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Ateshian et al.

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(54) **SYSTEMS AND APPARATUSES FOR MANIPULATING BENDABLE ALLOGRAFTS**

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Related U.S. Application Data

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(60) Provisional application No. 62/748,917, filed on Oct. 22, 2018.

(51) **Int. Cl.**

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A61B 17/00	(2006.01)
A61B 17/29	(2006.01)
A61F 2/46	(2006.01)

(52) **U.S. Cl.**
CPC ***A61B 17/2812*** (2013.01); ***A61B 17/282*** (2013.01); *A61B 2017/00433* (2013.01); *A61B 2017/2808* (2013.01); *A61B 17/2909* (2013.01); *A61B 2017/2911* (2013.01); *A61B 2017/2937* (2013.01); *A61B 2017/2939* (2013.01); *A61B 2017/2947* (2013.01); *A61F 2/4601* (2013.01); *A61F 2002/4622* (2013.01)

(58) **Field of Classification Search**
CPC A61B 17/0482; A61B 17/0483; A61B 17/0625; A61B 17/128; A61B 17/1796; A61B 17/885; A61B 17/2804; A61B 17/2812; A61B 17/282; A61B 17/30; A61B 2017/2926; A61F 2/4601; A61F 2/4611; A61F 2/4618
See application file for complete search history.

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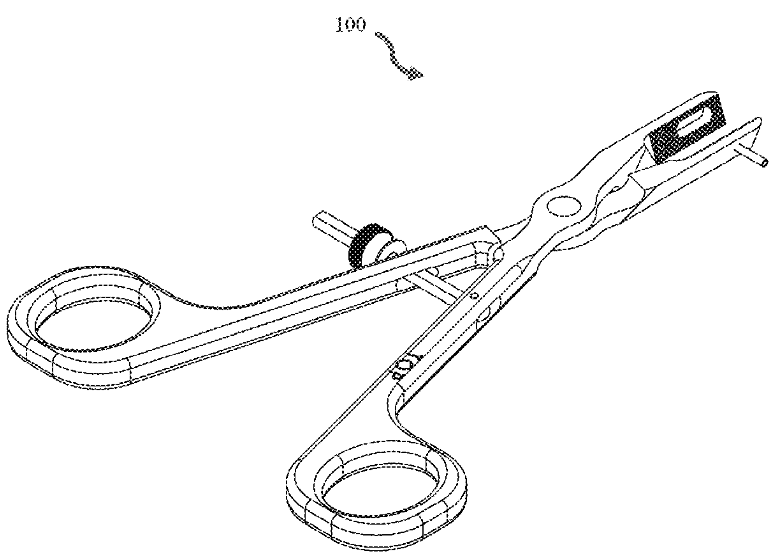
(57) **ABSTRACT**

A Surgical forceps device comprising a pair of shanks and a clamping jaw portion, the clamping jaw surfaces set at an angle that produces a desired angular position for grasping a bendable osteochondral allograft.

12 Claims, 25 Drawing Sheets



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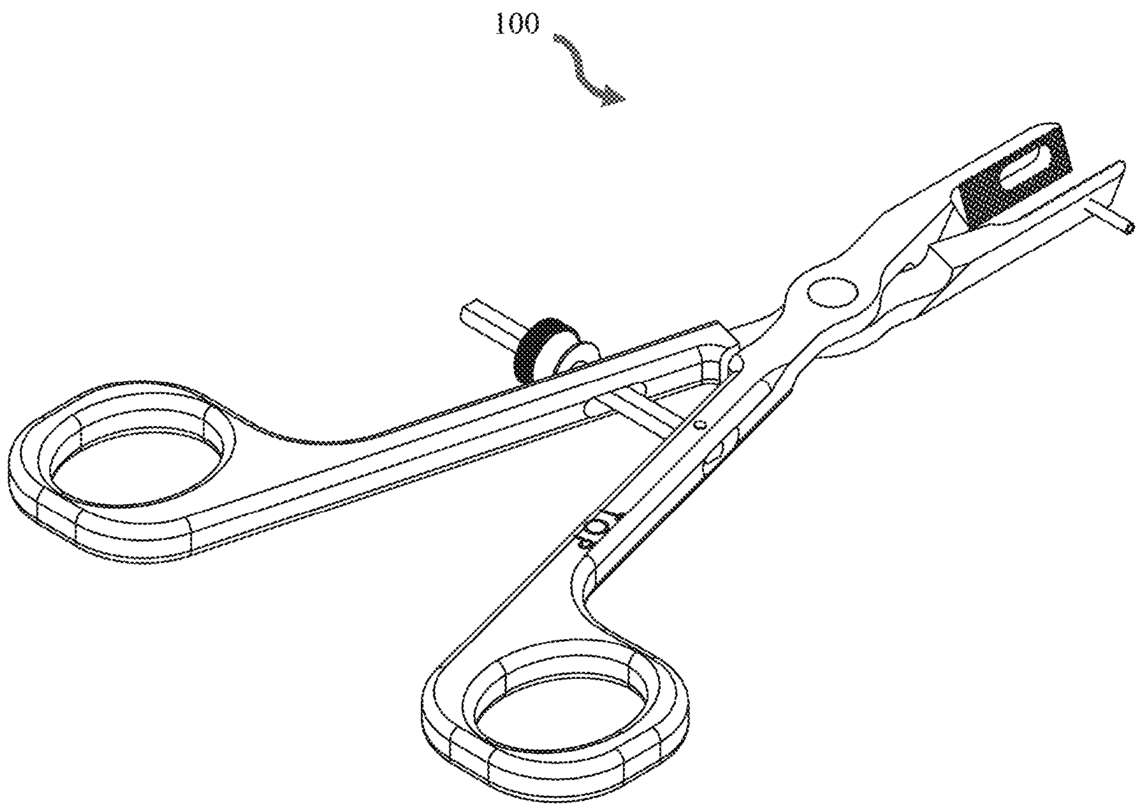


FIGURE 1A

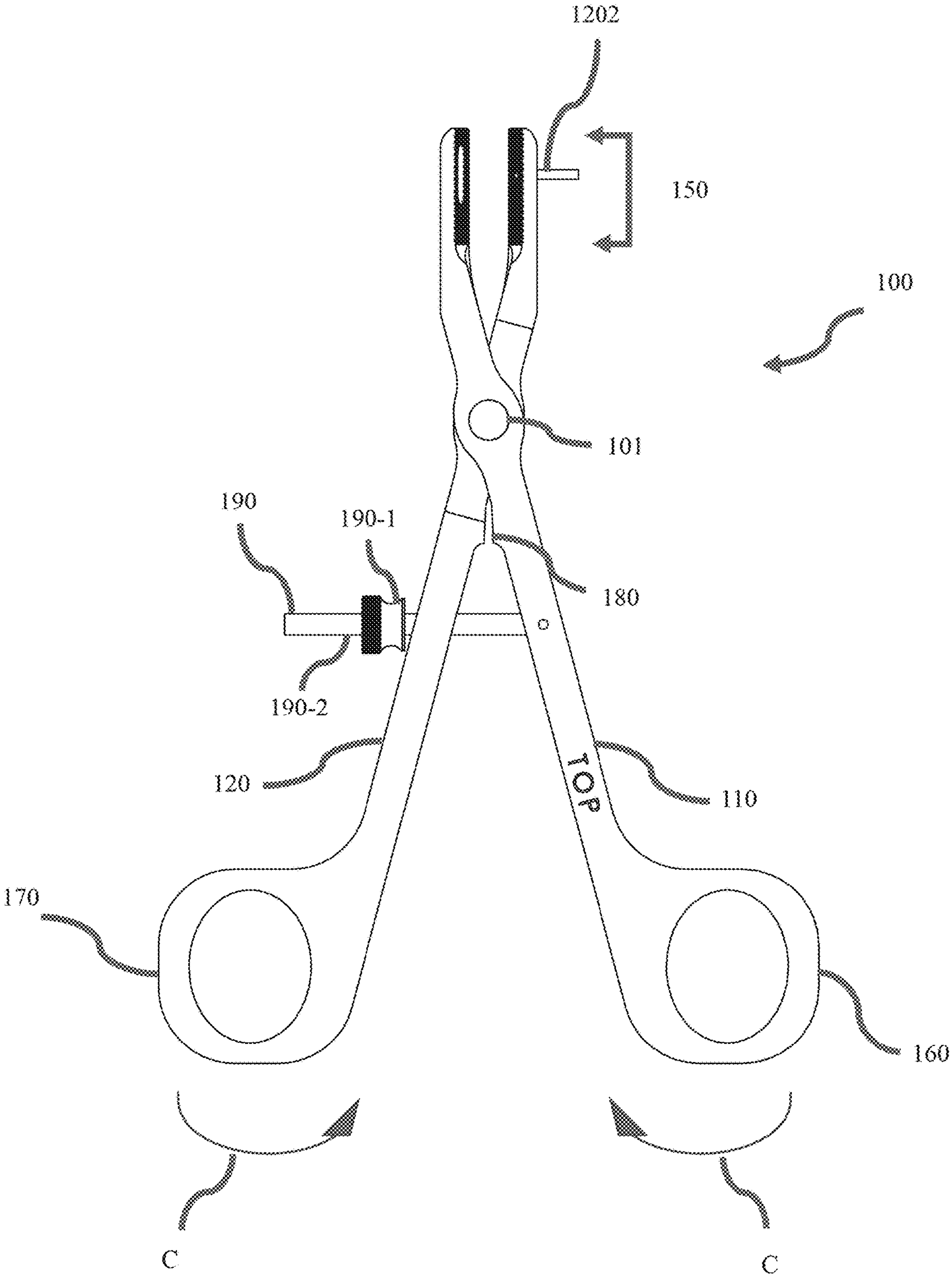


FIGURE 1B

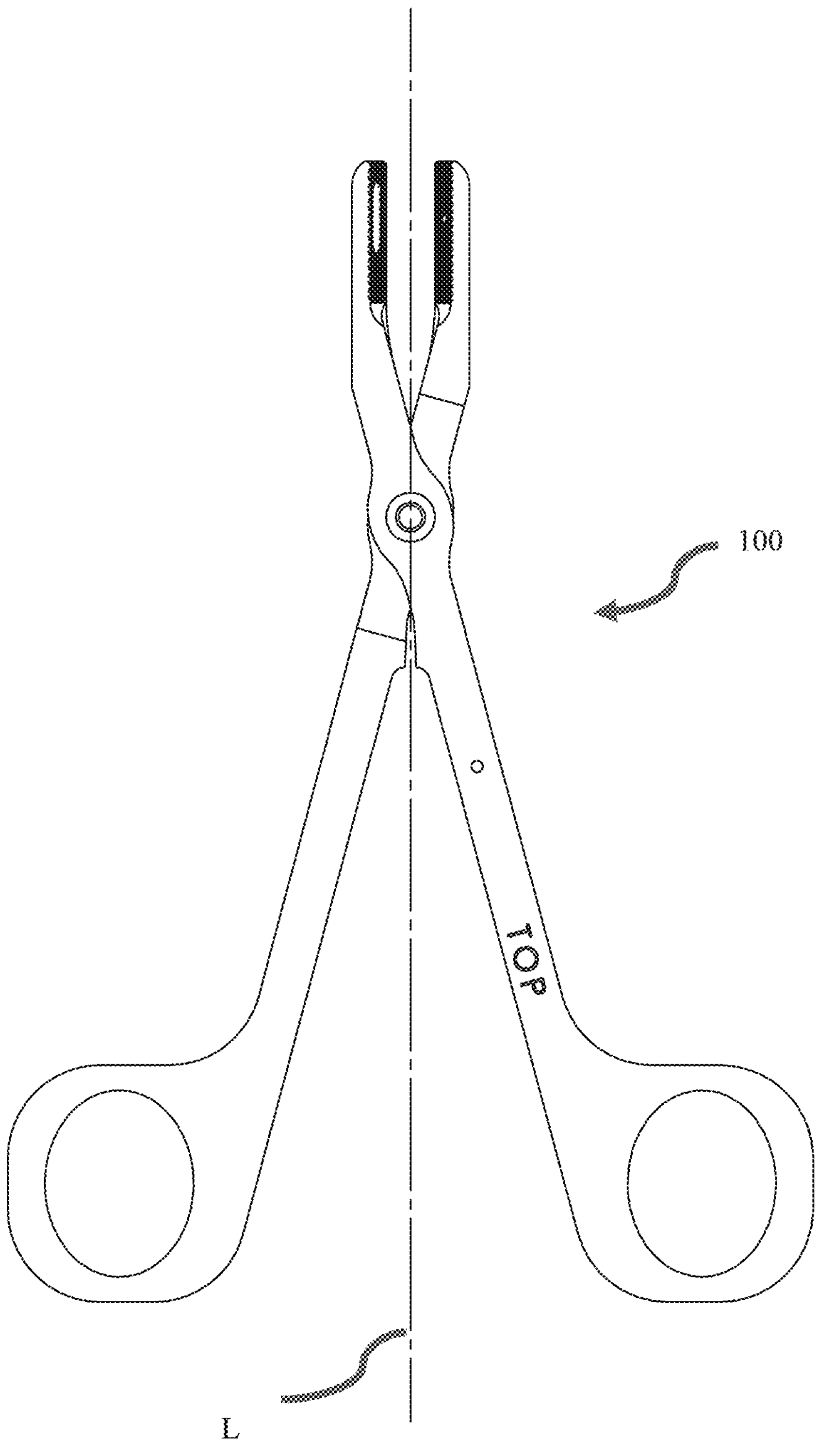


FIGURE 1C

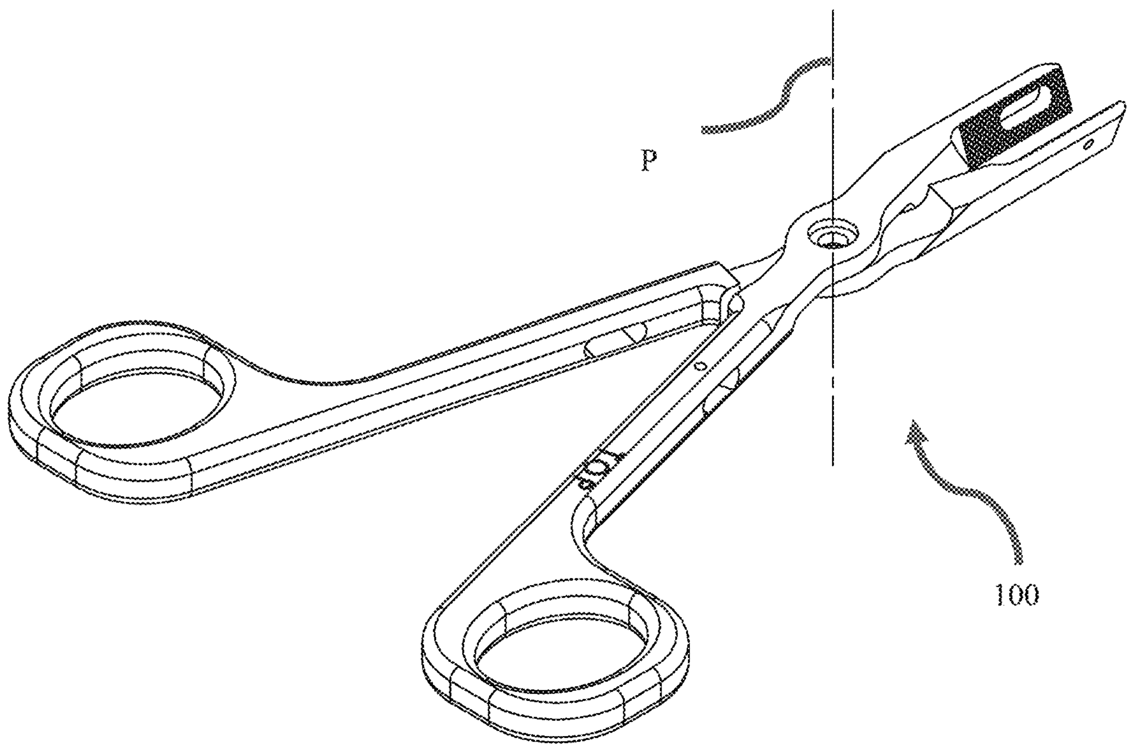


FIGURE 1D

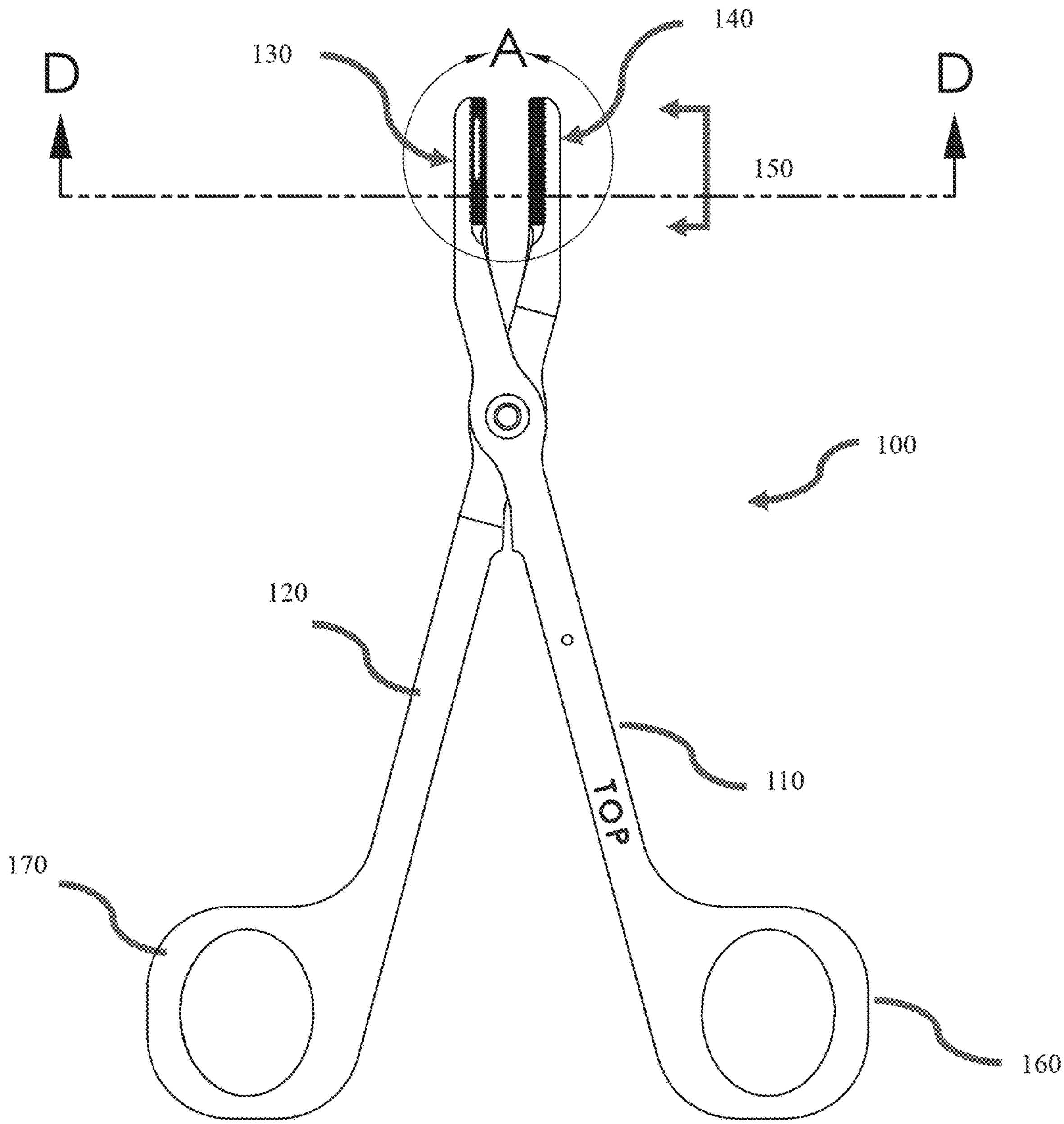


FIGURE 2

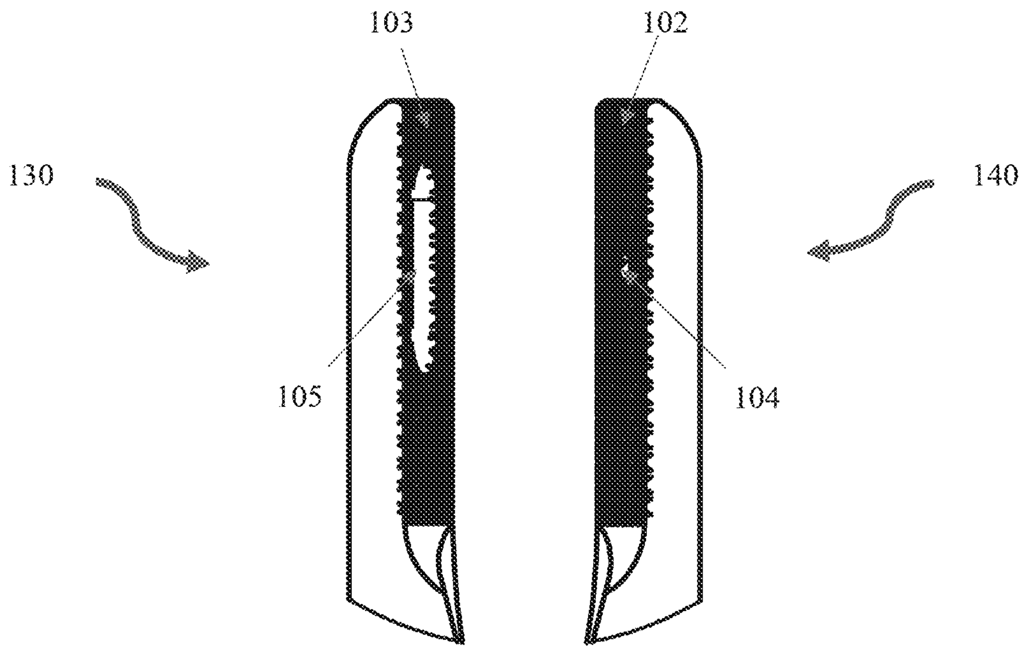


FIGURE 2A

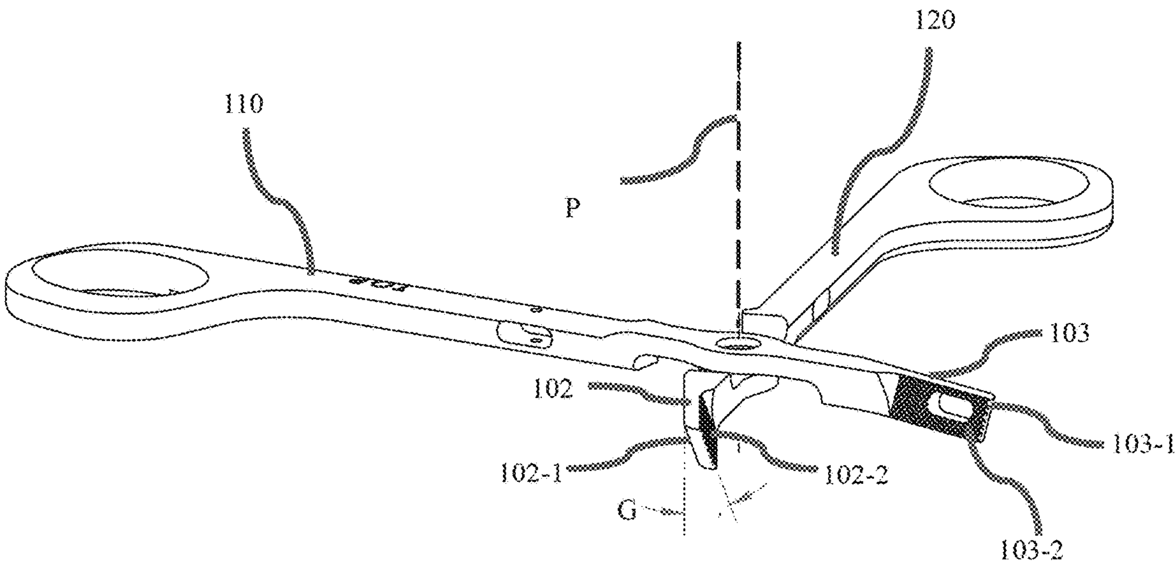


FIGURE 2B

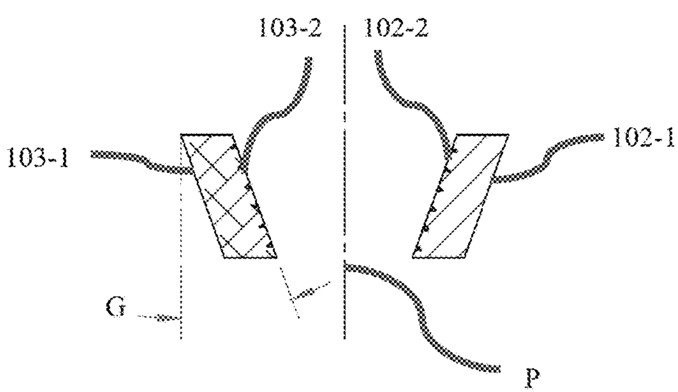


FIGURE 2C

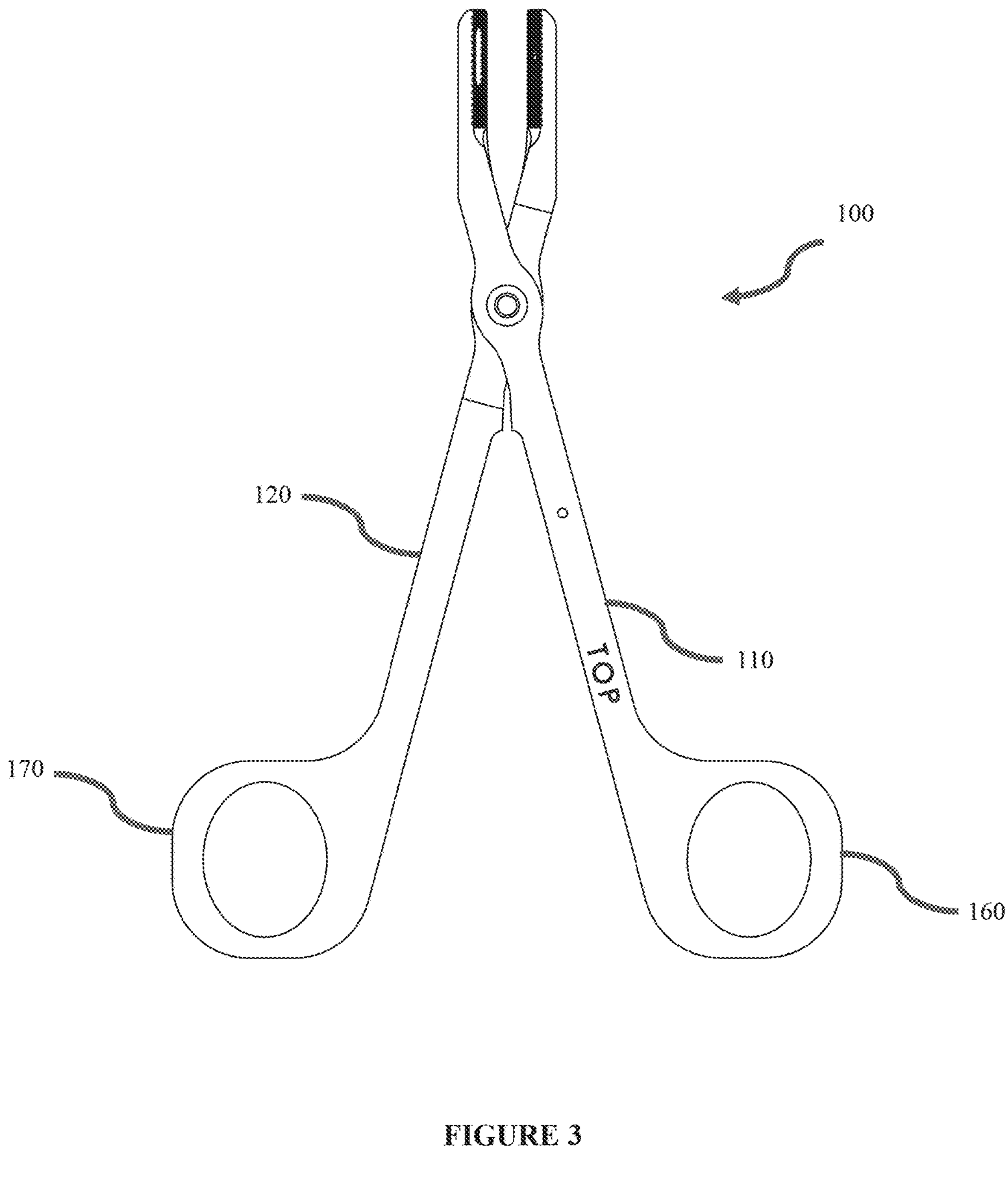


FIGURE 3

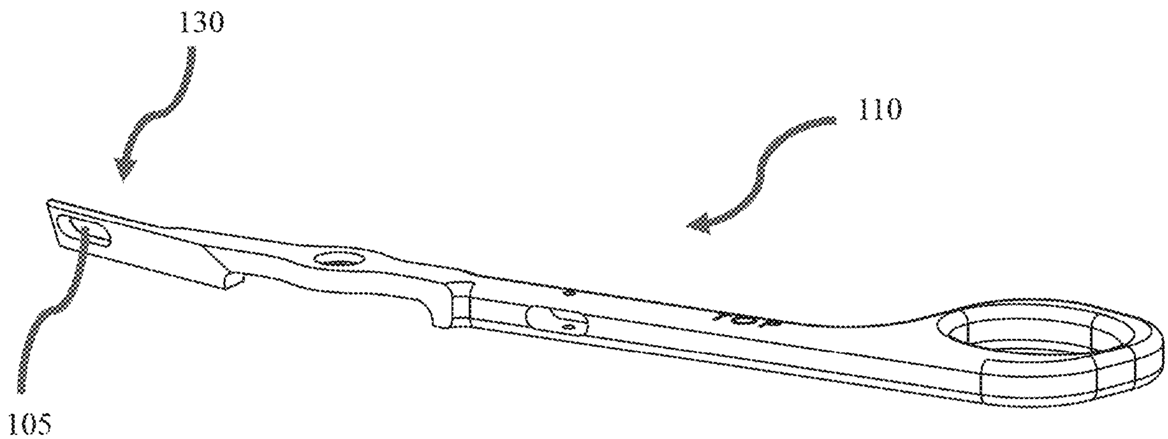


FIGURE 3A

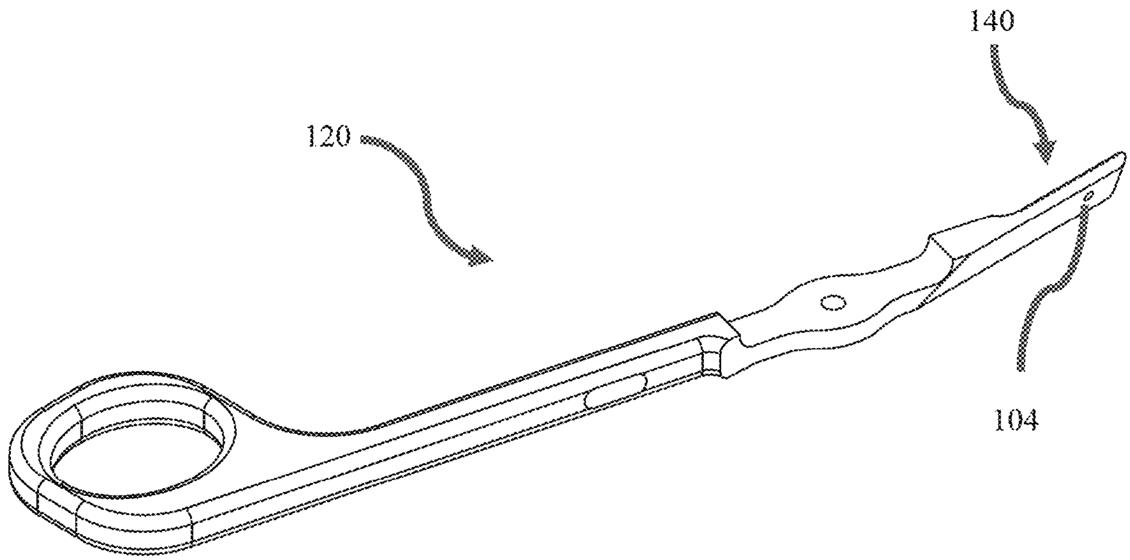


FIGURE 3B

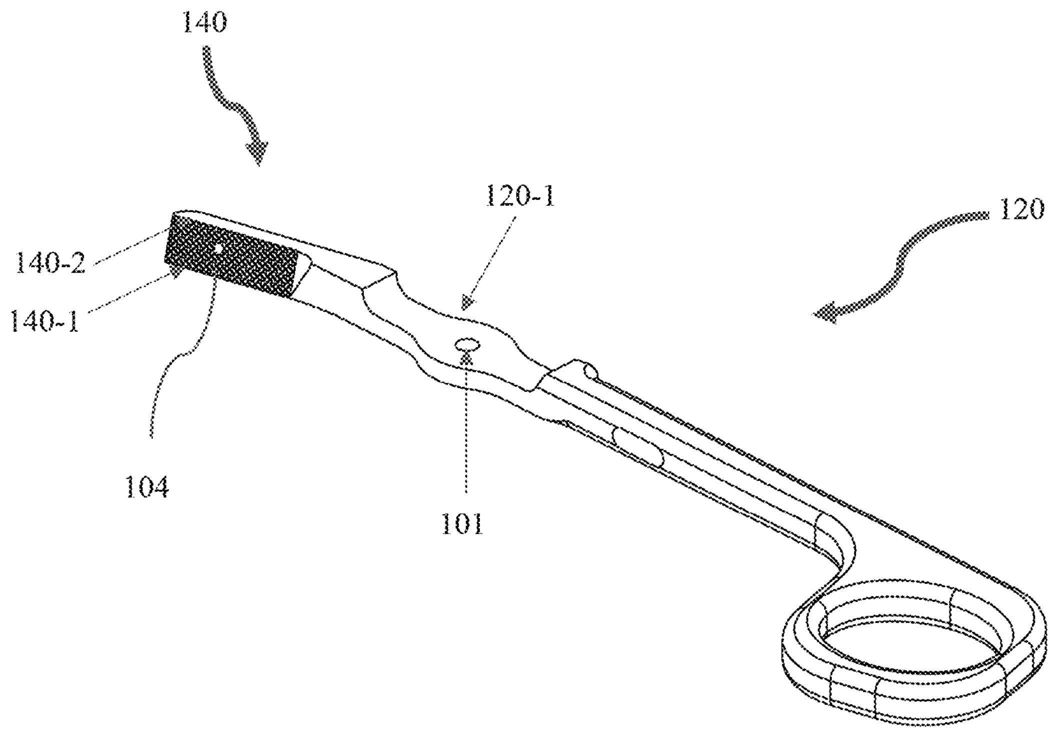


FIGURE 4

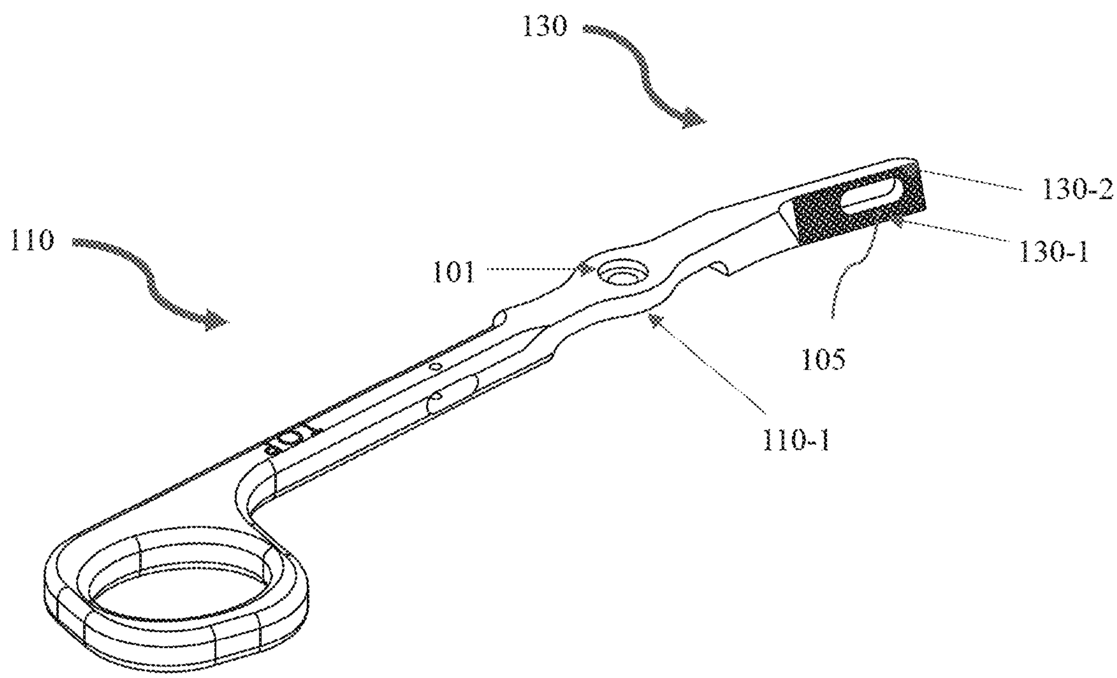


FIGURE 5

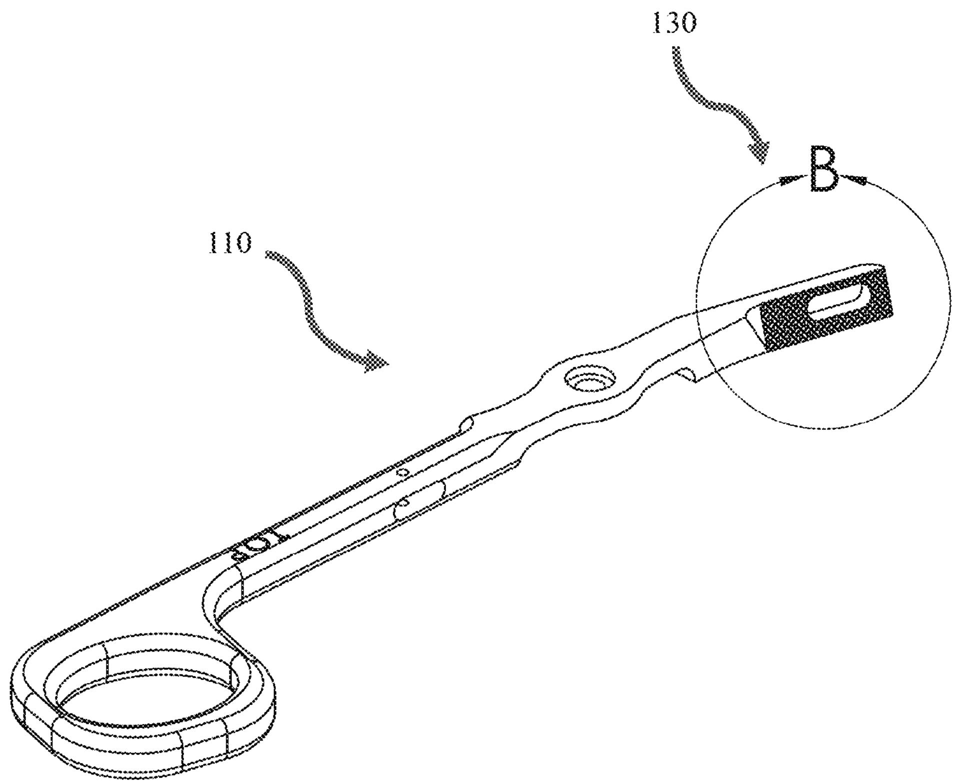


FIGURE 6A

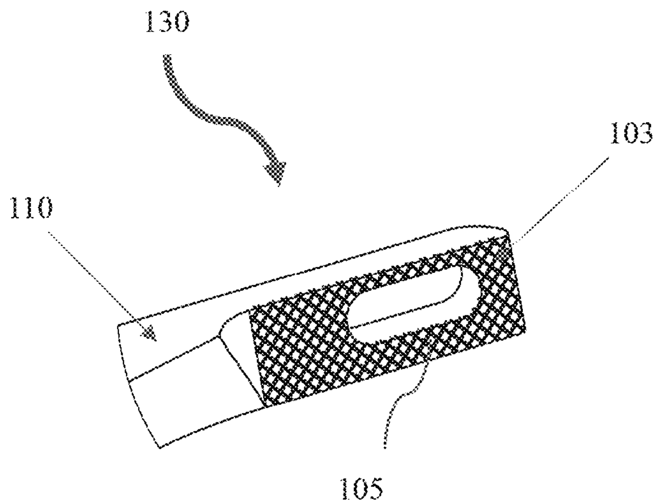


FIGURE 6B

FIGURE 7A

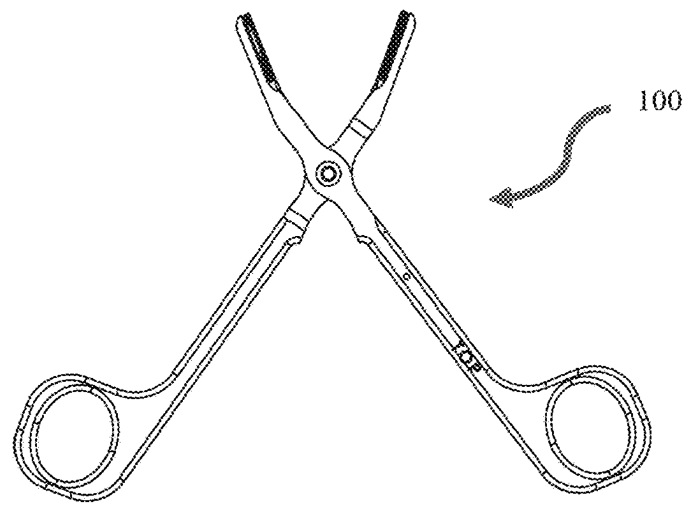


FIGURE 7B

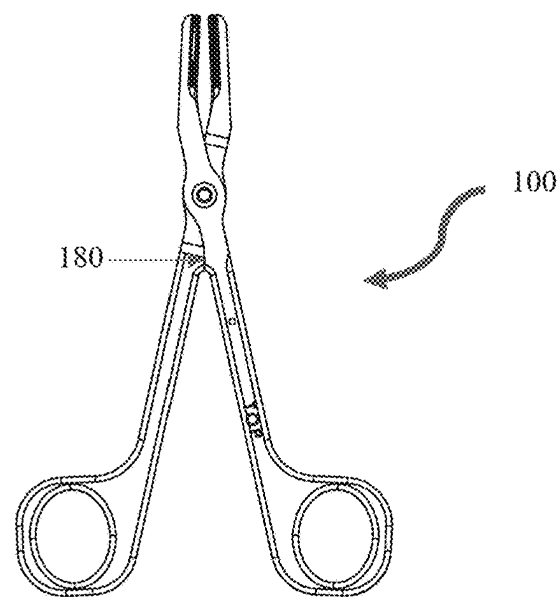
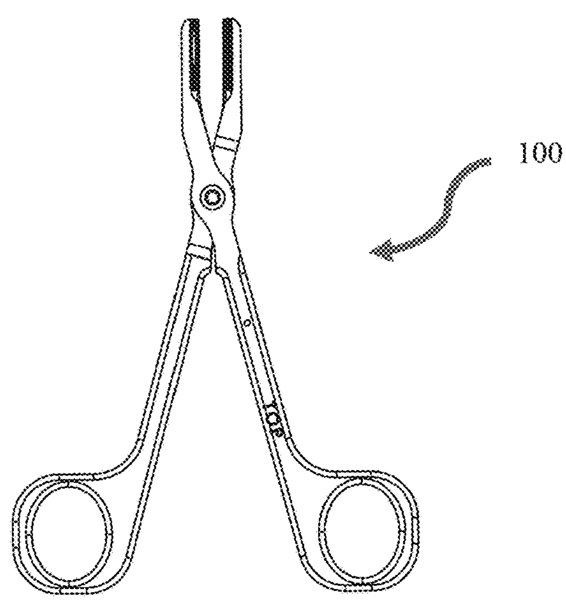


FIGURE 7C



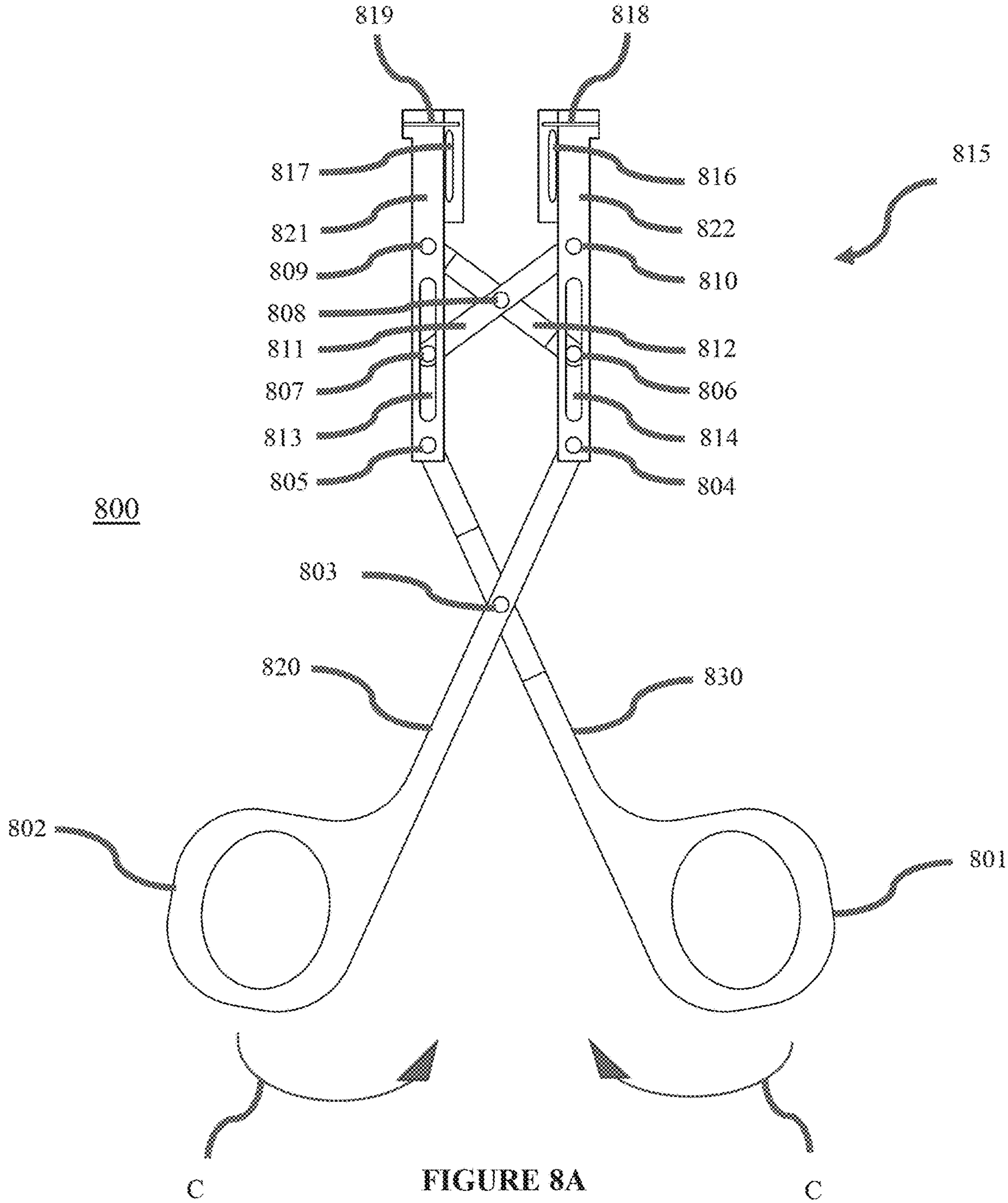

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FIGURE 8A

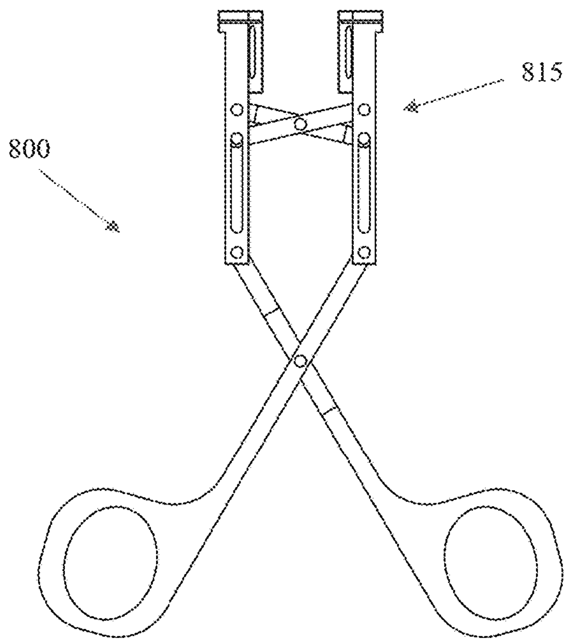

FIGURE 8B

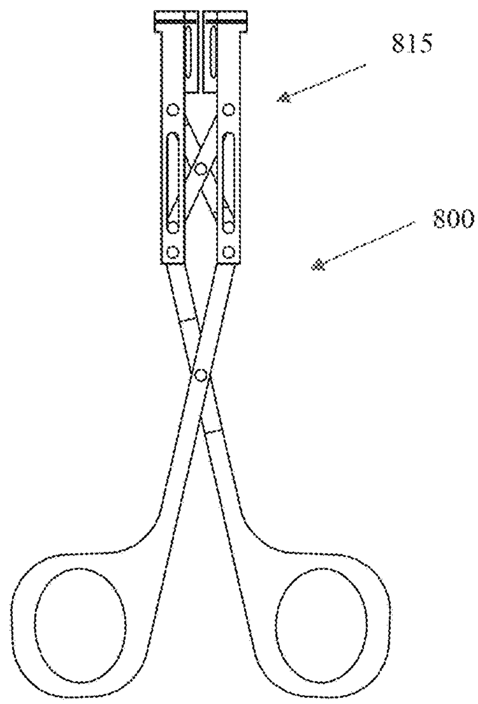

FIGURE 8C

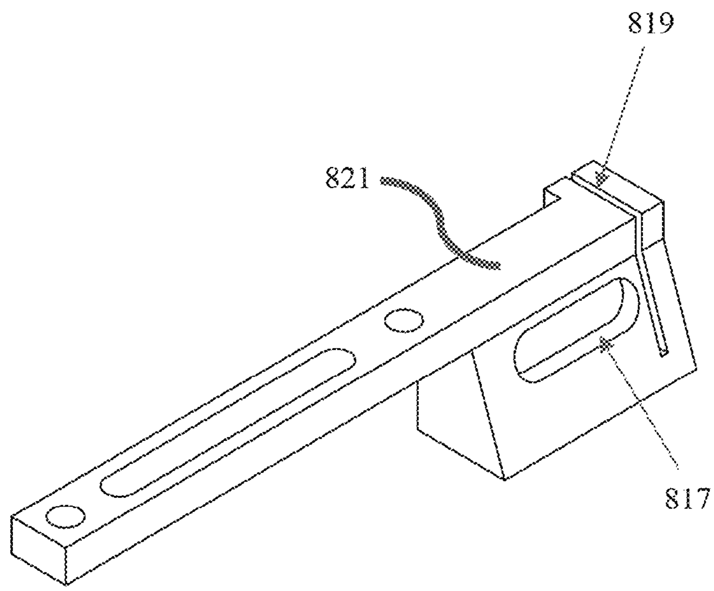

FIGURE 8D

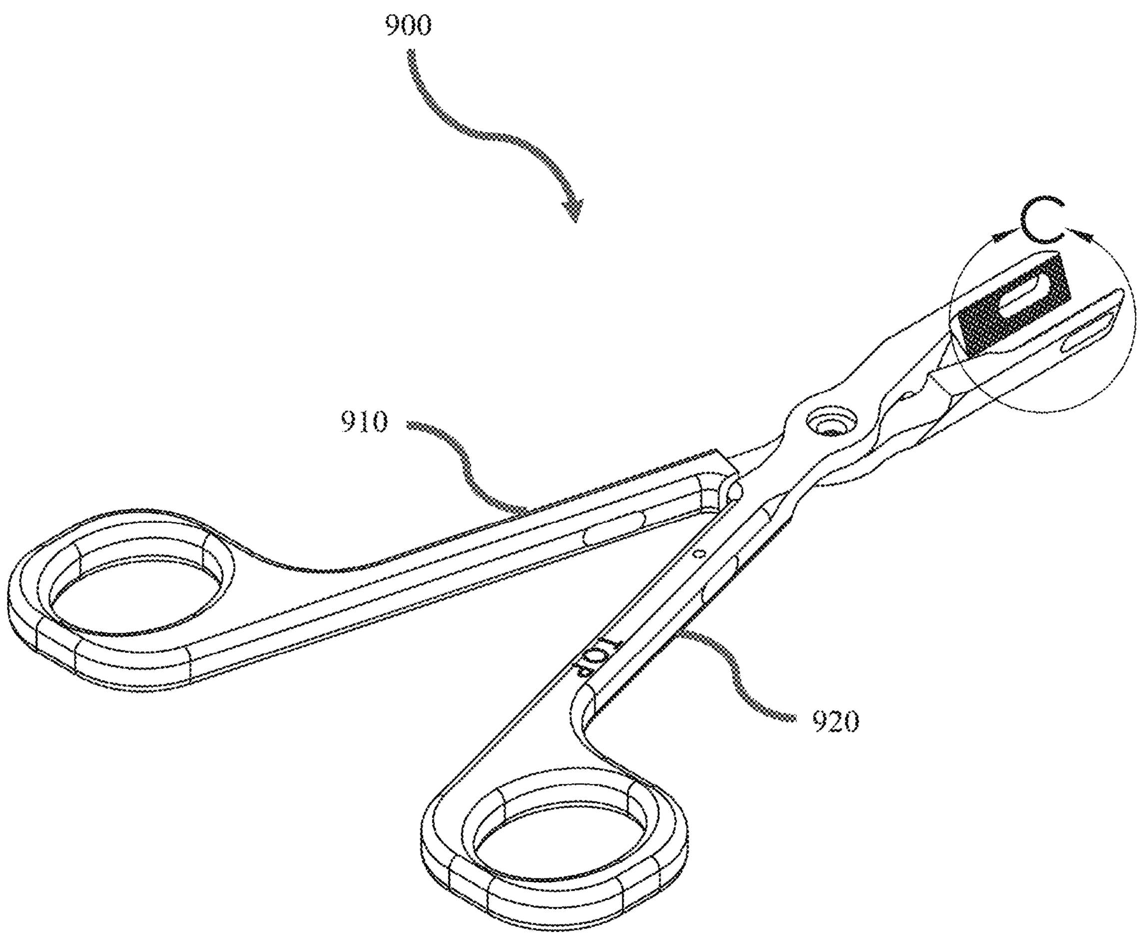

FIGURE 9A

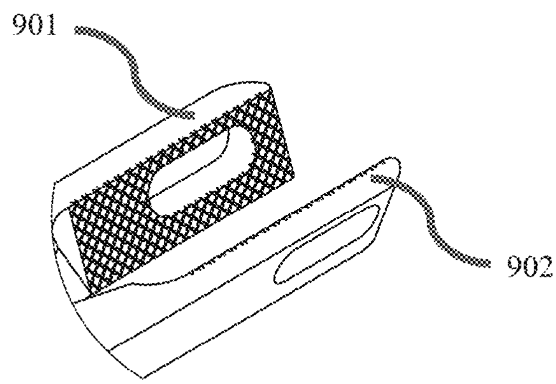

FIGURE 9B

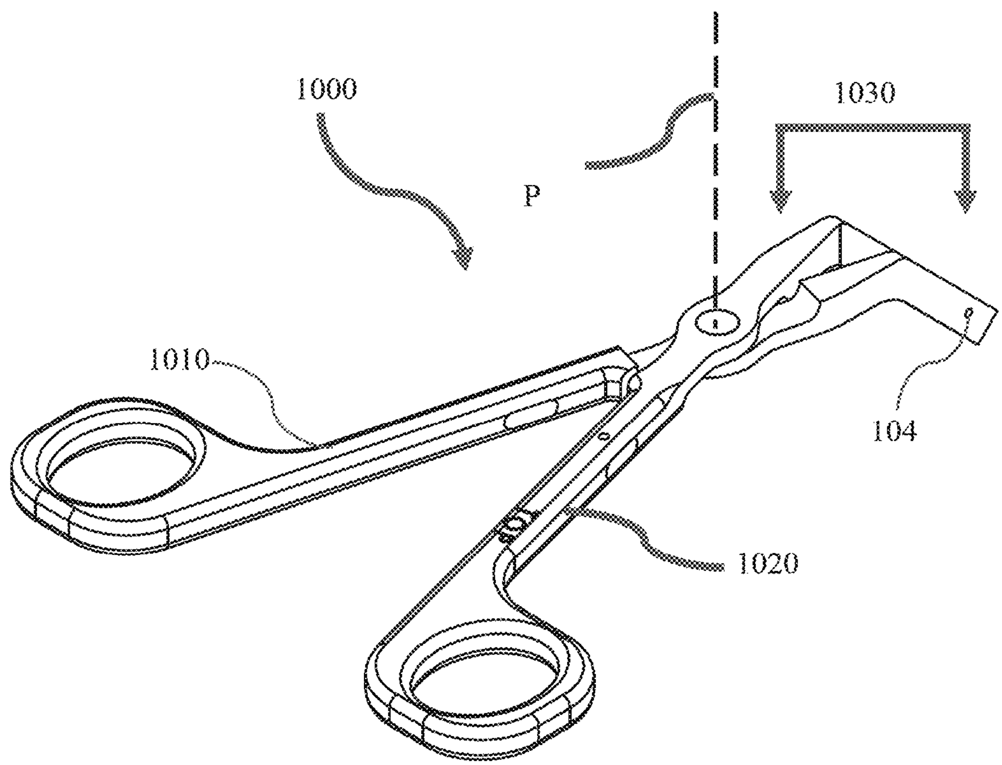

FIGURE 10A

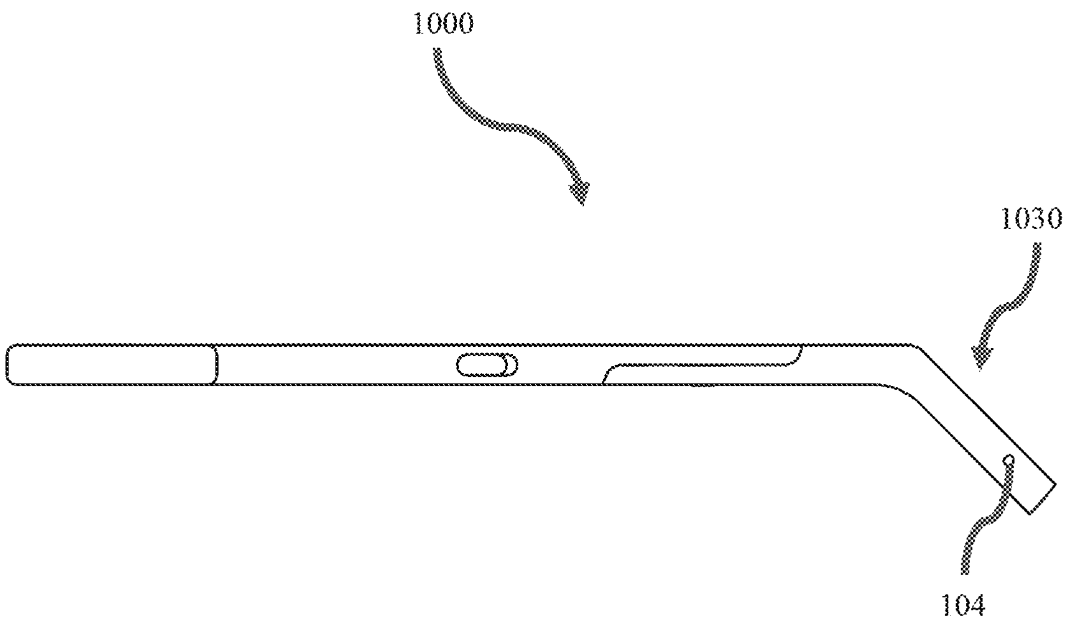

FIGURE 10B

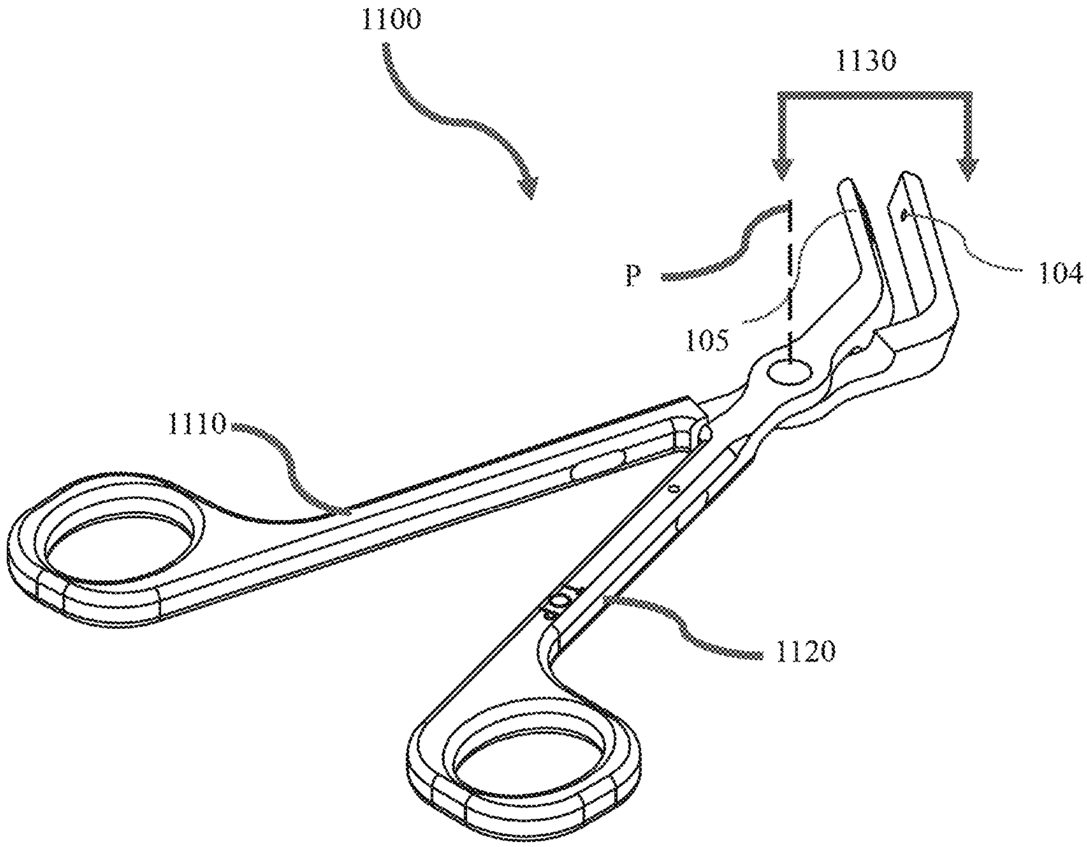

FIGURE 11A

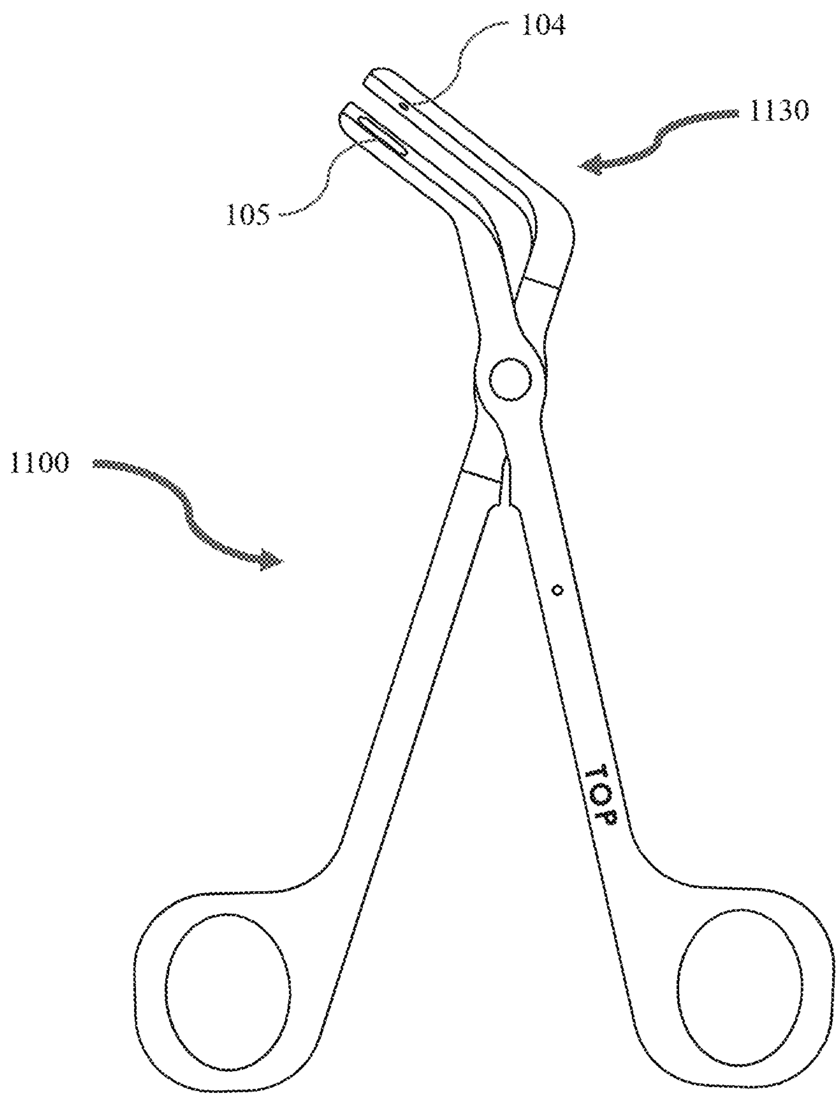

FIGURE 11B

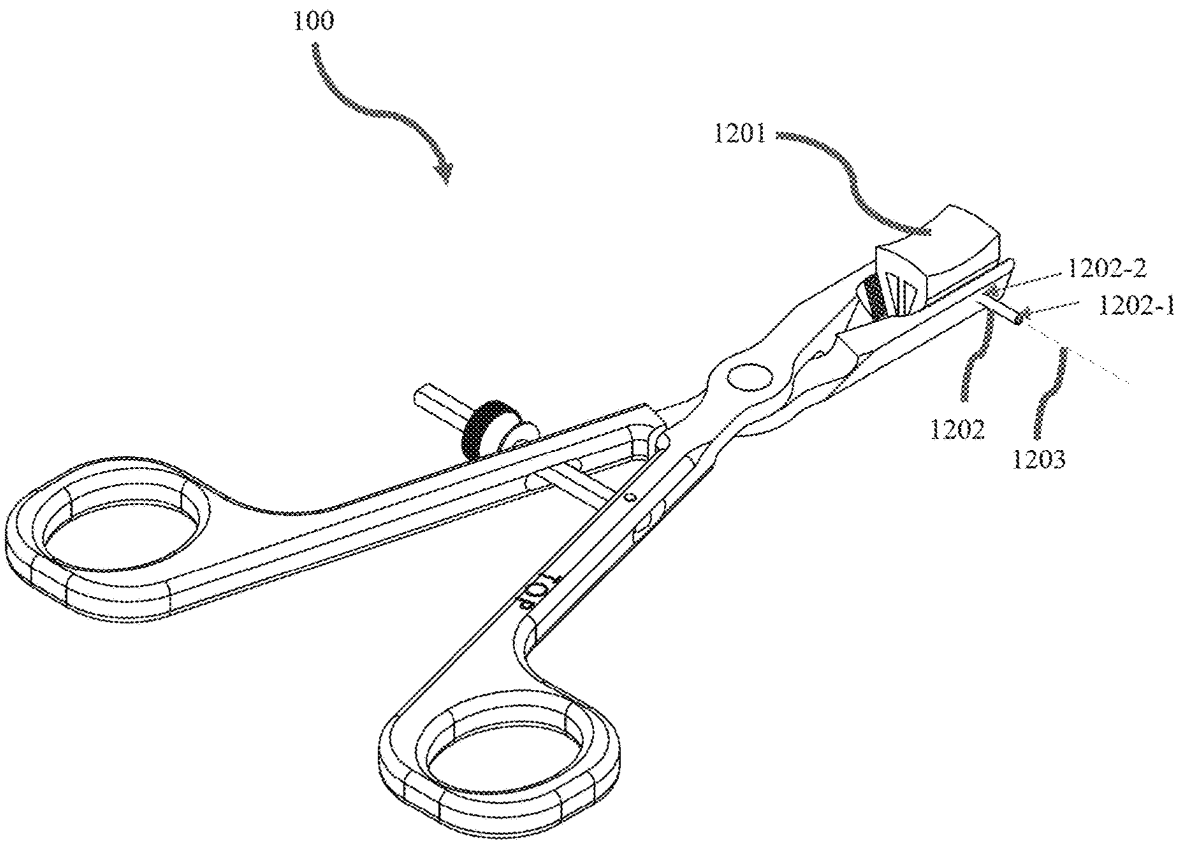

FIGURE 12

SYSTEMS AND APPARATUSES FOR MANIPULATING BENDABLE ALLOGRAFTS

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application is a continuation of PCT/US2019/057363 filed Oct. 22, 2019, which claims priority to U.S. Provisional Application 62/748,917, filed Oct. 22, 2018, the entirety of which are incorporated herein by reference.

STATEMENT OF GOVERNMENT INTEREST

The invention was made with government support under 1144155, awarded by the National Science Foundation. The government has certain rights in the invention.

FIELD

Systems and apparatuses including surgical forceps device for manipulating a bendable osteochondral allograft.

BACKGROUND

Osteochondral grafting is a method of treating cartilage injuries that expose underlying bone. Osteochondral allografts replace both the articular cartilage on the surface and the underlying bone. Donor tissue must be adapted to match the patient, and as such these allografts typically need to be bent, trimmed, and clamped during the procedure by hand, without interference from wires or screws inserted to secure the allograft in its bent shape. However, surgical instruments lack the ability to effectively guide fixation of allografts, allow proper alignment for trimming and handling, and firmly secure the allograft, thereby introducing difficulties during surgery.

What is needed is a surgical device and system, and in particular, forceps capable of effectively aligning, and allowing for trimming and handling of a bendable allograft during surgery without interference of wires and screws.

SUMMARY

In one aspect, a surgical clamp system is provided. A surgical clamp system, includes a forceps device having first and second shanks, each shank including a distal jaw portion having an inwardly facing surface and an outwardly facing surface. The first and second shanks are configured to pivot between open and closed configurations, wherein the distal jaw portions are disposed in adjacent relationship in the closed configuration. The jaw portion of the second shank defining an opening therethrough from said inwardly facing surface to said outwardly facing surface. A tubular member is provided having first and second opposing ends and a lumen therethrough for receiving a guidewire, wherein the second end of the tubular member includes an outer diameter configured to be received within the opening in the second shank.

In some embodiments, the distal jaw portion of the first shank defines an opening therethrough.

In some embodiments, the surgical clamp system further includes a guidewire, wherein the tubular member is at least partially received within the opening of the second shank and the first opposing end of the tubular member extends outwardly away from the second shank, and the guidewire is received in the lumen.

In another aspect, a surgical forceps device is provided which includes a pair of shanks each defining a distal jaw portion, a proximal portion and a length therebetween and being pivotally interconnected at a position between the distal and proximal portions and movable through respective parallel planes between a closed position at which the respective distal jaw portions are disposed in adjacent relationship and an open position at which the respective distal ends are disposed in a spaced apart relationship from each other. The jaw portions define a clamping jaw, each of the jaw portions includes a polygonal body, the polygonal body of each respective jaw portion having a respective outwardly facing surface and a respective inwardly facing tapered surface.

In some embodiments, the respective axis of the respective clamping jaws are offset from the central axis of the forceps device.

In some embodiments, at least one of the jaw portions includes an opening formed therein, the opening extending along the width of the respective jaw portion. In some embodiments, the opening is an elongated slot extending partially along a length of at least one of the jaw portions. In some embodiments, the opening is a circular hole extending through at least one of the jaw portions along the width of the jaw portion. In some embodiments, the respective inwardly facing tapered surface of the jaw portion associated with the first shank opposes the respective inwardly facing tapered surface of the jaw portion associated with the second shank. In some embodiments, the respective inwardly tapered surface extends away from the respective outwardly facing surface at an angle. In some embodiments, the angle with respect to the rotation axis is about 20 degrees.

In some embodiments, the inwardly facing tapered surface includes a textured surface. In some embodiments, the textured surface includes a serrated or knurled surface.

In some embodiments, the first and second shanks pivot about a rotation axis, and wherein each distal jaw portion is bent in a plane orthogonal to the rotation axis. In some embodiments, the first and second shanks pivot about a rotation axis, and wherein each distal jaw portion is bent out of the plane orthogonal to the rotation axis of the main pivot joint.

In some embodiments, each distal jaw portion is fixed with respect to its respective shank. In some embodiments, each distal jaw portion is pivotally mounted with respect to its respective shank. In some embodiments, a positioning mechanism to maintain a parallel relationship of the first and second distal jaw portions.

In some embodiments, the proximal portion of each of the shanks is shaped to receive a finger or thumb of a person operating the forceps. In some embodiments, the adjacent clamping jaws of the shanks are configured to receive a bendable allograft.

In another aspect, a surgical forceps device is provided, including a pair of shanks each including a distal jaw portion, a proximal portion and a length therebetween and being pivotally interconnected about a first pivot point at a position between the distal and proximal portions and movable through respective parallel planes between a closed position at which the respective distal jaw portions are disposed in adjacent relationship to each other, and an open position at which the respective distal jaw portions are disposed in a spaced apart relationship from each other. The distal jaw portions define a distal jaw, each of the jaw portions including a polygonal body along the respective axis, the polygonal body of each respective jaw portions having a respective outwardly facing surface, which may be tapered, and a respective inwardly facing tapered surface. A positioning mechanism is operatively engaged to the pair of shanks, the positioning mechanism is configured to maintain a parallel alignment of the jaw portions.

In some embodiments, each jaw portion is pivotally mounted to each respective shank, and each jaw portion defines a longitudinal slot extending along a length of said jaw portion, and the positioning mechanism includes a first link and a second link, each link having first and second ends, wherein the first end of a respective link is secured to a respective jaw portion, and the second end of respective links is configured to translate in the slot disposed along a length of the opposite jaw portion. In some embodiments, the first link is connected to the second link at a second pivot point. In some embodiments, the second pivot point is aligned along a central axis of the surgical forceps. The second pivot point maintains alignment along the central axis of the surgical forceps irrespective of the open and closed positions of the shanks.

In some embodiments, a saw blade guide slot is disposed at a distal end of each jaw portion. In some embodiments, the saw blade guide slots are aligned with each other. In some embodiments, a locking mechanism is included to prevent the jaw portions from moving away from each other

These and other objects, features, and characteristics of the present disclosure, as well as the methods of operation and functions of the related elements of structure and the combination of parts and economies of manufacture, will become more apparent upon consideration of the following description and the appended claims with reference to the accompanying drawings, all of which form a part of this specification, wherein like reference numerals designate corresponding parts in the various figures. It is to be expressly understood, however, that the drawings are for the purpose of illustration and description only and are not intended as a definition of the limits of the disclosure. As used in the specification and in the claims, the singular form of "a," "an," and "the" include plural referents unless the context clearly dictates otherwise.

BRIEF DESCRIPTION OF THE DRAWINGS AND FIGURES

The disclosed aspects will hereinafter be described in conjunction with the appended drawings, provided to illustrate and not to limit the disclosed aspects, wherein like designations denote like elements.

FIG. **1**A is a perspective schematic diagram of the surgical forceps device according to an exemplary embodiment.

FIG. **1**B is a top view of the surgical forceps device as shown in FIG. **1**A.

FIG. **1**C indicates the central axis of the surgical forceps device as shown in FIG. **1**A.

FIG. **1**D indicates the axis of the main pivot joint of the surgical forceps device as shown in FIG. **1**A.

FIG. **2** is a schematic top view diagram of the surgical forceps device illustrating distal and proximal portions according to an exemplary embodiment.

FIG. **2**A is a detailed top view of a distal jaw portion of the surgical forceps device as illustrated in FIG. **2** according to an exemplary embodiment.

FIG. **2**B is a perspective view of the surgical forceps device detailing the distal jaw portion of the surgical forceps device as illustrated in FIG. **2**A.

FIG. **2**C is a cross-sectional view of the surgical forceps device taken from D-D of FIG. **2**, detailing the distal jaw portion of the surgical forceps device.

FIG. **3** is a schematic top view diagram of the surgical forceps device illustrating distal and proximal portions according to an exemplary embodiment.

FIG. **3**A is a schematic diagram in perspective of a first shank of the surgical forceps device shown in FIG. **3** according to an exemplary embodiment.

FIG. **3**B is a schematic diagram in perspective of a second shank of the surgical forceps device shown in FIG. **3** according to an exemplary embodiment.

FIG. **4** is a schematic diagram of the second shank of FIG. **3**B from an alternative perspective view according to an exemplary embodiment.

FIG. **5** is a schematic diagram of the first shank of FIG. **3**A from an alternative perspective view according to an exemplary embodiment.

FIG. **6**A is a perspective view of the first shank and distal jaw portion of the first shank as illustrated in FIG. **5** according to an exemplary embodiment.

FIG. **6**B is a detailed view of the distal portion of the first shank as illustrated in FIG. **6**A.

FIGS. **7**A-**7**C are top views of the surgical forceps device according to three different configurations according to an exemplary embodiment.

FIG. **8**A is a top view of a schematic diagram illustrating a surgical forceps device according to another exemplary embodiment.

FIGS. **8**B-**8**C are schematic diagrams illustrating biasing configurations of the surgical forceps device illustrated in FIG. **8**A according to the exemplary embodiment.

FIG. **8**D is a detailed schematic diagram in perspective of a component of the surgical forceps device as illustrated in FIG. **8**A.

FIG. **9**A is a perspective view of a schematic diagram of a surgical forceps device according to a further exemplary embodiment.

FIG. **9**B is a detailed illustration of a distal jaw portion of the surgical forceps device illustrated in FIG. **9**A according to an exemplary embodiment.

FIG. **10**A is a perspective view of a schematic of a surgical forceps device according to another exemplary embodiment.

FIG. **10**B is a side view of the exemplary embodiment of the surgical forceps device illustrated in FIG. **10**A.

FIG. **11**A is a perspective view of a schematic of a surgical forceps device according to another exemplary embodiment.

FIG. **11**B is a top view of the alternative exemplary embodiment of the surgical forceps device illustrated in FIG. **11**A.

FIG. **12** is a schematic diagram illustrating the method of manipulating the surgical forceps devices disclosed herein to manipulate customized bendable osteochondral allografts during a desired surgical procedure.

DETAILED DESCRIPTION OF THE DISCLOSED SUBJECT MATTER

Various aspects of the novel systems, apparatuses, and methods disclosed herein are described more fully hereinafter with reference to the accompanying drawings. This disclosure may, however, be embodied in many different forms and should not be construed as limited to any specific structure or function presented throughout this disclosure. Rather, these aspects are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the disclosure to those skilled in the art. Based on the teachings herein, one skilled in the art would appreciate that the scope of the disclosure is intended to cover any aspect of the novel systems, apparatuses, and methods disclosed herein, whether implemented independently of, or combined with, any other aspect of the disclosure. For example, an apparatus may be implemented or a method may be practiced using any number of the aspects set forth herein. In addition, the scope of the disclosure is intended to cover such an apparatus or method that is practiced using other structures, functionality, or structure and functionality in addition to or other than the various aspects of the disclosure set forth herein. It should be understood that any aspect disclosed herein may be implemented by one or more elements of a claim.

Although particular aspects are described herein, many variations and permutations of these aspects fall within the scope of the disclosure. Although some benefits and advantages of the preferred aspects are mentioned, the scope of the disclosure is not intended to be limited to particular benefits, uses, and/or objectives. The detailed description and drawings are merely illustrative of the disclosure rather than limiting, the scope of the disclosure being defined by the appended claims and equivalents thereof.

The surgical forceps device and system described herein are useful, for example, in connection with osteochondral allografts that need to be bent about a single axis. An example includes osteochondral allografts that are used in the thumb basal joint (also known as the thumb trapeziometcarpal joint, or thumb carpometacarpal joint), where bending about the radial-ulnar axis increases the convex curvature of the trapezial articular side along the dorsal-volar direction. As the osteochondral allograft is clamped down, the bony struts approximate (come close together). It is understood that the surgical forceps device and system described herein are useful with other bendable allografts. An allograft useful in connection with the apparatuses and devices herein, is described in U.S. Ser. No. 15/125,056, the disclosure of which is incorporated by reference in its entirety herein.

Referring to FIGS. **1**A-**1**D, a surgical forceps device **100** is illustrated according to an exemplary embodiment. The surgical forceps device **100** includes at least a first shank **110**, a second shank **120**, a first ring hole **160**, a second ring hole **170**, a hard stop **180**, a locking mechanism **190**, a distal jaw **150**, and a pivoting pin **101**. The first and second shanks **110**, **120** extend from the first and second ring holes **160**, **170** at a proximal portion to a distal jaw **150**. The first and second ring holes **160**, **170** include apertures therein that are configured to receive a user's fingers. The first and second shanks **110**, **120** along with the distal jaw **150** are configured to pivotally move by biasing about pivot axis P (illustrated in FIG. **1**D) around the pivot pin **101** as the first and second ring holes **160**, **170** are actuated by a user. That is, when the first and second ring holes **160**, **170** are pivotally moved (e.g., squeezed) in the direction indicated by arrows C illustrated in FIG. **1**B, the first and second shanks **110**, **120** move closer to each other at the distal jaw portion **150**. The hard stop **180** prevents the first and second shanks **110**, **120** from either touching or excessively engaging each other at the distal jaw portion **150**. Further, in order to lock the shanks **110**, **120** in place, the locking mechanism **190** is engaged by the user. In some embodiments, locking mechanism **190** includes a locking mechanism thumbwheel **190-1** and a locking mechanism screw **190-2** pivotably mounted to first shank **110** and extending through an opening in second shank **120**. In use, the user rotates the locking mechanism thumbwheel **190-1** around the locking mechanism screw **190-2** until the thumbwheel **190-1** engages with the second shank **120**, thereby preventing the shanks **110**, **120** from moving further away from each other. One skilled in the art would appreciate that a segment or portion of the locking mechanism screw **190-2** may be threaded in order to allow engagement with the thumbwheel **190-1**. FIGS. **1**C-**1**D indicate the central axis L and the rotation axis P of the main pivot joint of the surgical forceps device **100**, respectively. One skilled in the art would appreciate that these axes can be applied to other exemplary embodiments of the surgical forceps device, such as **800**, **900**, **1000**, or **1100** as seen below in FIG. **8**A, FIG. **9**A, FIG. **10**A, and FIG. **11**A.

The surgical forceps device **100**, which includes the aforementioned features, may be at least partially comprised of materials such as stainless steel, aluminum, or plastic.

Next FIGS. **2**A-**2**B in conjunction with FIG. **2** will be discussed. As noted, FIG. **2**, similar to FIGS. **1**A-**1**D is a schematic diagram of the surgical forceps device illustrating the distal and proximal portions according to an exemplary embodiment. The distal jaw **150** will be discussed in further detail with respect to FIGS. **2** and **2**A-**2**B. FIG. **2**A is a detailed view of distal jaw **150** taken of surgical forceps device **100** as shown by "A" in FIG. **2**. FIG. **2**A represents a detailed illustration of the distal jaw **150** including a first distal jaw portion **130** and a second distal jaw portion **140**. The first distal jaw portion **130** is associated with the first shank **110**, and the second distal jaw portion **140** is associated with the second shank **120**. The first distal jaw portion **130** is fixed to the first shank **110**, and the second distal jaw portion **140** is fixed to the second shank **120**. The first and second distal jaw portions are opposite each other and move in the plane orthogonal to the rotation axis P of the main pivot joint **101** of the surgical forceps device **100**. The first distal jaw portion **130** includes the first shank **110**, a first clamping jaw **103** and an aperture or opening **105** formed in the first clamping jaw **103**. Likewise, the second distal jaw portion **140** includes the second shank **120**, a second clamping jaw **102** and an aperture or opening **104** formed in the second clamping jaw **102**. As illustrated in FIG. **2**A, the first and second clamping jaws **103**, **102** and the first and second shanks **110**, **120** are opposite to one another as they face each other. As discussed in further detail below the clamping jaws **103**, **102** include angled or tapered clamping surfaces.

Further illustration of the surgical forceps device **100** is shown in FIG. **2**B and FIG. **2**C, which highlight the distal jaw **150** shown in FIG. **2**A. FIG. **2**B shows a perspective view of surgical forceps device **100** while FIG. **2**C shows cross-sectional view D-D as indicated in FIG. **2**. As illustrated in FIGS. **2**B and **2**C, the second clamping jaw **102** includes a polygonal body or shape that includes an outwardly facing angled surface **102-1** and an inwardly facing angled surface **102-2**. The inwardly facing angled surface **102-2** and the outwardly facing angled surface **102-1** are inclined at an angle G with respect to the axis P of the main pivot joint **101** as shown by the arrows. In an exemplary embodiment the angle G is at least 19° (nineteen degrees). In another exemplary embodiment, the angle G is at least 20° (twenty degrees) to produce the desired angular position of the clamp surfaces of the bendable osteochondral allograft. However, this is a non-limiting measurement, as one of ordinary skill in the art may achieve variations of this angle (i.e., zero, five, ten, fifteen, twenty, etc. degrees) as desired with either or both of the angled surfaces **102-1** and **102-2**.

Similar configuration as set forth above will be appreciated for the first clamping jaw **103**. In some embodiments, the first clamping jaw **103** includes an outwardly facing angled surface **103-1** and an inwardly facing angled surface **103-2**. The inwardly facing angled surface **103-2** and the outwardly facing angled surface **103-1** are inclined at an angle of at least 200 (twenty degrees) with respect to the axis of the main pivot joint **101**. However, as noted above, this is a non-limiting measurement, as one of ordinary skill in the art may achieve variations of this angle (i.e., zero, five, ten, fifteen, twenty, etc. degrees).

One skilled in the art would appreciate that all variations of the surgical forceps device **100** design employ clamping jaws **103**, **102** that are set at an angle that produces the final desired angular position of the bendable osteochondral allograft. The specific desired angle is a design parameter that depends on the surgical application. The design of the surgical forceps device **100** could allow for an adjustable angle of the opposing clamping jaws **103**, **102**.

Next, this paragraph will refer to FIGS. **3**A-**3**B in conjunction with FIG. **3**. FIG. **3** is a schematic diagram of the surgical forceps device illustrating distal and proximal portions according to an exemplary embodiment. As illustrated in FIG. **3**, and similarly set forth above, the surgical forceps device **100** includes first and second shanks **110**, **120**. In reference to FIG. **3**A, the first shank **110** will be discussed. FIG. **3**A illustrates a perspective view of the first shank **110**, which includes a first distal jaw portion **130**. The first distal jaw portion **130** includes an aperture or a surgical compression screw slot **105** such that a guidewire, screw, or a tube may pass therethrough. Similarly, with respect to the second shank **120**, illustrated in FIG. **3**B, the second shank **120** includes a second distal jaw portion **140** and a second aperture or the wire guide hole **104** formed in the second clamping jaw **102** such that a guidewire or a tube may pass there through.

One skilled in the art would appreciate that surgical compression screw slot **105** and the wire guide hole **104** serve different purposes. For examples, these apertures **105**, **104** may be used for inserting wires, screws, wire guides, drill guides, or other tools needed to secure the allograft in its bent shape. As shown in FIGS. **3**A-**3**B, the wire guide hole **104** on second distal jaw portion **140** accommodates a wire guide while the opposing surgical compression screw slot **105** on first distal jaw portion **130** is large enough for inserting a surgical compression screw. As illustrated in FIGS. **1**A and **1**B and discussed in further detail below with reference to FIG. **12**, the wire guide, e.g., tubular member **1202**, may be used to drive a wire guide **1203** across the clamped shanks, emerging through the slot **105** of the opposite clamp face; a hollow compression screw may then be guided along the wire **1203**, through the slot **105** of the clamp face **103-2**, and threaded into the shanks of the bent allograft.

Additionally, according to some example embodiments, the clamping jaws **102**, **103** may include openings or recesses, such as blind, stepped or through holes or slots, to accommodate proud wires, screws, or other anchors that have been used to secure the allograft in its bent shape. These openings or recesses allow the clamping surfaces to remain flush with the allograft. In an exemplary embodiment, a stepped slot may extend along the length of both clamps.

Next FIG. **4** will be discussed. FIG. **4** illustrates a schematic diagram of the second shank **120**. The distal jaw portion **140** of the second shank **120** includes the aperture or opening **104** as discussed above. The distal jaw portion **140** of the second shank **120** includes a tapered or angled clamping surface whose long edges **140-1** and **140-2** become parallel with the edges **130-1** and **130-2** of the distal jaw portion **130** of the first shank **110** upon clamping the bendable allograft into its final configuration. A recess **120-1** formed in the second shank **120** is illustrated. The recess **120-1** in the second shank **120** is configured to receive or mate with the first shank **110** such that the first shank **110** and the second shank **120** engage with each other and form a pivoting connection as they are held together at a pivoting pin joint **101**.

Similarly, FIG. **5** illustrates a schematic diagram of the first shank. The distal jaw portion **130** of the first shank **110** includes the aperture or the surgical compression screw slot **105** as discussed above. The surgical compression screw slot **105** is formed in the first shank **110**, wherein the distal jaw portion **130** of the first shank **110** includes a tapered or angled clamping surface whose long edges **130-1** and **130-2** become parallel with the edges **140-1** and **140-2** of the distal jaw portion **140** of the second shank **120** upon clamping the bendable allograft into its final configuration. A recess **110-1** formed in the first shank **110** is illustrated. The recess **110-1** in the first shank **110** is configured to receive or mate with the second shank **120** such that the first shank **110** and the second shank **120** engage with each other and form a pivoting connection as they are held together at a pivoting pin joint **101**.

Next referring to FIGS. **6**A-B, perspective views of the first shank **110** and distal jaw portion **130** of the first shank **110** are illustrated. In particular, detail view "B" outlined in FIG. **6**A is taken at the distal jaw portion **130** of the first shank **110**. The detail view "B" is further illustrated in FIG. **6**B. As noted in FIG. **6**B, distal jaw portion **130** of the first shank **110** includes an aperture or a surgical compression screw slot **105**, and the tapered or angled surface of the clamping jaw **103** of the first shank **110** includes a textured surface including a serrated or knurled surface. Having a textured surface that includes a serrated or knurled surface allows for further grasping and secure engagement of the customized bendable osteochondral allograft as it is being manipulated and maneuvered during a surgical procedure. One skilled in the art would appreciate that such configuration of the textured surface is not limited to the first shank **110**, as such configuration may also be applicable to the second shank **120**. In some exemplary embodiments, the clamping jaws **103**, **102** of the surgical forceps device **100** may be entirely or partially serrated or knurled to minimize slippage of the allograft in the clamping jaws **103**, **102**.

Next referring to FIGS. **7**A-**7**C, top views of the surgical forceps device **100** according to three different configurations are illustrated. As noted, FIG. **7**A illustrates the surgical forceps device **100** in an extended or open configuration wherein the first and second shanks **110**, **120** are separated from each other. FIG. **7**B illustrates a closed configuration wherein the first and second shanks **110**, **120** bias towards each other and the distal jaw portion **150** indicates that clamping jaws **103**, **102** of the respective shanks are nearly abutting each other. In this closed position, a hard stop **180** prevents the clamping jaws **103**, **102** from either touching or excessively engaging each other. Lastly, FIG. **7**C illustrates an intermediate position that is between the open position illustrated in FIG. **7**A and the closed position illustrated in FIG. **7**B. The intermediate position illustrated in FIG. **7**C represents a position where the surgical forceps device **100** is configured to engage, hold and maintain the position of a bent osteochondral allograft. One skilled in the art would appreciate that the surgical forceps device **100** consists of two parts pivoted at a single joint in a scissor-like design, such that the clamping jaws **103**, **102** become parallel, or nearly parallel, to each other when the osteochondral allograft has been bent by the desired amount.

Next, referring to FIGS. **8**A-**8**D a surgical forceps device according to another exemplary embodiment is illustrated.

The surgical forceps device illustrated in FIG. **8**A is similar to the surgical forceps device illustrated in FIGS. **1**A-**1**D, for example, as it also includes first and second ring holes **801**, **802** and pair of shanks **830**, **820**, which are similar to the first and second ring holes **160**, **170**, and the pair of shanks **110**, **120**, respectively, discussed above. Additionally, the surgical forceps device of FIG. **8**A includes a pivot pin **803**, similar to pivot pin **101** illustrated in FIG. **1**B, for example, that mates and holds together in place the pair of shanks **830**, **820**. The first and second shanks **830**, **820** are configured to pivotally move by biasing around the pivot pin **803** as the first and second ring holes **801**, **802** are actuated by a user. That is, when the first and second ring holes **801**, **802** are pivotally moved (e.g., squeezed) in the direction indicated by arrows illustrated in FIG. **8**A, the first and second shanks **830**, **820** move closer to each other at a distal jaw portion **815**.

Some of the differences of the surgical forceps device **800** include the pair of shanks **830**, **820** and the distal jaw **815**, which are structurally and functionally different than the pair of shanks **110**, **120** and the distal jaw portion **150** of the surgical forceps device **100** illustrated in FIGS. **1**A-**1**D, for example. The pair of shanks **830**, **820**, as illustrated in FIG. **8**A, extend from the pair of first and second ring holes **801**, **802** to first and second joints **804**, **805** in a non-parallel fashion to a central axis of the surgical forceps device **800**. That is, the pair of shanks **830**, **820** rotate in the plane orthogonal to the axis P of the main pivot joint **803** of the surgical forceps device **800**. Further, the pair of clamping jaw portions **822**, **821** are pivotally connected to shanks **820**, **830** and extend from the first and second joints **804**, **805** to a distal-most end of the surgical forceps device **800**. This portion of extension of the surgical forceps device **800** is parallel to the central axis of the surgical forceps device **800**.

Now, the distal jaw **815** of the surgical forceps device **800** will be discussed in further detail. The distal jaw **815** is different in configuration, functionality and structure from the distal jaw **150** of the surgical forceps device **100**. The distal jaw **815** is a positioning or a multi-jointed mechanism that ensures that clamping jaw portions **821**, **822** remain parallel to each other at all positions as the first and second ring holes **801**, **802** bias towards each other as shown by the arrows C in FIG. **8**A. The jaw portions **821**, **822** may include a polygonal body aligned parallel to the central axis of the surgical forceps **800**, the polygonal body of each respective clamping jaw having an outwardly facing surface substantially planar to the associated shank and an inwardly facing tapered surface.

The positioning mechanism of the surgical forceps device **800** includes a pair of sliding joints **806**, **807**, a pivoting joint **808**, a pair of fixed joints **809**, **810**, a pair of links **811**, **812**, and a pair of slots **813**, **814**.

The pair of links **811**, **812** are connected in a cross-configuration as first link **811** is positioned over second link **812** at the pivoting joint **808**. The pivoting joint **808** is aligned along the central axis of the surgical forceps device **800**. On one end, the pair of links **811**, **812** are affixed to the respective pair of clamping jaw portions **822**, **821** at the respective pair of fixed joints **810**, **809**, and on the other opposing end the pair of links **811**, **812** are affixed to the respective pair of sliding joints **807**, **806**. The fixed joints **809**, **810** are pivoting joints formed in the respective pair of clamping jaw portions **821**, **822**. That is, first fixed joint **809** is a pivoting or a linkage joint formed in the first clamping jaw portion **821** that allows the second link **812** to rotate around the fixed joint **809** while the pivoting joint **808** translates along the central axis L of the surgical forceps device **800**. Similarly, the second fixed joint **810** is a pivoting or a linkage joint formed in the second clamping jaw portion **822** that allows the first link **811** to rotate around the fixed joint **810** while the pivoting joint **808** translates along the central axis of the surgical forceps device **800**.

Still referring to FIG. **8**A, the pair of links **811**, **812** are affixed to the respective pair of sliding joints **807**, **806** on the opposing end. The sliding joints **807**, **806** are configured to translate in respective slots **813**, **814** between a first position and a second position as shown in FIGS. **8**B and **8**C. The sliding joints **807**, **806** may be similar to the fixed joints **809**, **810** in that they act similarly to a pivoting or a linkage joint, but they are also configured to translate between different positions in their respective slots **813**, **814**. The first sliding joint **807** is positioned in the slot **813** that is formed in the first clamping jaw portion **821**. The second sliding joint **806** is positioned in the slot **814** that is formed in the second clamping jaw portion **822**. The length of the slots **813**, **814** may correspond to the distance travelled between the two clamping jaws portions **821**, **822** as they come close to each other upon actuation of the first and second ring holes **801**, **802** (as shown by the arrows C in FIG. **8**A).

As the first and second ring holes **801**, **802** are actuated from an open position shown in FIG. **8**B to an intermediate or a closed position shown in FIG. **8**C, the sliding joints **806**, **807** translate from a distal end of their respective slots **814**, **813** to a proximal end of their respective slots **814**, **813**. During this sliding transition, the pair of links **811**, **812** go from a compressed configuration to an expanded or extended configuration. As the links **811**, **812** transition to an expanded or extended configuration and the sliding joints **806**, **807** translate to the proximal end of their respective slots **814**, **813**, the clamping jaw portions **822**, **821** move closer to each other while maintaining parallel orientation between the two heads. Additionally, the pivoting joint **808** continues to maintain its alignment with the central axis of the surgical forceps device **800**. As noted above, the clamping jaws portions **821**, **822** maintain their parallel orientation with respect to each other in order to ensure the osteochondral allograft that has been bent by the desired amount continues to be securely positioned in place between the clamping jaw portions **821**, **822** as it is being manipulated during a surgical procedure.

Still referring to FIG. **8**A, the distal jaw **815** further includes recess **819** formed in clamping jaw portion **821**. The recess **819** may be a guiding slot that accommodates a saw blade. Shown in further detail in FIG. **8**D is a detailed illustration of the distal clamping jaw portion **821**. As noted in FIG. **8**D, in conjunction with FIG. **8**A, the recess **819** may run parallel to the face of the distal end of the clamping jaw portion **821** such that it extends the width of the clamping jaw portion and extends down from the top face. Although discussion herein is made with respect to recess **819** formed in clamping jaw portion **821**, one skilled in the art would appreciate that similar configuration applies to recess **818** formed in clamping jaw portion **822**. The pair of recesses **819**, **818** formed in the respective clamping jaw portions **821**, **822** are in line with each other.

As shown in FIG. **8**D, the clamping jaw portion **821** includes recess **819** and opening **817**. The opening **817** may be similar to openings **104**, **105** discussed above with respect to surgical forceps device **100**. The opening **817**, as illustrated, may be a screw slot that is longitudinal, running partially along a length of the distal end of the clamping jaw portion **821**, and which is configured to receive at least one screw therein. The opposing clamping jaw portion **822** may also include a recess **818** and a similar opening or slot **816**.

Alternatively, the opposing clamping jaw portion **822** may only include the recess **818** and not the opening or slot **816**.

Next, referring to FIGS. **9A-9B**, surgical forceps device **900** according to another alternative exemplary embodiment is disclosed. The surgical forceps device **900** is generally similar to the surgical forceps device **100** illustrated in FIGS. **1A-D**; however, it includes a variation of clamping jaws **901**, **902** at the distal jaw portion. As shown in further detail in FIG. **9B**, which is a detail view of FIG. **9A** taken at "C," the clamping jaws **901**, **902** include tapered or angled clamping surfaces that are offset from the central axis of the surgical forceps device **900**. Additionally, the clamping jaws **901**, **902** include similar opening configuration as opening **817** discussed in FIG. **8D**, wherein the opening may be a screw slot that is longitudinal, running partially along a length of the distal end of the clamping jaw **821**, and which is configured to receive at least one screw therein. As illustrated in FIG. **9B**, such openings are formed on both clamping jaws **901**, **902**.

Next, referring to FIGS. **10A-10B**, surgical forceps device **1000** according to another alternative exemplary embodiment is disclosed. The surgical forceps device **1000** is generally similar to the surgical forceps device **100** illustrated in FIGS. **1A-D**; however, it includes a variation of the distal jaw portion **1030**. The distal jaw portion **1030** has been bent out of the plane orthogonal to the rotation axis P of the main pivot joint. An isometric view of **1000** is shown in FIG. **10A** and a side view indicating the clear bend of the distal jaw portion is shown in FIG. **10B**. The function of surgical forceps **1000** is similar to the function of surgical forceps **100** and the clamping jaws of the distal jaw portion **1030** allow a bendable osteochondral allograft to be bent and manipulated, but the bend at the distal jaw portion **1030** may be beneficial in certain surgical applications. One skilled in the art may appreciate that the angle of the bend may vary and would be dependent on surgical application.

FIG. **11A-B** will now be discussed. FIG. **11A** illustrates an isometric view of another alternative exemplary embodiment of a surgical forceps device **1100**. Similar to surgical forceps device **1000**, the distal jaw portion **1130** of surgical forceps device **1100** has a bend. The bend of the distal jaw portion **1130** is different than distal jaw portion **1030** in that the bend lies in the plane orthogonal to the rotation axis P of the main pivot joint as can be seen in the top view illustration shown in FIG. **11B**. One skilled in the art may appreciate that the angle of the bend may vary depending on surgical application. One skilled in the art may also appreciate that the bending of the distal jaw portions **1030** and **1130** indicate two possible angles and bending planes, but are not limiting.

Next, FIG. **12** will be discussed, which is a schematic diagram illustrating the method of manipulating the surgical forceps devices disclosed herein to manipulate customized bendable osteochondral allografts during a desired surgical procedure. As shown in FIG. **12**, surgical forceps device **100** is shown as if engaged by a user at the first and second ring holes **160**, **170**, which bias the first and second shanks **110**, **120**. Although the surgical forceps device **100** is shown and discussed herein, one skilled in the art would appreciate that other exemplary embodiments disclosed herein such as in FIGS. **8A-8D**, **9A-9B**, **10A-10B**, and **11A-11B** may alternatively be used to perform the steps discussed herein. As shown, FIG. **12** includes the osteochondral allograft **1201** that is positioned between the clamping jaws **102**, **103**.

Further, FIG. **12** illustrates a tubular member **1202** that is affixed or engaged with the distal jaw portion **150** of the surgical forceps device **100**. In particular, the tubular member **1202** engages or mates with the wire guide hole **104** discussed above with respect to FIG. **3B**. The tubular member **1202** may be a separate or independent piece such that the tubular member **1202** and the surgical forceps device **100** are sold as part of a kit or package. Alternatively, the tubular member **1202** may be manufactured with the surgical forceps device **100** such that the two components comport to be a single piece. The tubular member **1202** includes first and second opposing ends **1202-1**, **1202-2** and a lumen extending there through between the first and second ends **1202-1**, **1202-2**. The second end **1202-2** of the tubular member **1202** includes an outer diameter configured to be received within the opening **104** in the shank **120**. As shown in FIG. **12**, the tubular member **1202** mates or engages with shank **120** as it securely positions itself in the opening **104** in the shank **120** and extends away from the shank **120**. In other words, the axis of the tubular member **1202** is orthogonal to the central axis L of the surgical forceps device **100** when the clamping jaws **130** and **140** are in the parallel position with the bendable osteochondral allograft is in its final configuration as seen in FIG. **7C** and in FIG. **12**. As such, by engaging the tubular member **1202** with the opening **104**, a throughway passage is created that extends from first end **1202-1** to the opposing side or face of shank **120**.

Still referring to FIG. **12**, a guidewire **1203** is introduced through the lumen of the tubular member **1202** such that the guidewire **1203** extends from the first end **1202-1** to the second end **1202-2** of the tubular member **1202** and past the wire guide hole **104** formed in the shank **120**. Further, a screw gun or a similar tool may be employed or used by a user that engages with the guidewire **1203** in order to rotate the guidewire **1203** along its own axis that aids in engaging the guide wire **1203** with the allograft **1201** positioned between the clamping jaws **102**, **103**. Similar to the introduction of the guidewire **1203** via the tubular member **1202** and guide wire hole **104**, a surgical screw may be introduced into the allograft **1201** via the surgical compression screw hole **105** formed in shank **110**.

While the disclosure has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive. The disclosure is not limited to the disclosed embodiments. Variations to the disclosed embodiments and/or implementations can be understood and effected by those skilled in the art in practicing the claimed disclosure, from a study of the drawings, the disclosure and the appended claims.

It should be noted that the use of particular terminology when describing certain features or aspects of the disclosure should not be taken to imply that the terminology is being re-defined herein to be restricted to include any specific characteristics of the features or aspects of the disclosure with which that terminology is associated. Terms and phrases used in this application, and variations thereof, especially in the appended claims, unless otherwise expressly stated, should be construed as open-ended as opposed to limiting. As examples of the foregoing, the term "including" should be read to mean "including, without limitation," "including but not limited to," or the like; the term "comprising" as used herein is synonymous with "including," "containing," or "characterized by," and is inclusive or open-ended and does not exclude additional, unrecited elements or method steps; the term "having" should be interpreted as "having at least;" the term "such as" should be interpreted as "such as, without limitation;" the term 'includes" should be interpreted as "includes but is not limited to"; the term "example" is used to provide exemplary instances of the item in discussion, not an exhaustive or limiting list thereof, and should be interpreted as "example, but without limitation"; adjectives such as "known," "normal," "standard," and terms of similar meaning should not be construed as limiting the item described to a given time period or to an item available as of a given time, but instead should be read to encompass known, normal, or standard technologies that can be available or known now or at any time in the future; and use of terms like "preferably," "preferred," "desired," or "desirable," and words of similar meaning should not be understood as implying that certain features are critical, essential, or even important to the structure or function of the present disclosure, but instead as merely intended to highlight alternative or additional features that may or may not be utilized in a particular embodiment. Likewise, a group of items linked with the conjunction "and" should not be read as requiring that each and every one of those items be present in the grouping, but rather should be read as "and/or" unless expressly stated otherwise. Similarly, a group of items linked with the conjunction "or" should not be read as requiring mutual exclusivity among that group, but rather should be read as "and/or" unless expressly stated otherwise. The terms "about" or "approximate" and the like are synonymous and are used to indicate that the value modified by the term has an understood range associated with it, where the range can be ±20%, ±15%, ±10%, ±5%, or ±1%. The term "substantially" is used to indicate that a result (e.g., measurement value) is close to a targeted value, where close can mean, for example, that the result is within 80% of the value, within 90% of the value, within 95% of the value, or within 99% of the value. Also, as used herein "defined" or "determined" can include "predefined" or "predetermined" and/or otherwise determined values, conditions, thresholds, measurements, and the like.

We claim:

1. A surgical clamp system, comprising:

a forceps device comprising first and second shanks, each shank comprising a distal jaw portion having an inwardly facing surface and an outwardly facing surface, the first and second shanks configured to pivot about a pivot axis between open and closed configurations, wherein the distal jaw portions are disposed in adjacent relationship in the closed configuration, the jaw portion of the second shank defining an opening therethrough from said inwardly facing surface to said outwardly facing surface,

wherein the respective inwardly facing surface associated with the jaw portion of the first shank opposes the respective inwardly facing surface associated with the jaw portion of the second shank and wherein the respective inwardly facing surface and outwardly facing surface are tapered at an angle relative to the pivot axis;

a tubular member having first and second opposing ends and a lumen therethrough for receiving a guidewire, wherein the second end of the tubular member includes an outer diameter configured to be received within the opening in the second shank.

2. The surgical clamp system of claim **1**, wherein the distal jaw portion of the first shank defines an opening therethrough.

3. The surgical clamp system of claim **1**, wherein the distal jaw portion of the first shank comprises a clamping jaw and wherein the distal jaw portion of the second shank comprises a clamping jaw.

4. The surgical clamp system of claim **3**, wherein the first and second jaw portions are aligned along a plane parallel to the distal jaw portion of the first and second shanks.

5. The surgical clamp system of claim **4**, wherein each jaw portion includes a polygonal body.

6. The surgical clamp system of claim **1**, wherein the angle is about 20 degrees.

7. The surgical clamp system of claim **1**, wherein each inwardly facing surface includes a textured surface.

8. The surgical clamp system of claim **7**, wherein the textured surface includes a serrated or knurled surface.

9. The surgical clamp system of claim **1**, wherein the first and second shanks pivot about a rotation axis, and wherein each distal jaw portion is bent in a plane orthogonal to the rotation axis.

10. The surgical clamp system of claim **1**, wherein the first and second shanks pivot about a rotation axis, and wherein each distal jaw portion is bent out of the plane orthogonal to the rotation axis of the main pivot joint.

11. The surgical clamp system of claim **1**, wherein each distal jaw portion is fixed with respect to its respective shank.

12. The surgical forceps of claim **1**, further comprising a hard stop arranged to prevent the distal jaw portions of the first and second shanks from touching one another.

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