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(54) **TWO-PART FASTENERS FOR SURGICAL CLIP APPLIERS AND SURGICAL CLIP APPLIERS FOR DEPLOYING THE SAME**

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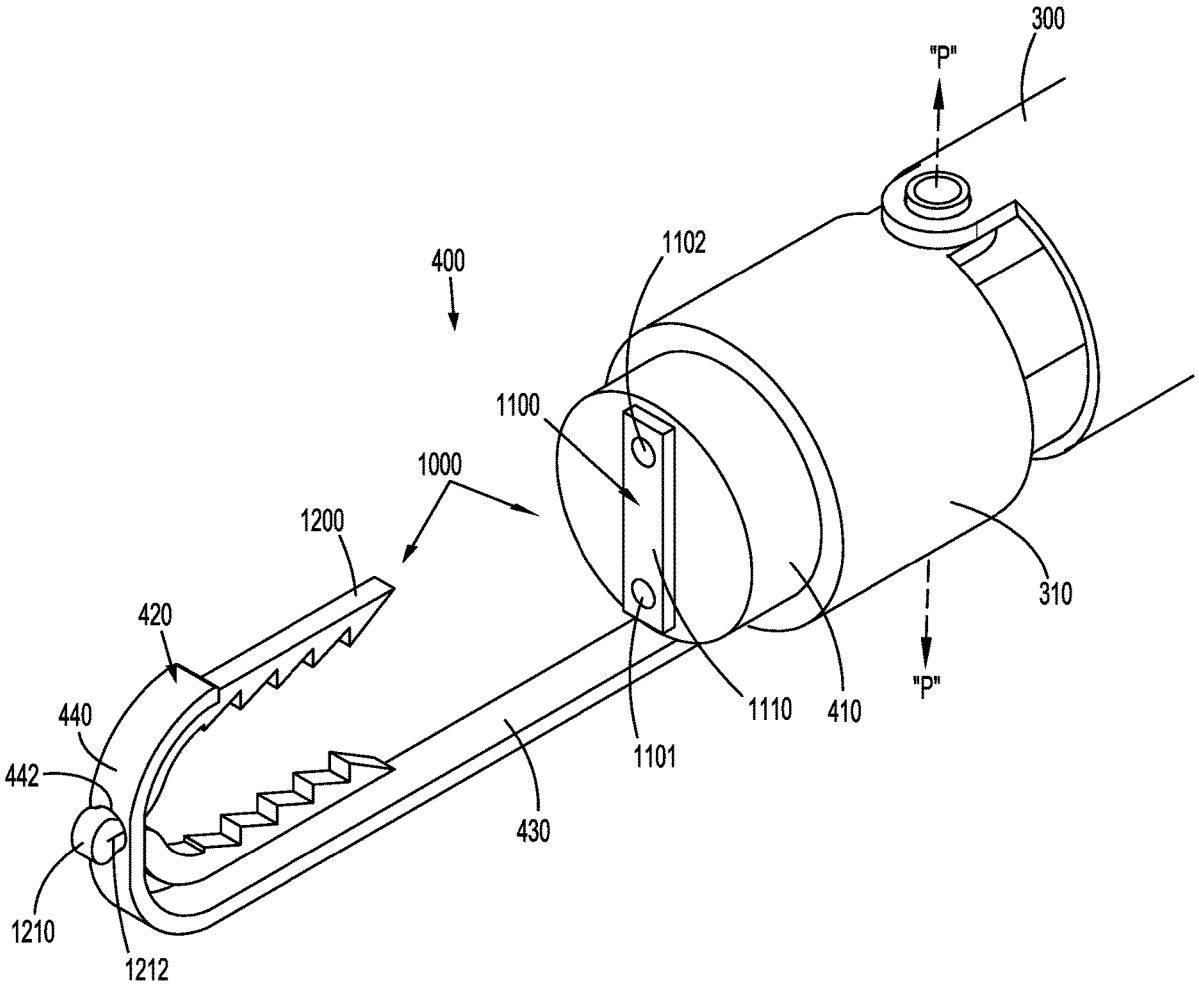
(57) **ABSTRACT**

A surgical clip applier includes an elongated portion, a drive shaft, and an end effector. The drive shaft extends at least partially through the elongated portion. The end effector is disposed adjacent a distal end of the elongated portion, and includes a collar and a distal housing. The collar is coupled to the drive shaft and is movable relative to the distal housing. The collar is configured to support a base of a two-part fastener. The distal housing includes a leg and a C-shaped portion extending from a distal end of the leg. The C-shaped portion is configured to support a clip of the two-part fastener.



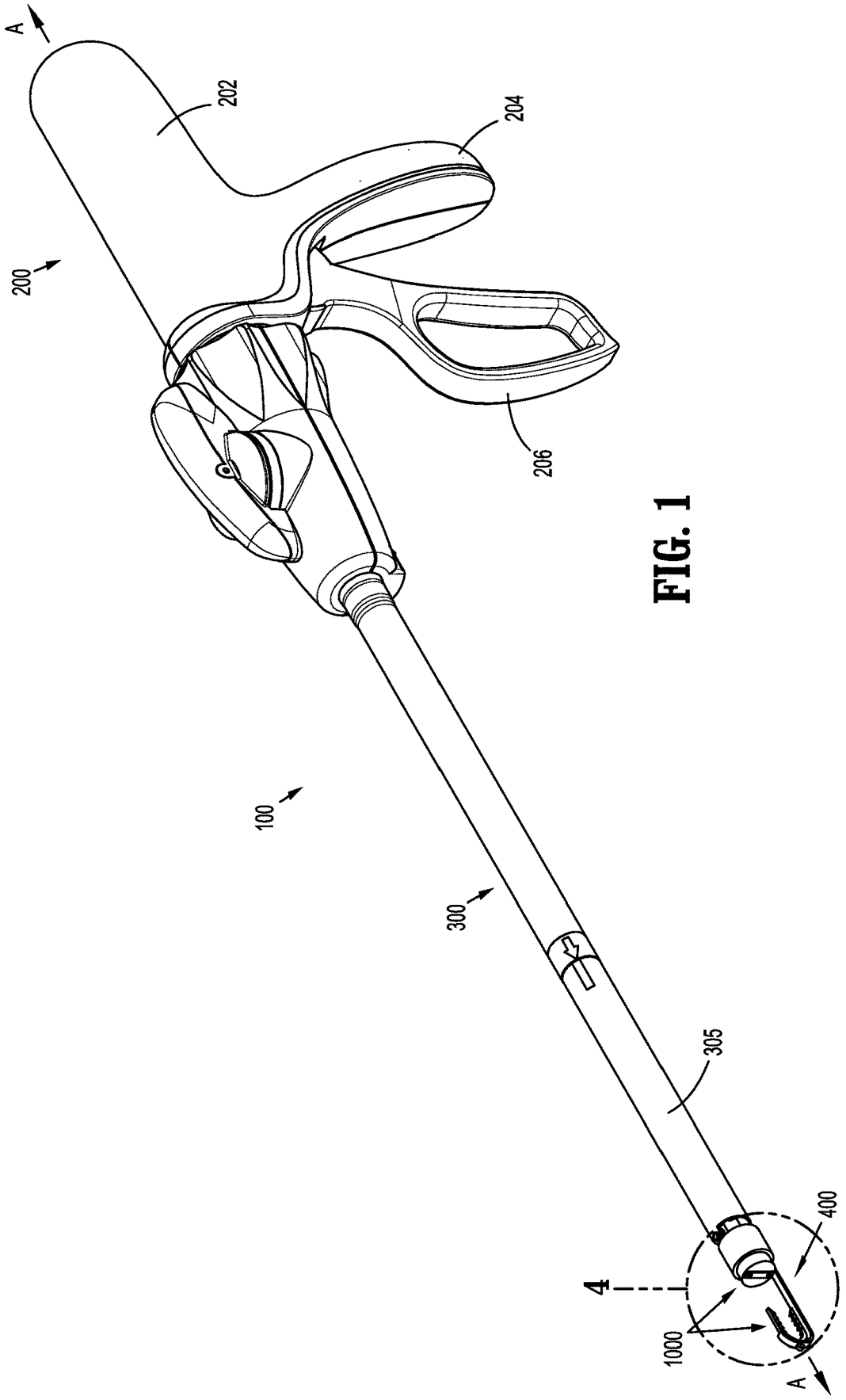


FIG. 1

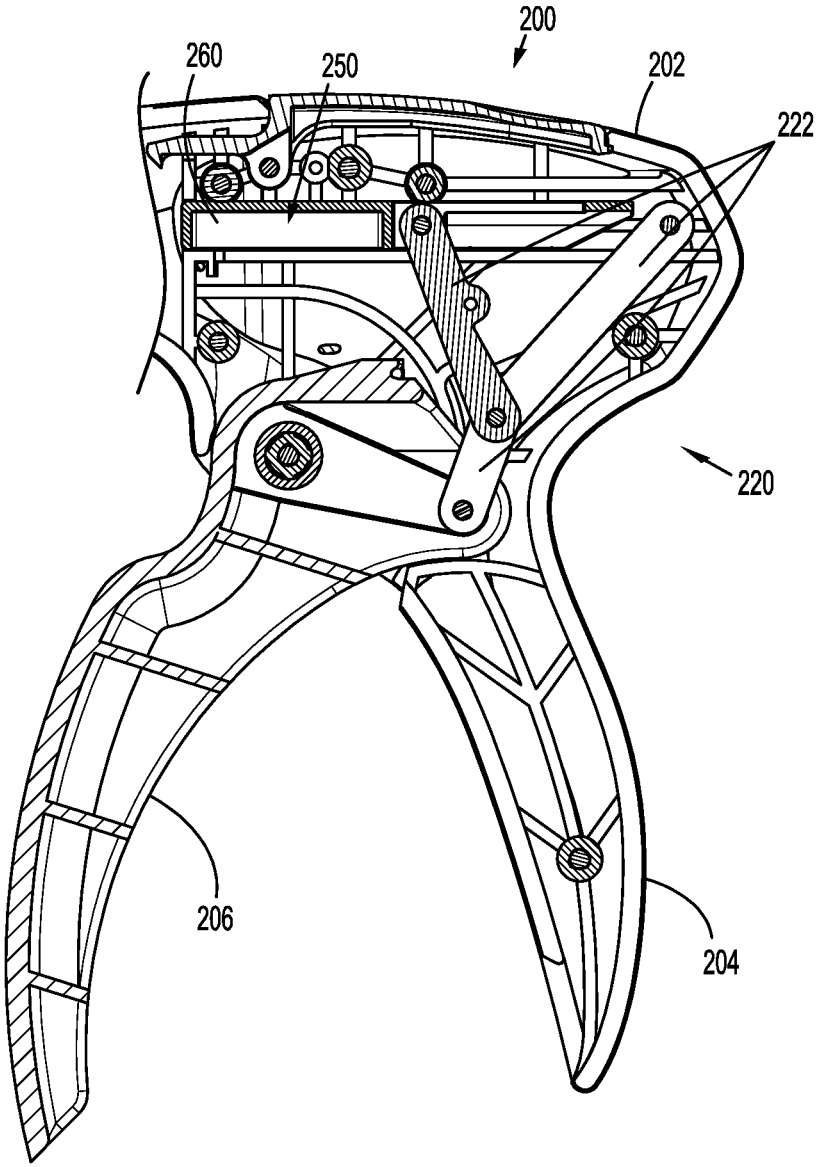


FIG. 2

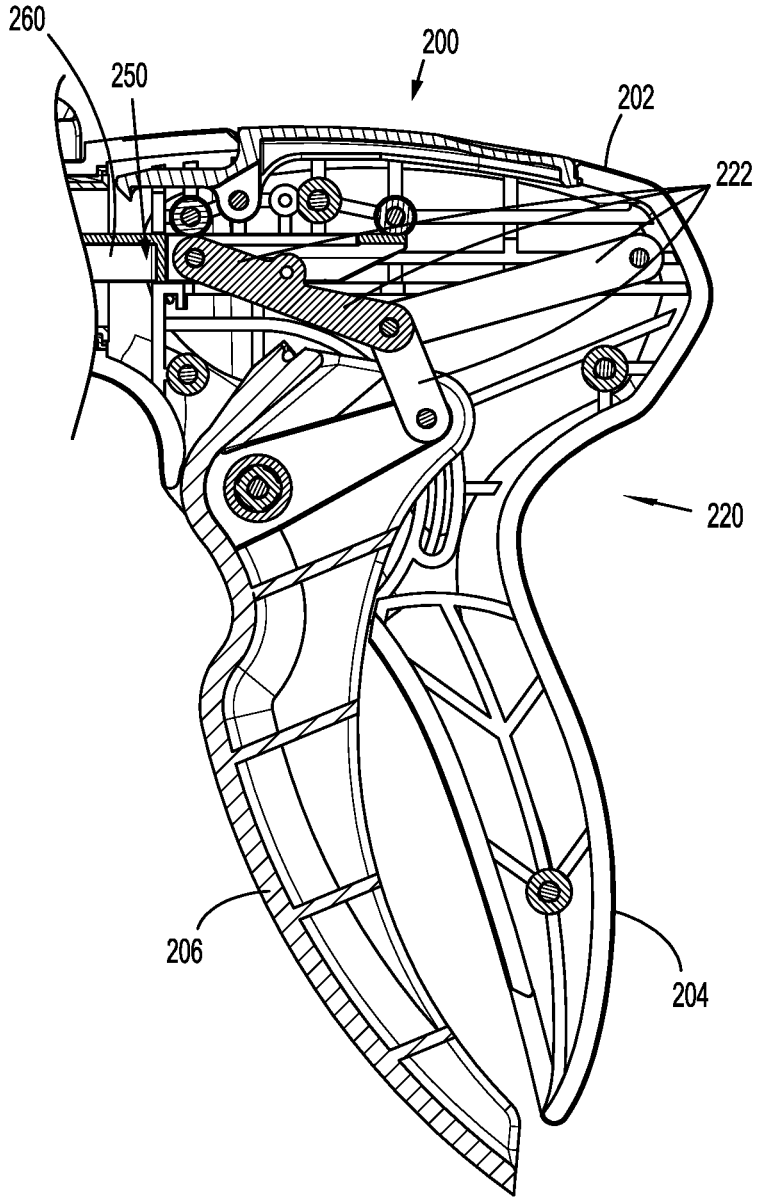


FIG. 3

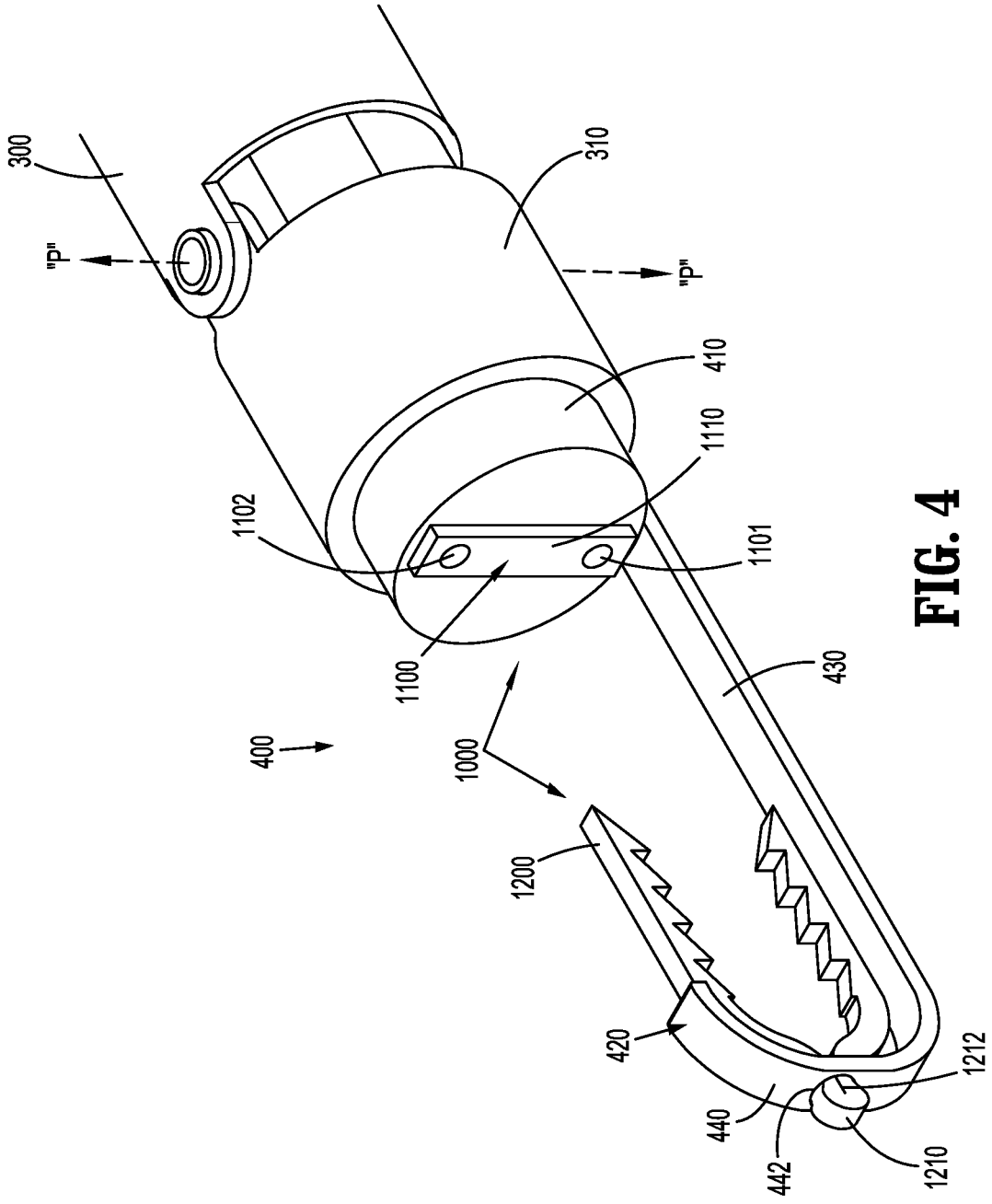
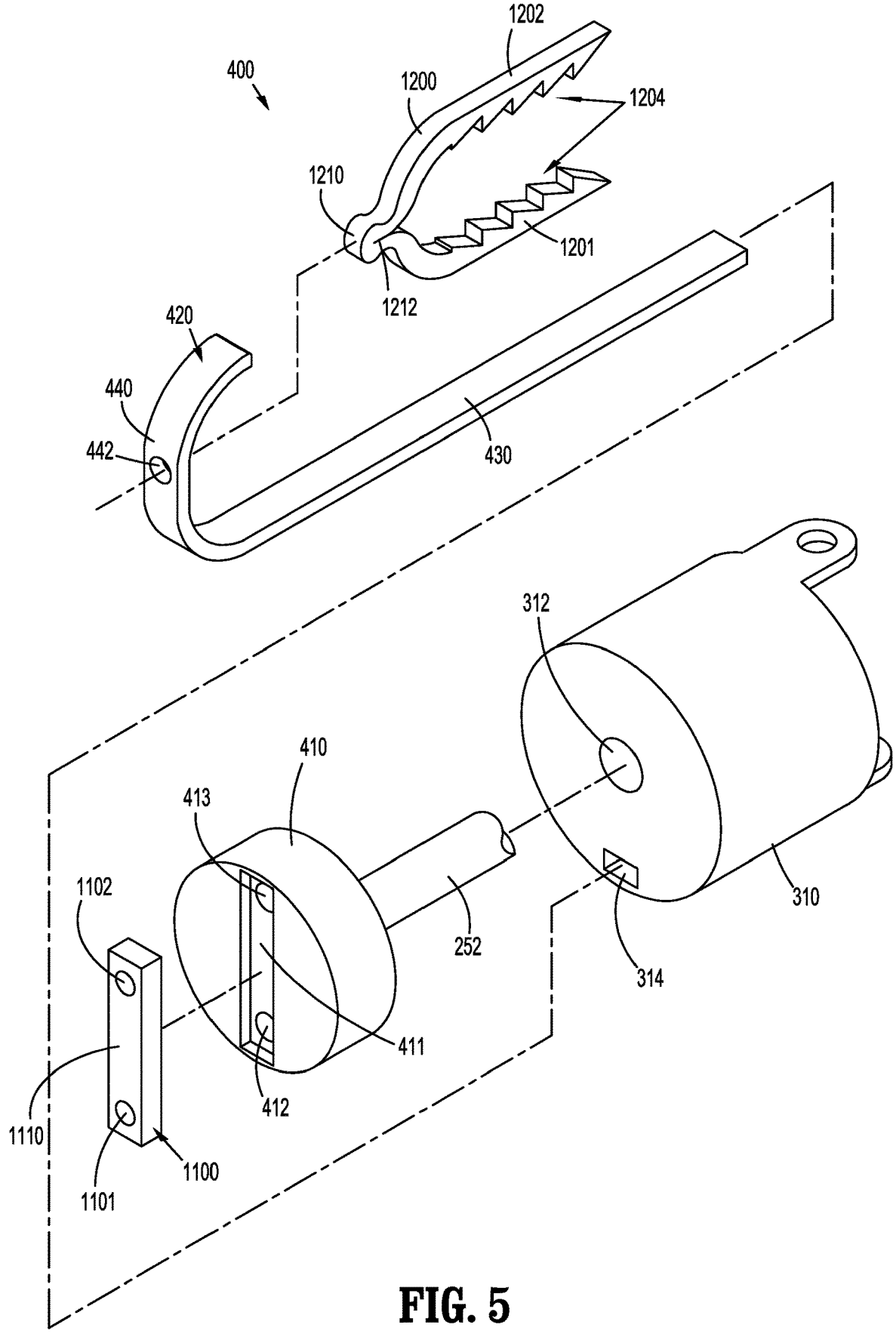

300
310
"P"
"P"
410
1110
1102
1101
1100
400
1000
430
1200
420
1212
440
442
1210

FIG. 4


400
1202
1200
1204
1210
1201
1212
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442
430
312
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413
1102
252
310
314
411
412
1110
1100
1101

FIG. 5

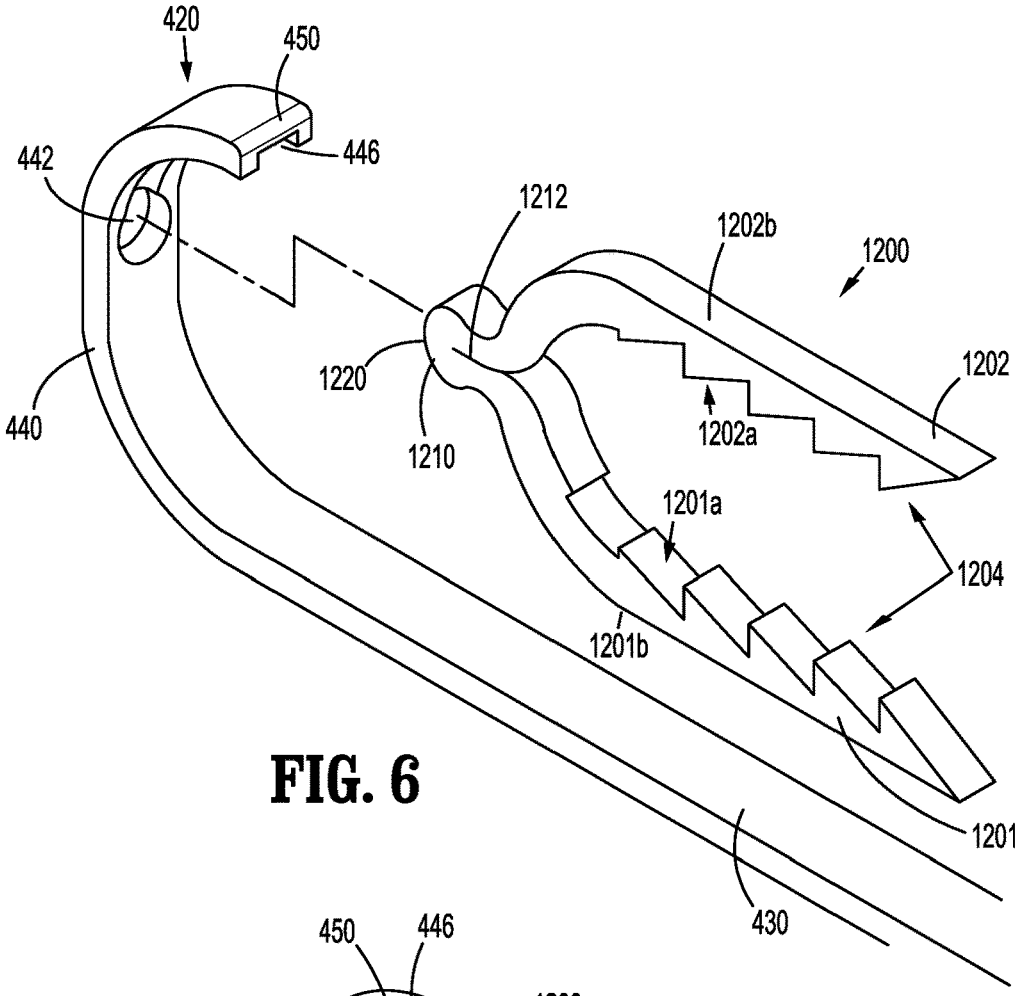
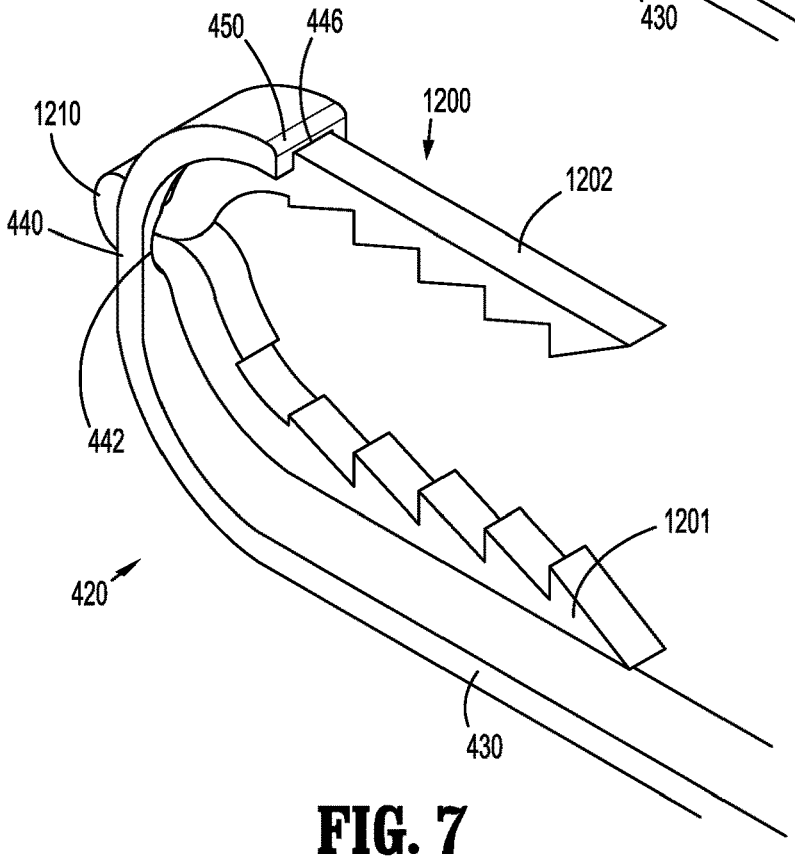

420
450
442
446
1212
1202b
1200
1220
1202
440
1210
1202a
1201a
1204
1201b
1201
430

FIG. 6


450
446
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1200
1202
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442
1201
420
430

FIG. 7

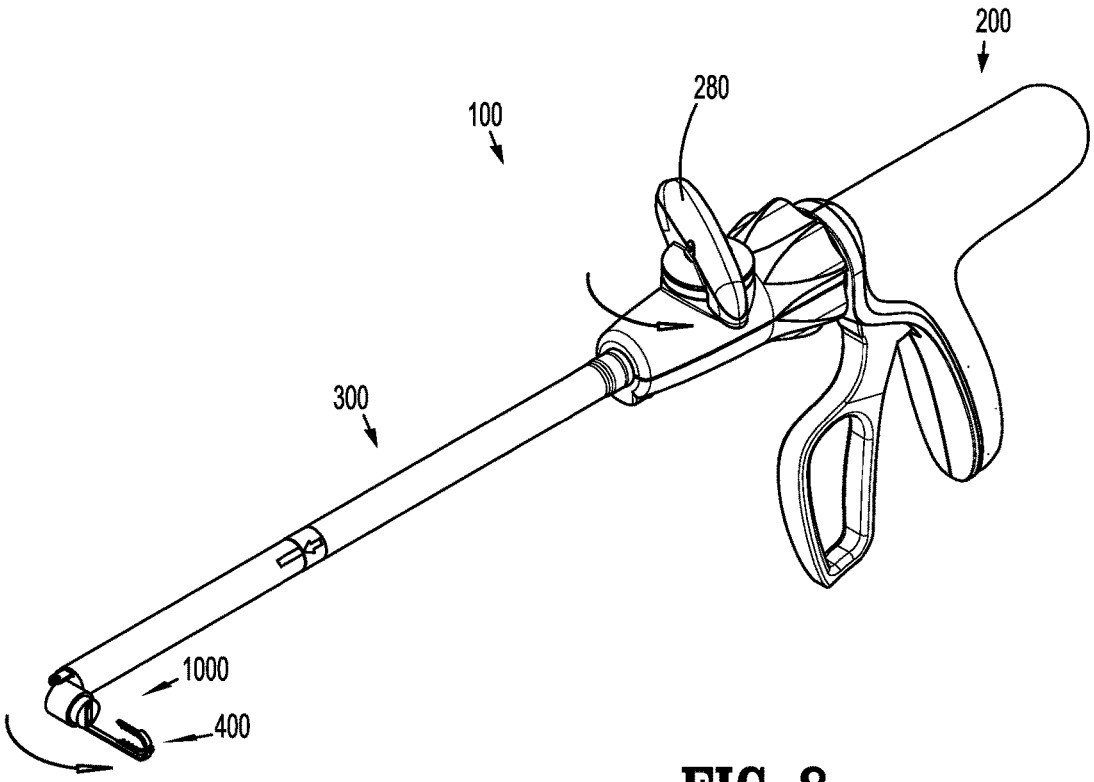


FIG. 8

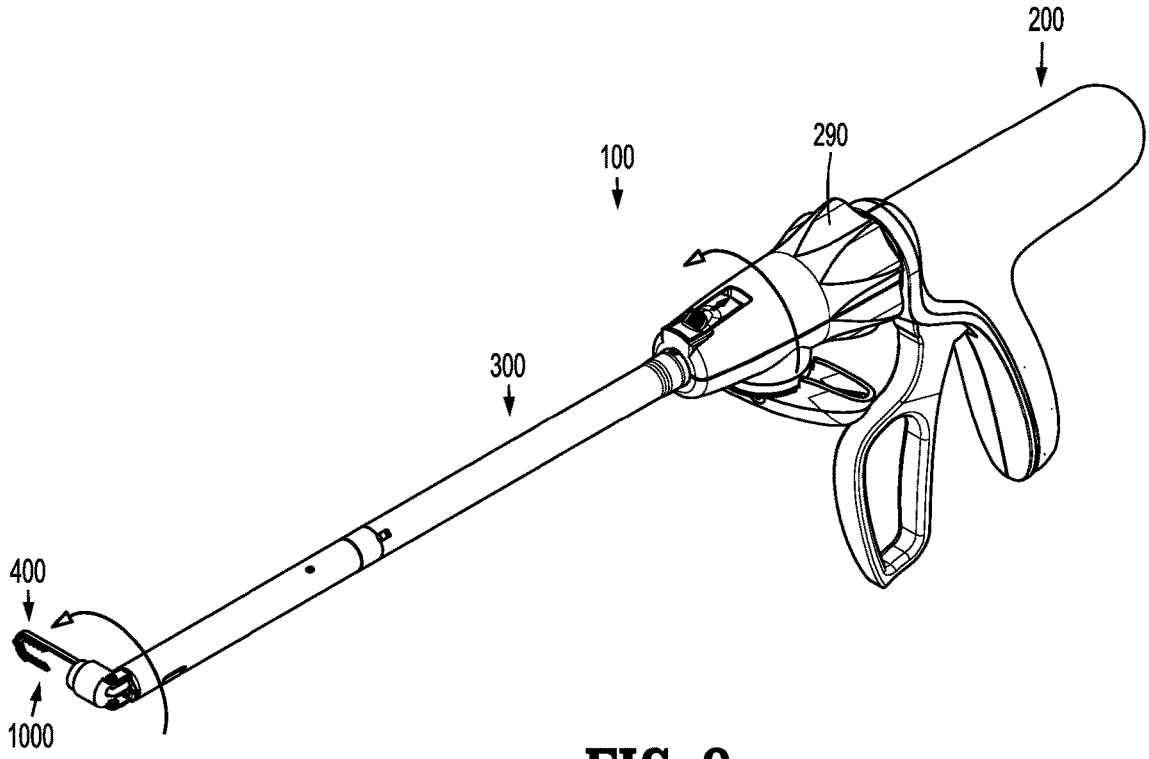
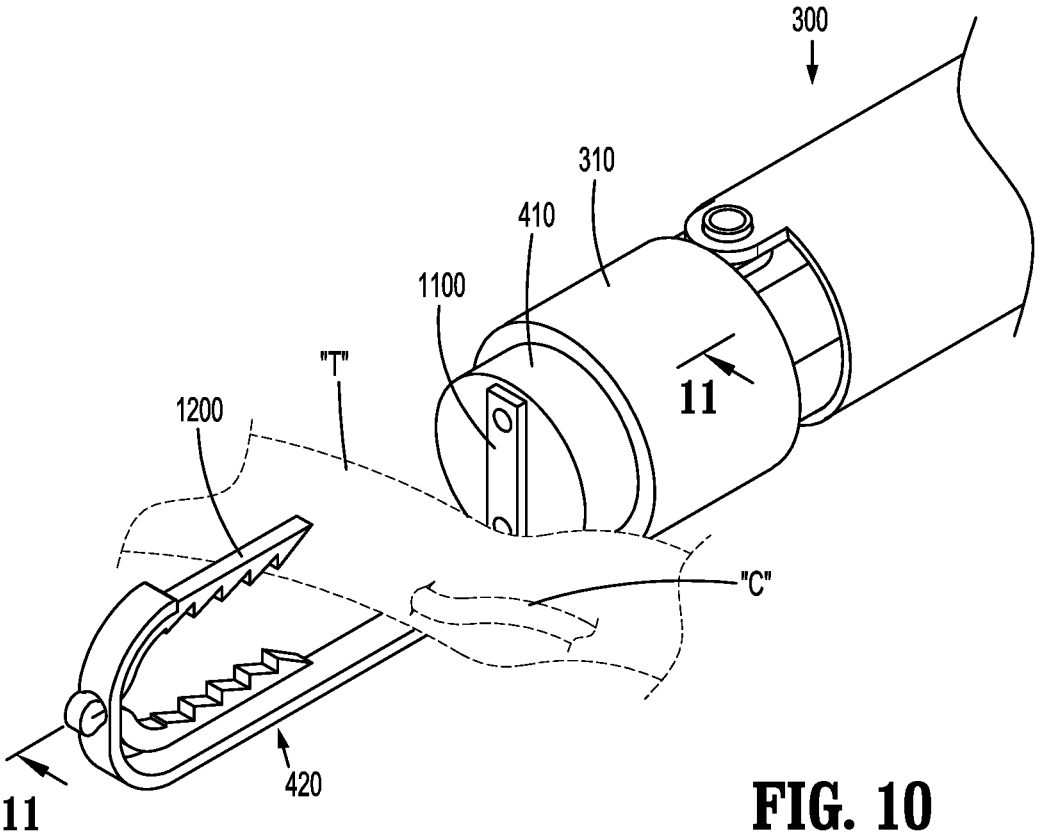


FIG. 9


300
310
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"T"
1200
11
"C"
420
11

FIG. 10

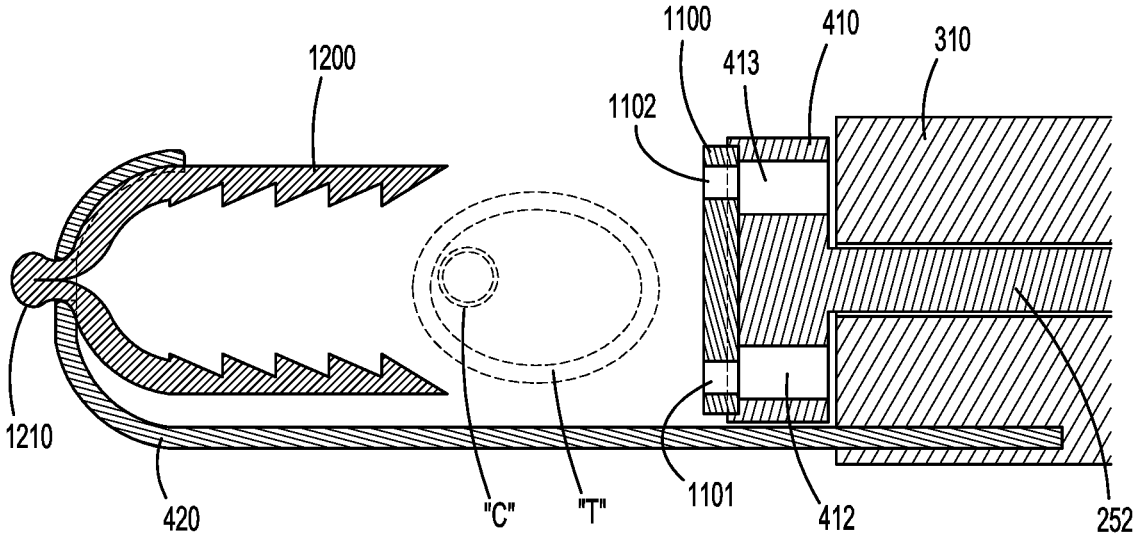
1100
410
310
413
1200
1102
1210
420
"C"
"T"
1101
412
252

FIG. 11

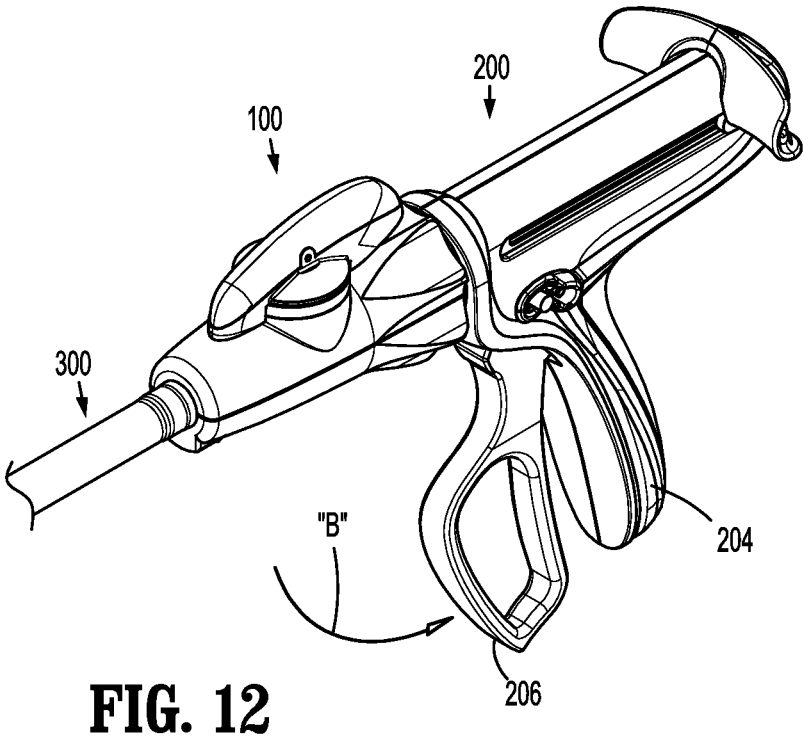
200
100
300
"B"
204
206

FIG. 12

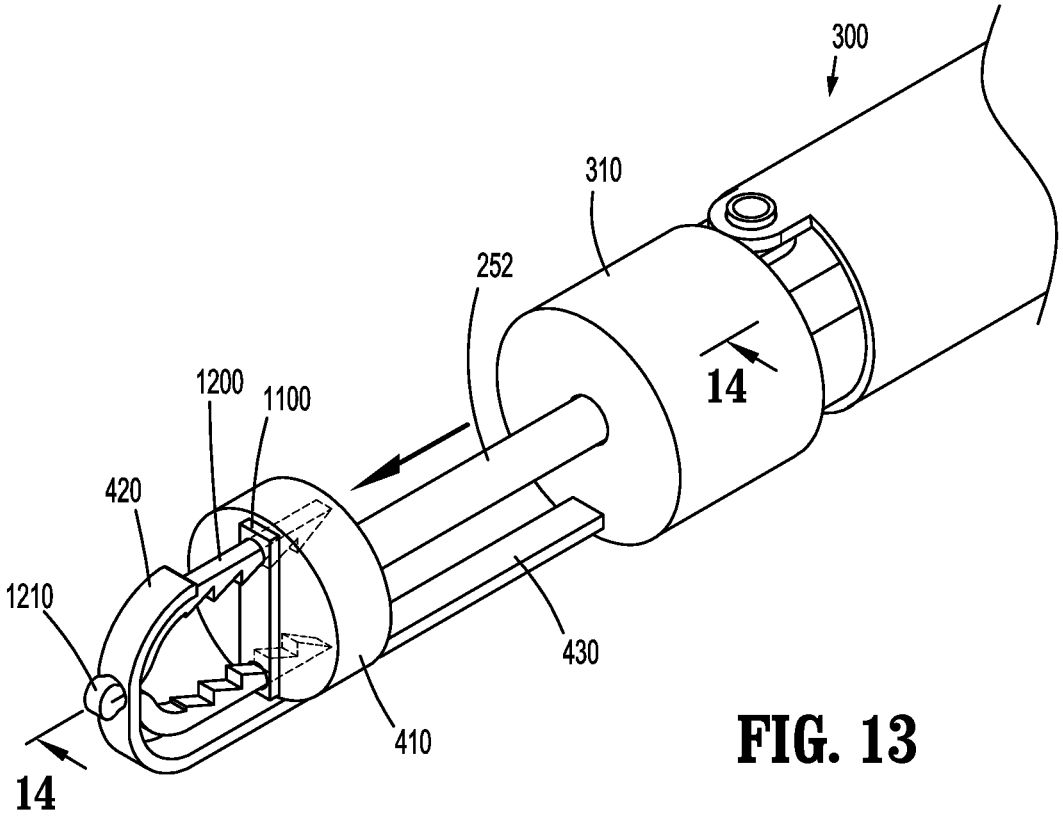
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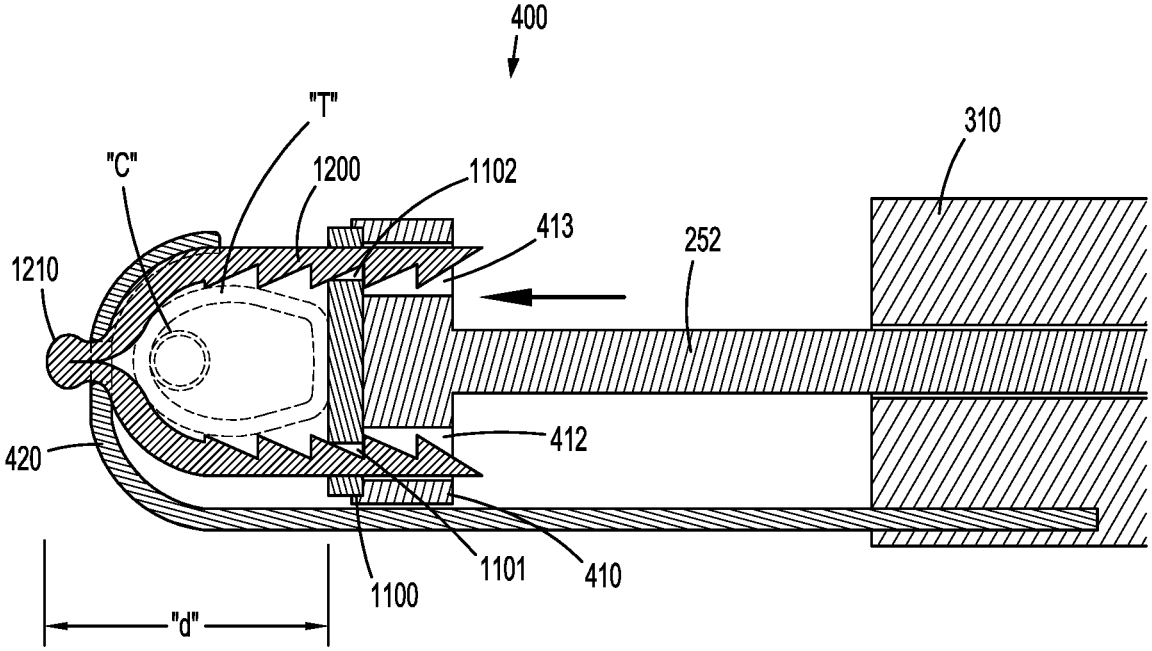
FIG. 13


400
"T"
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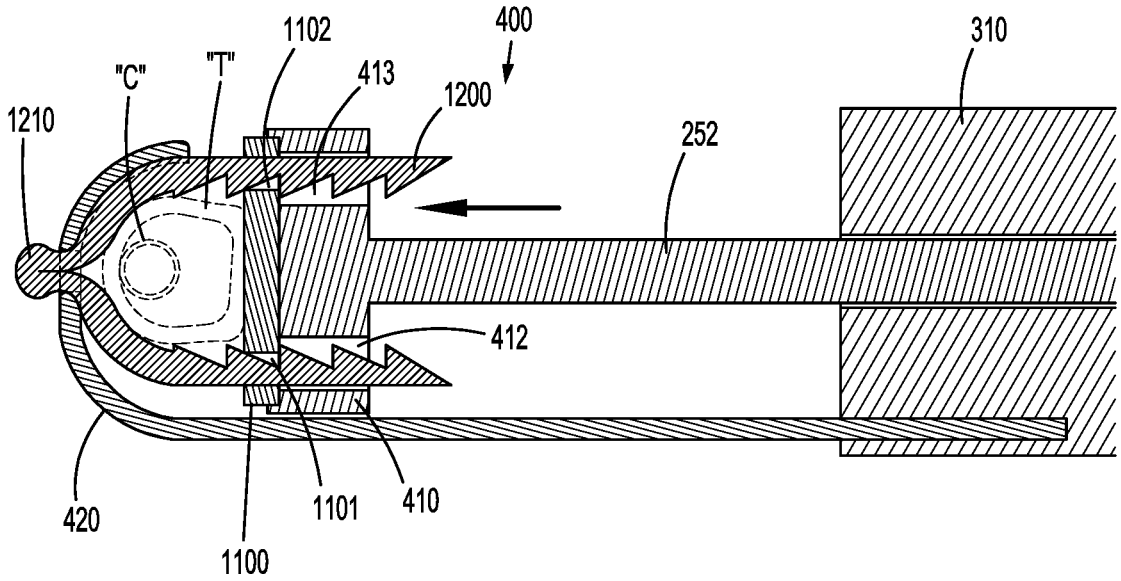
"d"

FIG. 14


1102
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"C"
"T"
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FIG. 15

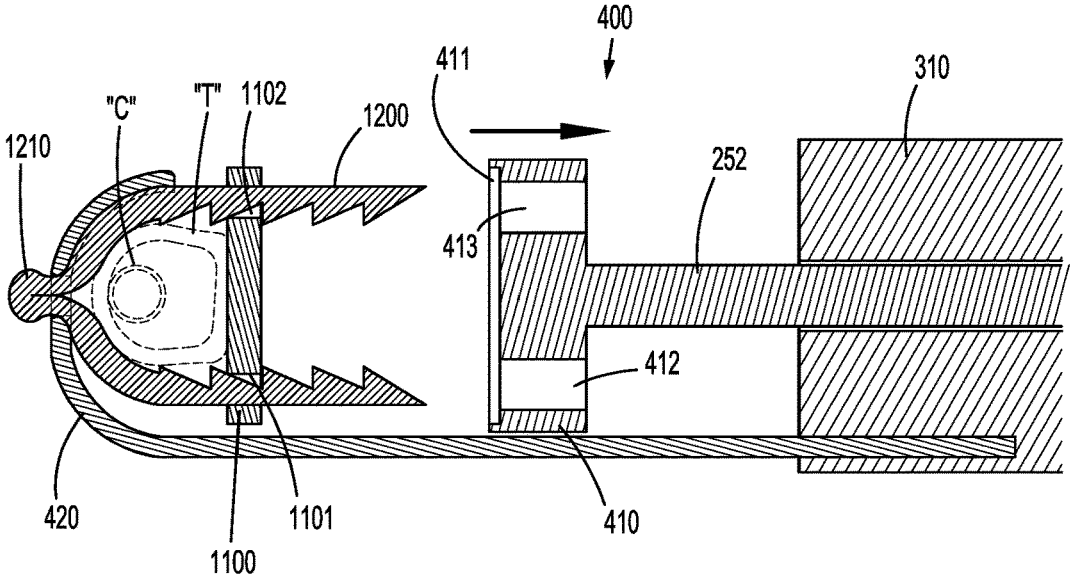

FIG. 16

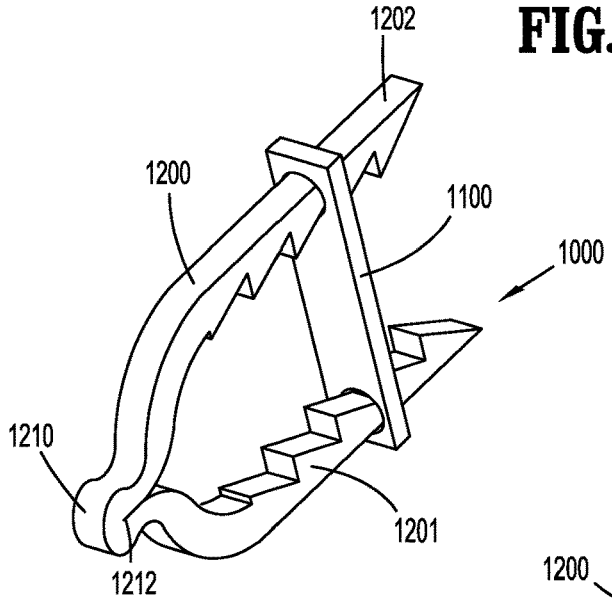

FIG. 17

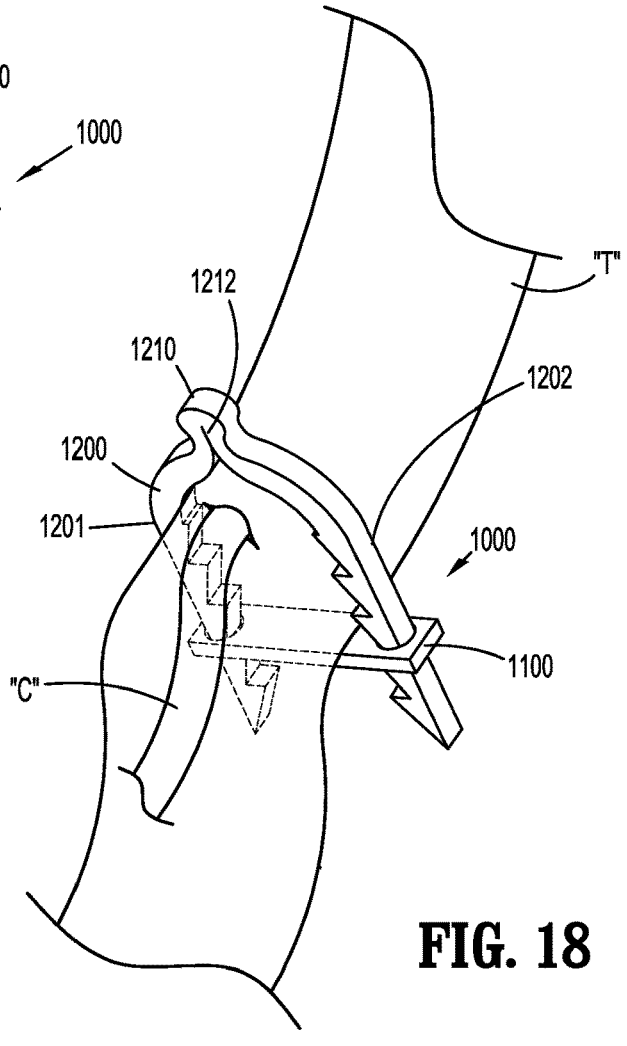

FIG. 18

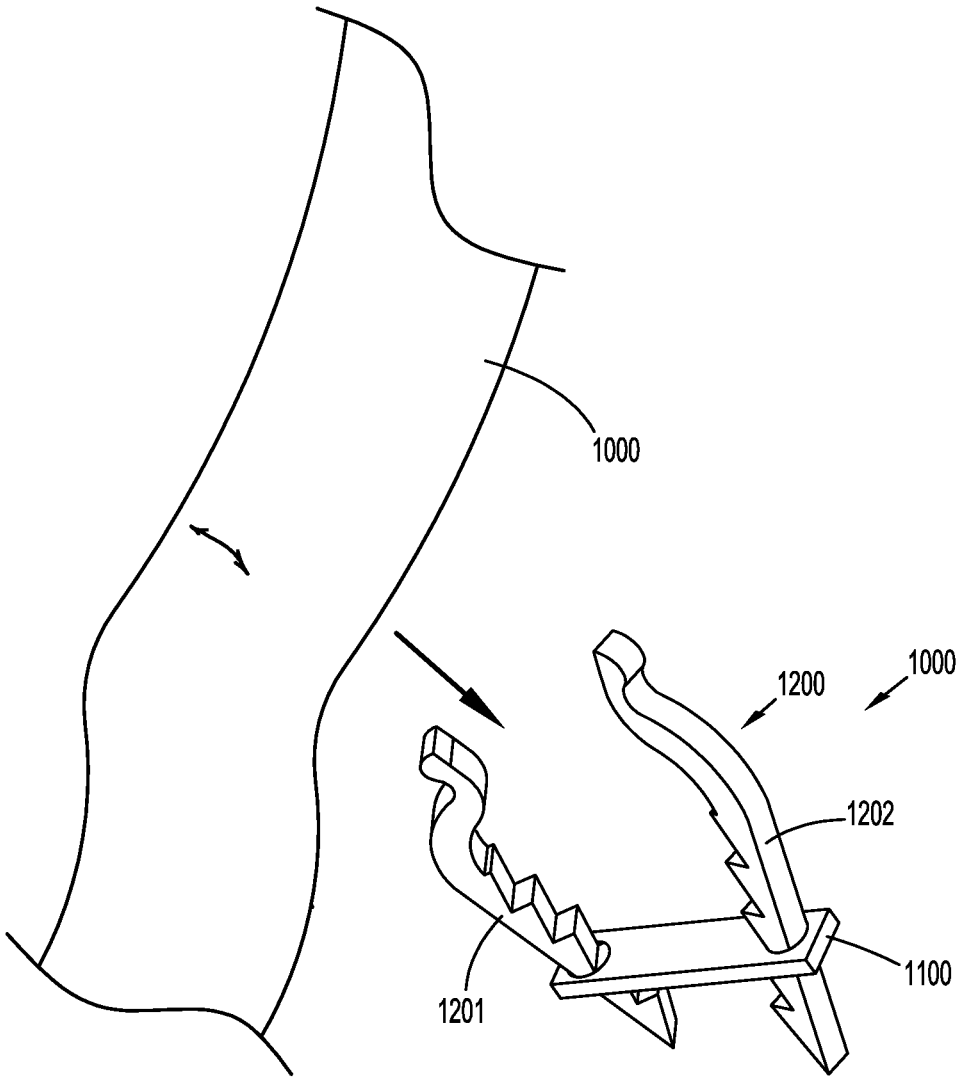

FIG. 19

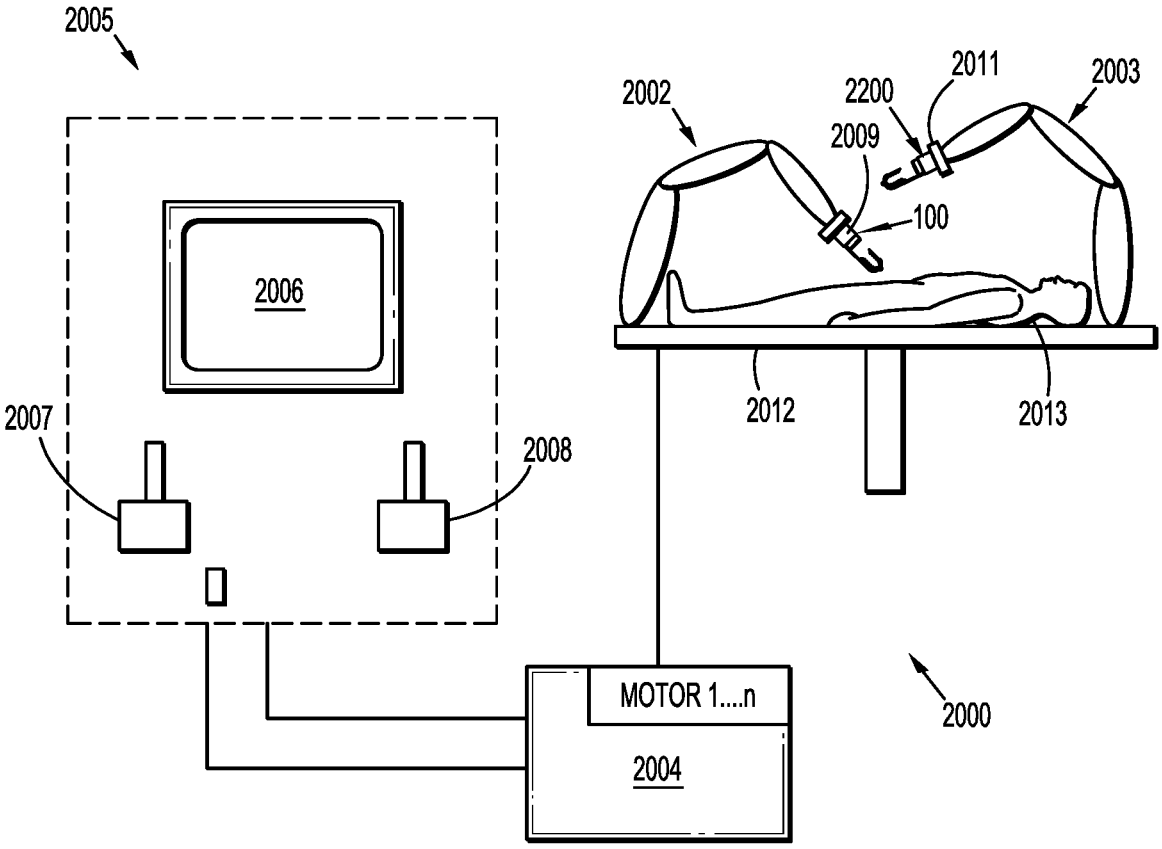
2005
2002
2200
2011
2003
2009
100
2006
2007
2008
2012
2013
MOTOR 1....n
2004
2000

FIG. 20

TWO-PART FASTENERS FOR SURGICAL CLIP APPLIERS AND SURGICAL CLIP APPLIERS FOR DEPLOYING THE SAME

BACKGROUND

[0001] This disclosure relates to surgical instruments and to fasteners for use with surgical instruments. More particularly, this disclosure relates to two-part surgical clips and surgical clip appliers for deploying the same.

[0002] Surgical clip appliers are known in the art and are used for a number of distinct and useful surgical procedures including endoscopic, open, and robotic surgical procedures. Surgical clip appliers having various sizes (e.g., diameters) are configured to apply a variety of diverse surgical clips, and are capable of applying a single or multiple surgical clips within the body cavity. Such surgical clips are typically fabricated from a biocompatible material and are usually compressed over tissue. Once applied to tissue, the compressed surgical clip terminates the flow of fluid through the tissue.

[0003] Certain surgical procedures or situations may benefit from the implementation of a partially-formed surgical clip to crimp a vessel, or to retain a catheter in a vessel without occluding the vessel (e.g., during cholangiograms), for instance.

SUMMARY

[0004] This disclosure relates to a surgical clip applier including an elongated portion, a drive shaft, and an end effector. The elongated portion defines a longitudinal axis and includes a distal end. The drive shaft extends at least partially through the elongated portion. The end effector is disposed adjacent the distal end of the elongated portion, and includes a collar and a distal housing. The collar is coupled to the drive shaft and is movable relative to the distal housing. The collar is configured to support a base of a two-part fastener. The distal housing includes a leg and a C-shaped portion extending from a distal end of the leg. The C-shaped portion of the distal housing is configured to support a clip of the two-part fastener.

[0005] In disclosed embodiments, a distal-most end of the C-shaped portion of the distal housing defines an aperture. In embodiments, the C-shaped portion of the distal housing defines a slot extending laterally from the aperture. The slot is configured to support a portion of the clip of the two-part fastener.

[0006] In disclosed embodiments, the distal housing is fixed from longitudinal movement relative to the elongated portion.

[0007] In disclosed embodiments, the collar of the end effector defines a recess for accepting the base of the two-part fastener partially in the recess.

[0008] In disclosed embodiments, the collar of the end effector defines a first leg aperture and a second leg aperture. The first leg aperture is configured to allow a first leg of the clip of the two-part fastener to extend through the collar. The second leg aperture is configured to allow a second leg of the clip of the two-part fastener to extend through the collar. In embodiments, the first leg aperture and the second leg aperture are defined within a recess of the collar.

[0009] This disclosure also relates to a surgical clip-applying system including a surgical clip applier and a two-part fastener. The surgical clip applier includes an elongated portion defining a longitudinal axis and including a distal end. The end effector is disposed adjacent the distal end of the elongated portion, and includes a collar and a distal housing. At least one of the collar or the distal housing is movable along the longitudinal axis relative to the elongated portion. The two-part fastener includes a base and a clip. The base is configured to be supported by the collar of the end effector of the surgical clip applier. The clip is configured to be supported by the distal housing of the end effector of the surgical clip applier, and includes a first leg and a second leg. A predetermined amount movement of at least one of the collar or the distal housing relative to the elongated portion causes the base of the two-part fastener to engage the clip of the two-part fastener.

[0010] In disclosed embodiments, the distal housing of the end effector includes a C-shaped portion.

[0011] In disclosed embodiments, the base of the two-part fastener defines a first aperture and a second aperture. In embodiments, the clip of the two-part fastener is C-shaped and includes a first leg and a second leg. The first leg is configured to selectively extend through the first aperture of the base of the two-part fastener, and the second leg configured to selectively extend through the second aperture of the base of the two-part fastener. In embodiments, each of the first leg and the second leg of the clip of the two-part fastener includes a plurality of teeth configured to engage the base of the two-part fastener in a ratcheting manner.

[0012] In disclosed embodiments, a distal-most end of the distal housing of the end effector defines an aperture. In embodiments, a distal end of the clip of the two-part fastener includes a distal tip configured to selectively extend through the aperture of the distal housing of the end effector. In embodiments, the distal tip of the clip of the two-part fastener defines a slit extending generally parallel to the first leg of the clip of the two-part fastener. In embodiments, when the distal tip of the clip of the two-part fastener is extended through the aperture of the distal housing of the end effector, the slit of the distal tip extends distally beyond the distal-most end of the distal housing of the end effector.

[0013] In disclosed embodiments, the base of the two-part fastener is supported partially within a recess of the collar of the end effector.

[0014] In disclosed embodiments, the collar of the end effector defines a first aperture and a second aperture, and the base of the two-part fastener defines a first aperture and a second aperture. In embodiments, after a predetermined amount of movement of the at least one of the collar or the distal housing relative to the elongated portion, the first leg of the clip of the two-part fastener extends through the first aperture of the collar and through the first aperture of the base of the two-part fastener, and the second leg of the clip of the two-part fastener extends through the second aperture of the collar and through the second aperture of the base of the two-part fastener.

[0015] This disclosure also relates to a two-part fastener for use with a surgical clip applier. The two-part fastener includes a base and a clip. The base includes a rectangular portion, a first aperture extending through the rectangular portion, and a second aperture extending through the rectangular portion. The clip includes a first leg, a second leg, and a distal tip interconnecting the first leg and the second leg. The first leg includes a plurality of teeth and is configured to selectively extend at least partially through the first aperture of the base. The second leg includes a plurality of

teeth and is configured to selectively extend at least partially through the second aperture of the base.

[0016] In disclosed embodiments, the first leg of the clip is generally parallel to the second leg of the clip.

[0017] In disclosed embodiments, at least a portion of the distal tip is generally parallel to the first leg and the second leg. In embodiments, the distal tip defines a slit extending through a proximal portion of the distal tip.

[0018] In disclosed embodiments, the first leg of the base is configured to selectively extend completely through the first aperture of the base. In embodiments, the second leg of the base is configured to selectively extend completely through the second aperture of the base.

[0019] In disclosed embodiments, the base is configured to engage the clip in a plurality of discrete positions.

[0020] This disclosure additionally relates to a method of fixing a catheter to a vessel. The method includes positioning an end effector of a surgical clip applier adjacent the vessel such that a distal housing of the end effector is positioned distally of the vessel, and a collar of the end effector is positioned proximally of the vessel. The method also includes moving the collar of the end effector distally such that a base of a two-part fastener supported by the collar moves toward a clip of the two-part fastener supported by the distal housing of the end effector. The method also includes moving the collar of the end effector distally such that a first aperture of the base of the two-part fastener engages a first leg of the clip of the two-part fastener and a second aperture of the base engages a second leg of the clip. The method also includes moving the collar of the end effector distally such that the base of the two-part fastener is in a desired discrete position relative to the clip of the two-part fastener such that the catheter is sufficiently fixed to the vessel and such that the vessel is not occluded.

[0021] In disclosed embodiments, moving the collar of the end effector distally until the base of the two-part fastener is in a desired discrete position relative to the clip of the two-part fastener includes moving the collar from a first discrete position to a second discrete position.

[0022] In disclosed embodiments, the method also includes moving the collar of the end effector distally such that the first leg of the clip of the two-part fastener extends through a first aperture of the collar, and such that the second leg of the clip of the two-part fastener extends through a second aperture of the collar.

[0023] In disclosed embodiments, the method also includes moving the collar proximally relative to the base of the two-part fastener. In embodiments, the method also includes moving the distal housing of the end effector distally relative to the clip of the two-part fastener such that a distal tip of the clip moves through an aperture of the distal housing. In embodiments, moving the distal housing of the end effector distally relative to the clip of the two-part fastener is performed after moving the collar proximally relative to the base of the two-part fastener. In embodiments, the method also includes cutting the distal tip of the clip of the two-part fastener to separate the first leg from the second leg of the clip of the two-part fastener.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] Embodiments of the disclosure are described in detail with reference to the drawing figures wherein like reference numerals identify similar or identical structural elements and:

[0025] FIG. **1** is a front, perspective view of an endoscopic surgical clip applier illustrating an end effector in an open position and supporting a two-part fastener, in accordance with embodiments of the disclosure;

[0026] FIG. **2** is a side view of a handle assembly of the surgical clip applier of FIG. **1**, with portions removed, and illustrating a trigger of the surgical clip applier disposed in an un-actuated position;

[0027] FIG. **3** is a side view of the handle assembly of the surgical clip applier of FIG. **1**, with portions removed, and illustrating the trigger in an actuated position;

[0028] FIG. **4** is an enlarged view of the area of detail indicated in FIG. **1** illustrating a distal end of the surgical clip applier supporting the two-part fastener;

[0029] FIG. **5** is a perspective, exploded view of the distal end of the surgical clip applier and two-part fastener of FIG. **1**;

[0030] FIG. **6** is a perspective, exploded view of a portion of the two-part fastener and a portion of the end effector of the surgical clip applier of FIG. **1**;

[0031] FIG. **7** is a perspective view of a portion of the two-part fastener engaged with a portion of the end effector of the surgical clip applier of FIG. **1**;

[0032] FIGS. **8** and **9** are perspective views of the surgical clip applier of FIG. **1** illustrating the end effector in various positions relative to an elongated portion of the surgical clip applier;

[0033] FIG. **10** is a perspective view of the two-part fastener engaged with the end effector of the surgical clip applier of FIG. **1** illustrating tissue and a catheter positioned between the two parts of the two-part fastener;

[0034] FIG. **11** is a cross-sectional view of the two-part fastener, end effector of the surgical clip applier, tissue and a catheter taken along line **11-11** in FIG. **10**;

[0035] FIG. **12** is a perspective view of a proximal portion of the surgical clip applier of FIG. **1** illustrating a pivotable handle in a partially-actuated position;

[0036] FIG. **13** is a perspective view of a distal portion of the surgical clip applier of FIG. **1** corresponding to the pivotable handle being in the partially-actuated position of FIG. **12**;

[0037] FIG. **14** is a cross-sectional view of the two-part fastener and end effector of the surgical clip applier taken along line **14-14** in FIG. **13**, and further illustrating tissue and the catheter positioned between the two parts of the two-part fastener;

[0038] FIG. **15** is a cross-sectional view of the two-part fastener, end effector of the surgical clip applier of FIG. **1**, tissue and the catheter positioned between the two parts of the two-part fastener, and corresponding to the pivotable handle of the surgical clip applier being in a further-actuated position;

[0039] FIG. **16** is a cross-sectional view of the two-part fastener, end effector of the surgical clip applier of FIG. **1**, tissue and the catheter secured between the two parts of the two-part fastener, following retraction of a collar of the surgical clip applier;

[0040] FIG. **17** is a perspective view of the two-part fastener of FIG. **1** illustrated in an engaged orientation;

[0041] FIG. **18** is a perspective view of the two-part fastener of FIG. **1** illustrated in an engaged orientation and surrounding tissue and the catheter;

[0042] FIG. **19** is a perspective view of the two-part fastener of FIG. **1** after the two-part fastener has been cut and released from tissue and the catheter; and

[0043] FIG. **20** is a schematic illustration of a robotic surgical system configured for use in accordance with the disclosure.

DETAILED DESCRIPTION

[0044] Embodiments of the disclosed surgical clip applier and two-part fastener are described in detail with reference to the drawings, in which like reference numerals designate identical or corresponding elements in each of the several views. Non-limiting examples of surgical clip appliers according to the disclosure include manual, robotic, mechanical and/or electromechanical, and the like. As used herein the term "distal" refers to that portion of the two-part fastener, surgical clip applier, or component thereof, farther from the user, while the term "proximal" refers to that portion of the two-part fastener, surgical clip applier, or component thereof, closer to the user.

[0045] As will be described in greater detail below, the disclosure includes a two-part fastener, and a surgical clip applier for utilizing the two-part fastener to fix a catheter to a vessel. Related methods of use are also encompassed by this disclosure.

[0046] FIGS. **1-20** illustrate surgical clip appliers and two-part fasteners in accordance with embodiments of the disclosure. While the figures illustrate an endoscopic surgical clip applier (e.g., FIG. **1**), and a robotic surgical clip applier (FIG. **20**), other types of surgical clip appliers (e.g., open surgical clip appliers) are encompassed by the scope of the present disclosure and are usable with the disclosed two-part fasteners. For simplicity, each of the disclosed surgical clip appliers is generally referred to as surgical clip applier **100**.

[0047] With initial reference to FIG. **1**, the surgical clip applier **100** includes a handle assembly **200**, an endoscopic or elongated portion **300** extending distally from the handle assembly **200** and defining a longitudinal axis "A-A," and an end effector **400** disposed adjacent a distal end of the elongated portion **300**. A two-part fastener **1000** is supported by the end effector **400**. Additionally, an actuation assembly **220** (FIGS. **2-3**) and a drive assembly **250** (FIGS. **2-3**) are disposed in mechanical cooperation with the handle assembly **200** and are configured to distally advance one part of the two-part fastener **1000**.

[0048] While details of a particular handle assembly **200**, a particular actuation assembly **220**, and a particular drive assembly **250** are discussed below, the disclosed surgical clip applier **100** is usable with other types of handle assemblies, actuation assemblies, and drive assemblies without departing from the scope of the disclosure.

[0049] Referring now to FIGS. **1-5**, further details of the handle assembly **200**, the actuation assembly **220**, the drive assembly **250**, and the distal portion of the surgical clip applier **100** are shown. The handle assembly **200** includes a handle housing **202**, a stationary handle **204**, and a pivotable handle **206**. The actuation assembly **220** includes a plurality of linkages **222** disposed in operative engagement with the pivotable handle **206**. The drive assembly **250** includes a drive shaft **252** (FIG. **5**). Generally, actuation of the pivotable handle **206** causes the drive shaft **252** to move distally, which in turn, causes formation of the two-part fastener **1000**. Further details of suitable drive assemblies and actuation assemblies are described in pending U.S. patent application Ser. No. 17/572,669, filed on Jan. 11, 2022, and U.S. Pat. No. 11,246,601, the entire contents of each of which are incorporated by reference herein.

[0050] With particular reference to FIGS. **4** and **5**, the end effector **400** includes a collar **410** and a distal housing **420**, and the two-part fastener **1000** includes a first part or a base **1100** and a second part or a clip **1200**. The collar **410** of the end effector **400** supports the base **1100**, and the distal housing **420** of the end effector **400** supports the clip **1200**.

[0051] With continued reference to FIG. **4**, the collar **410** of the end effector **400** defines a recess **411**, a first aperture or first leg aperture **412**, and a second aperture or second leg aperture **413**. The recess **411** is configured to releasably receive the base **1100** of the two-part fastener **1000** at least partially therein, e.g., in a press-fit manner. The first aperture **412** and the second aperture **413** are each configured to align with a respective first aperture **1101** and a second aperture **1102** of the base **1100** of the two-part fastener **1000** when the base **1100** is engaged with the recess **411**. The first aperture **412** of the collar **410** is configured to allow at least a portion of a first leg **1201** of the clip **1200** to pass through the first aperture **412**, and the second aperture **413** of the collar **410** is configured to allow at least a portion of a second leg **1202** of the clip **1200** to pass through the second aperture **413**.

[0052] Referring now to FIGS. **4-7**, the distal housing **420** of the end effector **400** generally includes a leg **430**, and a C-shaped portion **440** extending from a distal end of the leg **430**. A distal-most end of the C-shaped portion **440** defines an aperture **442** extending therethrough. The aperture **442** is configured to allow a distal tip **1210** of the clip **1200** of the two-part fastener **1000** to extend therethrough. The C-shaped portion **440** of the distal housing **420** also defines a slot **446** extending from the aperture **442** to a cantilevered end **450** of the distal housing **420**. The slot **446** is configured to support a portion of the second leg **1202** of the clip **1200** to help stabilize the clip **1200** relative to the distal housing **420**, for instance.

[0053] With reference to FIGS. **4** and **5**, a pivotable member **310** is disposed at a distal end of the elongated portion **300**. The pivotable member **310** is pivotable relative to an intermediate portion **305** (FIG. **1**) of the elongated portion **300** about axis "P-P" in FIG. **4** to allow for articulation of the end effector **400** relative to the intermediate portion **305** of the elongated portion **300**. Pivotable member **310** includes a first aperture **312** for slidingly engaging the drive shaft **252**, and a second aperture **314** for fixedly engaging a proximal portion of the leg **430** of the distal housing **420** of the end effector **400**.

[0054] With continued reference to FIGS. **4** and **5**, a distal end of the drive shaft **252** is mechanically coupled to the collar **410**, such that distal translation of the drive shaft **252** relative to the handle assembly **200** results in a corresponding distal translation of the collar **410** relative to the distal housing **420** of the end effector **400**. As discussed in further detail below, sufficient distal translation of the collar **410** relative to the distal housing **420** causes the base **1100** of the two-part fastener **1000** to engage the clip **1200** of the two-part fastener **1000**.

[0055] With particular reference to FIGS. **4-7**, further details of the two-part fastener **1000** are described. The base **1100** of the two-part fastener **1000** is configured to engage the clip **1200** of the two-part fastener **1000** in a plurality of discrete positions. In each position of engagement, a dis-

tance "d" between the base **1100** and the distal tip **1210** of the clip **1200** is different (see FIG. **13**, for instance).

[0056] The base **1100** may include a generally rectangular body portion **1110** as shown, or body portion **1110** may be of any other suitable shape. The first aperture **1101** and the second aperture **1102** extend through the body portion **1110**. The clip **1200** is generally U-shaped and includes the first leg **1201**, and the second leg **1202**, with the distal tip **1210** interconnecting the first leg **1201** and the second leg **1202**.

[0057] Each of the first leg **1201** and the second leg **1202** includes a plurality of teeth **1204** for engaging the base **1100** in a ratcheting manner. The plurality of teeth **1204** may be defined by other shapes and other angles than those shown herein without departing from the scope of the present disclosure. Additionally, the amount or number of teeth included in the plurality of teeth **1204** may be more or fewer than the amount shown in the accompanying figures without departing from the scope of the present disclosure.

[0058] In the illustrated embodiment, an inner-facing surface **1201***a* of the first leg **1201** and an inner-facing surface **1202***a* of the second leg **1202** include the plurality of teeth **1204** (see FIG. **6**). However, it is also envisioned and within the scope of this disclosure that an outer-facing surface **1201***b* of the first leg **1201** and/or an outer-facing surface **1202***b* of the second leg **1202** includes the plurality of teeth **1204**.

[0059] As shown in FIGS. **4-6**, for example, the distal tip **1210** of the clip **1200** protrudes distally from distal ends of the first leg **1201** and the second leg **1202**, and generally extends parallel to the longitudinal axis "A-A." As noted above, at least a portion of the distal tip **1210** is configured to extend through the aperture **442** defined within the C-shaped portion **440** of the distal housing **420** of the end effector **400**. Additionally, a slit **1212** extends longitudinally through a portion of the distal tip **1210**. As shown in FIG. **4**, the slit **1212** extends distally beyond the distal housing **420** of the end effector **400** when the clip **1200** is engaged with the distal housing **420**. Further, the slit **1212** does not extend to a distal-most end **1220** of the clip **1200** (FIG. **6**). In use, as discussed in further detail below, when a user wants to remove the two-part fastener **1000** from securement on tissue, for instance, the user can cut the distal tip **1210** of the clip **1200** (e.g., from a location at or adjacent the distal-most end **1220** of the clip **1200** to the slit **1212**) to separate the first leg **1201** of the clip **1200** from the second leg **1202** of the clip **1200**, thereby facilitating removal of the two-part fastener **1000** from tissue.

[0060] Referring now to FIGS. **8-19**, when a user desires to place the two-part fastener **1000** onto a vessel or tissue "T" and/or a catheter "C," for instance, (e.g., to variably occlude a vessel, or to retain a catheter in a vessel without occluding the vessel such as during cholangiograms), the user initially engages the base **1100** of the two-part fastener **1000** with the collar **410** of the end effector **400**, and engages the clip **1200** of the two-part fastener **1000** with the distal housing **420** of the end effector **400**. Alternatively, the user ensures the two-part fastener **1000** is properly engaged with the end effector **400**. Next, the user can position the end effector **400** at a desired location by articulating the end effector **400** by actuating an articulation knob **280** (FIG. **8**) and/or by rotating the end effector **400** by actuating a rotation knob **290** (FIG. **9**), for instance.

[0061] After the end effector **400** is in its desired position (e.g., FIG. **10**), the collar **410** of the end effector **400** is moved distally relative to the distal housing **420** of the end effector **400** by actuating the pivotable handle **206** in the general direction of arrow "B" (FIG. **12**), or another actuation mechanism, thereby advancing the drive shaft **252** distally, which moves the base **1100** toward the clip **1200** of the two-part fastener **1000**. (Other structures for moving the collar **410** relative to the distal housing **420**, such as depressing a button, are also envisioned.) When the base **1100** moves a sufficient distance relative to the clip **1200**, the first aperture **1101** of the base **1100** surrounds or engages a proximal portion of the first leg **1201** of the clip **1200**, and the second aperture **1102** of the base **1100** surrounds or engages a proximal portion of the second leg **1202** of the clip **1200**.

[0062] With reference to FIGS. **13-15**, the collar **410** of the end effector **400** is moved closer to the distal housing **420** until a desired compression or degree of crimp of the tissue "T" and/or the catheter "C" between the base **1100** and the clip **1200** of the two-part fastener **1000** is achieved. FIG. **14** illustrates the base **1100** in a first discrete position relative to the clip **1200**, and FIG. **15** illustrates the base **1100** in a second discrete position relative to the clip **1200**. There are several discrete positions of the base **1100** relative to the clip **1200** that allow the catheter "C" to be fixed to the tissue "T" without occluding the vessel.

[0063] Referring now to FIG. **16**, after the two-part fastener **1000** is desirably placed on the tissue "T" and/or the catheter "C," the drive shaft **252** is moved proximally (e.g., by moving the pivotable handle **206** away from the stationary handle **204**), thereby retracting the collar **410** of the end effector **400** relative to the distal housing **420**. As shown, the base **1100** remains engaged with the clip **1200** of the two-part fastener **1000**. Additionally, moving the surgical clip applier **100** distally relative to the tissue "T" causes the distal housing **420** of the end effector **400** to move out of engagement with the distal tip **1210** of the clip **1200** of the two-part fastener **1000**, thereby leaving the two-part fastener **1000** secured to the tissue "T" and/or the catheter "C" (FIG. **18**).

[0064] After the surgical clip applier **100** is removed, a surgical procedure, such as a cholangiogram, may be performed. When the surgical procedure is complete, for instance, the two-part fastener **1000** may be removed from the tissue "T" and/or the catheter "C." To remove the two-part fastener **1000**, the user may cut or sufficiently clamp the distal tip **1210** of the clip **1200**, e.g., adjacent the slit **1212**, to separate the first leg **1201** of the clip **1200** from the second leg **1202** of the clip **1200** (see FIG. **19**). After the first leg **1201** of the clip **1200** and the second leg **1202** of the clip **1200** have been separated, the two-part fastener **1000** can easily be removed from a body cavity, for instance (e.g., using graspers).

[0065] The present disclosure also includes a surgical clip-applying system, which includes both the surgical clip applier **100** and the two-part fastener **1000**. Additionally, the present disclosure includes methods of installing and/or removing the two-part fastener **1000**, and methods of fixing a catheter to a vessel using the surgical clip applier **100** and the two-part fastener **1000**.

[0066] The various embodiments disclosed herein may also be configured to work with robotic surgical systems and what is commonly referred to as "Telesurgery." Such systems employ various robotic elements to assist the surgeon in the operating theater and allow remote operation (or

partial remote operation) of surgical instrumentation. Various robotic arms, gears, cams, pulleys, electric and mechanical motors, etc. may be employed for this purpose and may be designed with a robotic surgical system to assist the surgeon during the course of an operation or treatment. Such robotic systems may include, remotely steerable systems, automatically flexible surgical systems, remotely flexible surgical systems, remotely articulating surgical systems, wireless surgical systems, modular or selectively configurable remotely operated surgical systems, etc.

[0067] The robotic surgical systems may be employed with one or more consoles that are next to the operating theater or located in a remote location. In this instance, one team of surgeons or nurses may prepare the patient for surgery and configure the robotic surgical system with one or more of the instruments disclosed herein while another surgeon (or group of surgeons) remotely control the instruments via the robotic surgical system. As can be appreciated, a highly skilled surgeon may perform multiple operations in multiple locations without leaving his/her remote console which can be both economically advantageous and a benefit to the patient or a series of patients.

[0068] The robotic arms of the surgical system are typically coupled to a pair of master handles by a controller. The handles can be moved by the surgeon to produce a corresponding movement of the working ends of any type of surgical instrument (e.g., end effectors, graspers, knifes, scissors, etc.) which may complement the use of one or more of the embodiments described herein. The movement of the master handles may be scaled so that the working ends have a corresponding movement that is different, smaller or larger, than the movement performed by the operating hands of the surgeon. The scale factor or gearing ratio may be adjustable so that the operator can control the resolution of the working ends of the surgical instrument(s).

[0069] The master handles may include various sensors to provide feedback to the surgeon relating to various tissue parameters or conditions, e.g., tissue resistance due to manipulation, cutting or otherwise treating, pressure by the instrument onto the tissue, tissue temperature, tissue impedance, etc. As can be appreciated, such sensors provide the surgeon with enhanced tactile feedback simulating actual operating conditions. The master handles may also include a variety of different actuators for delicate tissue manipulation or treatment further enhancing the surgeon's ability to mimic actual operating conditions.

[0070] With reference to FIG. **20**, a surgical system, such as, for example, a robotic surgical system is shown generally as surgical system **2000** and is usable with the surgical clip applier **100**, or portions thereof, of the disclosure. Surgical system **2000** generally includes a plurality of robotic arms **2002**, **2003**, a control device **2004**, and an operating console **2005** coupled with control device **2004**. Operating console **2005** includes a display device **2006**, which is set up in particular to display three-dimensional images; and manual input devices **2007**, **2008**, by means of which a person (not shown), for example a surgeon, is able to telemanipulate robotic arms **2002**, **2003** in a first operating mode, as known in principle to a person skilled in the art.

[0071] Each of the robotic arms **2002**, **2003** is composed of a plurality of members, which are connected through joints. System **2000** also includes an instrument drive unit **2200** connected to distal ends of each of robotic arms **2002**, **2003**. The surgical clip applier **100**, or portions thereof, may be attached to the instrument drive unit **2200**, in accordance with any one of several embodiments disclosed herein, as will be described in greater detail below.

[0072] Robotic arms **2002**, **2003** may be driven by electric drives (not shown) that are connected to control device **2004**. Control device **2004** (e.g., a computer) is set up to activate the drives, in particular by means of a computer program, in such a way that robotic arms **2002**, **2003**, their instrument drive units **2200** and thus the surgical clip applier **100** (including the end-effector **400**) execute a desired movement according to a movement defined by means of manual input devices **2007**, **2008**. Control device **2004** may also be set up in such a way that it regulates the movement of robotic arms **2002**, **2003** and/or of the drives.

[0073] Surgical system **2000** is configured for use on a patient **2013** lying on a patient table **2012** to be treated in a minimally invasive manner by means of the surgical clip applier **100**. Surgical system **2000** may also include more than two robotic arms **2002**, **2003**, the additional robotic arms likewise being connected to control device **2004** and being telemanipulatable by means of operating console **2005**.

[0074] Reference may be made to U.S. Pat. No. 8,828,023, entitled "Medical Workstation," the entire content of which is incorporated herein by reference, for a detailed discussion of the construction and operation of surgical system **2000**.

[0075] It should be understood that the foregoing description is only illustrative of the disclosure. Various alternatives and modifications can be devised by those skilled in the art without departing from the disclosure. Accordingly, this disclosure is intended to embrace all such alternatives, modifications and variances. The embodiments described with reference to the attached drawing figures are presented only to demonstrate certain examples of the disclosure. Other elements, steps, methods and techniques that are insubstantially different from those described above and/or in the appended claims are also intended to be within the scope of the disclosure.

What is claimed is:

1. A surgical clip applier, comprising:

an elongated portion defining a longitudinal axis and including a distal end;

a drive shaft extending at least partially through the elongated portion; and

an end effector disposed adjacent the distal end of the elongated portion, the end effector including a collar and a distal housing, the collar coupled to the drive shaft and movable relative to the distal housing, the collar configured to support a base of a two-part fastener, the distal housing including a leg and a C-shaped portion extending from a distal end of the leg, the C-shaped portion of the distal housing configured to support a clip of the two-part fastener.

2. The surgical clip applier according to claim **1**, wherein a distal-most end of the C-shaped portion of the distal housing defines an aperture.

3. The surgical clip applier according to claim **2**, wherein the C-shaped portion of the distal housing defines a slot extending laterally from the aperture, the slot configured to support a portion of the clip of the two-part fastener.

4. The surgical clip applier according to claim **1**, wherein the distal housing is fixed from longitudinal movement relative to the elongated portion.

5. The surgical clip applier according to claim **1**, wherein the collar of the end effector defines a recess for accepting the base of the two-part fastener partially in the recess.

6. The surgical clip applier according to claim **1**, wherein the collar of the end effector defines a first leg aperture and a second leg aperture, the first leg aperture configured to allow a first leg of the clip of the two-part fastener to extend through the collar, the second leg aperture configured to allow a second leg of the clip of the two-part fastener to extend through the collar.

7. The surgical clip applier according to claim **5**, wherein the collar of the end effector defines a first leg aperture and a second leg aperture, the first leg aperture defined within the recess of the collar and configured to allow a first leg of the clip of the two-part fastener to extend through the collar, the second leg aperture defined within the recess of the collar and configured to allow a second leg of the clip of the two-part fastener to extend through the collar.

8. A surgical clip-applying system, comprising:

a surgical clip applier, including:

an elongated portion defining a longitudinal axis and including a distal end; and

an end effector disposed adjacent the distal end of the elongated portion, the end effector including a collar and a distal housing, at least one of the collar or the distal housing being movable along the longitudinal axis relative to the elongated portion; and

a two-part fastener, including:

a base configured to be supported by the collar of the end effector of the surgical clip applier; and

a clip configured to be supported by the distal housing of the end effector of the surgical clip applier, and including a first leg and a second leg,

wherein a predetermined amount movement of at least one of the collar or the distal housing relative to the elongated portion causes the base of the two-part fastener to engage the clip of the two-part fastener.

9. The surgical clip-applying system according to claim **8**, wherein the distal housing of the end effector includes a C-shaped portion.

10. The surgical clip-applying system according to claim **8**, wherein the base of the two-part fastener defines a first aperture and a second aperture.

11. The surgical clip-applying system according to claim **10**, wherein the clip of the two-part fastener is C-shaped and includes a first leg and a second leg, the first leg configured to selectively extend through the first aperture of the base of the two-part fastener, and the second leg configured to selectively extend through the second aperture of the base of the two-part fastener.

12. The surgical clip-applying system according to claim **11**, wherein each of the first leg and the second leg of the clip of the two-part fastener includes a plurality of teeth configured to engage the base of the two-part fastener in a ratcheting manner.

13. The surgical clip-applying system according to claim **8**, wherein a distal-most end of the distal housing of the end effector defines an aperture.

14. The surgical clip-applying system according to claim **13**, wherein a distal end of the clip of the two-part fastener includes a distal tip configured to selectively extend through the aperture of the distal housing of the end effector.

15. The surgical clip-applying system according to claim **14**, wherein the distal tip of the clip of the two-part fastener defines a slit extending generally parallel to the first leg of the clip of the two-part fastener.

16. The surgical clip-applying system according to claim **15**, wherein when the distal tip of the clip of the two-part fastener extends through the aperture of the distal housing of the end effector, and the slit of the distal tip extends distally beyond the distal-most end of the distal housing of the end effector.

17. The surgical clip-applying system according to claim **8**, wherein the base of the two-part fastener is supported partially within a recess of the collar of the end effector.

18. The surgical clip-applying system according to claim **8**, wherein the collar of the end effector defines a first leg aperture and a second leg aperture, and the base of the two-part fastener defines a first leg aperture and a second leg aperture.

19. The surgical clip-applying system according to claim **18**, wherein after a predetermined amount of movement of the at least one of the collar or the distal housing relative to the elongated portion, the first leg of the clip of the two-part fastener extends through the first leg aperture of the collar and through the first leg aperture of the base of the two-part fastener, and the second leg of the clip of the two-part fastener extends through the second leg aperture of the collar and through the second leg aperture of the base of the two-part fastener.

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