale sensiblement plane ;

une partie transversale (547) s'étendant transversalement à partir de l'extrémité distale de la partie longitudinale (541), la partie transversale (547) définissant un crochet (550) ayant une extrémité libre configurée pour tirer et disséquer un tissu, la partie transversale (547) comprenant :

une section incurvée (551) s'étendant depuis une extrémité distale de la surface longitudinale sensiblement plane ;
une surface de pointe (544) définie au niveau de l'extrémité libre ;
une surface interne proximale sensiblement plane (549) s'étendant depuis la section incurvée (551) jusqu'à la surface de pointe (544) ; et
un élément formant charrue (590) s'étendant depuis la surface de pointe (544) jusqu'à la surface d'hémostase distale (548), l'élément formant charrue (590) comprenant des première et seconde surfaces latérales (552) s'étendant depuis une inflexion de surface définissant un bord coupant (591) ; et

un bord de dissection distal (546) défini au niveau d'une inflexion de surface des première et seconde surfaces latérales (552) et de la surface d'hémostase distale (548).

2. Lame chirurgicale à ultrasons selon la revendication 1, dans laquelle le bord de dissection distal (546) comprend un sommet le plus distal (592) défini par l'élément formant charrue (590) et la surface d'hémostase distale (548).

3. Lame chirurgicale à ultrasons selon la revendication 1, dans laquelle l'élément formant charrue (590) est concave.

4. Lame chirurgicale à ultrasons selon la revendication 1, comprenant en outre une surface de pointe angulaire d'attaque (545) s'étendant depuis la surface de pointe (554) jusqu'aux première et seconde surfaces latérales (552) .

5. Lame chirurgicale à ultrasons selon la revendication 1, dans laquelle les première et seconde surfaces latérales (552) comprennent chacune une section de surface (552') et dans laquelle chaque section de surface est concave.

6. Lame chirurgicale à ultrasons selon la revendication 1, dans laquelle la partie longitudinale (541) comprend une surface d'hémostase proximale (554) située à l'opposé de la surface longitudinale sensiblement plane (561).

7. Lame chirurgicale à ultrasons selon la revendication 6, comprenant en outre des première et seconde surfaces latérales proximales (560, 560') s'étendant depuis le corps solide jusqu'à la surface d'hémostase proximale (554) définissant des premier et second bords coupants latéraux (565, 565') définis au niveau des première et seconde inflexions de surface entre les première et seconde surfaces latérales proximales (560, 560') et la surface d'hémostase proximale (554).

8. Lame chirurgicale à ultrasons selon la revendication 1, comprenant en outre un bord biseauté (582) défini entre la surface de pointe (544) et la surface interne proximale sensiblement plane (549).

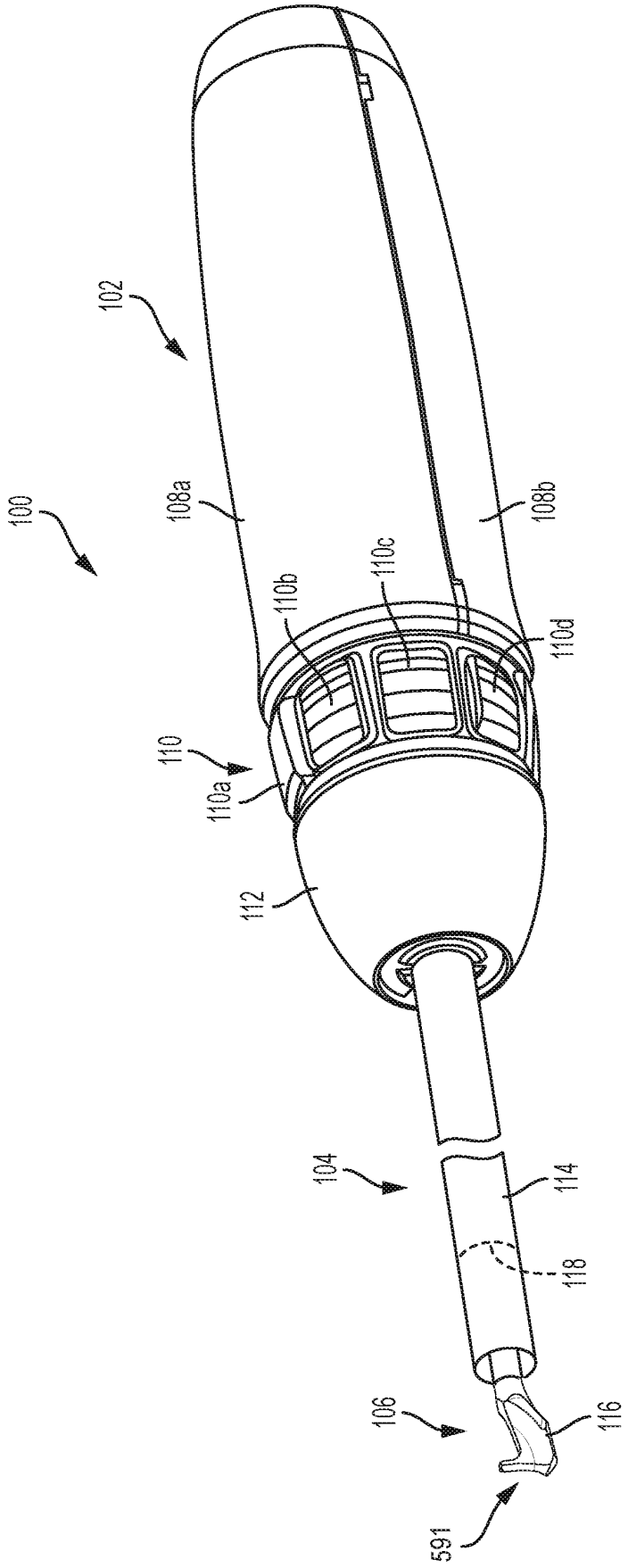
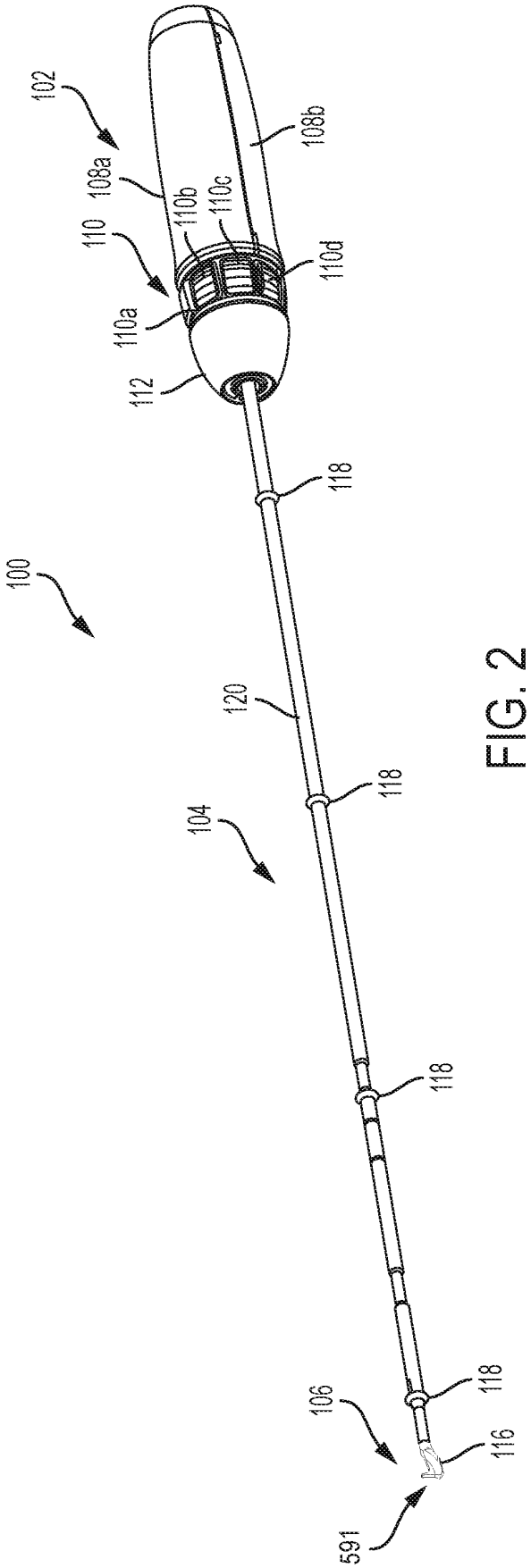

100
102
108a
108b
110
110a
110b
110c
110d
112
104
114
118
106
116
591

FIG. 1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108a
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110b
110c
110d
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118
100
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104
106
116
591

FIG. 2

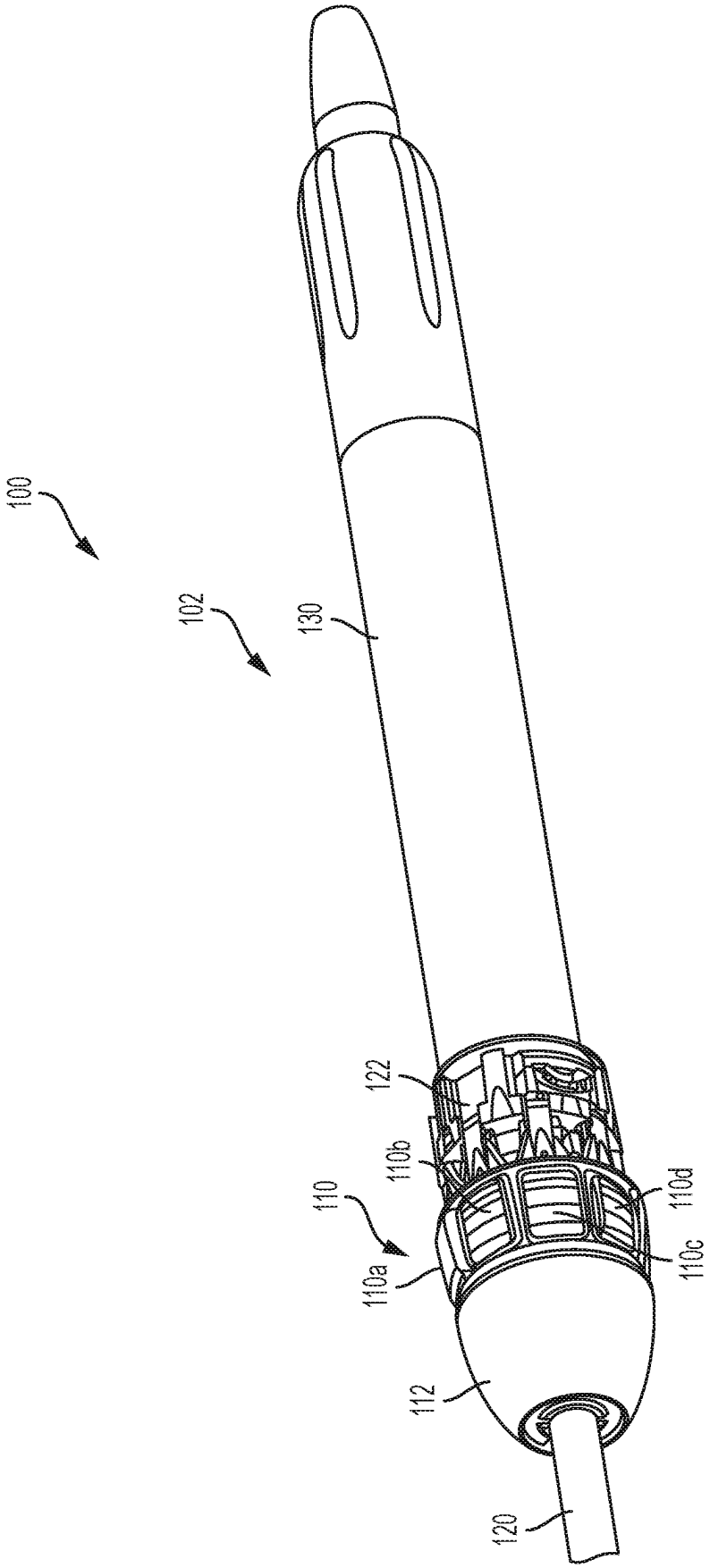


FIG. 3

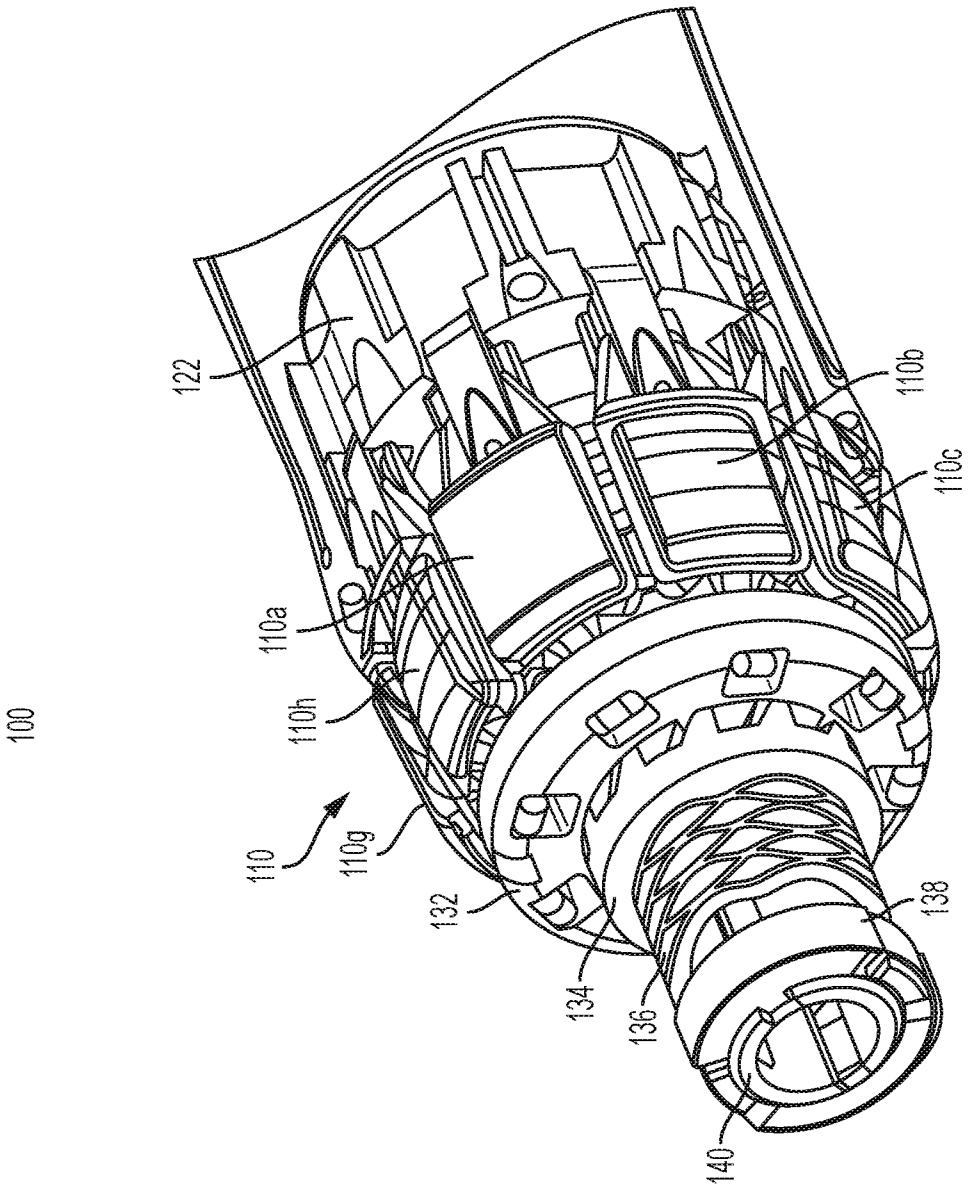
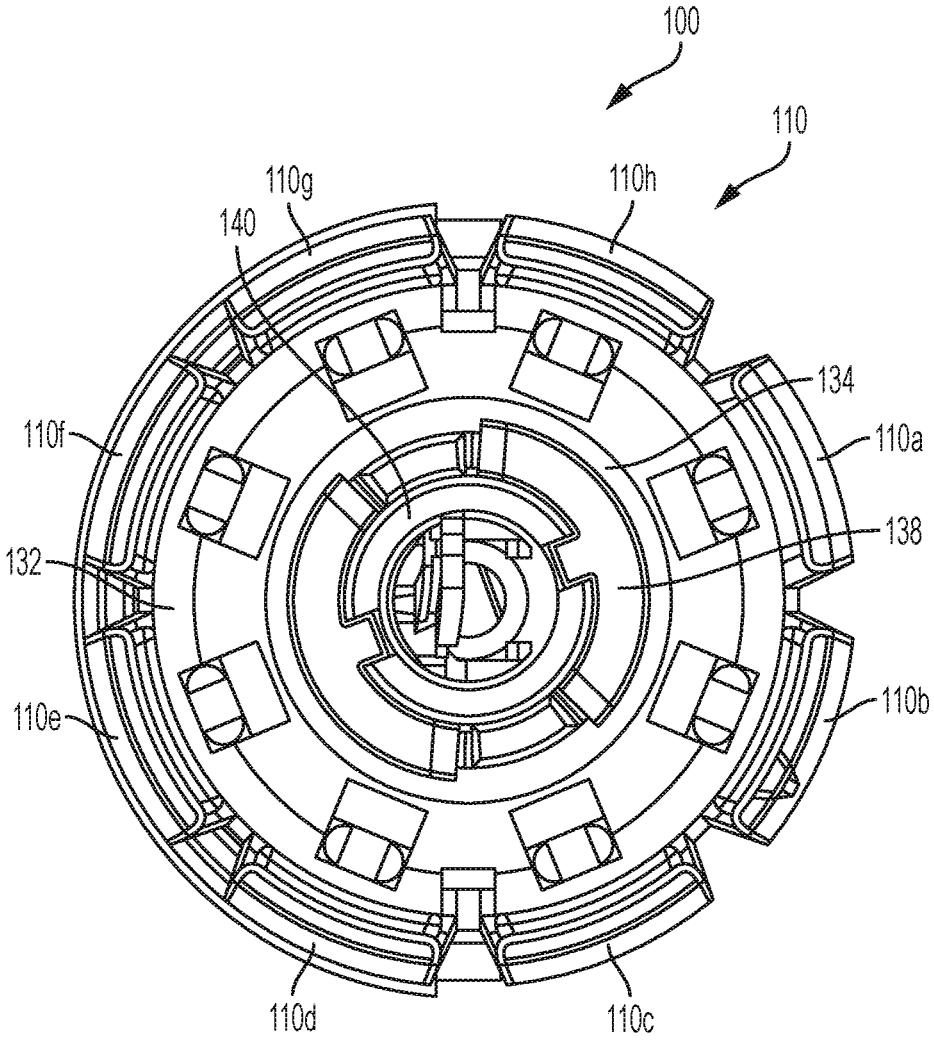


FIG. 4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110g
110h
140
134
110f
110a
138
132
110e
110b
110d
110c

FIG. 5

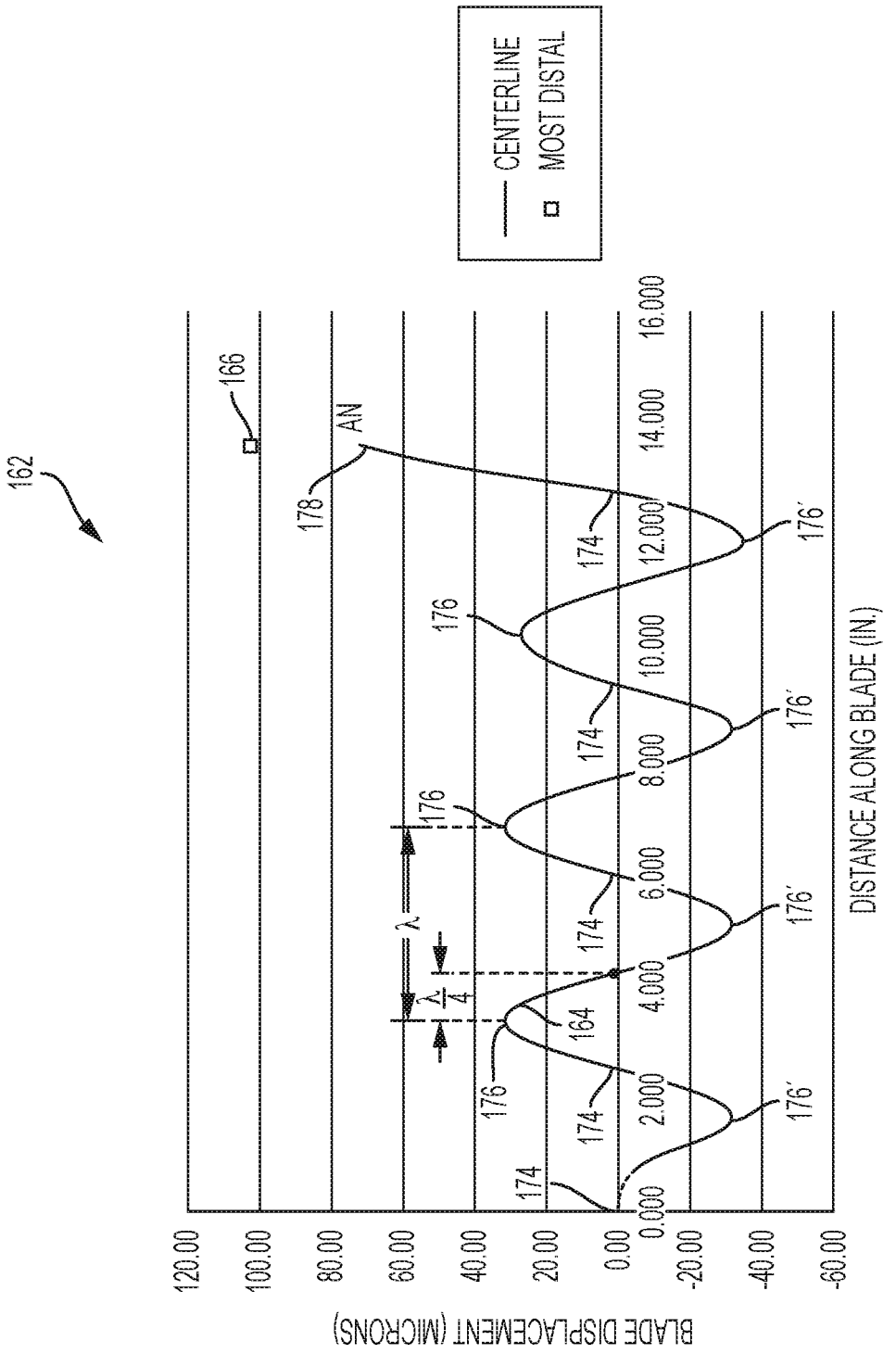

162
166
AN
178
CENTERLINE
MOST DISTAL
176
174
176′
164
λ
λ/4
120.00
100.00
80.00
60.00
40.00
20.00
0.00
-20.00
-40.00
-60.00
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
16.000
BLADE DISPLACEMENT (MICRONS)
DISTANCE ALONG BLADE (IN.)

FIG. 6

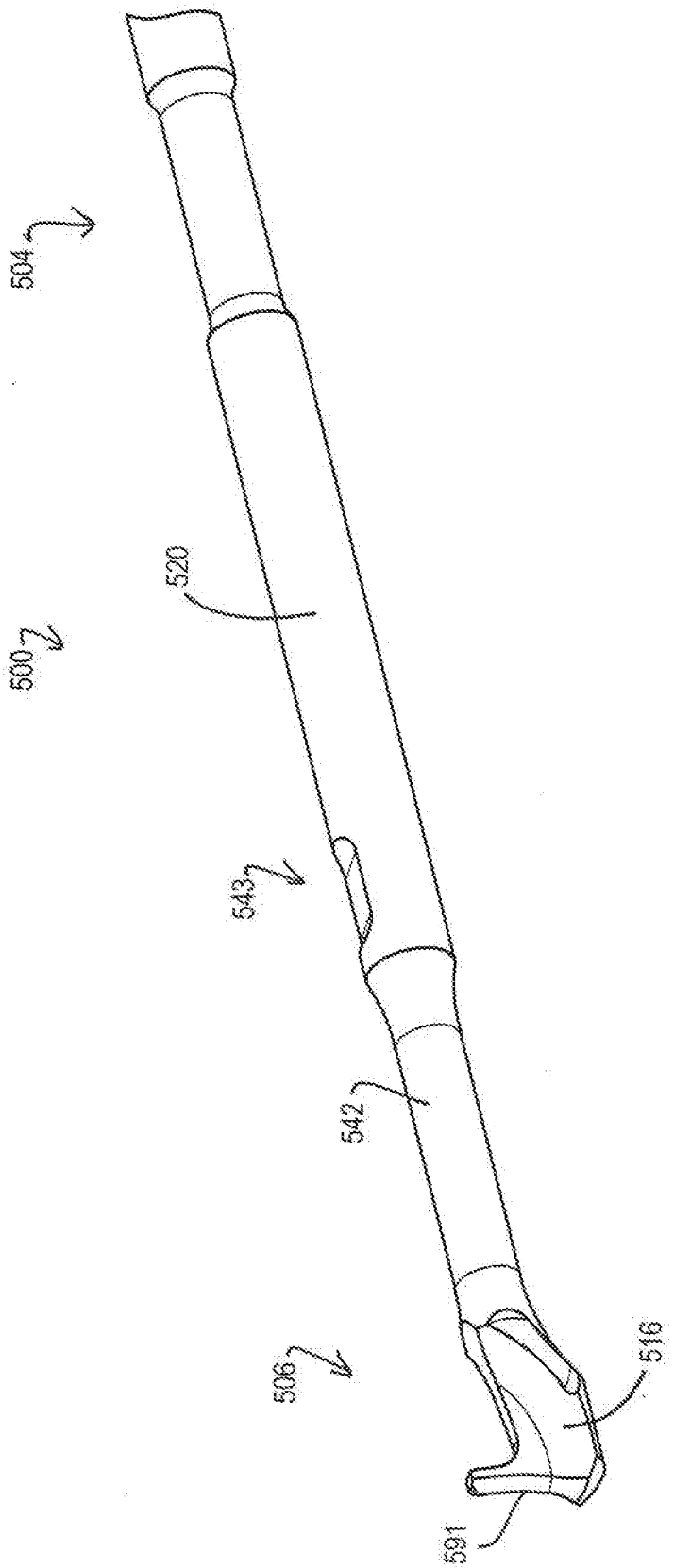


FIG. 7

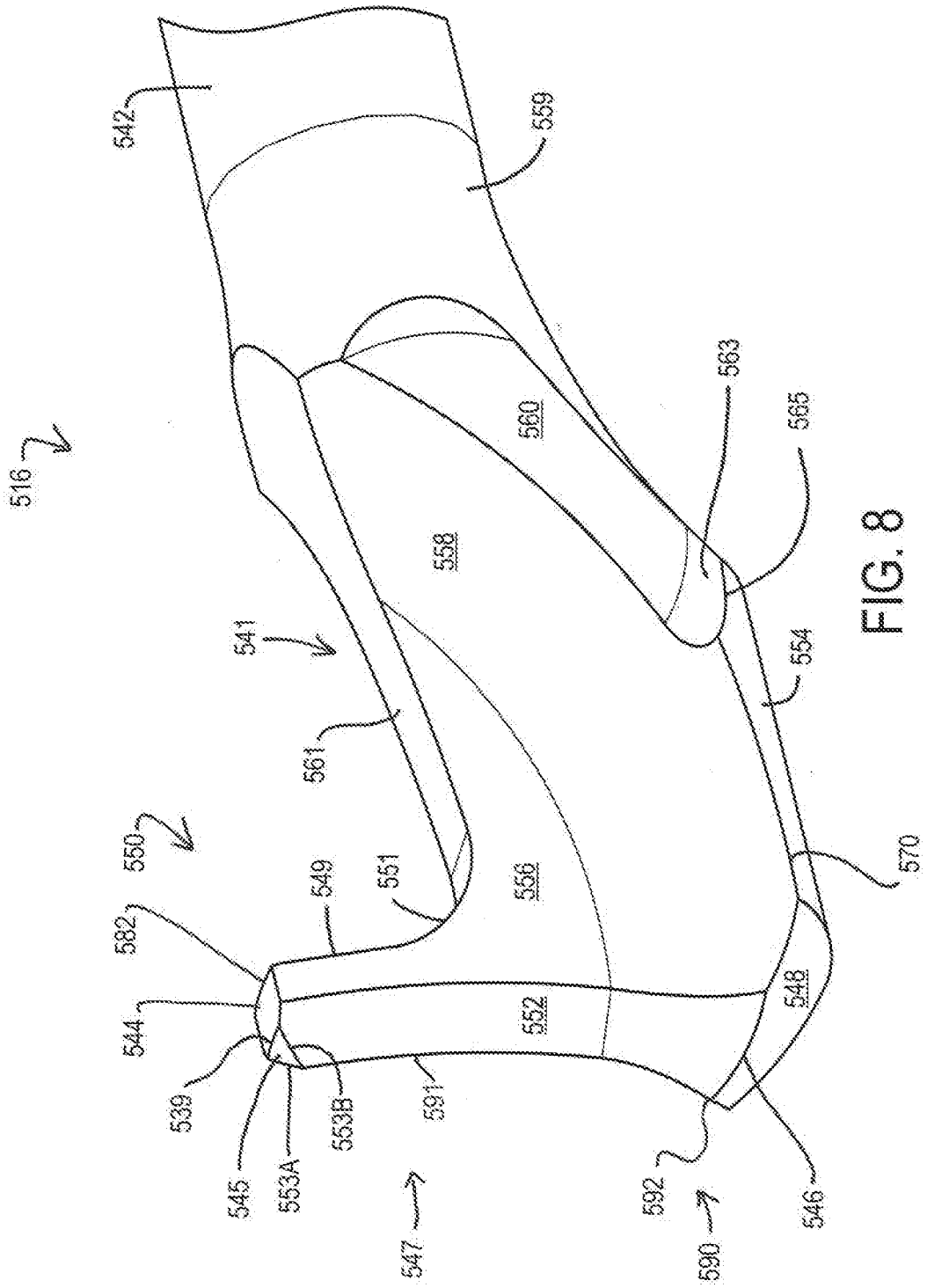
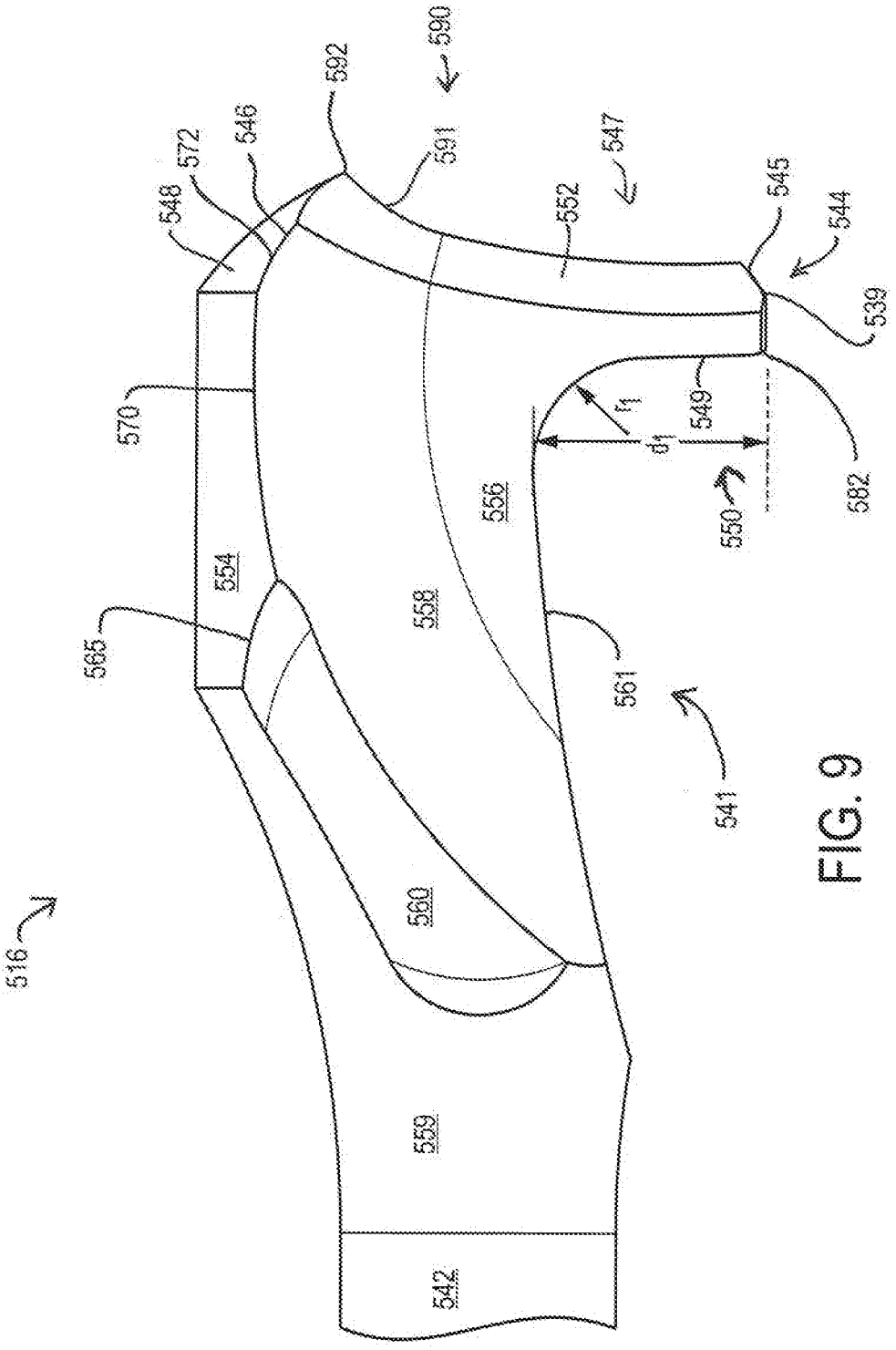

516
542
559
560
563
565
558
541
561
554
550
549
551
556
582
570
544
552
548
539
591
553B
553A
545
547
592
590
546

FIG. 8


516
565
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554
548
572
546
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590
591
547
552
545
544
539
549
582
550
556
558
561
541
560
559
542

FIG. 9

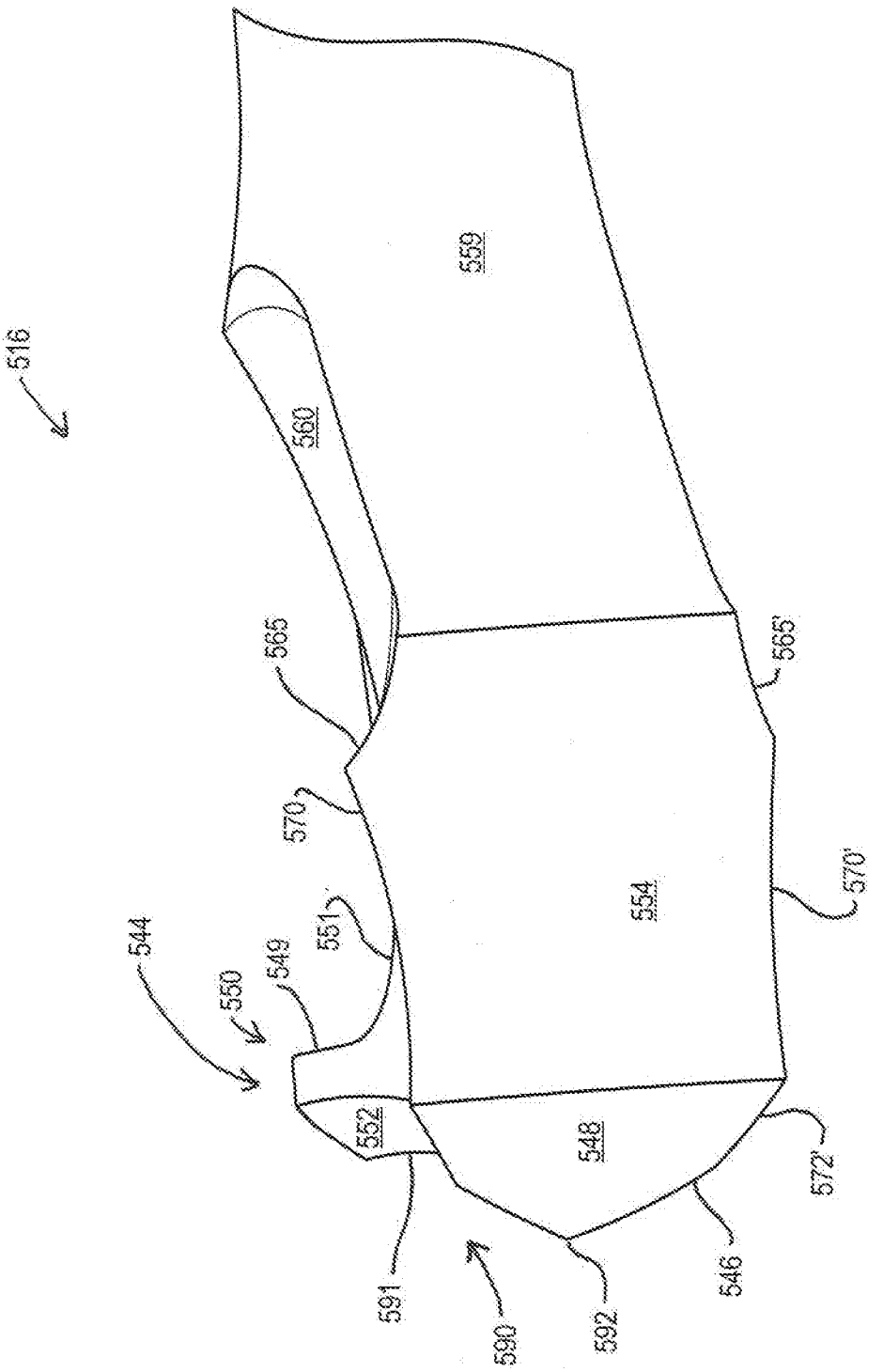
516
559
560
565
563'
570
570'
554
544
550
549
551
552
548
572'
591
590
592
546

FIG. 10

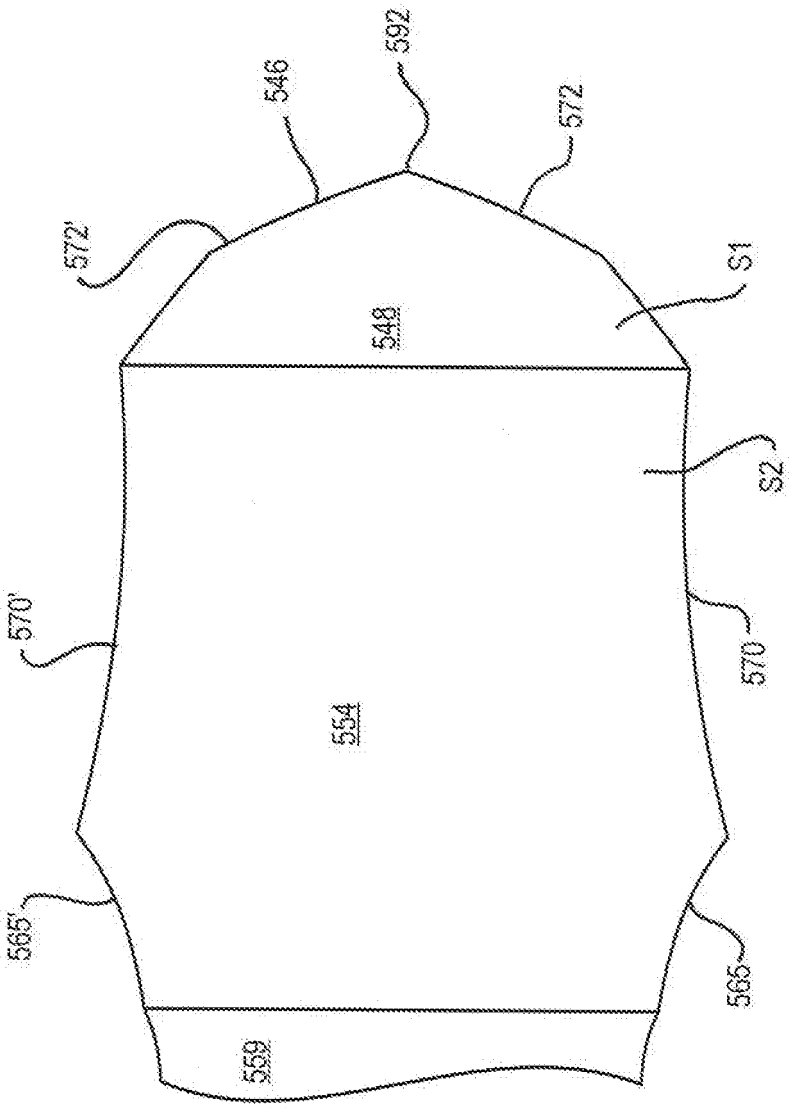

FIG. 11

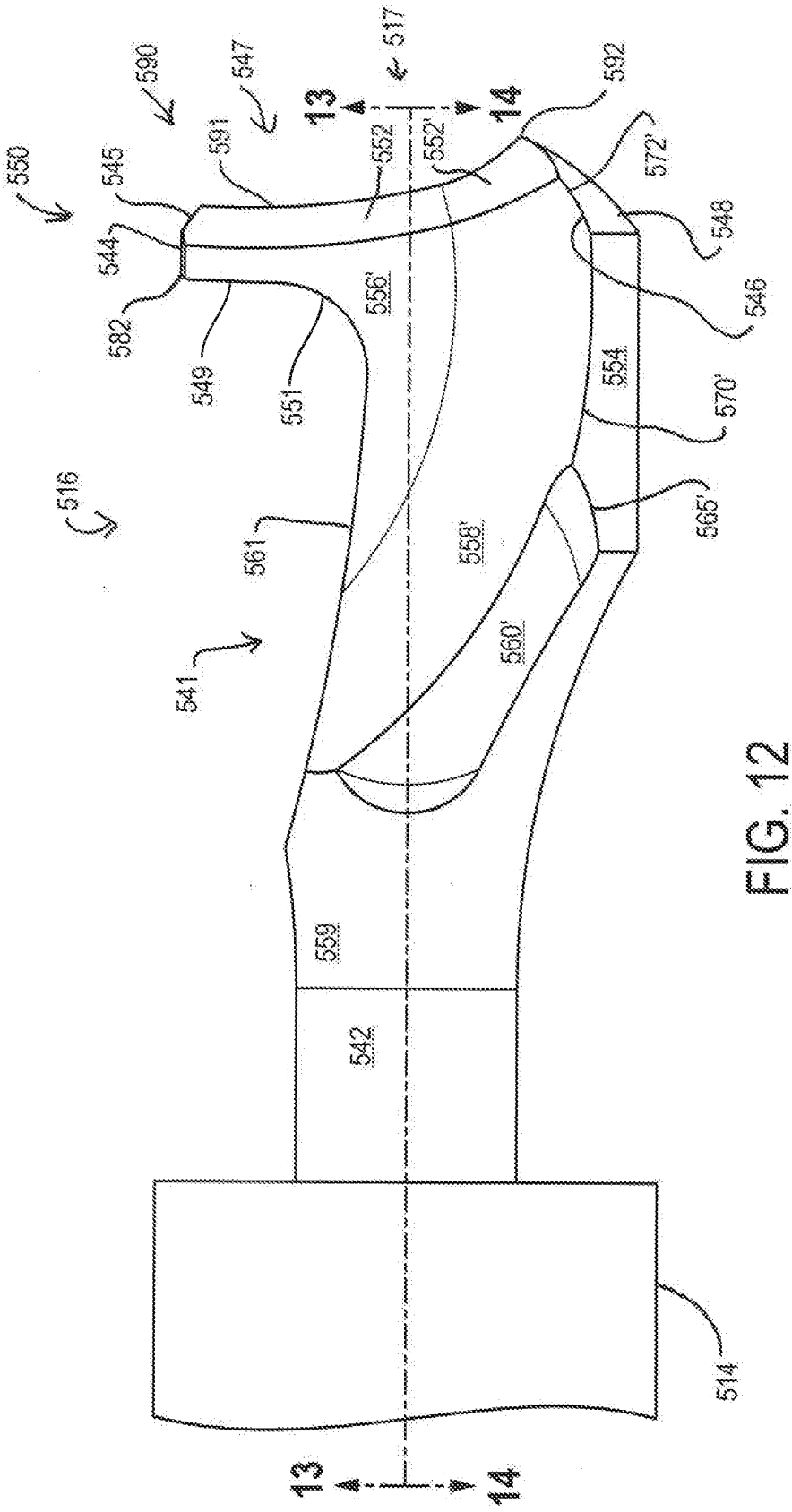
550
590
547
517
13
14
592
591
552
552'
572'
545
548
544
546
582
556'
549
551
554
570'
516
565'
561
558'
560'
541
559
542
514
13
14

FIG. 12

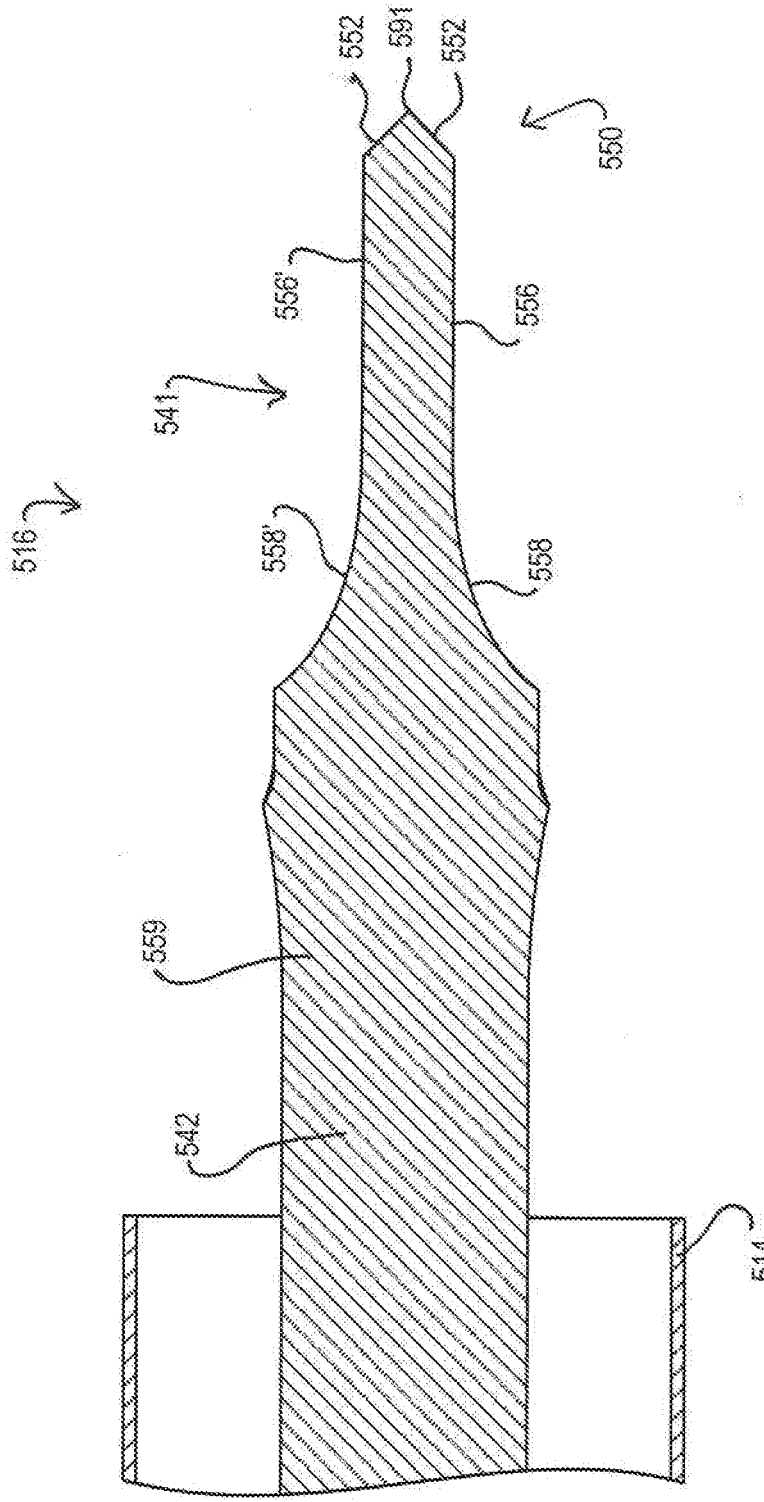

FIG. 13

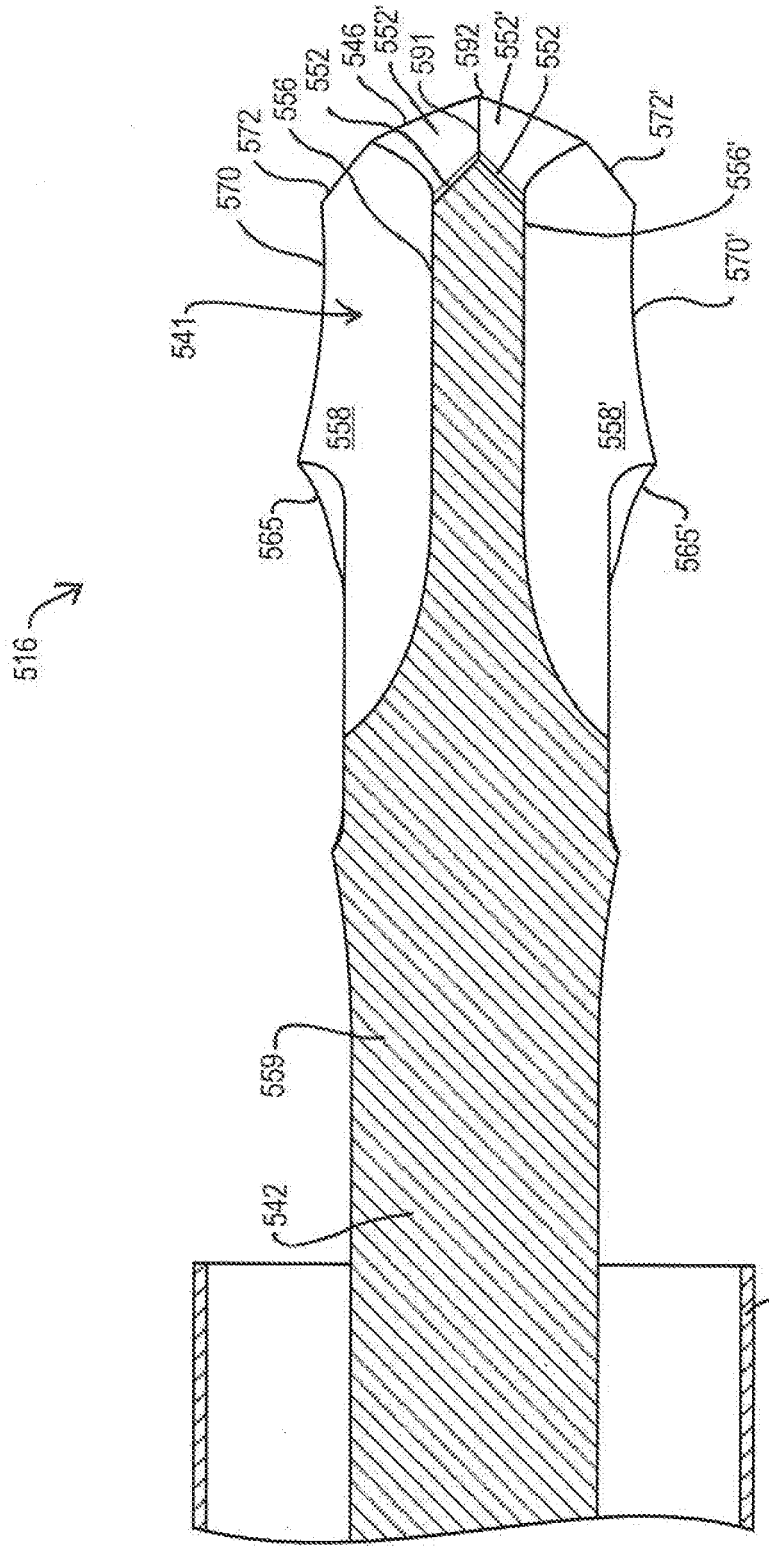
516
541
570
572
556
552
546
552'
591
592
552'
552
572'
556'
570'
558
558'
565
565'
559
542
514

FIG. 14

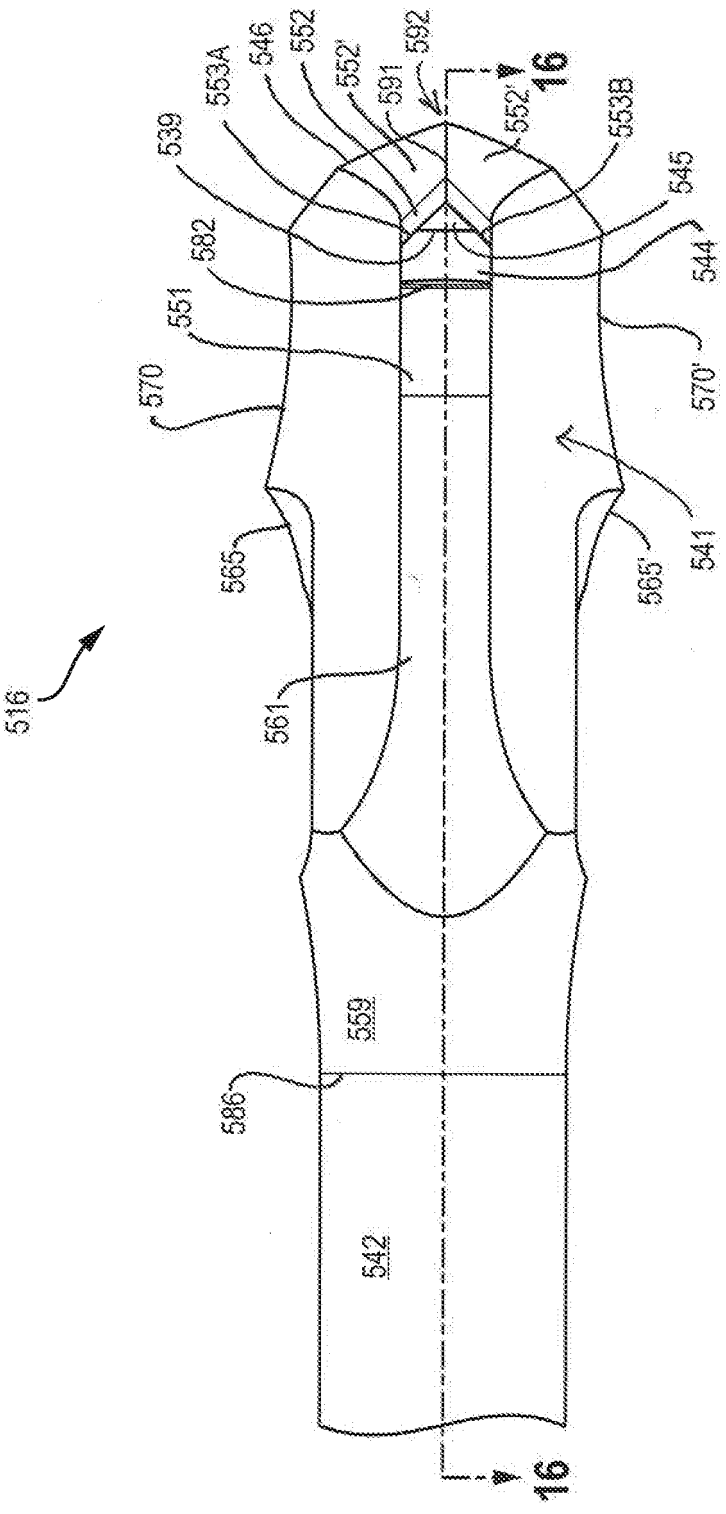
516
539
553A
546
552
552'
591
592
16
552'
553B
545
544
582
551
570
570'
565
565'
541
561
559
586
542
16

FIG. 15

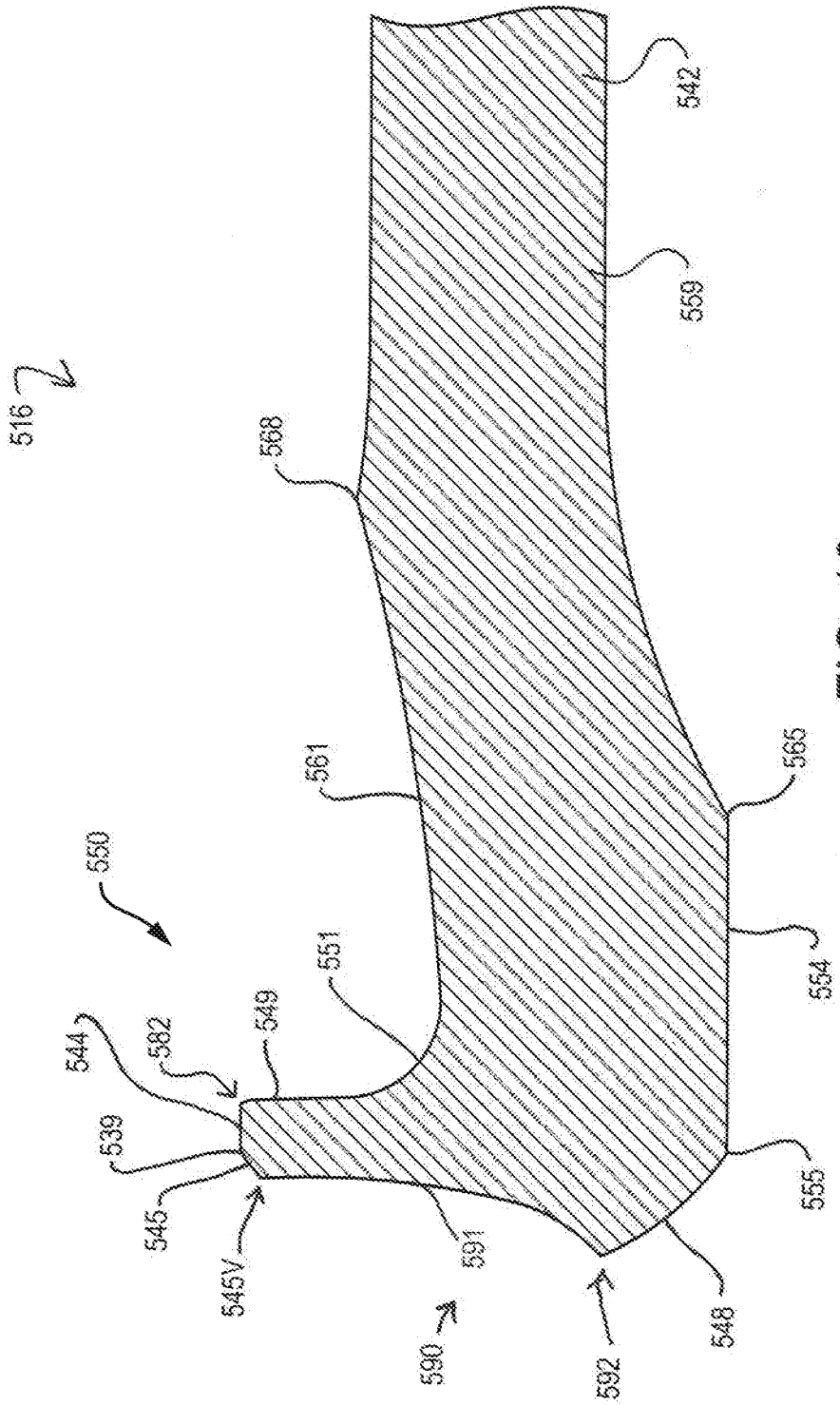
516
542
559
568
561
565
550
551
554
549
582
544
539
555
545
591
545V
548
590
592

FIG. 16

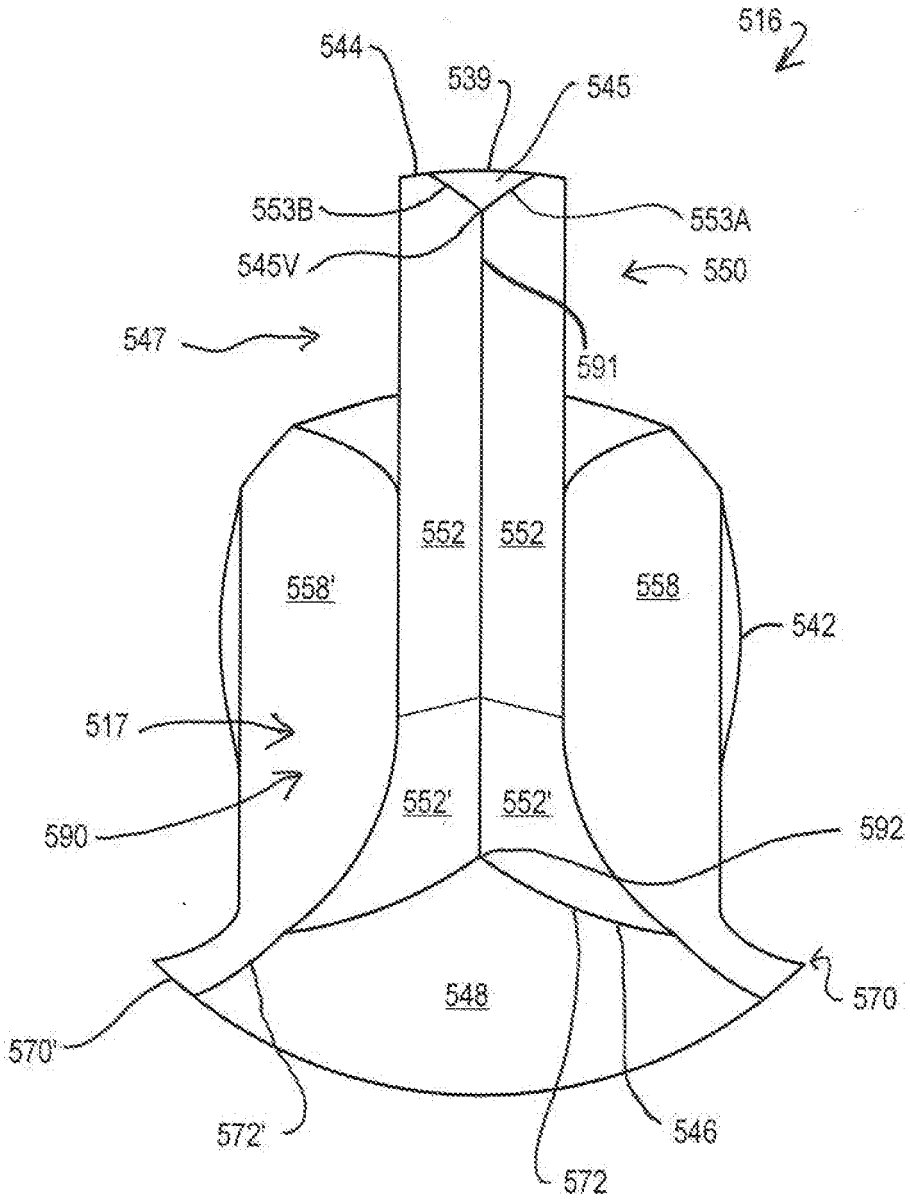
516
544
539
545
553B
553A
545V
550
547
591
552
552
558'
558
542
517
552'
552'
590
592
548
570
570'
572'
572
546

FIG. 17

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 2015088181 A1 **[0007]**
- US 2008009848 A1 **[0008]**
- US 5318570 A **[0008]**
- US 78974415 **[0032]**

专利名称(译)	超声波手术刀片具有改进的鞋跟部分		
公开(公告)号	EP3496632A1	公开(公告)日	2019-06-19
申请号	EP2017751563	申请日	2017-08-02
[标]申请(专利权)人(译)	ETHICON，LLC		
申请(专利权)人(译)	ETHICON LLC		
当前申请(专利权)人(译)	ETHICON LLC		
[标]发明人	CONLON SEAN P BOYD BENJAMIN M		
发明人	CONLON, SEAN P. BOYD, BENJAMIN M.		
IPC分类号	A61B17/32		
CPC分类号	A61B17/320068 A61B2017/320072 A61B2017/320074 A61B2017/320078 A61B2017/320082		
优先权	15/232113 2016-08-09 US		
其他公开文献	EP3496632B1		
外部链接	Espacenet		

摘要(译)

公开了具有改进的脚跟部分的超声外科刀片。 所述刀片包括：固体；纵向部分，其具有被配置为联接至超声传输波导的近端；以及横向部分，其从纵向部分的远端横向延伸。 在刀片上提供至少一个解剖边缘和至少一个止血表面。 横向部分限定了具有自由端的钩，该自由端被构造成拉动和解剖组织。 刀片还包括组织犁，该组织犁包括犁边缘和最远侧的顶点，以增加脚跟解剖和组织转移的效率。