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**Pak et al.**

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(54) **SURGICAL INSTRUMENTS WITH  
COUPLING MEMBERS TO EFFECT  
MULTIPLE PIVOT AXES**

(71) Applicant: **Arculant, Inc.**, Santa Clara, CA (US)

(72) Inventors: **Jimmy Joung Pak**, Moraga, CA (US);  
**Mark Andrew Spencer**, Santa Clara,  
CA (US)

(73) Assignee: **Arculant, Inc.**, Santa Clara, CA (US)

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(51) **Int. Cl.**

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**A61B 17/28** (2006.01)

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(52) **U.S. Cl.**

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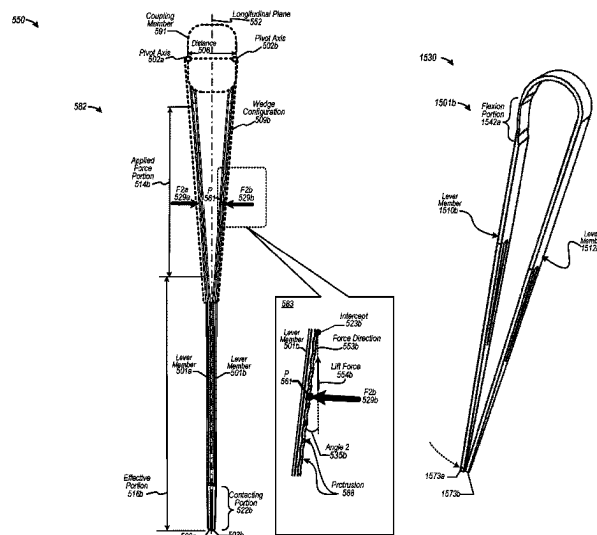
(74) *Attorney, Agent, or Firm* — KOKKA & BACKUS,  
PC

(57)

#### **ABSTRACT**

Various embodiments relate generally to surgical instruments, tools, and apparatuses for medical use, including, but not limited to, forceps, tweezers, and pincers, as well as other anatomical tools for surgical and medical uses, and, more specifically, to surgical instruments implementing a coupling member to effectuate multiple pivot axes enhance, for example, effective lengths with which to access an internal surgical site. In some examples, a surgical instrument may include lever members, each of which may include a pivot portion, a force application portion, and a contacting portion. The surgical instrument may also include a coupling member configured to position multiple pivot portions adjacent proximal ends of a first and second lever member to effectuate a closing state at which contacting portions are positioned at a second distance, which is less than the first distance, at distal ends of a first and second lever member.

**17 Claims, 20 Drawing Sheets**



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B25B 9/02 (2006.01)

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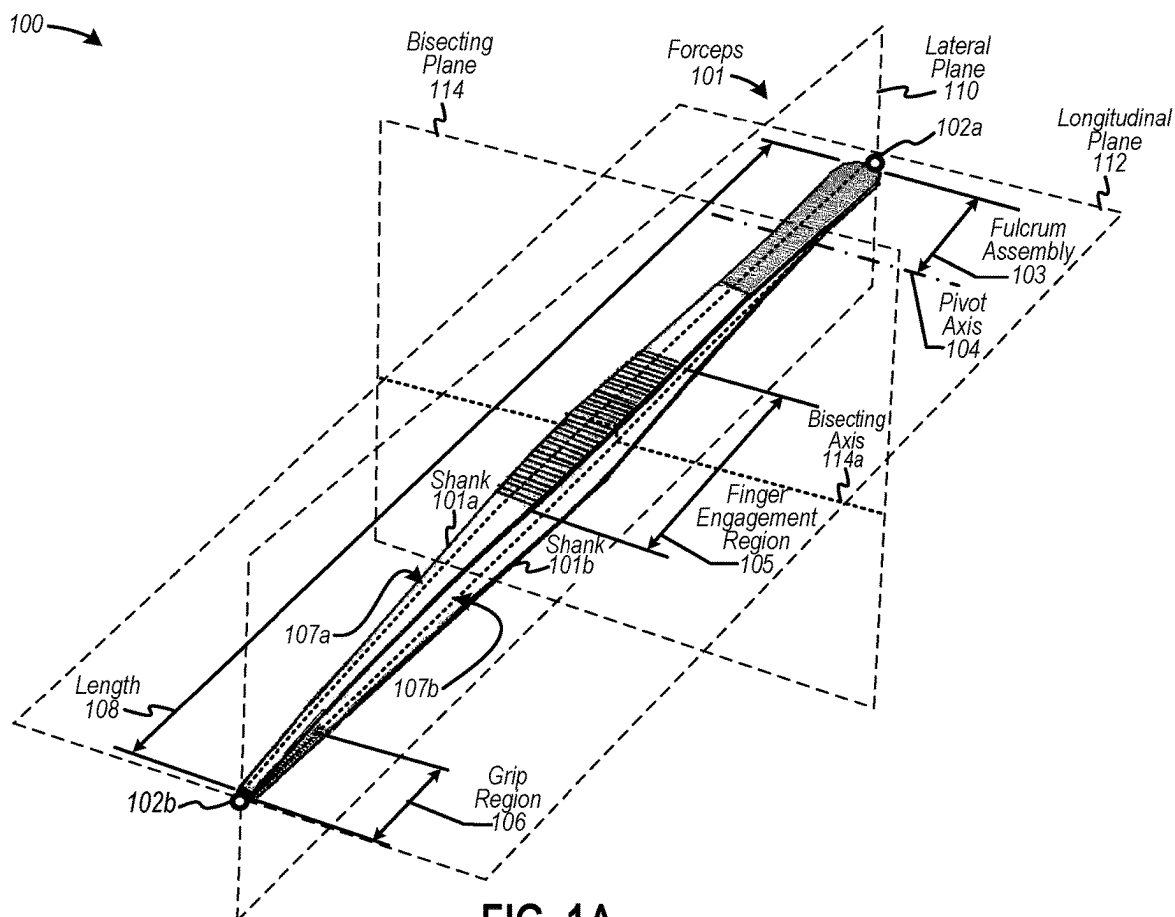
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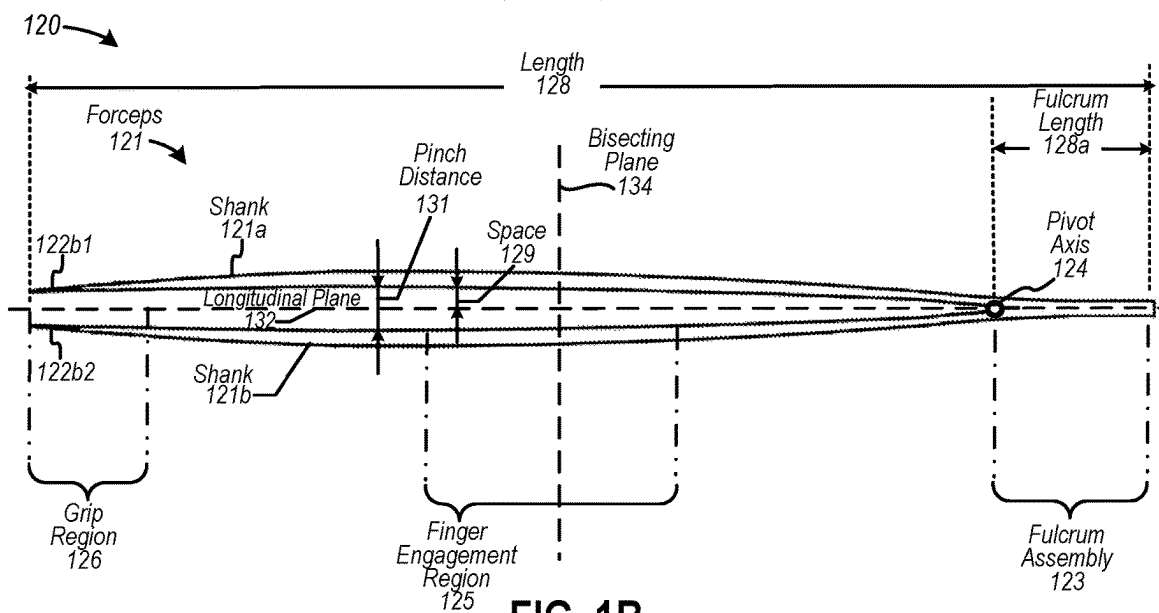
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**FIG. 1A**  
(Prior Art)



**FIG. 1B**  
(Prior Art)

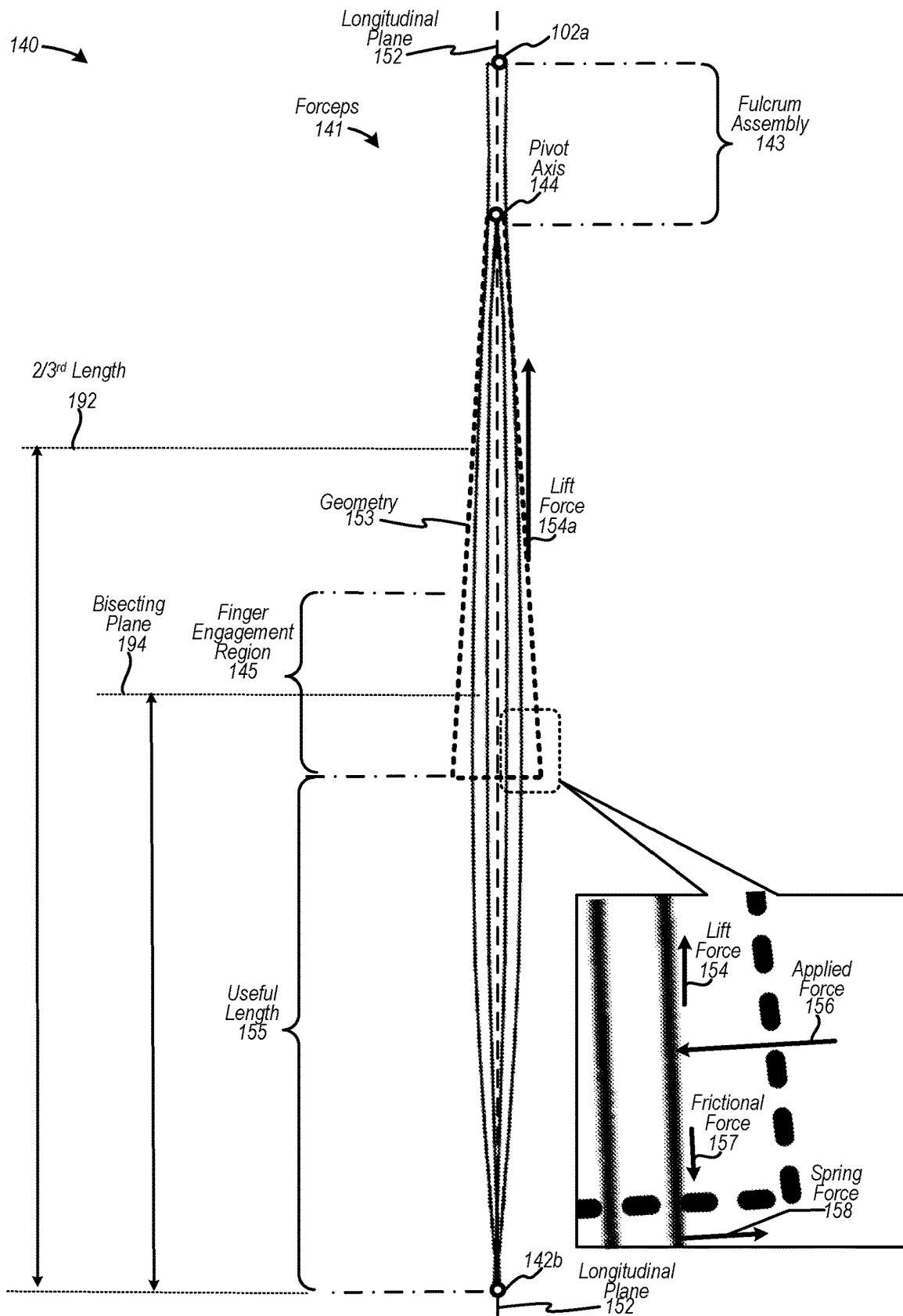
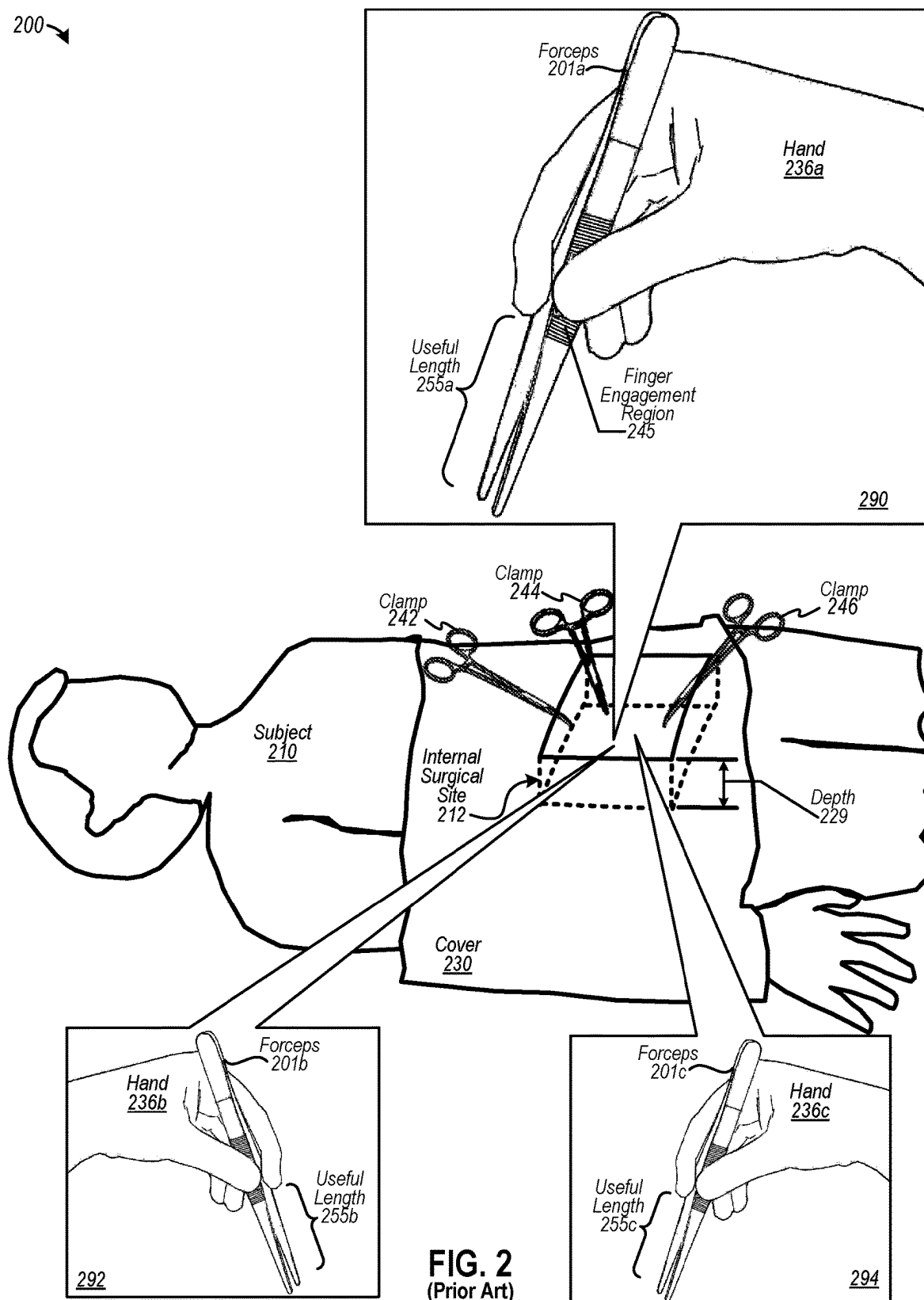
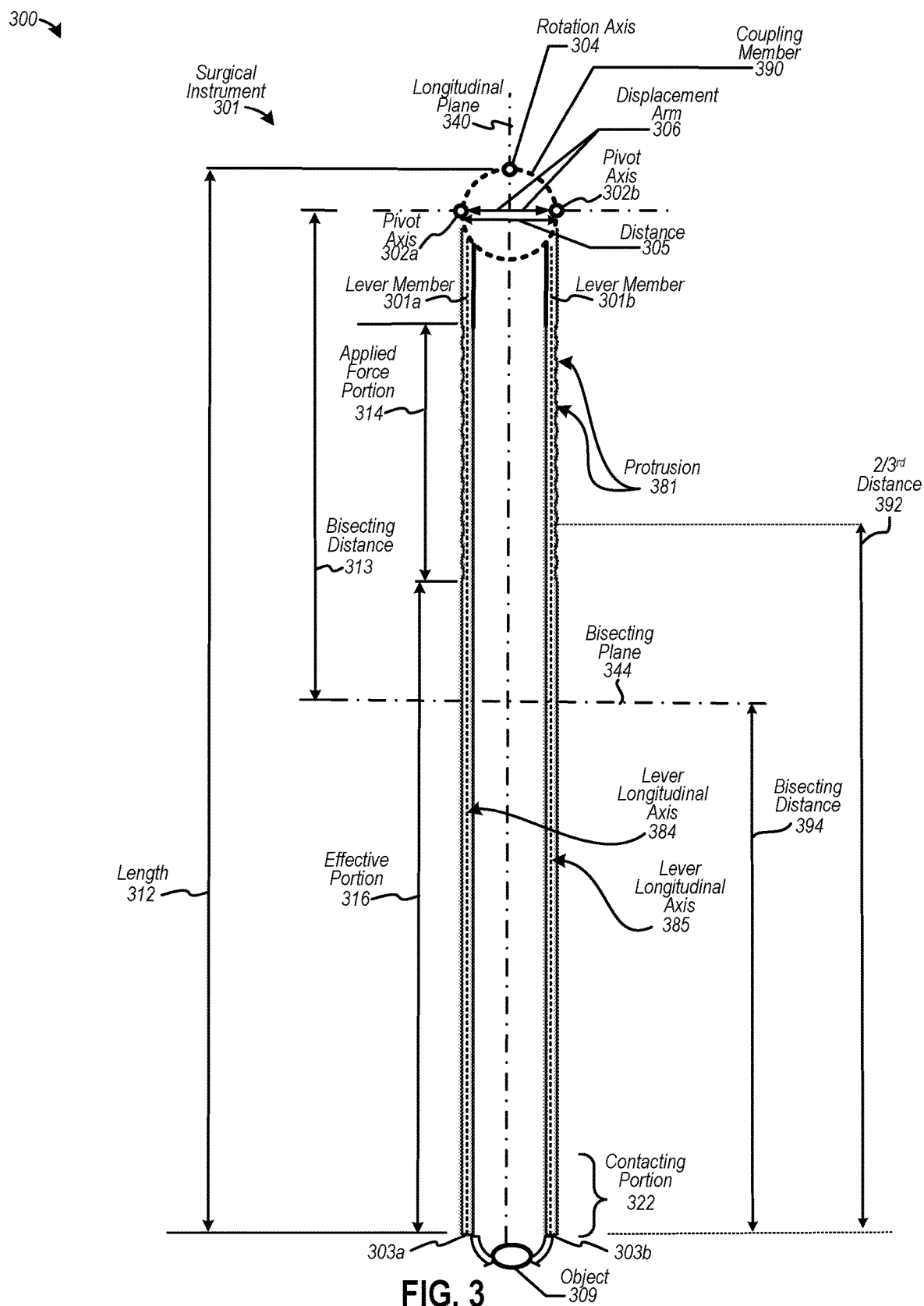


FIG. 1C  
(Prior Art)

200 →





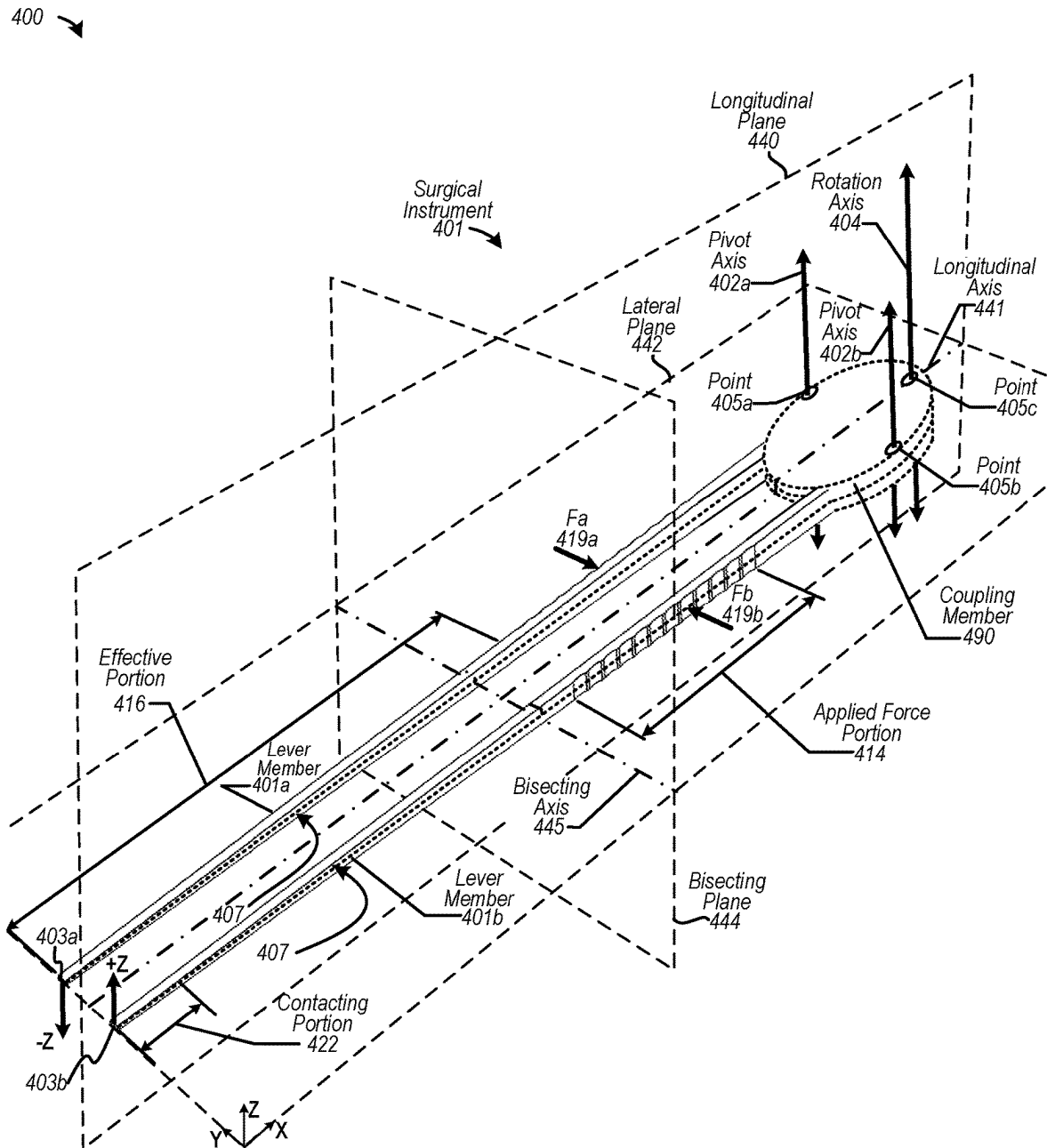


FIG. 4

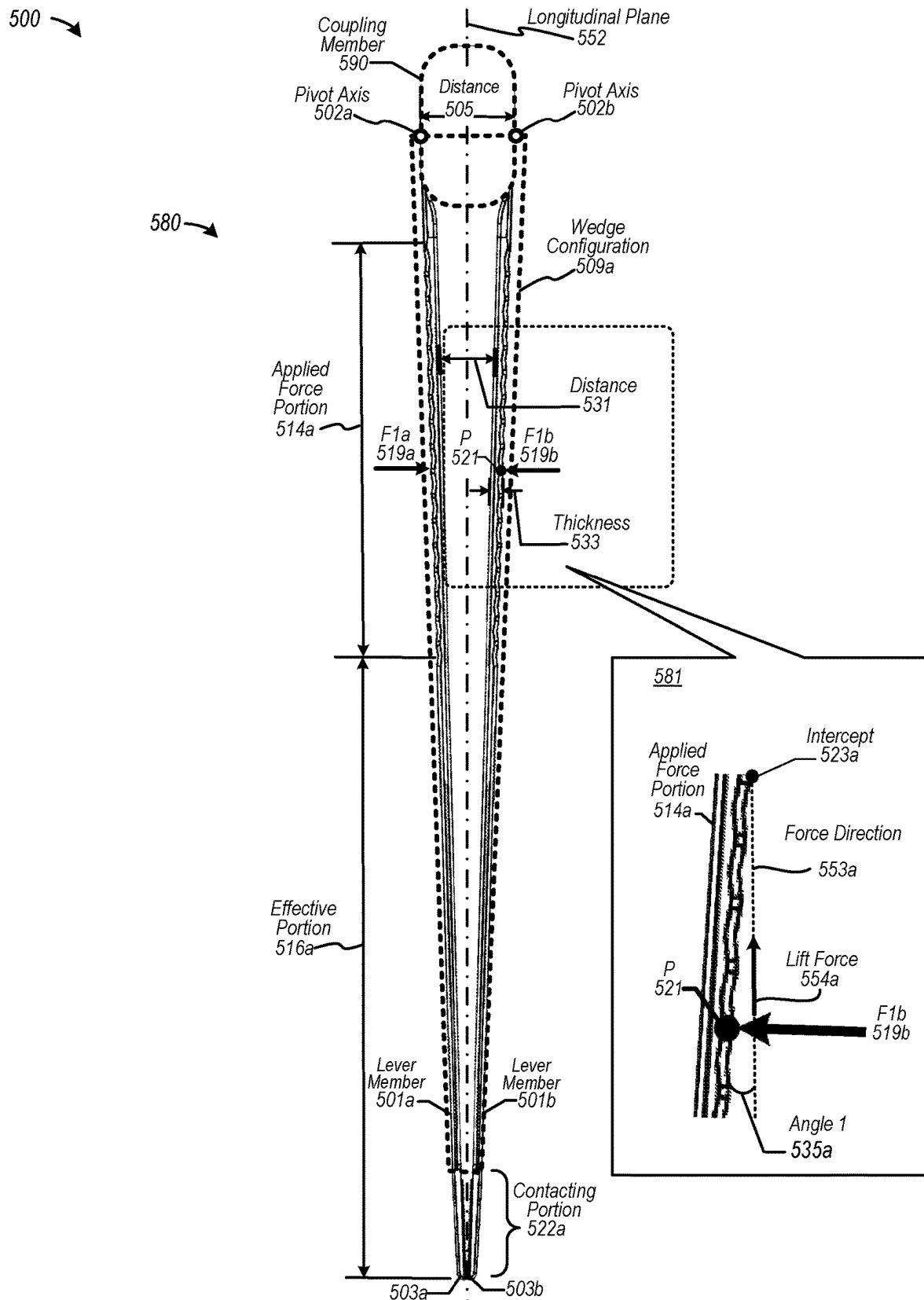


FIG. 5A



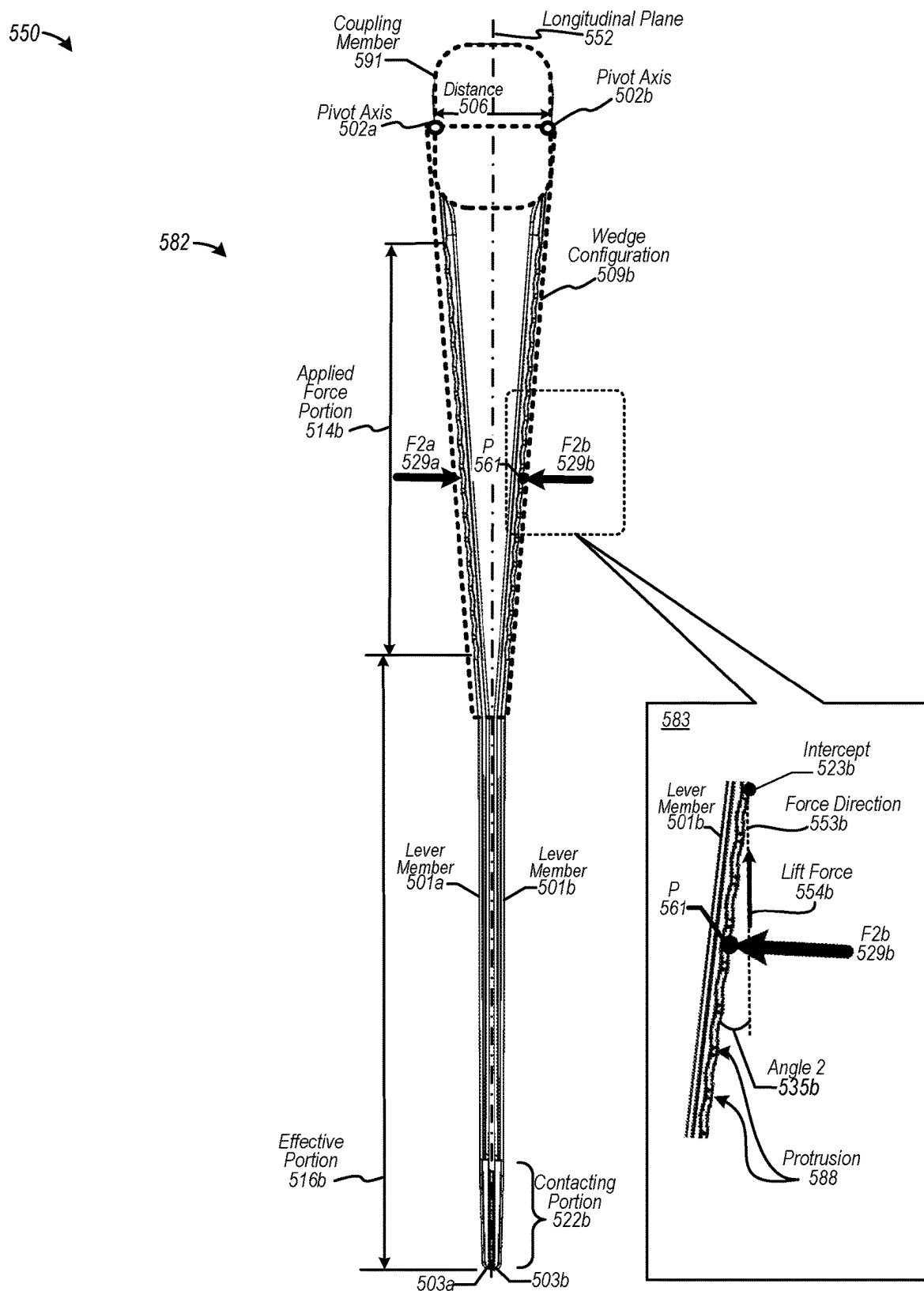


FIG. 5B

600

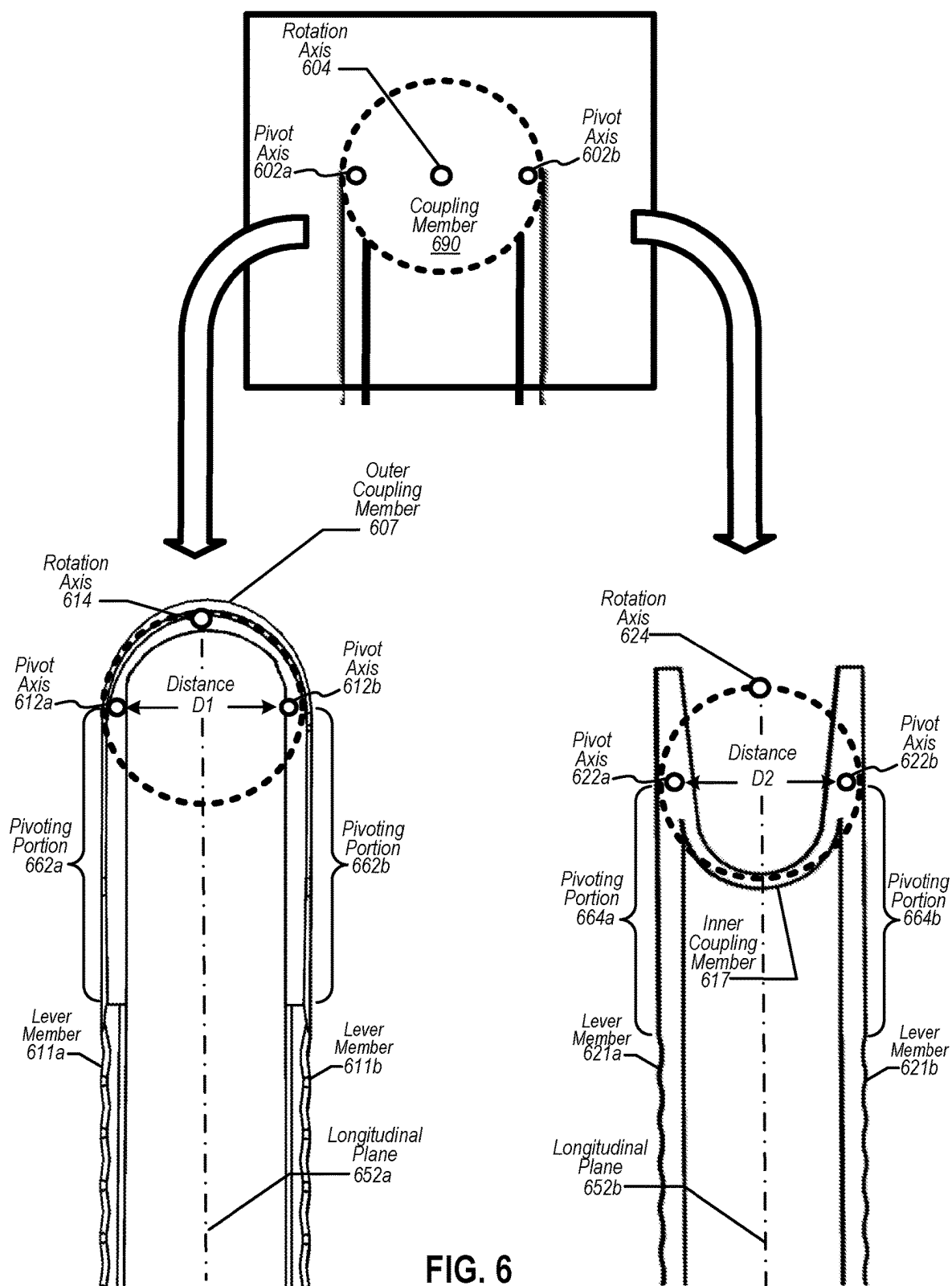


FIG. 6

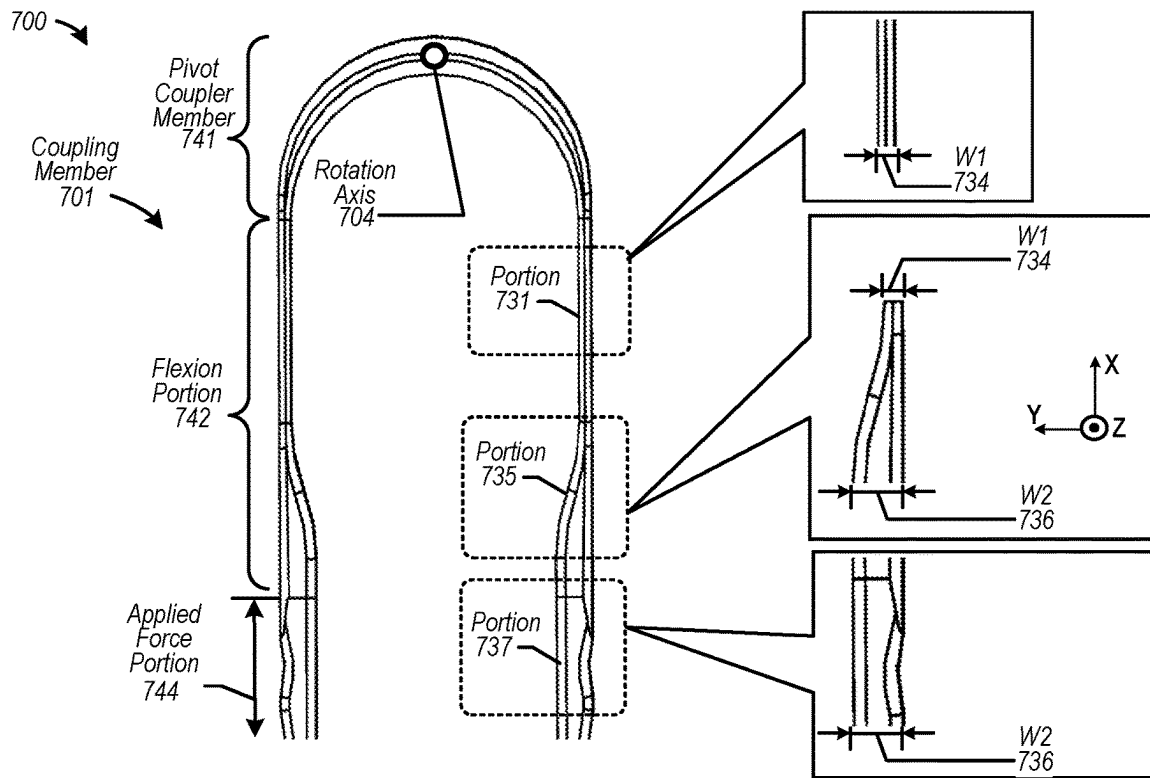


FIG. 7A

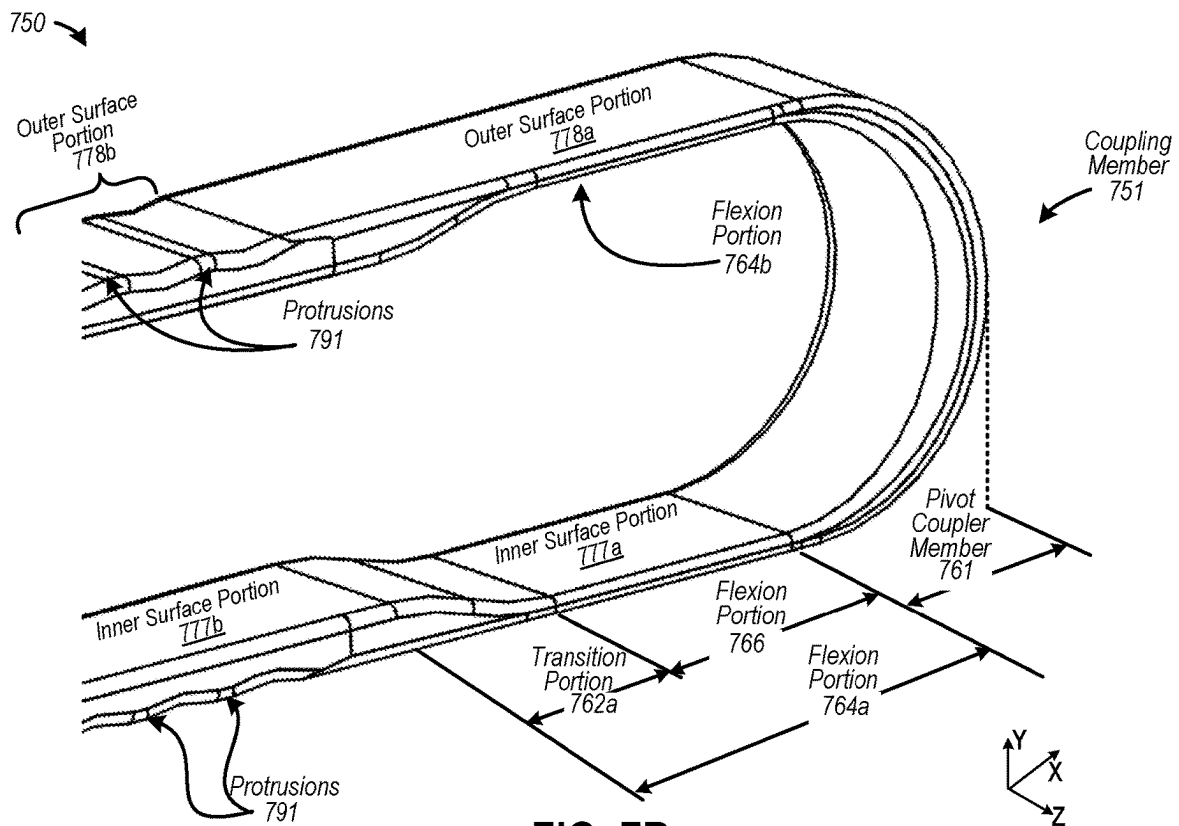


FIG. 7B

780 →

Coupling  
Member  
781 →

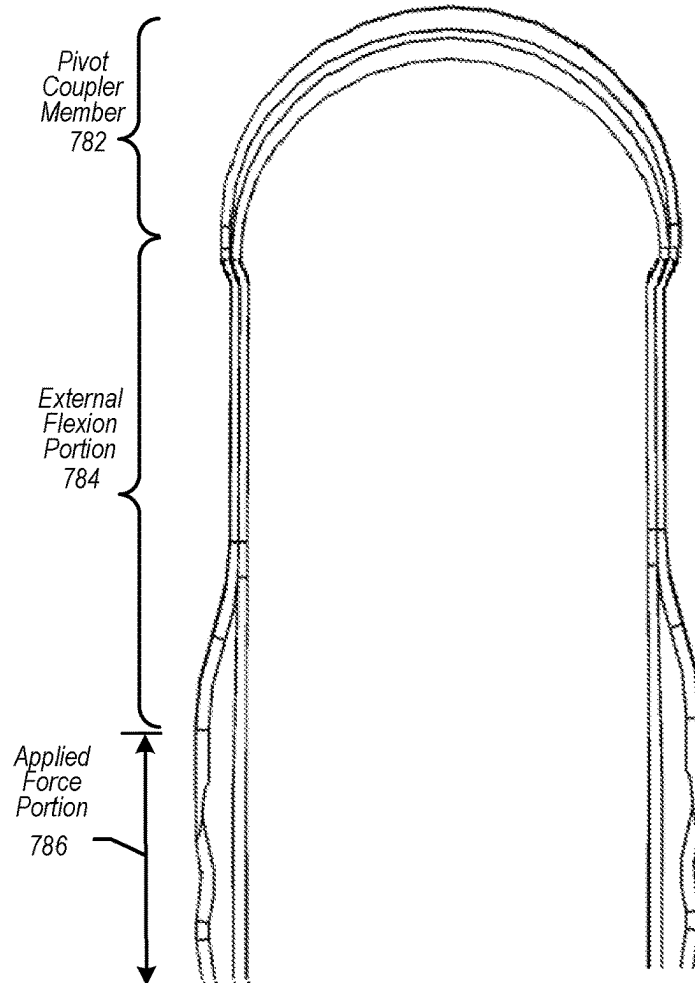


FIG. 7C

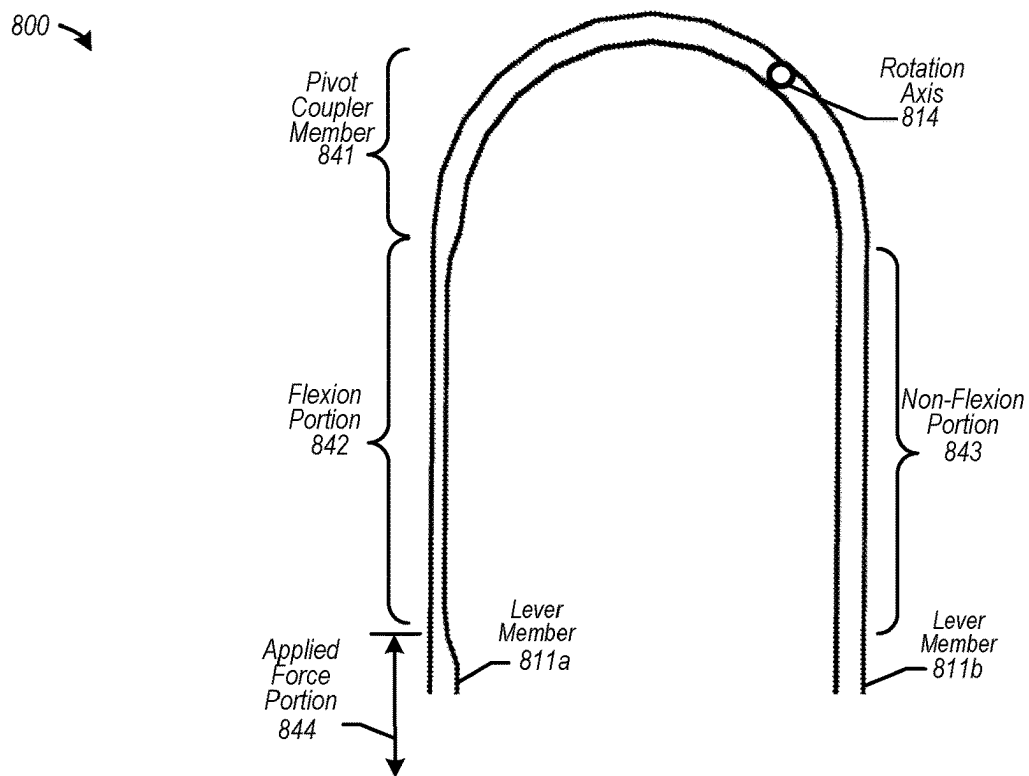


FIG. 8A

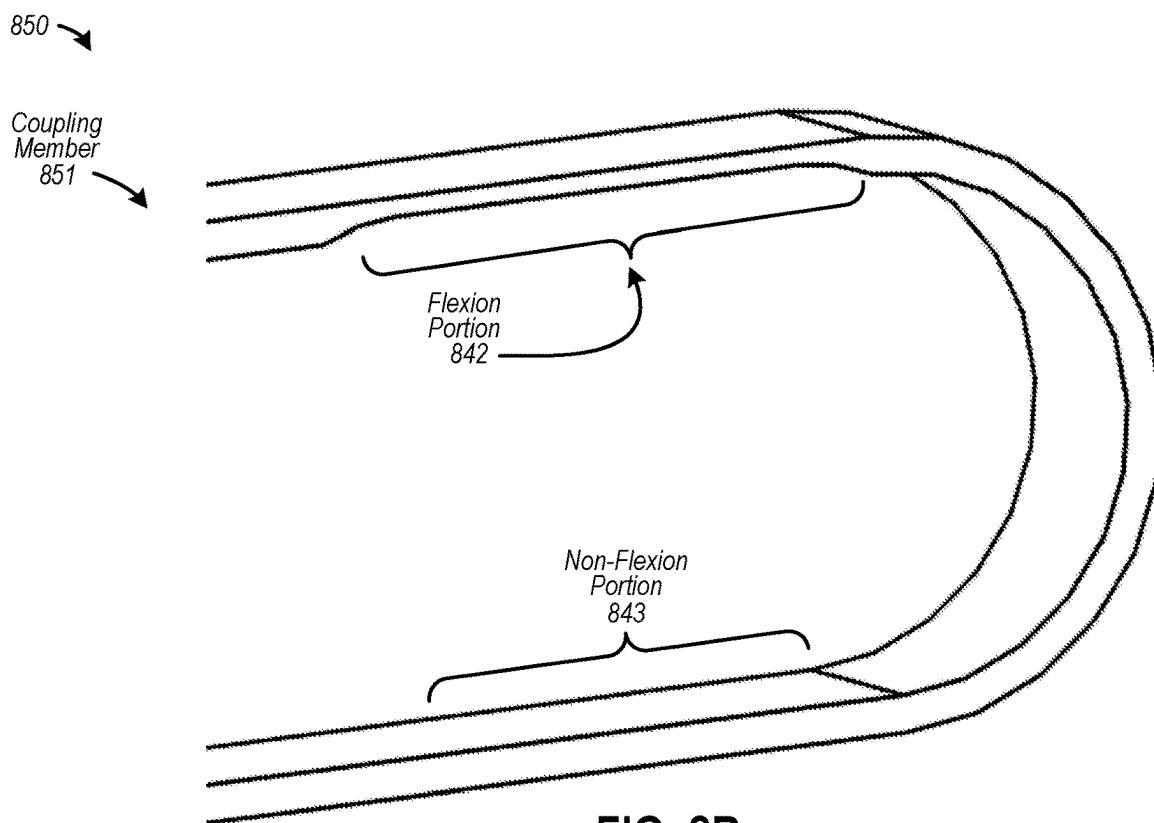


FIG. 8B

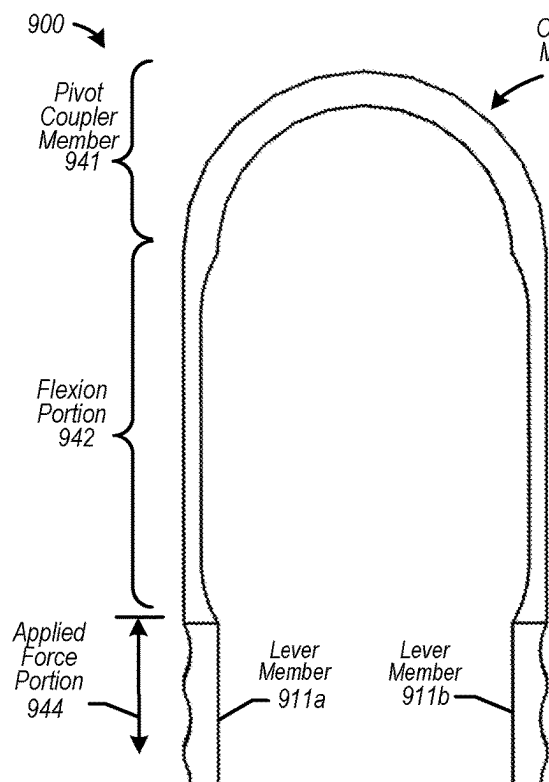


FIG. 9A

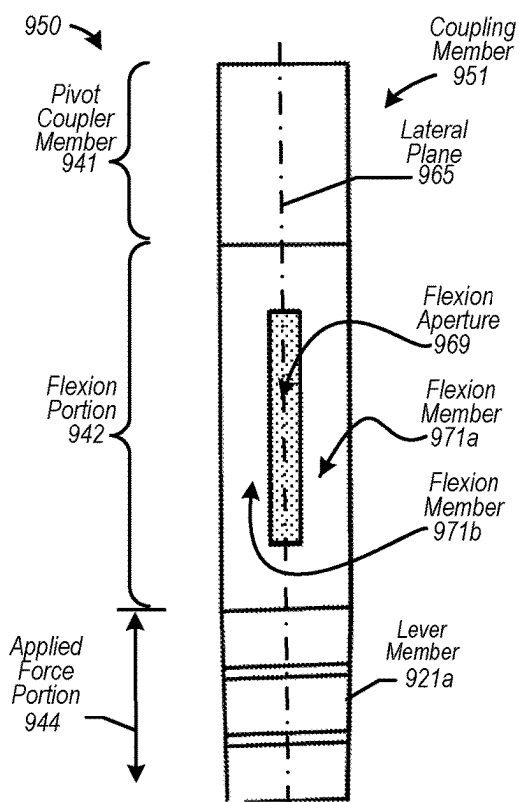


FIG. 9B

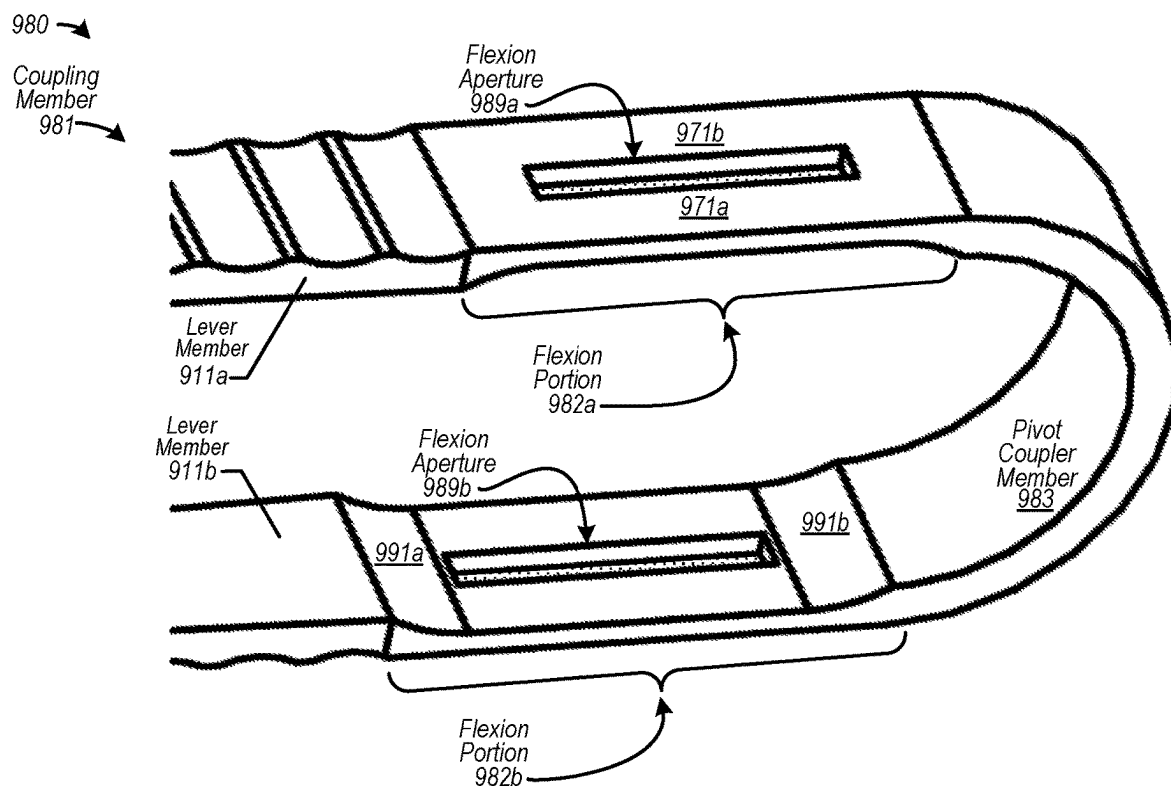


FIG. 9C

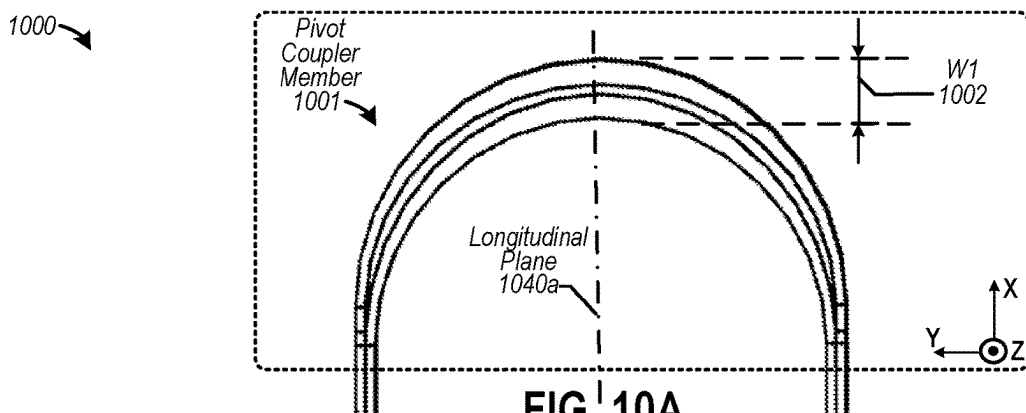


FIG. 10A

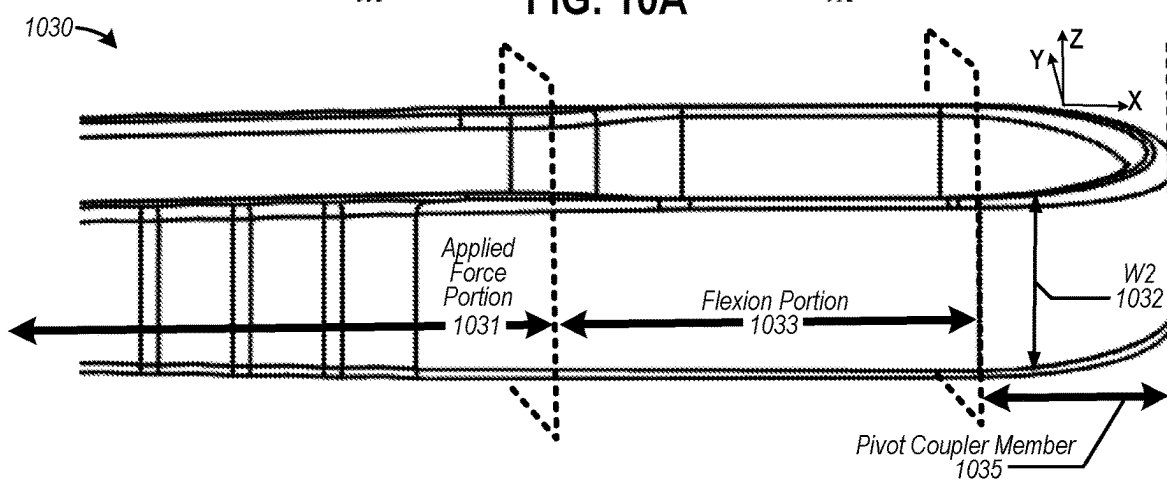


FIG. 10B

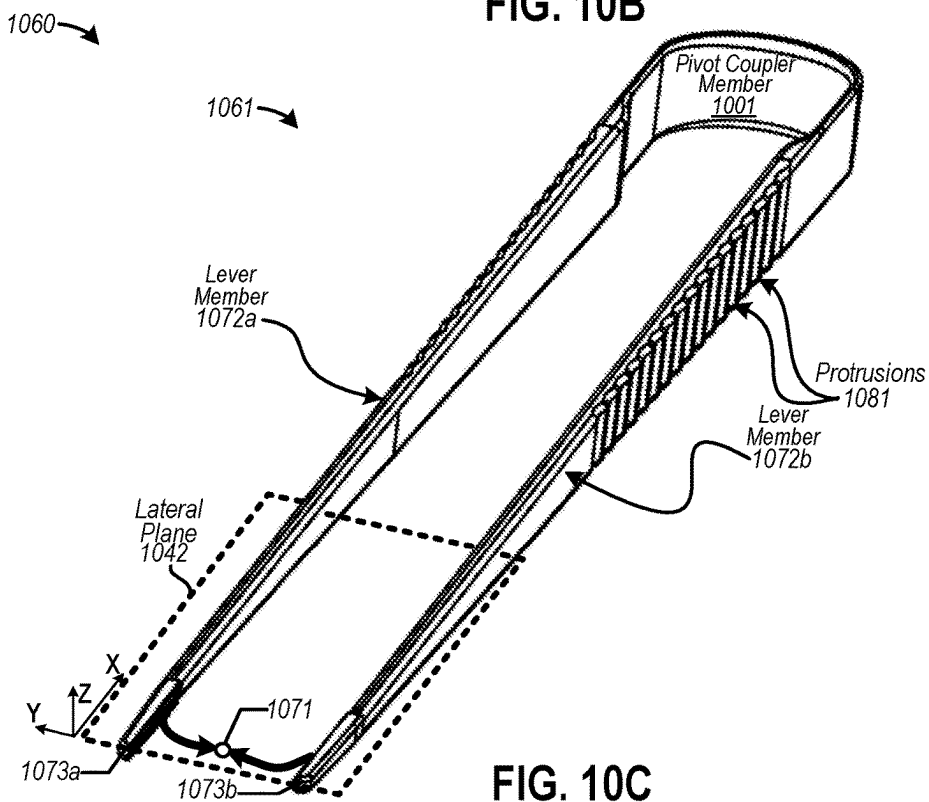
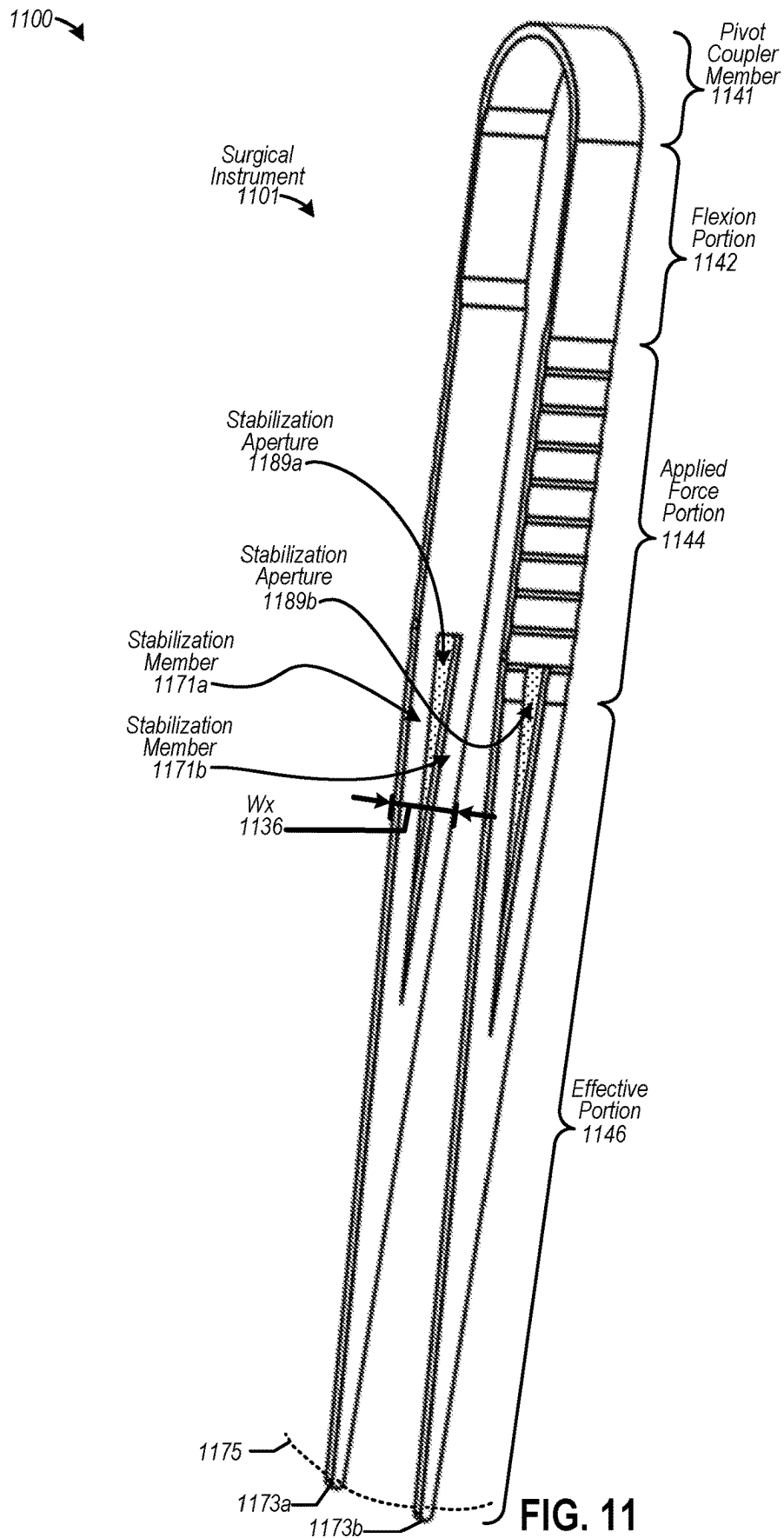
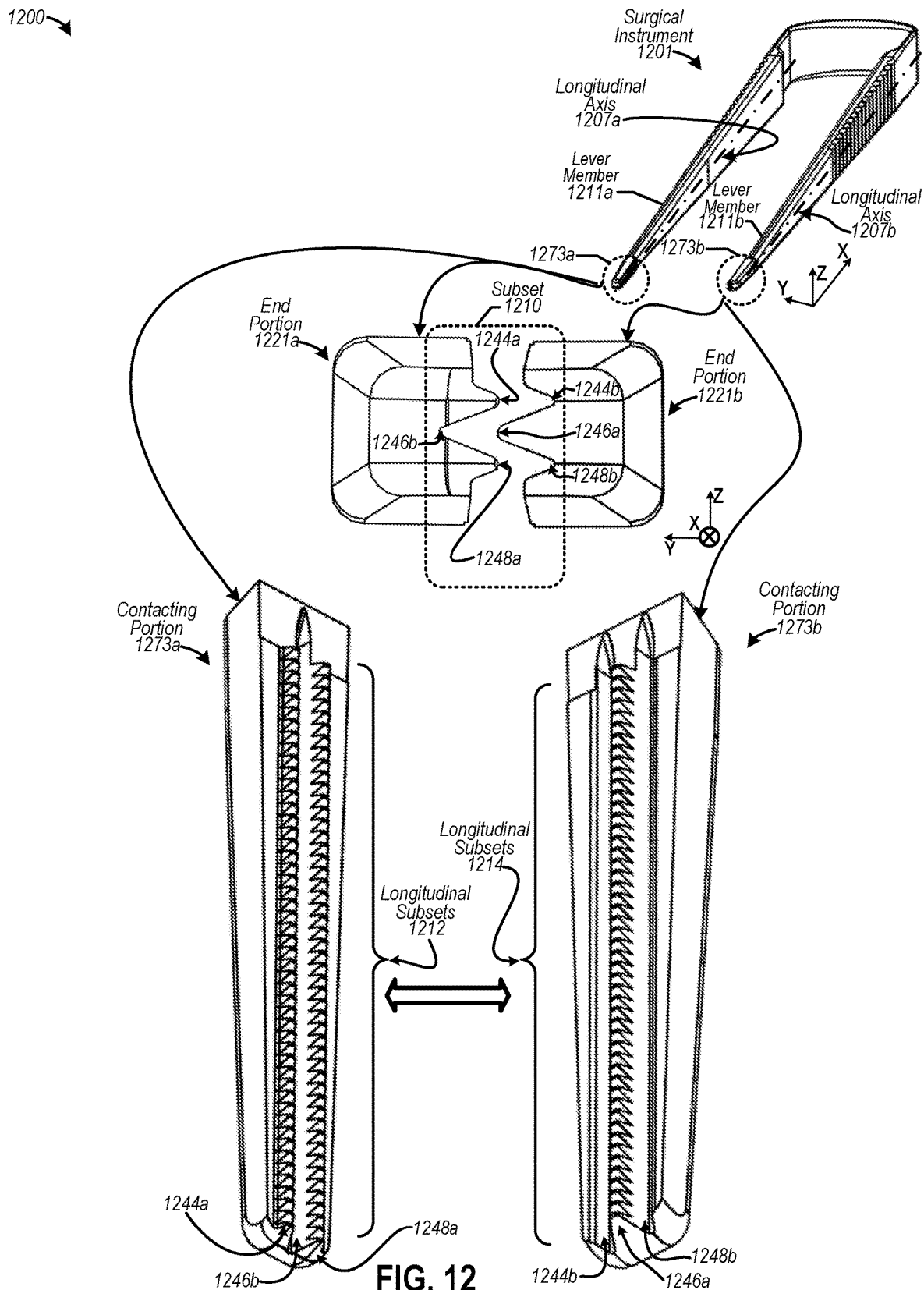


FIG. 10C







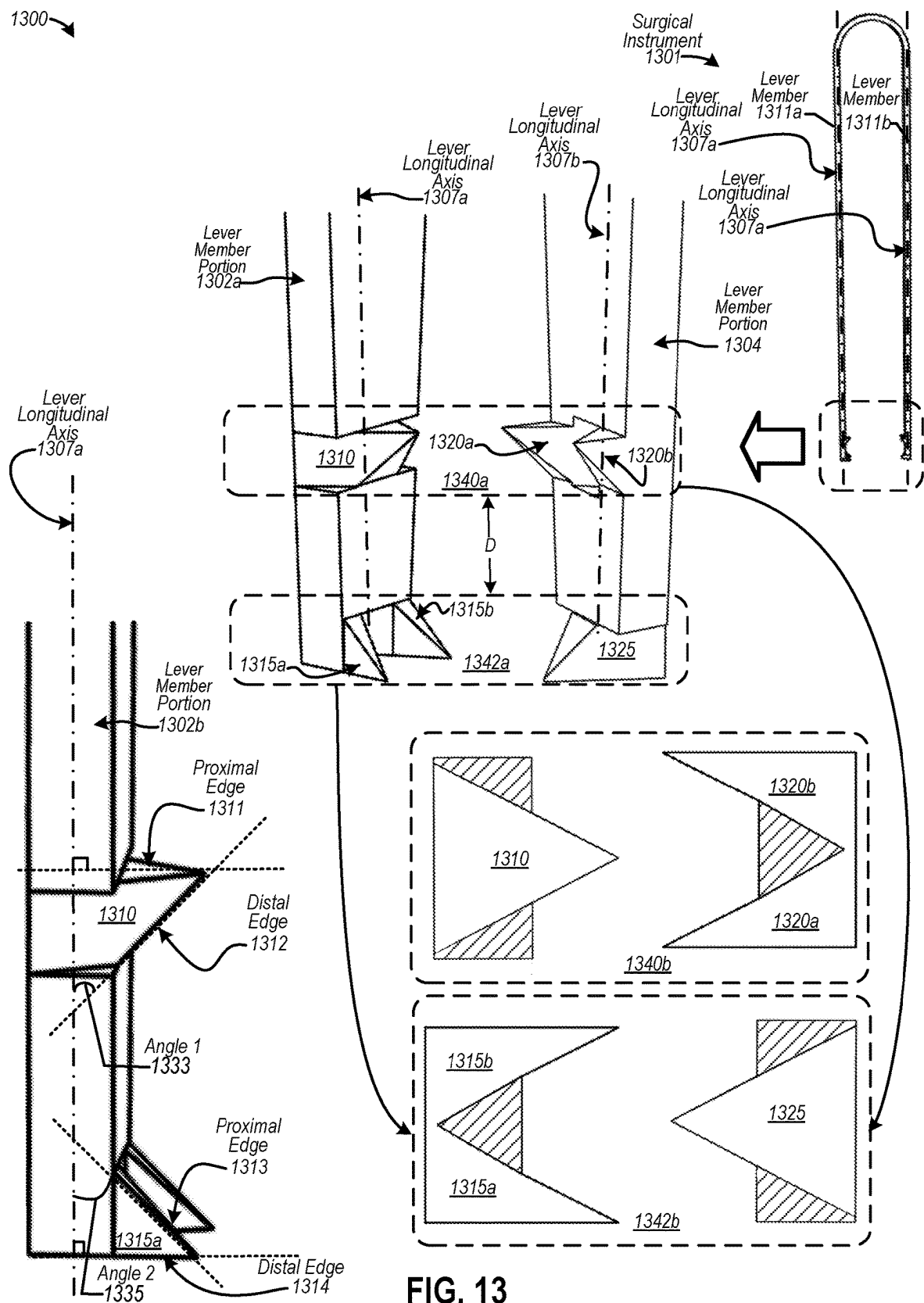


FIG. 13

1400



FIG. 14A

1430

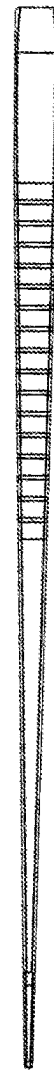


FIG. 14B

1460

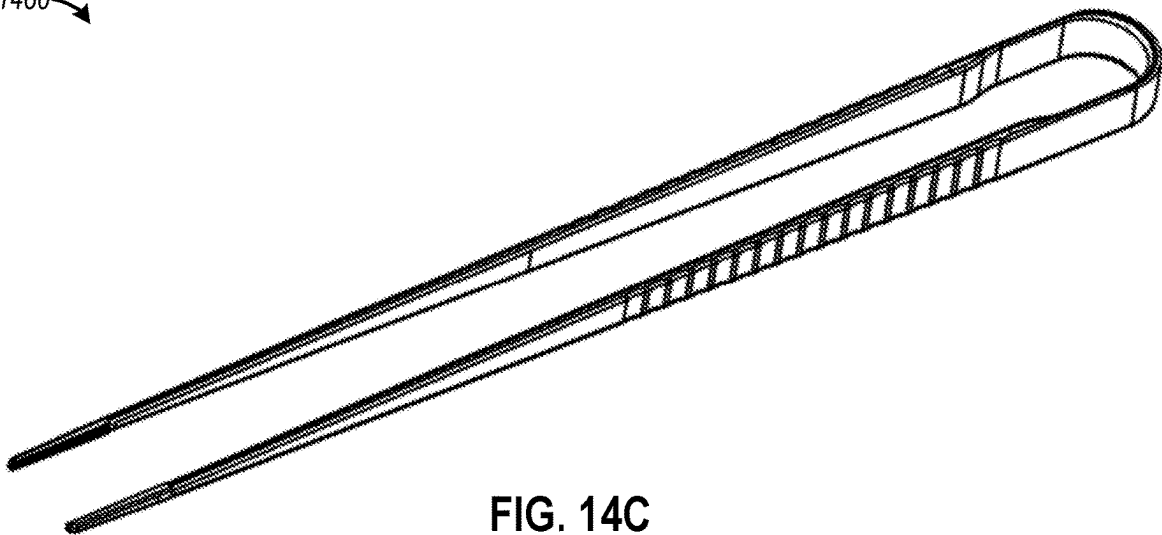
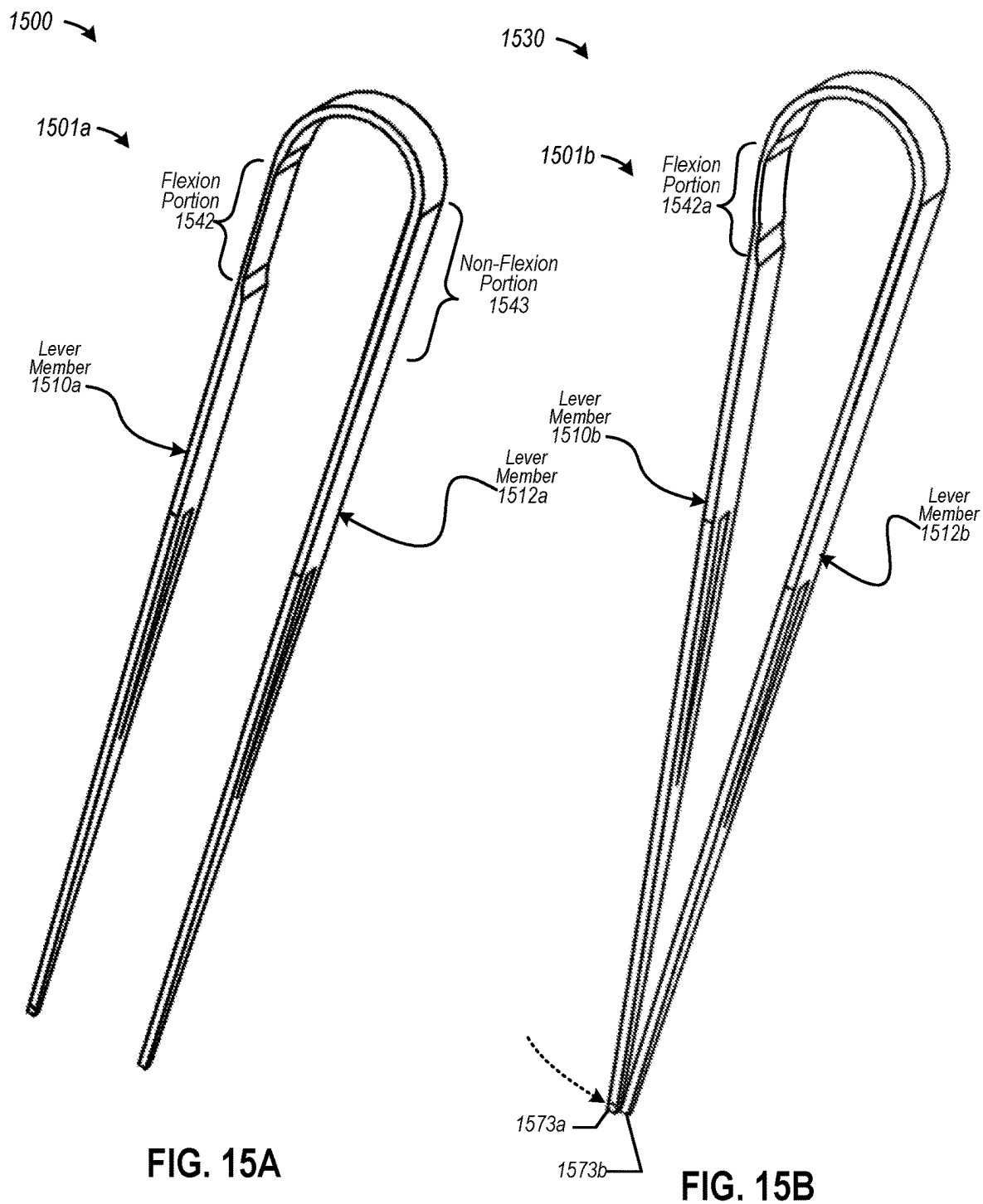


FIG. 14C



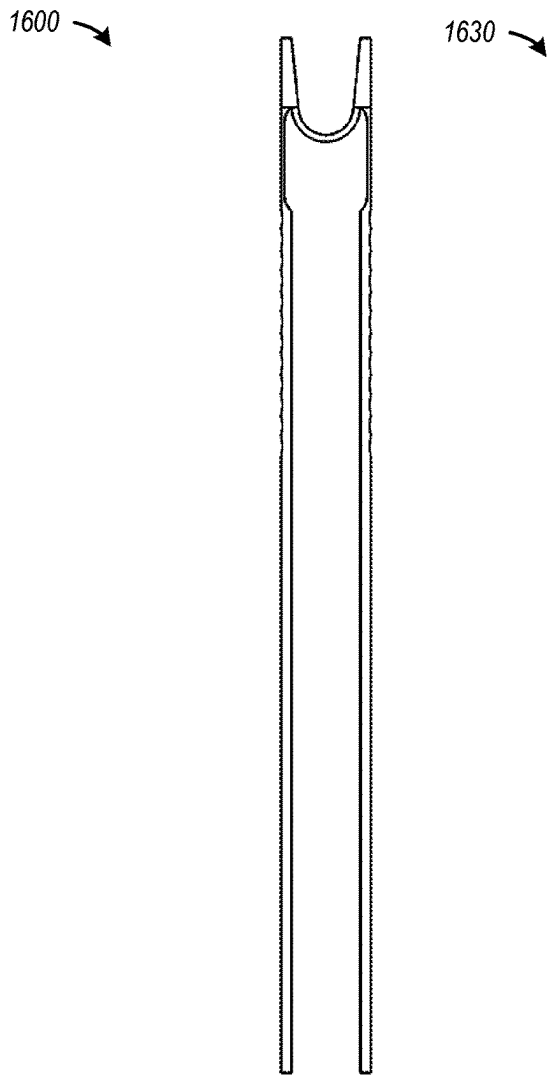


FIG. 16A

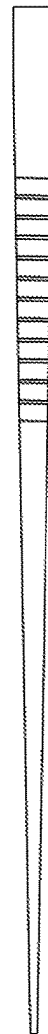


FIG. 16B

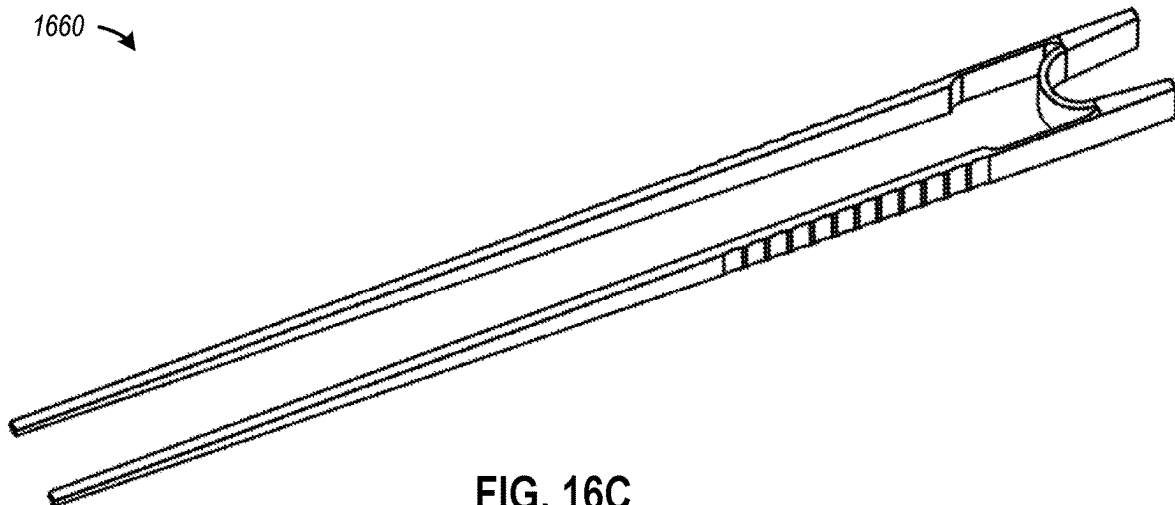


FIG. 16C

1700

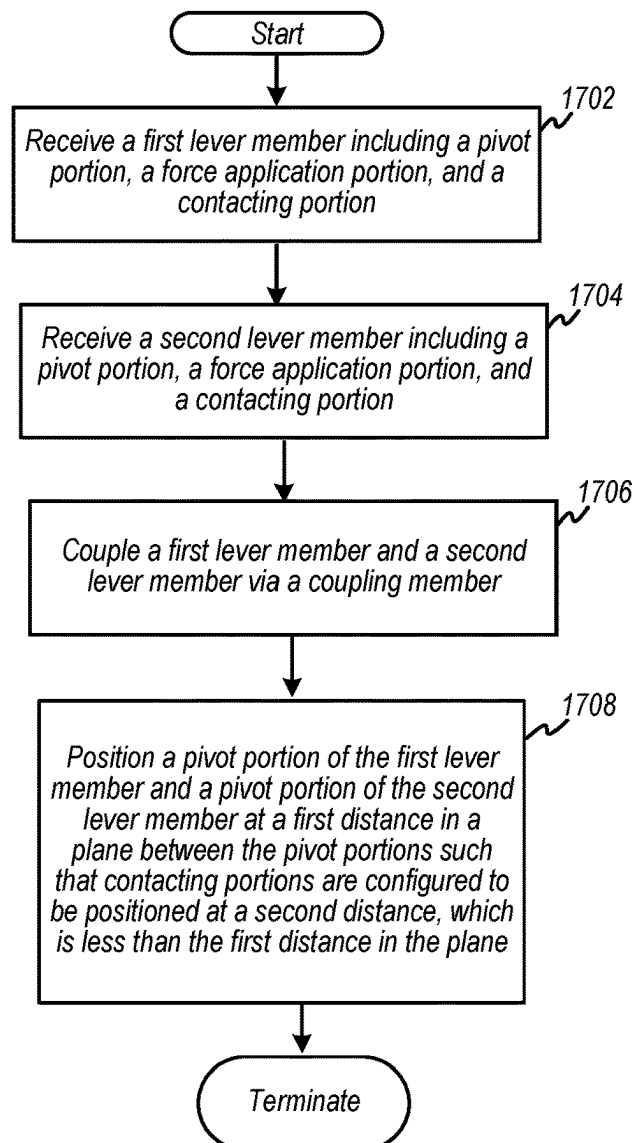


FIG. 17

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# **SURGICAL INSTRUMENTS WITH COUPLING MEMBERS TO EFFECT MULTIPLE PIVOT AXES**

## **CROSS-REFERENCE TO APPLICATIONS**

This application is a continuation application of copending U.S. patent application Ser. No. 17/183,334, filed Feb. 23, 2021 and titled, "SURGICAL INSTRUMENTS WITH COUPLING MEMBERS TO EFFECT MULTIPLE PIVOT AXES," U.S. patent application Ser. No. 17/183,334 is a continuation application of U.S. patent application Ser. No. 16/820,518 filed on Mar. 16, 2020 and titled, "SURGICAL INSTRUMENTS WITH COUPLING MEMBERS TO EFFECT MULTIPLE PIVOT AXES," U.S. patent application Ser. No. 16/820,518 claims the benefit of U.S. Provisional Patent Application No. 62/819,637 filed on Mar. 17, 2019 and titled, "ADVANCED SURGICAL FORCEPS," all of which are herein incorporated by reference in their entirety for all purposes.

## **FIELD**

Various embodiments relate generally to surgical instruments, tools, and apparatuses for medical use, including, but not limited to, forceps, tweezers, and pincers, as well as other anatomical tools for surgical and medical uses, and, more specifically, to surgical instruments implementing a coupling member to effectuate multiple pivot axes that enhance, for example, effective lengths with which to access an internal surgical site and application of force to facilitate grasping and manipulation of tissues associated with surgery.

## **BACKGROUND**

Surgeons and medical professionals are increasingly required to improve productivity with an aim to maintain or reduce healthcare costs, including costs related to operating rooms and surgeries. Some traditional surgical tools hinder the goals of improving productivity as some surgical tools may implement suboptimal designs and configurations that have not changed in decades. For example, suboptimal designs and configurations can cause fatigue unnecessarily, and can provide for less than optimal useable length of the tool to accomplish the tool's function. One class of surgical tools susceptible to impeding improved productivity includes conventional forceps that employ a fixed hinge mechanism. These traditional forceps have several drawbacks.

FIG. 1A is a diagram 100 showing a perspective view of conventional surgical forceps 101 that has fulcrum assembly 103 as a flat, fixed hinge connected to each shank 101a and 101b to enable tips of forceps 101 in grip region 106 to grip any number of anatomical items, such as tissues, organs (e.g., bowels), arteries, veins, bones, etc. Structures of conventional surgical forceps 101 can be described relative to a lateral plane 110, a longitudinal plane 112, and a bisecting plane 114. As shown, longitudinal plane 112 includes a pivot axis 104 about which shanks 101a and 101b rotate, and substantially divides surgical forceps 101 into two halves, whereby one half includes shank 101a and the other half includes shank 101b. Lateral plane 110 is orthogonal to longitudinal plane 112 and substantially divides each of shanks 101a and 101b into symmetrical halves along, for example, plane-intersection lines 107a and 107b. Bisecting plane 114 divides a length 108 of forceps 101 from point

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102a to point 102b in half, and is orthogonal to both lateral plane 110 and longitudinal plane 112. Bisecting axis 114a is a line at which bisecting plane 114 intersects longitudinal plane 112. Finger engagement region 105, which typically extends through bisecting plane 114, includes a surface at which a finger or thumb may engage forceps 101 to grasp an object, such as tissue.

FIG. 1B is a diagram 120 as a side view of conventional surgical forceps 121 in an open state. Forceps 121 include a fulcrum assembly 123 at one end and tips 122b1 and 122b2 in a grip region 126 at the other end. Typically, fulcrum assembly 123 is a flat, fixed hinge connected to a shank 121a and a shank 121b, and provides a pivot axis 124 about which each of shanks 121a and 121b rotate. Usually, fulcrum assembly 123 is formed by welding shanks 121a and 121b to each other to form a flat hinge that is non-locking and without a pivot assembly (e.g., a rivet or pin typically used to provide 'scissoring'-like functionality). As a result, flat material within fulcrum length 128a reduces the potential use of forceps length 128. Further, finger engagement region 125 is usually disposed at and over bisecting plane, and thus is typically designed for surgeons to grasp forceps 121 at the middle of length 128, which, in turn, usually reduces a useful working length between a surgeon's fingers on forceps 121 and tips 122b1 and 122b2. Note that in an initially closed state, forceps 121 are commonly in a "bowed" shape in which distances 129 between one of shanks 121a and 121b and a longitudinal plane 132 are present when tips 122b1 and 122b2 are in contact.

Yet another drawback to conventional forceps 121 is that a relatively small or limited range of motion provided by a "pinch distance" 131, in turn, limits a force that can cause tips 122b1 and 122b2 to transfer the force to grasp an object. In typical usage, pinch distance 131 decreases to about a zero distance when a maximal force is applied. Hence, a limitation usually arises as a thumb and a pad of an index finger (e.g., of a surgeon) causes pinch distance 131 to decrease from, for example, about 4 mm to about 0 mm, which may be a limited range of motion with which to apply a force for transference to tips 122b1 and 122b2. As such, a maximal force is typically reached at pinch distance 131 of about 0 mm, which, in turn, causes shanks 121a and 121b to contact each other along their longitudinal length from point 102a to point 102b of FIG. 1A (e.g., in a "flattened" configuration). Once the limited range of motion associated with pinch distance 131 is depleted for forceps 121, any additional forces applied to forceps 121 do not transfer generally to tips 122b1 and 122b2.

FIG. 1C is a diagram 140 showing a side view of conventional surgical forceps 141 in a closed state. As shown, a longitudinal plane 152 passes through a fulcrum assembly 143, a pivot axis 144, and engaged tips 142b. An applied force 156 is shown to be applied to a surface of a finger engagement region 145 to maintain forceps 141 in a closed state. Applied force 156 is of at least an amount to overcome a spring force 158 that naturally causes forceps 141 to return to an open state. In event forceps 141 are used to lift an object (e.g., tissue), a lift force 154a may be applied to a common surface portion at which applied force 156 is exerted. During a lifting event, friction force 157 may be applied to a textured surface on shanks 121a and 121b to enhance a surgeon's grip. In a closed state, a geometry 153 formed to include pivot axis 144 and surface portions of finger engagement region 145 is such that a direction of a lift force 154a (e.g., parallel to longitudinal plane 152) that omits a structure of forceps 141. Further, a point at which application of applied force 156 is applied usually defines a

useful length **155** with which a surgeon or medical professional may effectively use forceps **141** to grasp tissue.

Forceps **141** may be Debakey forceps and may be 12 inches in length extending from end **191a** to tips **142b**. Forces exerted at or about bisecting plane **194** increasing from approximately 4 Newtons to approximately 18 Newtons may generate approximately 0 megapascals ("MPa") to approximately 0.25 MPa of pressure at tips **142b**. However, forces exerted at or about bisecting plane **194** increasing from approximately 18 Newtons to approximately 32 Newtons may yield decreasing amounts of pressure (e.g., from about 0.25 MPa to about 0 MPa). By contrast, forces exerted at or about  $\frac{2}{3}$ <sup>rd</sup> distance **192** from tips **142b** ranging from approximately 4 Newtons to approximately 9 Newtons may generate approximately 0.2 megapascals ("MPa") to approximately 0.4 MPa of pressure at tips **142b**. However, forces exerted at or about  $\frac{2}{3}$ <sup>rd</sup> distance **192** (e.g., 66.7% of 12 inches) increasing from approximately 9 Newtons to approximately 32 Newtons may yield decreasing amounts of pressure (e.g., from about 0.4 MPa to about 0.2 MPa). Thus, in the example shown, maximum amounts of pressure are about 0.25 MPa and 0.4 MPa for forces exerted at or about bisecting plane **194** and  $\frac{2}{3}$ <sup>rd</sup> distance **192**, respectively.

FIG. **2** is a diagram **200** depicting a typical approach to using conventional surgical forceps with traditional design configurations. As shown, a subject **210** undergoing surgery may require any number of surgical tools, forceps **201a**, **201b**, and **201c** or any other tool, such as clamping tools **242**, **244**, **246**, etc., at an internal surgical site **212**. A cover **230**, such as a surgical drape, towel, pad, etc., may define a size of an opening of internal surgical site **212**. Also, clamping tools **242**, **244**, **246** may be disposed on a cover **230** and may extend upward from subject **210**, thereby obstructing a use of forceps **201a**. These tools, including forceps **201a**, **201b**, and **201c**, may be required to access tissue or objects at a depth **229**. Inset **290** depicts a hand **236a** of a first surgeon using a "pencil grip" to hold forceps **201a** at finger engagement region **245**. Commonly, other surgeons may also vie to gain access to internal surgical site **212** during a surgery. For example, consider two additional surgeons are participating in the surgery. A hand **236b** of a second surgeon is holding forceps **201b**, as shown within inset **292**. A hand **236c** of a third surgeon is holding forceps **201c**, as shown within inset **294**. Drawbacks to conventional forceps **201a**, **201b**, and **201c** include reduced useful lengths **255a**, **255b**, and **255c** with which surgeons may use to avoid each other's tools, clamps **242** to **246**, or any other obstacle when accessing anatomical objects at depth **229**. Reduced useful lengths **255a**, **255b**, and **255c** typically requires more coordination and stresses to successfully grasp and hold objects to ensure a successful result for subject **210**.

Thus, what is needed is a solution for facilitating implementation of surgical tools without the limitations of conventional techniques.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Various embodiments or examples ("examples") of the invention are disclosed in the following detailed description and the accompanying drawings:

FIG. **1A** is a diagram showing a perspective view of conventional surgical forceps that has a fulcrum assembly;

FIG. **1B** is a diagram as a side view of conventional surgical forceps in an open state;

FIG. **1C** is a diagram showing a side view of conventional surgical forceps in a closed state;

FIG. **2** is a diagram depicting a typical approach to using conventional surgical forceps with traditional design configurations;

FIG. **3** is a diagram depicting an example of a surgical instrument implementing a coupling member including multiple pivot axes, according to some embodiments;

FIG. **4** is a diagram depicting a perspective view of an example of a surgical instrument implementing a coupling member including multiple pivot axes, according to some embodiments;

FIGS. **5A** and **5B** are diagrams depicting a surgical instrument in various examples of closing states, according to some embodiments;

FIG. **6** is a diagram depicting examples of a coupling member, according to some embodiments;

FIGS. **7A** to **7C** are diagrams depicting various examples of flexion portions implemented as pivoting portions in accordance with various embodiments;

FIGS. **8A** to **8B** are diagrams depicting various other examples of flexion portions implemented as pivoting portions in accordance with some embodiments;

FIGS. **9A** to **9C** are diagrams depicting various alternative examples of flexion portions implemented as pivoting portions in accordance with some embodiments;

FIGS. **10A** to **10C** are diagrams depicting examples of a pivot coupler member configured to stabilize distal ends of a surgical instrument, according to some embodiments;

FIG. **11** is a diagram depicting an example of a surgical instrument implementing stabilization members in accordance with various embodiments;

FIG. **12** is a diagram depicting an example of contacting portions of a surgical instrument in accordance with some examples;

FIG. **13** is a diagram depicting another example of contacting portions of a surgical instrument, according to some examples;

FIGS. **14A**, **14B**, and **14C** depict a front view, a side view, and a perspective view, respectively, of a first example of a surgical instrument, according to various examples;

FIGS. **15A** and **15B** are diagrams depicting different states of a second example of a surgical instrument, according to some examples;

FIGS. **16A**, **16B**, and **16C** depict a front view, a side view, and a perspective view, respectively, of another example of a surgical instrument, according to various examples; and

FIG. **17** is a diagram depicting an example of a flow to manufacture a surgical instrument, according to some examples.

#### DETAILED DESCRIPTION

Various embodiments or examples may be implemented in numerous ways, including as a system, a process, an apparatus, a user interface, or a series of program instructions on a computer readable medium such as a computer readable storage medium or a computer network where the program instructions are sent over optical, electronic, or wireless communication links. In general, operations of disclosed processes may be performed in an arbitrary order, unless otherwise provided in the claims.

A detailed description of one or more examples is provided below along with accompanying figures. The detailed description is provided in connection with such examples, but is not limited to any particular example. The scope is limited only by the claims, and numerous alternatives, modifications, and equivalents thereof. Numerous specific details are set forth in the following description in order to



provide a thorough understanding. These details are provided for the purpose of example and the described techniques may be practiced according to the claims without some or all of these specific details. For clarity, technical material that is known in the technical fields related to the examples has not been described in detail to avoid unnecessarily obscuring the description.

FIG. 3 is a diagram depicting an example of a surgical instrument implementing a coupling member including multiple pivot axes, according to some embodiments. Diagram 300 depicts a surgical instrument 301 including a coupling member 390 to, among other things, implement multiple pivot axes, such as a pivot axis 302a and a pivot axis 302b. Coupling member 390 may be configured to couple to a lever member 301a at or adjacent to pivot axis 302a, and may be further configured to couple to a lever member 301b at or adjacent to pivot axis 302b. As shown, one or more of lever member 301a and lever member 301b each may include an applied force portion 314, an effective portion 316, and a contacting portion 322, which may include ends 303a and 303b. In some cases, ends 303a and 303b may be disposed distally, as distal ends, relative to pivot axes 302a and 302b, as well as a rotation axis 304, each of which may be disposed at another end (e.g., at a proximal end). In the example shown, surgical instrument 301 and lever members 301a and 301b is depicted as being in an open state (e.g., absence of applied forces to applied force portion 314). In operation, under applied forces, lever members 301a and 301b rotate relative to pivot axes 302a and 302b, respectively, and ends 303a and 303b of surgical instrument may rotate relative to rotation axis 304, which may be positioned in various positions within coupling member 390.

Applied force portion(s) 314 of lever members 301a and 301b may be configured to receive one or more forces to translate or activate one or more ends 303a and 303b in contacting portions 322 to apply pressure to, or release pressure from, an anatomical object 309 or the like. In at least one example, applied force regions 314 of lever members 301a and 301b may include protrusions 381 or any other surface treatment (including dimples, cavities, holes, ridges, etc.) to facilitate an enhanced grip by a surgeon's hand (or any other person's hand). Protrusions 381 may enhance frictional forces to reduce slippage, and may provide a structure for receiving a lift force, which may increase a grip when surgical forceps 301 are lifted. Further, applied force portions 314 in some examples may be disposed on one side of a bisecting plane 344, the one side being proximal to pivot axes 302a and 302b. In this example, bisecting plane 344 is disposed at a bisecting distance 313 relative to a pivot axis or proximal end (e.g., at rotation axis 304) of surgical instrument 301. Hence, bisecting plane 344 may be disposed at or adjacent one-half of length 312 of surgical instrument 301. In various examples, an applied force may be imparted upon one or more of applied force portions 314 by a human operator (e.g., under manually-operation) or, in some cases, by a robotic-controlled force generation mechanism (e.g., via a linear motor). In some examples, one or more ends 303a and 303b of contacting portion 322 may be implemented as jaws of a pair of forceps.

Effective portion 316 may be a portion of either lever members 301a and 301b, or both, that facilitates implementation of surgical instrument 301 to access various depths at which to engage object 309. In some examples, effective region 316 provides a portion of length 312 to facilitate access to an internal surgical site as well as to navigate around and about obstacles during surgery (e.g., other surgeons' hands, other tools, such as clamps, internal anatomy,

and any other encumbrance). Further, effective portions 316, may, in some examples, be disposed on one side of a bisecting plane 344, the one side being distal to pivot axes 302a and 302b, and adjacent to contacting portions 322 of lever members 301a and 301b. Note that contacting portions 322, including distal ends 303a and 303b, may be formed as part of effective portion 316, and may have any shape, such as straight, curved, or angled. Further, contacting portions 322 may include smooth or textured surfaces (e.g., cross-hatched), as well as a serrations or teeth. Contacting portions 322 also may include rings, cups, grooves, or any other engagement shape adapted to a particular purpose. For example, contacting surfaces at ends 303a and 303b may be configured to grip, clamp, grasp, join, support, compress or hold object 309, which may include bodily structures such as tissues, organs, arteries, vessels, veins, bones, etc. Object 309 may also include sponges, swabs, gauze or medical instruments, such as suture needles or other surgical items.

As shown, coupling member 390 may be configured to position pivot axes 302a and 302b at a distance 305 from each other. In some examples, distance 305 is along a line perpendicular to a longitudinal plane 340. In various examples, coupling member 390 may be configured to include any structure that provides for a displacement arm 306 extending from longitudinal plane 340 to pivot axis 302b, and another displacement arm 306 extending from longitudinal plane 340 to pivot axis 302a at a distance 305 from each other. In one closed state (or closing state) distal ends 303a and 303b may directly contact each other, or may contact an object 309 with which to engage. In various examples, distance 305 between pivot axes 302a and 302b may be greater than a distance between distal ends 303a and 303b.

In some examples, lever member 301a and a lever member 301b may have physical configurations and dimensions that may be described as a function of a longitudinal axis (e.g., a lever longitudinal axis) passing length-wise through a lever member. In some examples, a longitudinal axis of a lever member may be a line passing through each centroid of a number of cross sections of a lever member. A longitudinal axis need not reside internal to a lever member. In this example, a physical orientation or configuration of lever member 301a, as well as its functionality, may be described relative to a lever longitudinal axis 384, whereas a physical orientation or configuration of lever member 301b may be described relative to a lever longitudinal axis 385. Further, lever members 301a and 301b and any of their constituent elements may be configured to have any length and width dimension. Therefore, an applied force portion 314, such as an applied force of lever members 301a and 301b, and effective portions 316 may be configured to have any length dimension. While diagram 300 depicts lever members 301a and 301b having a substantially straight shape, lever members 301a and 301b may be formed to include or have any shape, such as curves, bends, etc.

In some examples, consider surgical instrument 301 may have a length 312 of 12 inches from, for example, rotation axis 304 to distal ends 303a and 303b. Exemplary forces applied at or about bisecting plane 344 may range from approximately 4 Newtons to approximately 32 Newtons may generate a range of pressures at distal ends 303a and 303b (e.g., from approximately 1.6 MPa to approximately 1.74 MPa of pressure). Bisecting plane 344 may be disposed at bisecting distance 394, which may be about 50% of length 312 (e.g., about 6 inches). In this case, surgical instrument 301 and its configuration may be provide efficiencies from

at or about 7 to 16 times more pressure at distal ends **303a** and **303b** than otherwise might be the case.

By contrast, forces applied at or about  $\frac{2}{3}$ <sup>rd</sup> distance **392** from distal ends **303a** and **303b** may range from approximately 4 Newtons to approximately 2.7 Newtons to generate another range of pressures at distal ends **303a** and **303b** (e.g., from approximately 0.80 MPa to approximately 2.7 MPa of pressure).  $\frac{2}{3}$ <sup>rd</sup> distance **392** may be about 66.70% of length **312** (e.g., about 8 inches). In this case, surgical instrument **301** and its configuration may be provide efficiencies from at or about 4 to 13 times more pressure at distal ends **303a** and **303b** than otherwise might be the case. In some examples, amounts of pressures at distal ends **303a** and **303b** may be determined using, for instance, Fujifilm® FPD-8010E digital pressure mapping system, which is developed and maintained by Fujifilm of Tokyo, Japan.

In view of the foregoing, a surgeon implementing surgical instrument **301** (or any other instrument configuration described hereinafter) may be able to apply relatively less force to grasp and hold tissue. Efficiencies described above may facilitate reduced fatigue that a surgeon may experience when grasping and holding tissue in the operating room for extended periods of time. Note further that the amounts of forces applied (e.g., Newtons) and resulting amounts of pressures (e.g., MPa) are recited as example amounts and are not intended to be limiting. Thus, any amount of forces may be applied to generate any amount of pressures at distal ends **303a** and **303b**.

FIG. 4 is a diagram depicting a perspective view of an example of a surgical instrument implementing a coupling member including multiple pivot axes, according to some embodiments. Diagram **400** depicts a surgical instrument **401** including a lever member **401a** and a lever member **401b** each coupled to a coupling member **490**, which is a distributive coupling member that distributes or positions multiple pivot axes **401a** and **401b** at a distance from each other (e.g., a distance perpendicular to the longitudinal axis **441**). Each lever member **401a** and lever member **401b** include an applied force portion **414**, an effective portion **416**, and a contacting portion **422**, which includes ends **403a** and **403b**.

Diagram **400** also shows a surgical instrument **401** and its constituent elements depicted relative to a longitudinal plane **440**, a longitudinal plane **442**, and a bisecting plane **444**, in at least one example. Longitudinal plane **440** may intersect lateral plane **442** at a longitudinal axis **441**, and substantially divides surgical instrument **401** into two halves, whereby one half includes lever member **401a** and the other half includes lever member **401b**. Lateral plane **442** is orthogonal to longitudinal plane **440** and substantially divides each of surgical instrument **401** and lever members **401a** and **401b** into symmetrical halves along, for example, plane-intersection lines **407**. As shown, lateral plane **442** may include point **405a** and point **405b** at which a pivot axis **402a** and a pivot axis **402b**, respectively, intersect lateral plane **442**. Further, lateral plane **442** may include a point **405c** at which a rotation axis **404a** intersects lateral plane **442**. In operation, lever members **401a** and **401b** rotate about pivot axis **402a** and pivot axis **402b**, respectively, in lateral plane **442**. Bisecting plane **444** divides a length of surgical instrument **401** along longitudinal axis **441** in half, and may intercept lateral plane **442** at a bisecting axis **445**.

In operation, consider an example in which applied forces (“Fa”) **419a** and (“Fb”) **419b** are directed to associated applied force portions **414**. Responsive to receiving applied forces **419a** and **419b**, ends **403a** and **403b** may traverse within lateral plane **442** toward each other. For example,

ends **403a** and **403b** may rotate within lateral plane **442** relative to pivot axes **402a** and **402b**, respectively. In some examples, surgical instrument **401** and any of its constituent elements, such as, coupling member **490** and lever members **401a** and **401b**, as well as corresponding applied force portions **414**, effective portions **416**, and contacting portions **422** each may be dimensioned to stabilize ends **403a** and **403b** during operation (e.g., prevent scissoring or displacement of end **403a** in a -Z direction and **403b** in a +Z direction that may cause lever members to cross over each other). For example, a dimension parallel to an X-Z plane for coupling member **490** may be sized to enhance stabilization of ends **403a** and **403b**. In addition, surgical instrument **401** and any of its constituent elements may be dimensioned to, for example, reduce a resistance of a material to elastically deform (e.g., reduce elastic modulus of a material, such as metal). For example, a dimension (e.g., a thickness) parallel to an Y-Z plane of coupling member **490** or lever member **401a** and a lever member **401b** may be sized to provide for enhanced flexion (e.g., at a pivot axis, a pivoting region, and/or at a flexion region).

FIGS. 5A and 5B are diagrams depicting a surgical instrument in various examples of closing states, according to some embodiments. Diagram **500** of FIG. 5A depicts a surgical instrument **580** including a coupling member **590** coupled via pivot axis **502a** and pivot axis **502b** to a lever member **501a** and a lever member **501b**, respectively. Each of lever members **501a** and **501b** may include an applied force portion **514a**, an effective portion **516a** and a contacting portion **522a**, which may include ends at **503a** and **503b**. As shown, coupling member **590** may be configured to position pivot axis **502a** and pivot axis **502b** at a distance **505** from each other (e.g., in a direction perpendicular to a longitudinal plane **552**).

In the example shown, applied forces (“F1a”) **519a** and (“F1b”) **519b** are directed to associated applied force portions **514a**. For example, force **519b** may be directed to point (“P”) **521** on or adjacent to one of applied force portions **514a**. Applied forces **519a** and **519b** may be of sufficient magnitude to rotate lever members **501a** and **501b** such that ends **503a** and **503b** touch in a first closing state. In some cases, a portion of surfaces of contacting portions **522a** may yet to touch or engage with each other. In this configuration, distance **505** is greater than the distance between ends **503a** and **503b**, and lever members **501a** and **501b** (and applied force portions **514a**) form a wedge configuration **509a**.

Further to the example shown, consider surgical instrument **580** may be used to lift an object in a direction, for example, parallel to longitudinal plane **552**. As shown within inset **581**, applied force **519b** (or a portion thereof) is applied at point **521** in a direction, for example, orthogonal (or substantially orthogonal) to a surface of applied force portion **514a**. Based on wedge configuration **509a**, a second applied force may be applied to or adjacent point **521**. At least a portion of second force portion may be a lift force **554a** having a force direction **553a**, which intercepts a surface portion of applied force portion **514a** at intercept point **523a**. In some examples, force direction **553a** may be applied to a protrusion (not shown) that may be configured to direct a greater magnitude of force into surgical instrument **580**. The force direction **553a** may be at an angle (“1”) **535a**. Thus, at least a portion of lift force **554a** is applied to (e.g., directly to) surgical instrument **580**.

FIG. 5B is a diagram **550** depicting a surgical instrument **582** including a coupling member **591** coupled via pivot axis **502a** and pivot axis **502b** to a lever member **501a** and a lever member **501b**, respectively. Each of lever members **501a**

and **501b** may include an applied force portion **514b**, an effective portion **516b** and a contacting portion **522b**, which may include ends at **503a** and **503b**. As shown, coupling member **591** may be configured to position pivot axis **502a** and pivot axis **502b** at a distance **506** from each other (e.g., in a direction perpendicular to a longitudinal plane **552**).

In the example shown, applied forces (“F2a”) **529a** and (“F2b”) **529b** are directed to associated applied force portions **514b**, whereby applied forces **529a** and **529b** may be greater in magnitude than applied forces **519a** and **519b** of FIG. **5A**. As shown in this example, force **529b** of FIG. **5B** may be directed to point (“P”) **561** on or adjacent to surface portions of one of applied force portions **514b**. Applied forces **529a** and **529b** may be of sufficient magnitude to further rotate lever members **501a** and **501b** such that ends **503a** and **503b** touch in a second closing state. Also, portions of surfaces of contacting portions **522a** may touch or engage with each other, and, optionally, portions of effective portion **516b** may traverse closer to each (e.g., based on flexion of lever members **501a** and **501b**). In this configuration, distance **506** is greater than the distance between ends **503a** and **503b**, and lever members **501a** and **501b** (and applied force portions **514b**) form a wedge configuration **509b**.

Further to the example shown, consider surgical instrument **582** may be used to lift an object in a direction, for example, parallel to longitudinal plane **552**. As shown within inset **583**, applied force **529b** (or a portion thereof) may be applied at point **561** in a direction, for example, orthogonal (or substantially orthogonal) to a surface of applied force portion **514b**. Based on wedge configuration **509b**, a second applied force may be applied to or adjacent point **561**. At least a portion of second force portion may be a lift force **554b** having a force direction **553b**, which intercepts a surface portion of applied force portion **514b** at intercept point **523b**. In some examples, force direction **553b** may be applied to a protrusion **588** that may be configured to direct a greater magnitude of force into surgical instrument **582**. The force direction **553b** may be at an angle (“2”) **535b**, which may be a greater angle than angle (“1”) of FIG. **5A**. As such, a greater angle **535b** between force direction **553b** and lever member **501b** facilitates a greater magnitude of force directed into surgical instrument **582** to facilitate lifting an object, for example.

In view of the foregoing and descriptions herein, surgical instrument **582** may be configured to establish, for example, distance **506**, which, in turn, provides for a relatively increased amount of distance for which to place a pad of a thumb and a pad on an index finger, as an example. In at least one embodiment, coupling member **591** provides for an amount of distance that enhances, for example, a “pinch distance” in association with application of **529a** and **529b** on surgical instrument **582**. Also, in at least some examples, a distance **531** of FIG. **5A** between lever member **501a** and lever member **501b** (and a thicknesses **533** thereof) may be facilitated based on distance **506**. In some implementations, a distance **531** (e.g., a pinch distance) may provide a range of movement to provide an enhanced force at ends **503a** and **503b** as a function, for example, distance **506**. According to some examples, distance **531** enables a user (e.g., a surgeon) a greater range of motion with which to apply various graduated increments of force via ends **503a** and **503b** than otherwise might be the case.

FIG. **6** is a diagram depicting examples of a coupling member, according to some embodiments. Diagram **600** depicts a coupling member **690** including a rotation axis **604** and pivot axes **602a** and **602b**. As shown, coupling member **690** may be formed as an outer coupling member **607** or as

an inner coupling member **617**. Outer coupling member **607** may be configured to include or couple to a lever member **611a** and a lever member **611b** at or adjacent to a pivot axis **612a** and a pivot axis **612b**, respectively. In some examples, pivot axis **612a** and pivot axis **612b** may be configured to facilitate rotation of lever member **611a** relative to pivot axis **612a** and rotation of lever member **611b** relative to pivot axis **612b**. In some examples, pivot axis **612a** and pivot axis **612b** may be implemented as a pivoting portion **662a** and a pivoting portion **662b**, respectively, whereby pivoting portions **662a** and **662b** may be formed or implemented as portions of a corresponding lever member. Any of pivoting portions **662a** and **662b** may be configured to facilitate rotation of distal ends (not shown) of lever members **611a** and **611b** about, for example, a rotation axis **614** to effect a closing state. For example, any of pivoting portions **662a** and **662b** may be formed to include a material or may be constructed to reduce a resistance of a material to elastically deform (e.g., reduce elastic modulus of a material, such as metal), thereby enabling material at pivoting portions **662a** and **662b** to bend responsive to forces applied to lever members **611a** and **611b**. As shown, rotation axis **614** may lie in a longitudinal plane **652a** at a proximal end of a surgical instrument, thereby using a length of that surgical instrument, according to at least some examples.

Further, diagram **600** depicts inner coupling member **617** including a rotation axis **624** and pivot axes **622a** and **622b** at which a lever member **621a** and a lever member **621b** may be coupled respectively. In some examples, pivot axis **622a** and pivot axis **622b** may be configured to facilitate rotation of lever member **621a** relative to pivot axis **622a** and rotation of lever member **621b** relative to pivot axis **622b**. In some examples, pivot axis **622a** and pivot axis **622b** may be implemented as a pivoting portion **664a** and a pivoting portion **664b**, respectively, whereby pivoting portions **664a** and **664b** may be formed or implemented as portions of a corresponding lever member. Any of pivoting portions **664a** and **664b** may be formed to include a material property to facilitate bending responsive to forces applied to lever members **621a** and **621b**. As shown, rotation axis **624** may lie in a longitudinal plane **652b** adjacent a proximal end of a surgical instrument and need not reside in or on material forming the surgical instrument. In some cases, distance **D2** between pivot axes **622a** and **622b** facilitates disposition of rotation axis **624** relative to rotation of distal ends (not shown) of lever members **621a** and **621b**.

FIGS. **7A** to **7C** are diagrams depicting various examples of flexion portions implemented as pivoting portions in accordance with various embodiments. Diagram **700** of FIG. **7A** includes a coupling member **701** coupled to an applied force portion **744**, according to some examples. Further, coupling member **701** may include pivot coupler member **741** and may optionally include a flexion portion **742**, whereby flexion portion **742** may be implemented as a pivoting portion (or a pivot axis) to facilitate rotation of distal ends of a surgical instrument (not shown) relative to a rotation axis **704**. In some examples, a portion **731** may be formed to have a dimensioned width (“W1”) **734**, which is less than a dimensioned width (“W2”) **736** of applied force portion **744**. Dimensioned width **734** may be configured or sized to promote flexion to rotate the distal ends responsive to amount of forces applied to applied force portions **744** of lever members. Further to diagram **700**, flexion portion **742** may include a transition portion **735** at which dimensioned width **734** transitions to dimensioned width **736**. In some instances, dimensioned widths **734** and **736** may be relative to (or in) a Y-Z plane. According to various examples,

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dimensioned widths **734** and **736** may be of any size. For example, dimensioned width **734** may be in a range from 30% to 40% of dimensioned width **736**, or any other proportion, which may be a function of a type of material used (e.g., a type of metal used). In a non-limiting example, dimensioned widths **734** and **736** may be 1.0 mm and 4.0 mm, or any other amounts, in at least one implementation.

FIG. 7B is a diagram **750** depicting a perspective view of a coupling member including flexion portions, according to some examples. As shown, coupling member **751** may include pivot coupler member **761**, a flexion portion **764a**, and a flexion portion **764b**, whereby diagram **750** depicts relative dimensions of flexion portions **764a** and **764b**. In some examples, flexion portion **764a** may include a transition portion **762a** and flexion portion **766**. Further, dimensioned widths **734** and **736** of FIG. 7A may be relative to outer surfaces, which may provide a relatively constant reference. For example, outer surface portion **778a** of flexion portion **764b** and outer surface portion **778b** of an applied force portion may be relatively constant (e.g., substantially in a same reference plane). Outer surface portion **778b** of an applied force portion are shown to include protrusions **791**. Thus, inner surface portion **777b** and inner surface portion **777a** of flexion portion vary relative in dimensions to each other. As such, flexion portions **764a** and **764b** are “inner” flexion portions.

FIG. 7C is a diagram **780** includes a coupling member **781** coupled to an applied force portion **786**, according to some examples. As shown, coupling member **781** may include pivot coupler member **782**, an external flexion portion **784**, and an applied force portion **786**, whereby diagram **750** depicts relative dimensions of external flexion portion **784** and applied force portion **786**. In this example, inner surface portions of external flexion portion **784** and applied force portion **786** may be relatively constant (e.g., substantially in a same reference plane). Thus, outer surface portions of flexion portion **784** and applied force portion **786** vary relative in dimensions to each other. As such, external flexion portion **784** is an “outer” flexion portions. In some examples, a thinner portion (e.g., flexion portion) disposed on an outer surface, such as external flexion portion **784**, may be configured to enhance an amount of leverage (e.g., an additional 2 mm of leverage) to generate ranges of pressures at the distal ends.

FIGS. 8A to 8B are diagrams depicting various other examples of flexion portions implemented as pivoting portions in accordance with various embodiments. Diagram **800** of FIG. 8A includes a coupling member coupled to a lever member **811a**, the coupling member including a pivot coupler member **841** and a flexion portion **842**. Lever member **811a** is shown to also include an applied force portion **844**. By contrast, lever member **811b** omits a flexion portion at a region depicted as a non-flexion portion **843**. Therefore, lever member **811b** may remain relatively stationary as an applied force impinges on applied force portion **844** to rotate an end (not shown) associated with lever member **811a**. In some examples, non-flexion portion **843** may shift or alter a rotation axis **814** adjacent closer to lever member **811b**, as shown.

FIG. 8B is a diagram **850** depicting a perspective view of a coupling member including a non-flexion portion, according to some examples. As shown, coupling member **851** may include a flexion portion **842** and a non-flexion portion **843**.

FIGS. 9A to 9C are diagrams depicting various alternative examples of flexion portions implemented as pivoting portions in accordance with various embodiments. Diagram **900** of FIG. 9A includes a coupling member **901** coupled to a

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lever member **911a**, and coupling member **901** includes a pivot coupler member **941** and a flexion portion **942**. Lever member **911a** is shown to also include an applied force portion **944**. As shown, lever member **911b** may also include flexion portion **942**.

FIG. 9B is a diagram **950** depicting a side view of a coupling member **951** coupled to a lever member **921a**, and coupling member **951** includes pivot coupler member **941** and flexion portion **942**. Lever member **921a** is shown to also include applied force portion **944**. Further, flexion portion **942** may be configured to include a flexion aperture **969** to modify a material property of flexion portion **942** (e.g., modify a resistance of a material to elastically deform to promote enhance ability to bend with reduced application of force). In some examples, flexion portion **942** may include a flexion member **971a** and a flexion member **971b** that are configured to couple coupling member **951** to applied force portion **944**. Flexion member **971a** and flexion member **971b** may be dimensioned to form a flexion aperture **969** (e.g., along a portion of a lateral plane **965** or another plane parallel thereto), whereby dimensions of flexion aperture **969** may influence determining a degree of flexibility of flexion portion **942**. Hence, absence of a material at flexion aperture **969** may enhance flexibility of flexion portion **942**.

FIG. 9C is a diagram **980** depicting a perspective view of a coupling member **981** and flexion portions **982a** and **982b** having flexion apertures **989a** and **989b**, respectively, according to some examples. As shown, a coupling member **981** may include a pivot coupler member **983** coupled via flexion portion **982a** to a lever member **911a**. Also, pivot coupler member **983** may further be coupled via flexion portion **982b** to a lever member **911b**. Flexion member **971a** and flexion member **971b** may be dimensioned to form a flexion aperture, such as flexion aperture **969**. Diagram **980** also depicts transition regions **991a** and **991b** of flexion portion **982b**.

FIGS. 10A to 10C are diagrams depicting examples of a pivot coupler member configured to stabilize distal ends of a surgical instrument, according to some embodiments. FIG. 10A is a diagram **1000** depicting a pivot coupler member **1001** having a first dimensioned width (“W1”) **1002**. FIG. 10B is a diagram **1030** depicting a pivot coupler member **1035** having a second dimensioned width (“W2”) **1032**. Pivot coupler member **1035** may be coupled via a flexion portion **1033** to applied force portion **1031**. FIG. 10C is a diagram **1060** depicting a perspective view of a surgical instrument **1061** including a pivot coupler member **1001** coupled to lever members **1072a** and **1072b**, which may include protrusions **1081**. Pivot coupler member **1001** may be configured to stabilize and urge ends **1073a** and **1073b** to rotate in lateral plane **1042** to engage an object **1071**. Therefore, pivot coupler member **1001** may be formed to reduce or prevent ends **1073a** and **1073b** from “scissoring” or “overlapping” each other (e.g., pivot coupler member **1001** may negate or decrease translation of ends **1073a** and **1073b** in a Z direction). In some non-limiting examples, dimensioned width (“W1”) **1002** of FIG. 10A may be in a range from 20% to 30% of dimensioned width (“W2”) **1032**, or any other proportion, which may be a function of a type of material used (e.g., a type of metal used). In another non-limiting example, dimensioned widths **734** and **736** of FIG. 7A may be between, for example, 1.5 mm and 3.0, or any other amounts, in at least one implementation. In some examples, dimensioned widths **734** and **736** may be, for instances, at a 1 to 2 ratio (or any variation thereof).

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FIG. 11 is a diagram depicting an example of a surgical instrument implementing stabilization members in accordance with various embodiments. Diagram 1100 depicts a surgical instrument 1101 including a pivot coupler member 1141 and lever members that include flexion portions 1142, applied force portions 1144, effective portions 1146, and ends 1173a and 1173b, which are configured to rotate in an arc 1175 in a lateral plane. As shown, surgical instrument 1101 may be configured to implement a stabilization member 1171a and a stabilization member 1171b in either an effective portion 1144 or applied force portion 1144, or both. Stabilization members 1171a and 1171b are configured to form a stabilization aperture 1189a of a first lever member (or stabilization aperture 1189b of a second lever member). According to various examples, an absence of material associated with stabilization aperture 1189a reduces a mass or weight of surgical instrument 1101. In turn, the material omitted from stabilization aperture 1189a may be used to increase a dimension ("Wx") 1136 along, for example, effective portion 1146 adjacent to ends 1173a and 1173b. Increased amount of dimension 1136 may promote or enhance stabilization of ends 1173a and 1173b to, for example, negate or reduce "scissoring" or "overlapping" ends 1073a and 1073b (e.g., ends 1073a and 1073b translate in a plane (or substantially in plane) that includes a range of motion or arc 1175). For example, ends 1073a and 1073b may be configured to translate in plane 1042 of FIG. 10C.

FIG. 12 is a diagram depicting an example of contacting portions of a surgical instrument in accordance with some examples. Diagram 1200 depicts a surgical instrument 1201 including lever members 1211a and 1211b. Lever member 1211a may include a lever longitudinal axis 1207a and a contacting portion 1273a, whereas lever member 1211b may include a lever longitudinal axis 1207b and a contacting portion 1273b. Contacting portion 1273a includes an end portion 1221a having engagement teeth 1244a and 1248a, and a channel 1246b, whereas contacting portion 1273b includes an end portion 1221b having channels 1244b and 1248b and engagement tooth 1246a. In this example, a subset 1210 of engagement portions include engagement teeth 1244a, 1246a, and 1248a configured to engage or contact channels 1244b, 1246b, and 1248b. Further, diagram 1200 depicts subset 1210 as one subset of engagement portions in longitudinal subsets 1212 of contacting portion 1273a and longitudinal subsets 1214 of contacting portion 1273b.

FIG. 13 is a diagram depicting another example of contacting portions of a surgical instrument, according to some examples. Diagram 1300 depicts a surgical instrument 1301 including lever members 1311a and 1311b. Lever member 1311a may include a lever longitudinal axis 1307a and a lever member portion 1302a, whereas lever member 1311b may include a lever longitudinal axis 1307b and a lever member portion 1304. Lever member portion 1302a and lever member portion 1304 include a first subset 1340a of engagement members and a second subset 1342 of engagement members, subset 1340a being disposed in a longitudinal distance, D, from subset 1342a. According to some examples, surgical instrument 1301 may facilitate a modification of a "Bonnie" forceps configuration.

In the example shown, subset 1340a of engagement members includes an engagement tooth 1310 associated with lever member portion 1302a and engagement teeth 1320a and 1320b associated with lever member portion 1304. By contrast, subset 1340b of engagement members is a converse arrangement of engagement members disposed in subset 1340a. For example, subset 1340a of engagement

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members includes engagement teeth 1315a and 1315b associated with lever member portion 1302a, and engagement tooth 1325 associated with lever member portion 1304. Cross-sectional views of engagement members of subsets 1340a and 1340b are depicted in subsets 1340b and 1342b, respectively.

According to some examples, engagement members in subsets 1340a and 1342a may be configured differently. To illustrate, consider that a lever member portion 1302b includes an engagement tooth 1310 having a proximal edge 1311 orthogonal to longitudinal axis 1307a and a distal edge 1312 at an angle ("1") 1333, whereas engagement teeth 1315, such as engagement tooth 1315a, may have a proximal edge 1313 at an angle ("2") 1335 and a distal edge 1314 orthogonal to longitudinal axis 1307a. Note that each subset of engagement members may include any number of engagement teeth, according to various examples.

FIGS. 14A, 14B, and 14C depict a front view, a side view, and an perspective view, respectively, of a first example of a surgical instrument, according to various examples.

FIGS. 15A and 15B are diagrams depicting different states of a second example of a surgical instrument, according to some examples. Diagram 1500 of FIG. 15A depicts a surgical instrument 1501a in at least one open state. Surgical instrument 1501a includes a flexion portion 1542 associated with a lever member 1510a, and includes a non-flexion portion 1543 associated with a lever member 1512b. Diagram 1550 of FIG. 15B depicts a surgical instrument 1501b in at least one closed (or closing) state. Upon application of one or more applied forces to one or more lever members 1510b and 1512b, flexion portion 1542a may elastically deform or bend to facilitate rotation of end 1573a to end 1573b. In some cases, end 1573b may stationary (or substantially stationary), or may rotate at a rate less than that of end 1573a.

FIGS. 16A, 16B, and 16C depict a front view, a side view, and an perspective view, respectively, of another example of a surgical instrument, according to various examples.

FIG. 17 is a diagram depicting an example of a flow to manufacture a surgical instrument, according to some examples. At 1720, a first lever member including a pivot portion, a force application portion, and a contacting portion is received. At 1704, a second lever member including a pivot portion, a force application portion, and a contacting portion is received. At 1706, a first lever member and a second lever member coupled to each other via a coupling member, each of which may be formed together as using a monolithic material, or may be integrated together. At 1708, a pivot portion of a first lever member and a pivot portion of a second lever member may be positioned at a first distance in a plane from each other. Further, surgical instrument may be configured to rotate one or more contacting portions to a second distance from each other. The second distance may be less than the first distance in the plane.

In view of the foregoing, the structures and/or functionalities depicted in FIGS. 3 and 4 as well as other description and figures described herein, describe a surgical instrument implementing a coupling member that provides for multiple pivot axes displaced from each other, according to some embodiments. According to various examples, surgical forceps implementing multiple pivot axes described herein may provide for one or more of (1) enhanced effective length with which to access a surgery site, (2) increased flexibility or ability to elastically deform to reduce applied forces, which, in turn, may reduce fatigue in a surgeon's hand, and (3) increased grip strength at the ends based on, for example,

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a wedge configuration formed among multiple pivot axes and the ends or tips of lever members.

Displacement of pivot axes from each other may facilitate application of more pressure or closing forces at the ends of lever members of exemplary surgery forceps. Further, the displacement of pivot axes from each other also facilitates an ability to position a rotation axis at a proximal end of surgical forceps, thereby increasing an amount of usable or effective length than otherwise might be the case. In some non-limiting examples, an effective or useable length may be 25 to 40% more than otherwise might be the case. In various implementations, applied force portions of surgical forceps may be disposed on one side of a bisecting plane, the one side including a proximal end adjacent to multiple pivot axes.

In some examples, one or more flexion portions may be implemented adjacent a proximal end of surgical forceps, which, in turn, may enhance its mechanical advantage. In addition, displacement of pivot axes and positioning of a rotation axis enables closure of lever members in a manner that provides a more ergonomic position to apply pressure or forces to surgical forceps, which, in turn, reduces fatigue to a surgeon.

In some examples, surgical forceps may be non-locking and non-pivoting, thereby omitting a pivot assembly, which may simplify manufacturing processes that may reduce costs. In some implementations, a first lever member, a second lever member, and a coupling member portion may be formed with a monolithic material as a monolithic, contiguous structure (e.g., a first lever member, a second lever member, and a coupling member portion may be formed in a single mold or from a single piece of material, such as stainless steel flat bar stock). Surgical forceps described herein may be formed using plastic materials, such as styrene, ABS, and polycarbonate, or any other medical-grade materials, etc.

Examples herein describe and depict various examples of locking elements and various examples of protective members with certain functionalities, orientations, structures, and configurations, all of which are merely exemplary and are not intended to be limiting. Thus, various other functionalities, structures, orientations, and configurations of the structures described herein are within the scope of the present disclosure. Note, too, that various surgical tools described herein are applicable for performing surgery on any organism, including veterinary uses.

Note that the structures and constituent elements described herein, as well as their functionality, may be aggregated or combined with one or more other structures or elements. Alternatively, the elements and their functionality may be subdivided into constituent sub-elements, if any.

A detailed description of one or more examples has been provided above along with accompanying figures. The detailed description is provided in connection with such examples, but is not limited to any particular example. The scope is limited only by the claims, and numerous alternatives, modifications, and equivalents are encompassed. Numerous specific details are set forth in the following description in order to provide a thorough understanding. These details are provided as examples and the described techniques may be practiced according to the claims without some or all of the accompanying details. For clarity, technical material that is known in the technical fields related to the examples has not been described in detail to avoid unnecessarily obscuring the description.

The description, for purposes of explanation, uses specific nomenclature to provide a thorough understanding of the

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various embodiments. However, it will be apparent that specific details are not required in order to practice the various embodiments. In fact, this description should not be read to limit any feature or aspect of any embodiment; rather features and aspects of one example can readily be interchanged with other examples. Notably, not every benefit described herein need be realized by each example of the various embodiments; rather any specific example may provide one or more of the advantages discussed above. In the claims, elements and/or operations do not imply any particular order of operation, unless explicitly stated in the claims. It is intended that the following claims and their equivalents define the scope of the various embodiments.

What is claimed:

1. A surgical instrument comprising:

a coupling member configured to couple a first lever member to a second lever member, the coupling member formed to include an arc shape, the coupling member including a structural portion at which a first axis of rotation at a proximal end, the first axis of rotation offset from a longitudinal plane;

the first lever member including a first flexion portion aligned with a first longitudinal axis terminating at a first contacting portion at a first distal end, the first lever member including a first effective portion that includes the first contacting portion and a first applied force portion at which to receive a force to rotate the first lever member about the first axis of rotation, the first applied force portion being disposed between a bisecting plane and the proximal end, the bisecting plane dividing a length of the surgical instrument in approximately one half; and

the second lever member including a non-flexion portion aligned with a second longitudinal axis terminating at a second contacting portion at a second distal end, the second lever member including a second effective portion that includes the second contacting portion and a second applied force portion, the second applied force portion being disposed between the bisecting plane and the proximal end, the first flexion portion is dimensioned to have a width less than the non-flexion portion of the second lever member, the width being dimensioned relative to a plane in which the first lever member and the second lever member rotate, the plane being a plane of rotation, the first flexion portion being disposed between first applied force portion and the proximal end,

wherein a first distance in the plane between the first flexion portion and the non-flexion portion of the second lever member is equivalent to a second distance in the plane between the first contacting portion and the second contacting portion in at least one open state,

wherein the non-flexion portion being configured to establish the first axis of rotation closer to the second lever member than the first lever member,

wherein one or more of the first applied force portion and the second applied force portion is configured to receive one or more first applied forces to translate the first contacting portion and the second contacting portion into at least a first closing state at which the first contacting portion is positioned at the second distance, the second distance being less than the first distance as dimensioned in the plane of rotation, and

wherein the one or more of first applied force portion and the second applied force portion are further configured to receive one or more second applied forces to translate the first contacting portion and the second contact-

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ing portion into at least a second closing state in which the one or more second applied forces are configured to contact substantially the first and the second effective portions at one more distances substantially along surfaces of the first and second lever members from the first and the second contacting portions including distances approximately to the bisecting plane.

2. The surgical instrument of claim 1, wherein at least one of the first lever member and the second lever member has a substantially straight shape extending either from the first flexion portion to the first contacting portion or from the non-flexion portion, or both.

3. The surgical instrument of claim 2, wherein the substantially straight shape is associated with one or more of the first and the second longitudinal axes.

4. The surgical instrument of claim 1, wherein the coupling member includes a width greater than widths of portions of the first and the second lever members.

5. The surgical instrument of claim 1, wherein the at least one first flexion portion comprises:

a flexion aperture portion being disposed between the first applied force portion and the proximal end.

6. The surgical instrument of claim 1, wherein the at least one of the first lever member and the second lever member comprises:

a stabilization aperture.

7. The surgical instrument of claim 1, wherein the at least one first flexion portion comprises:

a material dimensioned to have less resistance to elastic deformation than the non-flexion portion of the second lever member.

8. The surgical instrument of claim 1, wherein the first contacting portion and the second contacting portion comprises:

a first set of engagement teeth and a channel, and a second set of engagement teeth and one or more channels,

wherein each of the engagement teeth has proximal edges and distal edges at angles to the first or the second longitudinal axis, each engagement tooth being triangular-shaped.

9. The surgical instrument of claim 1, wherein the first contacting portion and the second contacting portion comprises:

a first set of engagement members, each engagement member having a first proximal edge at an angle relative to a first distal edge that is orthogonal to the first or the second longitudinal axis;

a second set of engagement members having a second distal edge at an angle relative to a second proximal edge that is orthogonal to the first or the second longitudinal axis,

wherein the first and the second set of engagement members are configured to engage each other.

10. The surgical instrument of claim 1, wherein the non-flexion portion is configured to maintain the second contacting portion substantially stationary as the first contacting portion translates into the first and/or second closing state.

11. The surgical instrument of claim 1, wherein the first applied force portion is configured to receive the force at substantially two-thirds distance from the first distal end.

12. The surgical instrument of claim 1, wherein the first flexion portion is at substantially one-third distance from the proximal end.

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13. A surgical instrument comprising:

a first lever member including a first flexion portion including a first pivot axis aligned with a first longitudinal axis terminating at a first contacting portion at a first distal end, the first distal end being disposed opposite of a proximal end, the first lever member including a first effective portion that includes the first contacting portion and a first applied force portion at which to receive a force to rotate the first lever member about the first axis pivot axis, the first applied force portion being disposed between a bisecting plane and the proximal end, the bisecting plane dividing a length of the surgical instrument in approximately one half;

a second lever member including a non-flexion portion aligned with a second longitudinal axis terminating at a second contacting portion at a second distal end, the second lever member including a second effective portion that includes the second contacting portion and a second applied force portion, the second applied force portion being disposed between the bisecting plane and the proximal end, the first flexion portion including the first pivot axis being dimensioned to have a width less than the non-flexion portion of the second lever member, the width being dimensioned relative to a plane in which the first lever member and the second lever member rotate, the plane being a plane of rotation, the first flexion portion being disposed between first applied force portion and the proximal end; and

a coupling member configured to couple the first lever member to the second lever member, the coupling member formed to include an arc shape, the coupling member including a structural portion at which a first axis of rotation adjacent the proximal end, the first axis of rotation offset from a longitudinal plane; and

a set of engagement teeth or members at each of the first contacting portion at the first distal end and the second contacting portion at a second distal end, wherein each of the engagement teeth has proximal edges and distal edges at angles to the first or the second longitudinal axis, each engagement tooth being triangular-shaped, wherein the non-flexion portion is configured to establish the first axis of rotation closer to the second lever member than the first lever member,

wherein one or more of the first applied force portion and the second applied force portion is configured to receive one or more first applied forces to translate the first contacting portion and the second contacting portion into at least a first closing state at which the first contacting portion is positioned at a distance relative to the second contacting portion as dimensioned in the place of rotation,

wherein the one or more of first applied force portion and the second applied force portion are further configured to receive one or more second applied forces to translate the first contacting portion and the second contacting portion into at least a second closing state in which the one or more second applied forces are configured to contact substantially the first and the second effective portions at other distances substantially along surfaces of the first and the second lever members from the first and the second contacting portions approximately to the bisecting plane.

14. A method to form a surgical instrument comprising: forming a coupling member configured to couple a first lever member to a second lever member, the coupling member formed to include an arc shape, the coupling member including a structural portion at which a first

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axis of rotation at a proximal end, the first axis of rotation offset from a longitudinal plane;  
 forming the first lever member including a first flexion portion aligned with a first longitudinal axis terminating at a first contacting portion at a first distal end, the first lever member including a first effective portion that includes the first contacting portion and a first applied force portion at which to receive a force to rotate the first lever member about the first axis of rotation, the first applied force portion being disposed between a bisecting plane and the proximal end, the bisecting plane dividing a length of the surgical instrument in approximately one half; and  
 forming the second lever member including a non-flexion portion aligned with a second longitudinal axis terminating at a second contacting portion at a second distal end, the second lever member including a second effective portion that includes the second contacting portion and a second applied force portion, the second applied force portion being disposed between the bisecting plane and the proximal end,  
 the first flexion portion being dimensioned to have a width less than the non-flexion portion of the second lever member, the width being dimensioned relative to a plane in which the first lever member and the second lever member rotate, the plane being a plane of rotation, the first flexion portion being disposed between first applied force portion and the proximal end,  
 wherein a first distance in the plane between the first flexion portion the non-flexion portion of the second lever member is equivalent to a second distance in the plane between the first contacting portion and the second contacting portion in at least one open state, wherein the non-flexion portion is configured to establish the first axis of rotation closer to the second lever member than the first lever member,  
 wherein one or more of the first applied force portion and the second applied force portion is formed to receive one or more first applied forces to translate the first

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contacting portion and the second contacting portion into at least a first closing state at which the first contacting portion is positioned at the second distance relative to the second contacting portion, the second distance being less than the first distance as dimensioned in the plane of rotation,

wherein the one or more of first applied force portion and the second applied force portion are further configured to receive one or more second applied forces to translate the first contacting portion and the second contacting portion into at least a second closing state in which the one or more second applies forces are configured to contact substantially the first and the second effective portions at other distances substantially along surfaces of the first and the second lever members from the first and the second contacting portions approximately to the bisecting plane.

**15.** The method of claim **14** to form the surgical instrument comprising:

forming at least one of the first lever member and the second lever member to have a substantially straight shape extending either from the first flexion portion to the first contacting portion or from the non-flexion portion, or both.

**16.** The method of claim **15** to form the surgical instrument comprising:

forming at least one of the first lever member and the second lever member wherein the substantially straight shape is associated with one or more of the first and the second longitudinal axes.

**17.** The method of claim **14** to form the surgical instrument comprising:

forming the coupling member to include a width greater than widths of portions of the first and the second lever members.

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