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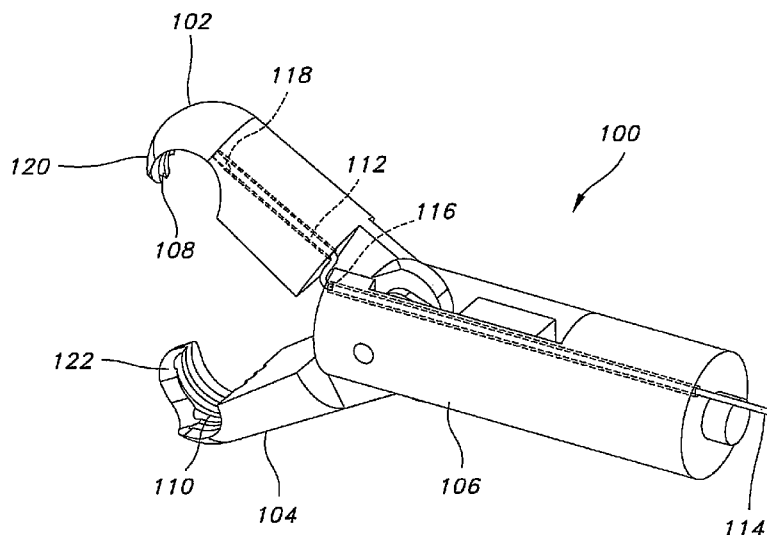


FIG. 1

(57) Abstract: Various embodiments are directed to a surgical device comprising an end effector. The end effector may comprise a first jaw member defining a first groove and a second jaw member defining a second groove. The first jaw member and the second jaw member may be selectively pivotable between an open position and a closed position. Also, the first groove and the second groove align to form a combined helical groove when the first jaw member and the second jaw member are in the closed position. In addition, the first jaw member may define a wire opening aligned with the first groove.

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TITLE

SURGICAL FASTENING DEVICE

BACKGROUND

[0001] Various embodiments relate to surgical fastening devices and to creating and/or placing surgical fastening devices. The surgical fastening devices may be particularly suited to use in open, laparoscopic and/or endoscopic surgical environments and, in various embodiments, may be inserted through a natural orifice in the body to reach a surgical site.

[0002] Surgical clips are generally used to apply clamping force to ducts, vessels, and other tissues. In addition, surgical clips are used to control bleeding of a tissue in lieu of suturing or stapling where suturing and stapling are difficult, such as in laparoscopic and/or endoscopic surgical environments. For example, surgical clips may be used to close perforations in the gastrointestinal tract resulting from ulcers, polypectomies, *etc.* Because of their relatively large size, it is difficult to place multiple surgical clips in close proximity to one another. Therefore, if a surgeon fails to place a surgical clip at an optimum location on the first attempt, it may be necessary to remove the surgical clip before placing another. This may unnecessarily lengthen surgical procedures and cause damage to tissue.

[0003] It is also known to use surgical sutures to close various wounds. In a laparoscopic or endoscopic environment, however, it may be difficult to pass instruments suitable for performing a typical “pass and catch” suturing method through a trocar or an endoscope working channel. Accordingly, various suture anchors such as “T-tags” and other fasteners have been developed. These fasteners anchor themselves either through or within tissue. Suture material is then secured to the anchors, allowing a wound or other opening to be closed. Suture anchors, however, present their own difficulties. For example, placing a suture anchor often requires partially or completely perforating the tissue, creating a risk of puncture or injury to surrounding tissue and organs. Also, once a suture anchor has been placed, it may be

difficult to remove it or place additional anchors in close proximity. Additional fastening methods are needed.

FIGURES

[0004] The novel features of the various embodiments are set forth with particularity in the appended claims. The various embodiments, however, both as to organization and methods of operation, together with advantages thereof, may best be understood by reference to the following description, taken in conjunction with the accompanying drawings as follows.

[0005] Figure 1 illustrates one embodiment of an end effector of a surgical device for creating and placing helical surgical fasteners in an open position.

[0006] Figure 2 illustrates one embodiment of the end effector of Figure 1 in a closed position.

[0007] Figure 3 illustrates one embodiment of the end effector of Figure 1 approaching tissue.

[0008] Figure 4 illustrates one embodiment of the end effector of Figure 1 with tissue placed between jaw members and the jaw members in the closed position.

[0009] Figure 5 illustrates one embodiment of the end effector of Figure 1 with a wire advancing through a wire opening of a jaw member.

[0010] Figure 6 illustrates one embodiment of the end effector of Figure 1 with the jaw members in an open position showing a beveled edge at a distal end of the wire opening.

[0011] Figure 7 illustrates one embodiment of the tissue after the end effector of Figure 1 has been opened and removed.

[0012] Figure 8 illustrates one embodiment of the tissue with an additional fastener placed.

[0013] Figure 9 illustrates one embodiment of an end effector with an alternate groove configuration.

[0014] Figure 10 illustrates one embodiment of a surgical instrument that may utilize the end effector of Figure 1 showing a hand piece and shaft assembly.

[0015] Figure 11 is an elevational view of one embodiment of an end effector and a shaft assembly of a surgical instrument.

[0016] Figure 12 is a perspective view of one embodiment of the end effector of Figure 11.

[0017] Figure 13 is an additional perspective view of one embodiment of the end effector of Figure 11.

[0018] Figure 14 is a left elevational view of one embodiment of the end effector of Figure 11.

[0019] Figure 15 is a right elevational view of one embodiment of the end effector of Figure 11.

[0020] Figure 16 is an end view of one embodiment of the end effector of Figure 11.

[0021] Figure 17 is a left elevational view of one embodiment of the end effector of Figure 11 with a clevis removed.

[0022] Figure 18 is a left elevational view of one embodiment of a coupling between the end effector and the shaft assembly of the surgical instrument of Figure 11.

[0023] Figure 19 is a left elevational view of the coupling of Figure 11 with additional components removed.

[0024] Figure 20 is a perspective view of one embodiment of a surgical instrument.

[0025] Figure 21 is a cross-sectional view of one embodiment of a hand piece of the surgical instrument of Figure 20.

DESCRIPTION

[0026] Various embodiments will now be described to provide an overall understanding of the principles of the structure, function, manufacture, and use of the devices and methods disclosed herein. One or more examples of these embodiments are illustrated in the accompanying drawings. Those of ordinary skill in the art will understand that the devices and methods specifically described herein and illustrated in the accompanying drawings are non-limiting embodiments and that the scope of the various embodiments is defined solely by the claims. The features illustrated or described in connection with one embodiment may be combined with the features of other embodiments. Such modifications and variations are intended to be included within the scope of the claims.

[0027] It will be appreciated that the terms “proximal” and “distal” are used herein with reference to a clinician manipulating an end of an instrument extending from the clinician to a surgical site (*e.g.*, through a trocar, through a natural orifice, through an open surgical site, *etc.*). The term “proximal” refers to the portion closest to the clinician, and the term “distal” refers to the portion located away from the surgeon. It will be further appreciated that for conciseness and clarity, spatial terms such as “vertical,” “horizontal,” “up,” and “down” may be used herein with respect to the drawings. However, surgical instruments are used in many orientations and positions, and these terms are not intended to be limiting and absolute.

[0028] The various embodiments generally provide methods and devices for creating and placing helical surgical fasteners. Figure 1 illustrates one embodiment of an end effector 100 of a surgical device for creating and placing helical surgical fasteners. In Figure 1, the end effector 100 is shown in an open position. The end effector 100 may be utilized with any suitable surgical device type and may be introduced to a surgical site according to any suitable method. For example, the end effector 100 may be utilized in a traditional open surgical environment, or may be introduced via a trocar in a laparoscopic surgical environment. According to various embodiments, the end effector 100 may be introduced via natural orifices and may be combined with trans-organ techniques. In one embodiment, Natural Orifice

Translumenal Endoscopic Surgery (NOTES)TM techniques may be employed to introduce instruments into the patient and carry out the various procedures described hereinbelow. A NOTESTM technique is a minimally invasive therapeutic procedure that may be employed to treat diseased tissue through a natural opening of the patient without making incisions in the abdomen. A natural opening may be the mouth, anus, and/or vagina. Medical implantable instruments may be introduced into the patient to the target area via the natural opening. In a NOTESTM technique, a surgeon inserts a flexible endoscope into one or more natural openings of the patient to view the target area using a camera. During endoscopic surgery the surgeon inserts surgical devices through one or more lumens or working channels of the endoscope to perform various key surgical activities (KSA). These KSAs include forming an anastomosis between organs, repairing ulcers and other wounds, *etc.*

[0029] Referring again to Figure 1, the end effector 100 may comprise a first jaw member 102 and a second jaw member 104 pivotably connected to a housing or clevis 106. At least one of the jaw members 102, 104 may be pivotable relative to the other to transition the end effector 100 from the open position shown in Figure 1 to a closed position. Figure 2 shows one embodiment of the end effector 100 in a closed position. The jaw members 102, 104 may each define grooves 108, 110. When the jaw members 102, 104 are moved to the closed position, the grooves 108, 110 may come together to form a combined groove 108, 110 that may be helical or about helical. According to various embodiments, the jaw members 102, 104 may comprise interlocking teeth. Figures 1 and 2 illustrate a pair of interlocking teeth 120, 122, however, additional teeth may be provided. The teeth 120, 122 may serve to grab and grip tissue when the end effector 100 is in the closed position. As shown in Figures 1 and 2, the grooves 108, 110 are positioned at distal portions of the respective jaw members 102, 104.

[0030] Jaw member 102 may additionally define a wire opening 112. The wire opening 112 may extend distally through the jaw member 102 and may align with the groove 108 (*e.g.*, an end of the groove). A corresponding wire opening 116 may extend proximally through the clevis 106 and may ultimately extend to a handle (not shown in Figure 2) or another clinician-

accessible location. In this way, a wire 114 may be extended from the clinician-accessible location, through the clevis 106, through the jaw member 102 and ultimately to the grooves 108, 110 to create and place a helical fastener, as described herein. The wire 114 may be any wire suitably sized and constituted to form helical fasteners. According to various embodiments, the wire 114 may be between 5 and 15 thousandths of an inch. The wire 114 may be made from any suitable material including, for example, stainless steel, titanium, cobalt chrome, *etc.*

[0031] According to various embodiments, the end effector 100 may apply helical fasteners by grasping tissue, and then forming the wire 114 into a helical shape utilizing the grooves 108, 110. Because tissue is present between the jaw members 102, 104 while the wire 114 is formed into a helical shape, the wire may be forced through the tissue, which may tend to bind the tissue. Figure 3 illustrates one embodiment of the end effector 100 approaching tissue 300. The tissue 300 may have an opening 302 to be closed by a helical fastener, as described herein. The opening 302 may be any naturally or artificially occurring opening in tissue 300 including, for example, an incision, an ulcer or other wound, or part of an anastomosis. Figure 4 illustrates one embodiment of the end effector 100 with the tissue 300 placed between the jaw members 102, 104, which are shown in the closed position. Force provided by the jaw members 102, 104 may tend to close the opening 302, as shown. Figure 5 illustrates one embodiment of the end effector 100 with wire 114 advancing through the wire opening 112 of the jaw member 102. As the wire 114 advances through the wire opening 112, it may encounter the grooves 108, 110, which may tend to form the wire into a helical or near-helical shape. Because the tissue 300 is present within the jaw members 102, 104, the helical or near-helical shape may be formed through the tissue 300. As a result, the helical shaped wire 114 may serve as a fastener and, if desired, may be placed to bind the opening 302.

[0032] When the wire 114 reaches the end of the grooves 108, 110 and/or when the clinician determines that the resulting helical fastener is of sufficient width, the clinician may sever the fastener from the remainder of the wire 114 in any suitable way. For example, Figure 6 illustrates one embodiment of the end effector 100 with the jaw members 102, 104 in an open

position showing a beveled edge 118 at a distal end of the wire opening 112. When the wire 114 is to be cut, it may be retracted through the opening 112. When the wire 114 is substantially parallel to the wire opening 112, it may pass smoothly through. When a curved portion of the wire 114 contacts the beveled edge 118, however, the beveled edge 118 may sever the wire 114, leaving the helical-shaped portion of the wire 114 embedded in the tissue 300 as a fastener. The end effector 100 may then be opened and removed from the surgical site. Figure 7 illustrates one embodiment of the tissue 300 after the end effector 100 has been opened and removed. The fastener 700, formed from the wire 114, may bind the previous opening 302. In other embodiments, the wire 114 may be severed according to other methods. For example, cutters (not shown) may be provided to the surgical site to cut the wire 114 (*e.g.*, via an endoscope working channel, trocar, *etc.*).

[0033] According to various embodiments, it may be necessary and/or desirable to place additional helical fasteners. For example, the opening 302 may be a bleeding ulcer or other bleeding wound, making it difficult for the clinician to know exactly where a fastener should be placed. Also, the size of the opening 302 may require additional fasteners. Because of the substantially helical shape of the fastener 700, it may be possible for a clinician to place a second fastener very close to the first fastener 700. Figure 8 illustrates one embodiment of the tissue 300 with an additional fastener 702 placed. As illustrated, the second fastener 702 is interlaced within the first fastener 700. By contrast, if a surgical clip or suture anchor is slightly misplaced, it may not be possible to place another close by. Instead, the clinician may have to remove the errant clip or anchor, which may cause additional damage to the tissue.

[0034] Figure 9 illustrates one embodiment of an end effector 100' with an alternate groove configuration. The end effector 100' may comprise first and second jaw members 102', 104'. The jaw members 102', 104' may comprise grooves 108', 110' and two or more interlocking teeth 906, 908. In contrast to the embodiments shown in Figures 1-8, the grooves 108', 110' may be positioned proximally relative to the teeth 906, 908. In use, the teeth 906, 908 may be used to grasp tissue and pull it towards the grooves 108', 110', where it may be

compressed when the end effector 100' is closed. The end effector 100' may also define a wire opening (not shown in Figure 9) in line with at least one of the grooves 108', 110'. A wire (not shown in Figure 9) may be advanced through the wire opening and grooves 108', 110' to form a helical wire portion that may serve as a helical fastener, for example, as described above.

[0035] As described above, the end effector 100 may be utilized with any suitable surgical instrument. Figure 10 illustrates an embodiment of one such surgical instrument 20. The surgical instrument 20 may include the end effector 100, a shaft assembly 22, and a hand piece 24. In at least one embodiment, the shaft assembly 22 may comprise a flexible shaft of an endoscopic surgical instrument wherein at least portions of the end effector 100 and the shaft assembly 22 may be configured to be positioned within and/or inserted through a working channel of an endoscope. The hand piece 24 may be configured to be grasped by a surgeon and, in at least one embodiment, the hand piece 24 may comprise a pistol grip including the stationary member 26 and movable member, or trigger, 28. In use, as described in greater detail below, the trigger 28 may be moved toward a stationary member 26 as indicated by arrow 27, for example, in order to operate the end effector within a surgical site.

[0036] In various embodiments, referring to Figures 11-17, the jaw members 102 and 104 may be movably coupled to the housing, or clevis, 106 such that they may be moved, or pivoted, between open and closed positions about pivot pin 58. In use, the jaw members 102 and 104 may be positioned in their closed, or at least partially closed, positions before they are inserted into a surgical site through a trocar, for example. In various embodiments, the jaw members 102 and 104 may be configured such that they may be positioned within and/or inserted through a working channel of an endoscope. Once positioned within the surgical site, the jaw members 102 and 104 may then be reopened. In their open position, the jaw members 102 and 104 may be positioned on, or relative to, the targeted soft tissue within the surgical site. Thereafter, in at least one embodiment, the jaw members 102 and 104 may be pivoted into their closed position to hold the soft tissue therebetween. In various embodiments, the jaw members

102 and 104 may have an interlocking rat's teeth 120, 122 style interface at their distal ends, as shown.

[0037] In order to more easily position the end effector 100, the shaft assembly extending between the end effector 100 and the hand piece 24 may be flexible. In at least one embodiment, referring to Figure 11, the shaft assembly 80 may include a flexible elongate member 82 and a flexible coil spring 84 positioned therearound. In various embodiments, referring to Figures 15-19, a surgical instrument may further include an adapter assembly 86 for operably connecting the end effector 100 to the shaft assembly 80. In at least one embodiment, the adapter assembly 86 may include a ring capture 88 which may include an aperture therein, or any other suitable feature, for receiving and retaining an end of the coil spring 84. The adapter assembly 86 may further include a bushing coupler 83 which may include projection 85, or any other suitable feature, which may be fixedly connected to the housing 106. In addition to the above, the adapter assembly 86 may also include inner housing coupler 87 (Figure 19) which may be configured to connect the ring capture 88 to the bushing coupler 83 such that the end effector 100 is correspondingly coupled to the shaft assembly 80.

[0038] In order to move the jaw members 102 and 104 between their open and closed positions as described above, a trigger 28 of the hand piece 24 may be pivoted relative to the stationary member 26 such that the trigger 28 may displace an actuator, or rod, 44 (Figure 10) relative to shaft 22. In various embodiments, the actuator rod 44 may be round, or any other suitable shape, and may be either solid or tubular. In either event, referring to Figure 14, the actuator rod 44 may be operably engaged with an actuator 46 such that, when the trigger 28 is pivoted toward the stationary member 26 as described above, the actuator rod 44 and the actuator 46 may be slid proximally such that the actuator 46 pulls on jaw links 53 and 55. When jaw links 53 and 55 are pulled proximally, jaw links 53 and 55 may apply a force to jaws 102 and 104, respectively, such that they are pivoted about pivot pin 58 into their closed positions. In order to move jaws 102 and 104 into their open positions, the trigger 28 may be moved away from the stationary portion 26 and, correspondingly, the actuator rod 44 and the actuator 46 may

be moved distally by the trigger 28. Similarly, the actuator 46 may move links 53 and 55 distally such that links 53 and 55 apply a force to jaws 102 and 104 and rotate them about pivot pin 58 in the opposite, or open, direction. Now referring to another example embodiment illustrated in Figures 20 and 21, when a trigger 28' is pivotally moved (*e.g.*, squeezed) in the direction indicated by arrow 29, the actuator rod 44 may be moved in the direction indicated by arrow 47, and the first and second jaw members 102 and 104 may close in the direction indicated by arrow 49. When the trigger 28' is pivotally moved (*e.g.*, released) in the direction indicated by arrow 31, the actuator rod 44 may be moved in the direction indicated by arrow 45, and the first and second jaw members may open in the direction indicated by arrow 51.

[0039] Further to the above, in various embodiments, at least a portion of the proximal end of the actuator rod 44 may be fixedly received in a shaft collar 66' (Figure 21) such that, when the collar 66' is moved by the trigger 28', the actuator rod 44 may be moved proximally and distally as described above. In at least one embodiment, the trigger 28' may be operably engaged with a pin 67' in the shaft collar 66' such that the rotational movement of the trigger 28' may be converted to translational movement of the shaft collar 66'. More particularly, although not illustrated, the trigger 28' may include a cam slot which is configured to receive a pin 67' such that, when the trigger 28' is rotated as described above, the sidewalls of the slot may motivate the shaft collar 66', and the actuator rod 44 operably engaged therewith, along a path defined by the housing portion 65'. In various embodiments, although not illustrated, the hand piece 24' may further include a biasing member, or spring, which is configured to bias the trigger 28', and the jaw members 102 and 104, into one of a closed or open position.

[0040] In at least one embodiment, referring to Figure 21, the hand piece 24' may further include the spring holders 68' and 70' where the spring may be positioned therebetween. In various embodiments, the shaft collar 66' may be connected to one of the spring holders 68' and 70' and the other of the spring holders 68' and 70' may be connected to the housing portion 65'. In such embodiments, when the shaft collar 66' is moved relative to the housing portion 65', one of the spring holders 68' and 70' may be moved relative to the other such that the spring is

placed in either tension or compression and may apply a spring force to the trigger 28'. In at least one embodiment, when the trigger 28' is released from its closed position as indicated by arrow 31, the spring force may bias the trigger 28' into its open position, as indicated by arrow 29. In various other embodiments, although not illustrated, the trigger 28' may be biased into its closed position or any other suitable position. In at least one embodiment, the trigger 28' may further include a latch 25' which may be configured to hold the trigger 28' to the stationary portion 26' against the biasing force of the spring.

[0041] In various embodiments, referring to Figure 10, the hand piece 24 may include a rotation knob 21 and, similarly, referring to Figure 20, the hand piece 24' may include the rotation knob 21', where the rotation knobs 21 and 21' may be configured to rotate an end effector of their respective surgical instruments relative to the hand pieces 24 and 24'. In various embodiments, referring to Figures 20 and 21, a portion of the actuator rod 44 may be slidably received within an aperture (not shown) in the rotation knob 21' wherein at least one of the actuator rod 44 and the aperture may include a non-circular profile. In such embodiments, the non-circular profile may allow the actuator rod 44 to be rotated by the knob 21' yet allow the actuator rod 44 to slide relative thereto when it is moved proximally and distally by the trigger 28', as described above. In at least one embodiment, when the rotation knob 21' is rotated in the direction indicated by an arrow 62, the end effector 100 may also be rotated in the direction indicated by the arrow 62. Similarly, when the rotation knob 21' is rotated in the direction indicated by and arrow 64, the end effector 100 may be rotated in the direction indicated by the arrow 64. As a result of the above, the jaw members 102 and 104 may be rotated within the surgical site and may be more accurately positioned by a surgeon.

[0042] In various embodiments, surgical instruments utilizing various embodiments of the end effector 100 may be employed in conjunction with a flexible endoscope, such as a GIF-100 model available from Olympus Corporation, for example. In at least one such embodiment, the endoscope, a laparoscope, or a thoracoscope, for example, may be introduced into the patient trans-anally through the colon, the abdomen via an incision or keyhole and a trocar, or trans-

orally through the esophagus, for example. These devices may assist the surgeon to guide and position the electrical ablation system near the tissue treatment region to treat diseased tissue on organs such as the liver, for example. In another embodiment, these devices may be positioned to treat diseased tissue near the gastrointestinal (GI) tract, esophagus, and/or lung, for example. In various embodiments, the endoscope may comprise a flexible shaft where the distal end of the flexible shaft may comprise a light source, a viewing port, and at least one working channel. In at least one such embodiment, the viewing port may transmit an image within its field of view to an optical device such as a charge coupled device (CCD) camera within the endoscope, for example, so that an operator may view the image on a display monitor (not shown).

[0043] While several embodiments have been illustrated and described, and while several illustrative embodiments have been described in considerable detail, the embodiments are not intended to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications may readily appear to those skilled in the art. Those of ordinary skill in the art will readily appreciate the different advantages provided by these various embodiments.

[0044] While several embodiments have been described, it should be apparent, however, that various modifications, alterations and adaptations to those embodiments may occur to persons skilled in the art with the attainment of some or all of the advantages of the embodiments. For example, according to various embodiments, a single component may be replaced by multiple components, and multiple components may be replaced by a single component, to perform a given function or functions. This application is therefore intended to cover all such modifications, alterations and adaptations without departing from the scope of the appended claims.

[0045] The devices disclosed herein may be designed to be disposed of after a single use, or they may be designed to be used multiple times. In either case, however, the device may be reconditioned for reuse after at least one use. Reconditioning may include a combination of the steps of disassembly of the device, followed by cleaning or replacement of particular pieces,

and subsequent reassembly. In particular, the device may be disassembled, and any number of particular pieces or parts of the device may be selectively replaced or removed in any combination. Upon cleaning and/or replacement of particular parts, the device may be reassembled for subsequent use either at a reconditioning facility, or by a surgical team immediately prior to a surgical procedure. Those of ordinary skill in the art will appreciate that the reconditioning of a device may utilize a variety of different techniques for disassembly, cleaning/replacement, and reassembly. Use of such techniques, and the resulting reconditioned device, are all within the scope of the present application.

[0046] Preferably, the embodiments described herein will be processed before surgery. First, a new or used instrument is obtained and, if necessary, cleaned. The instrument may then be sterilized. In one sterilization technique, the instrument is placed in a closed and sealed container, such as a plastic or TYVEK® bag. The container and instrument are then placed in a field of radiation that may penetrate the container, such as gamma radiation, x-rays, or higher energy electrons. The radiation kills bacteria on the instrument and in the container. The sterilized instrument may then be stored in the sterile container. The sealed container keeps the instrument sterile until it is opened in the medical facility.

[0047] Any patent, publication, or other disclosure material, in whole or in part, that is said to be incorporated by reference herein is incorporated herein only to the extent that the incorporated materials do not conflict with existing definitions, statements, or other disclosure material set forth in this disclosure. As such, and to the extent necessary, the disclosure as explicitly set forth herein supersedes any conflicting material incorporated herein by reference. Any material, or portion thereof, that is said to be incorporated by reference herein, but which conflicts with existing definitions, statements, or other disclosure material set forth herein will only be incorporated to the extent that no conflict arises between that incorporated material and the existing disclosure material.

[0048] The embodiments are not to be construed as limited to the particular embodiments disclosed. The embodiments are therefore to be regarded as illustrative rather than

restrictive. Variations and changes may be made by others without departing from the scope of the claims. Accordingly, it is expressly intended that all such equivalents, variations and changes that fall within the scope of the claims be embraced thereby.

[0049] In summary, numerous benefits have been described which result from employing the concepts described herein. The foregoing description of the one or more embodiments has been presented for purposes of illustration and description. It is not intended to be exhaustive or limiting to the precise form disclosed. Modifications or variations are possible in light of the above teachings. The one or more embodiments were chosen and described in order to illustrate principles and practical applications to thereby enable one of ordinary skill in the art to utilize the various embodiments and with various modifications as are suited to the particular use contemplated. It is intended that the claims submitted herewith define the overall scope.

CLAIMS

What is claimed is:

1. A surgical device comprising an end effector, wherein the end effector comprises:
a first jaw member defining a first groove;
a second jaw member defining a second groove;
wherein the first jaw member and the second jaw member are selectively pivotable between an open position and a closed position;
wherein the first groove and the second groove align to form a combined helical groove when the first jaw member and the second jaw member are in the closed position; and
wherein the first jaw member defines a wire opening aligned with the first groove.
2. The surgical device of claim 1, wherein the first jaw member further defines a beveled edge at a distal portion of the wire opening, wherein the distal edge is configured to cut a wire when the wire is pulled proximally through the wire opening.
3. The surgical device of claim 1, wherein a distal edge of the first jaw member and a distal edge of the second jaw member define an interlocking pattern.
4. The surgical device of claim 1, further comprising a shaft portion pivotably connected to the first jaw member and the second jaw member.
5. The surgical device of claim 4, wherein the shaft portion comprises a shaft wire opening aligned with the wire opening.

6. The surgical device of claim 5, further comprising a handle, wherein the handle comprises a trigger, and wherein the trigger is actuatable to transition the first jaw member and the second jaw member from the open position to the closed position.

7. The surgical device of claim 1, wherein the first groove and the second groove are positioned at distal portions of the first and second jaw members.

8. The surgical device of claim 1, wherein the first jaw member and the second jaw member comprise a groove section and a tooth section, and wherein the tooth section is positioned distally relative to the groove section.

9. A method of using a surgical device comprising an end effector, wherein the end effector comprises first and second jaw members, wherein the first jaw member defines a first groove and the second jaw member defines a second groove, wherein the first jaw member and the second jaw member are selectively pivotable between an open position and a closed position, wherein the first groove and the second groove align to form a combined helical groove when the first jaw member and the second jaw member are in the closed position; and wherein the first jaw member defines a wire opening aligned with the first groove, the method comprising:

positioning the end effector the open position such that tissue at a surgical site is present between the first jaw member and the second jaw member;

closing the end effector to the closed position with the tissue between the first jaw member and the second jaw member; and

feeding a wire distally through the wire opening and into the combined helical groove, wherein the combined helical groove forms the wire through the tissue into a first helical portion of wire.

10. The method of claim 9, further comprising severing the first helical portion of wire from a remainder of the wire.

11. The method of claim 10, wherein the wire opening comprises a beveled edge, and wherein severing the first helical portion of wire from the remainder of the wire comprises retracting the wire through the wire opening until the first helical portion of wire contacts and is severed by the beveled edge.

12. The method of claim 10, wherein the severing comprises introducing a cutting instrument to the surgical site.

13. The method of claim 9, further comprising feeding the wire distally through the wire opening and into the combined helical groove until the wire reaches an end of the combined helical groove.

14. The method of claim 9, further comprising feeding the wire distally through the wire opening and into the combined helical groove until a clinician determines that the first helical portion of wire is of sufficient length.

15. The method of claim 9, further comprising:
positioning the end effector in the open position such that a second portion of the tissue is present between the first jaw member and the second jaw member, wherein the second portion of the tissue comprises at least a part of the first helical portion of wire;
closing the end effector to the closed position with the second portion of the tissue between the first jaw and the second jaw; and

feeding the wire distally through the wire opening and into the combined helical groove to form a second helical portion of wire, wherein the first and second helical portions of wire are at least partially interlaced.

16. The method of claim 15, further comprising severing the second helical portion of wire from a second remainder of the wire.

17. The method of claim 9, further comprising introducing the end effector to the surgical site via a working channel of an endoscope.

18. The method of claim 9, further comprising introducing the end effector to the surgical site via a trocar.

19. The method of claim 9, further comprising introducing the end effector to the surgical site via a Natural Orifice Translumenal Endoscopic Surgery (NOTES)TM technique.

20. The method of claim 9, further comprising introducing the end effector to the surgical site via an incision.

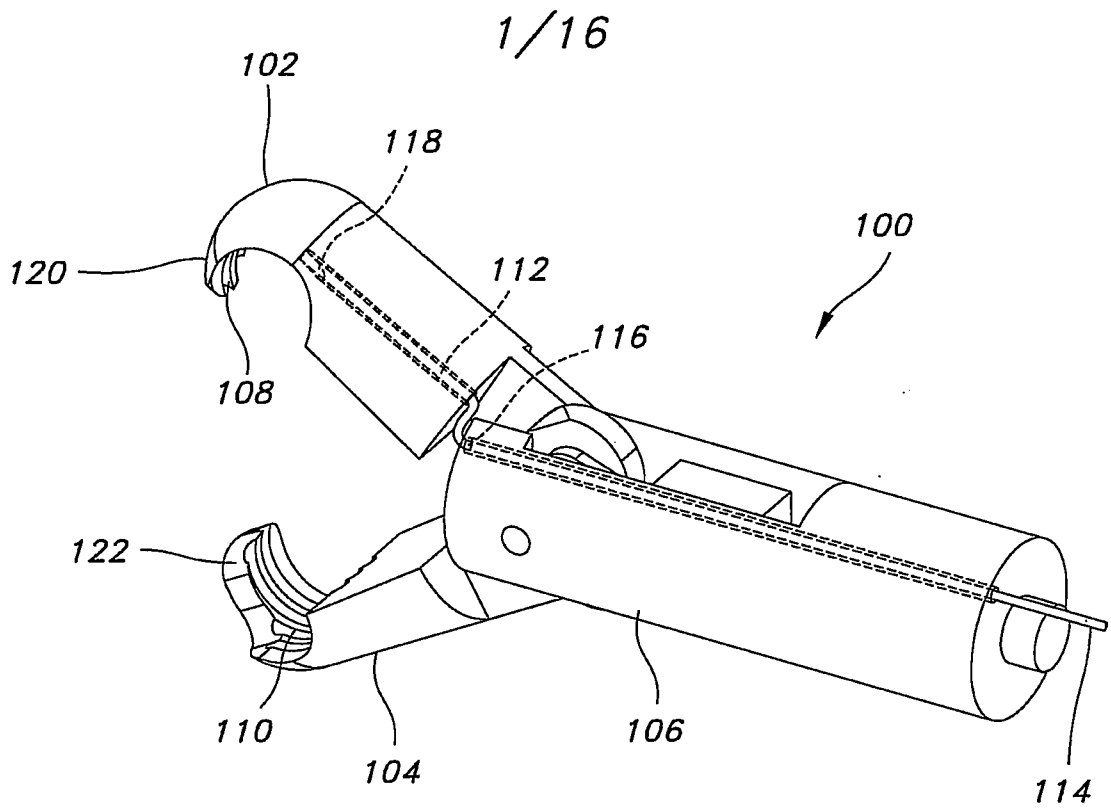


FIG. 1

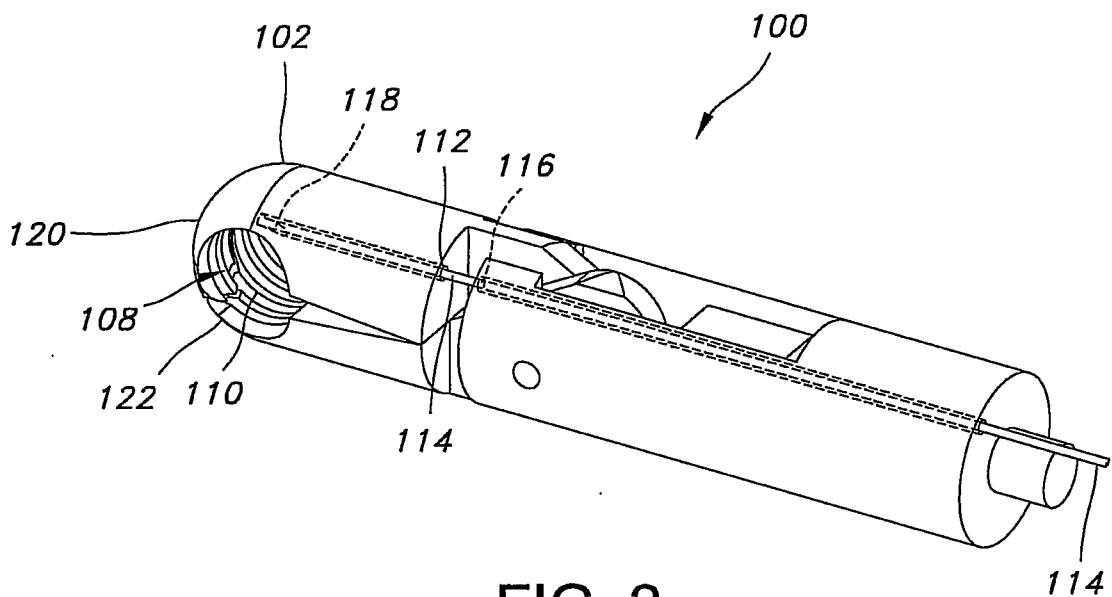
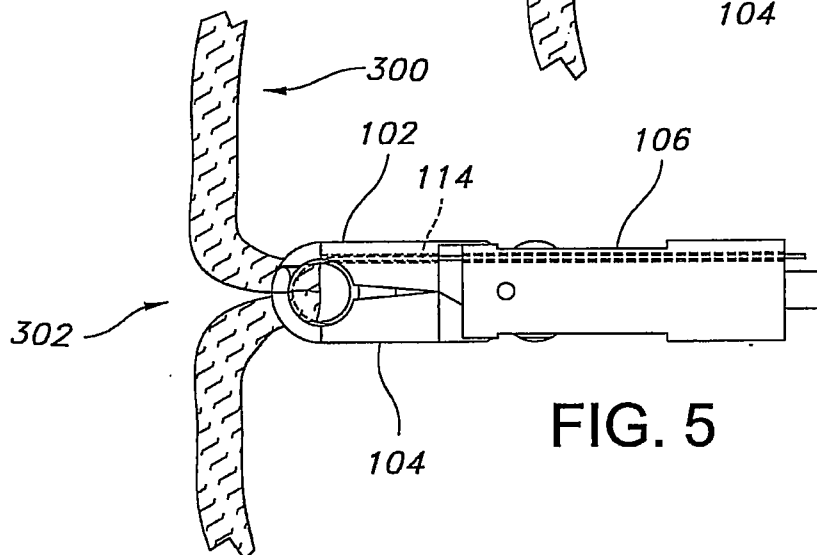
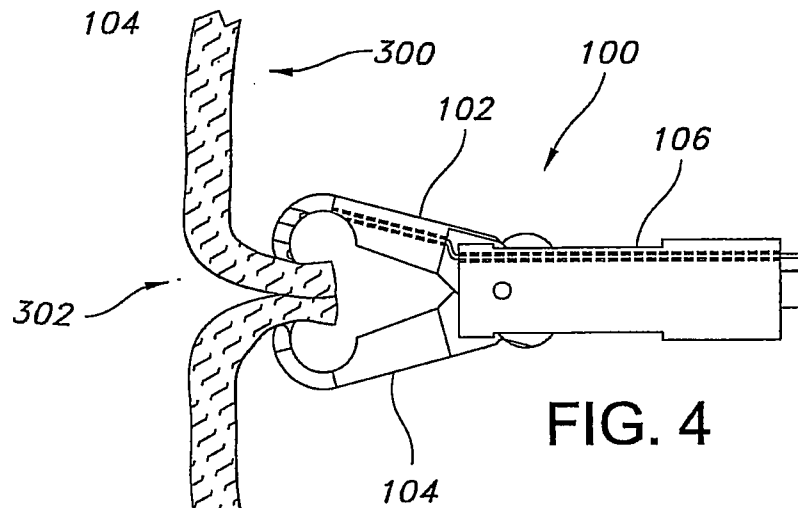
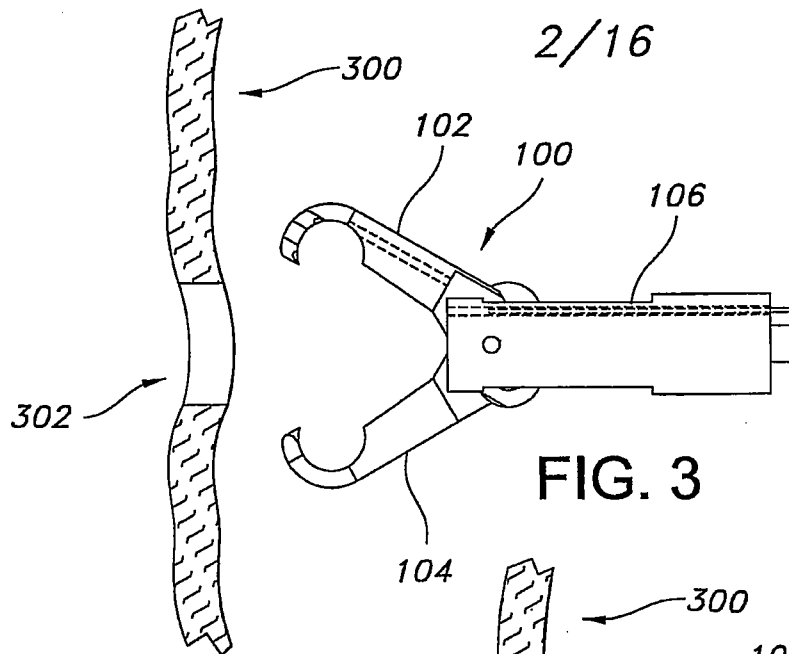


FIG. 2



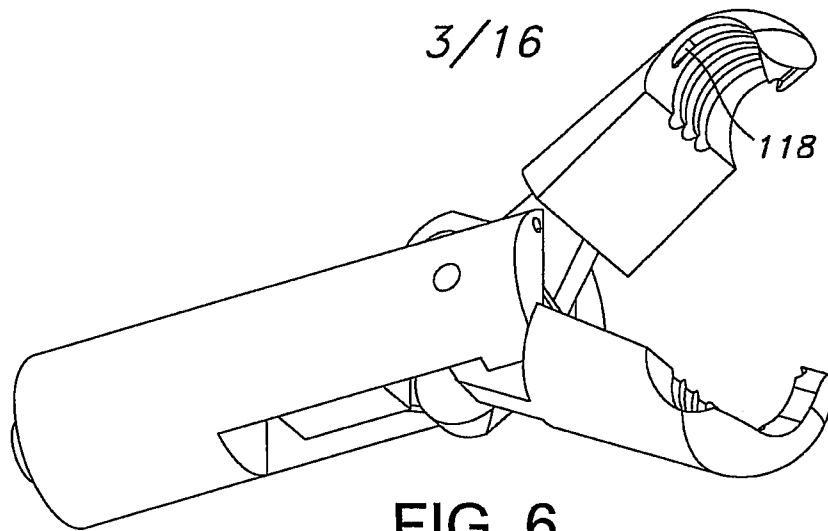


FIG. 6

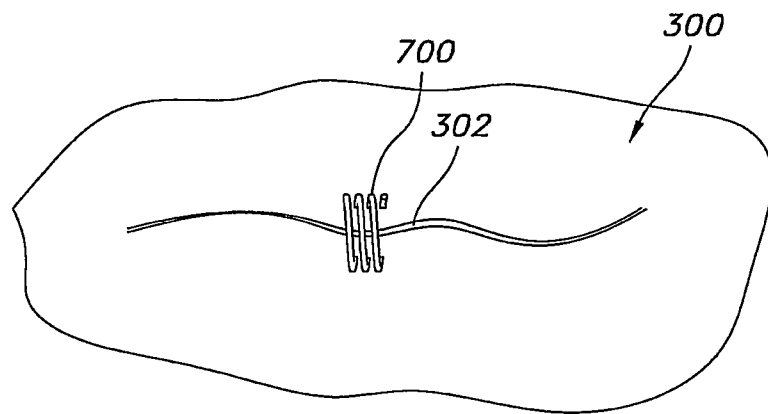


FIG. 7

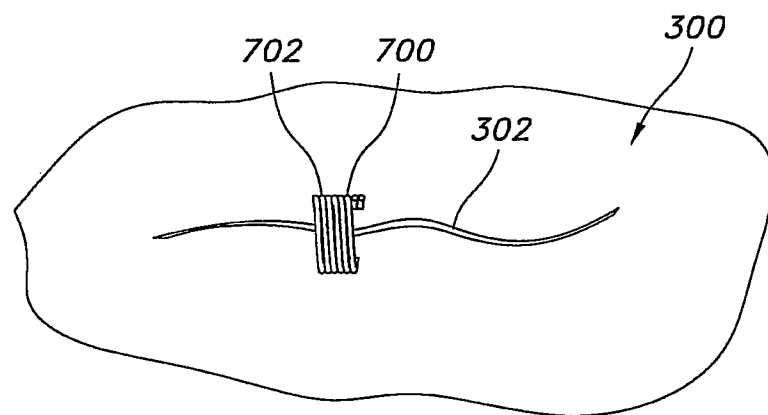


FIG. 8

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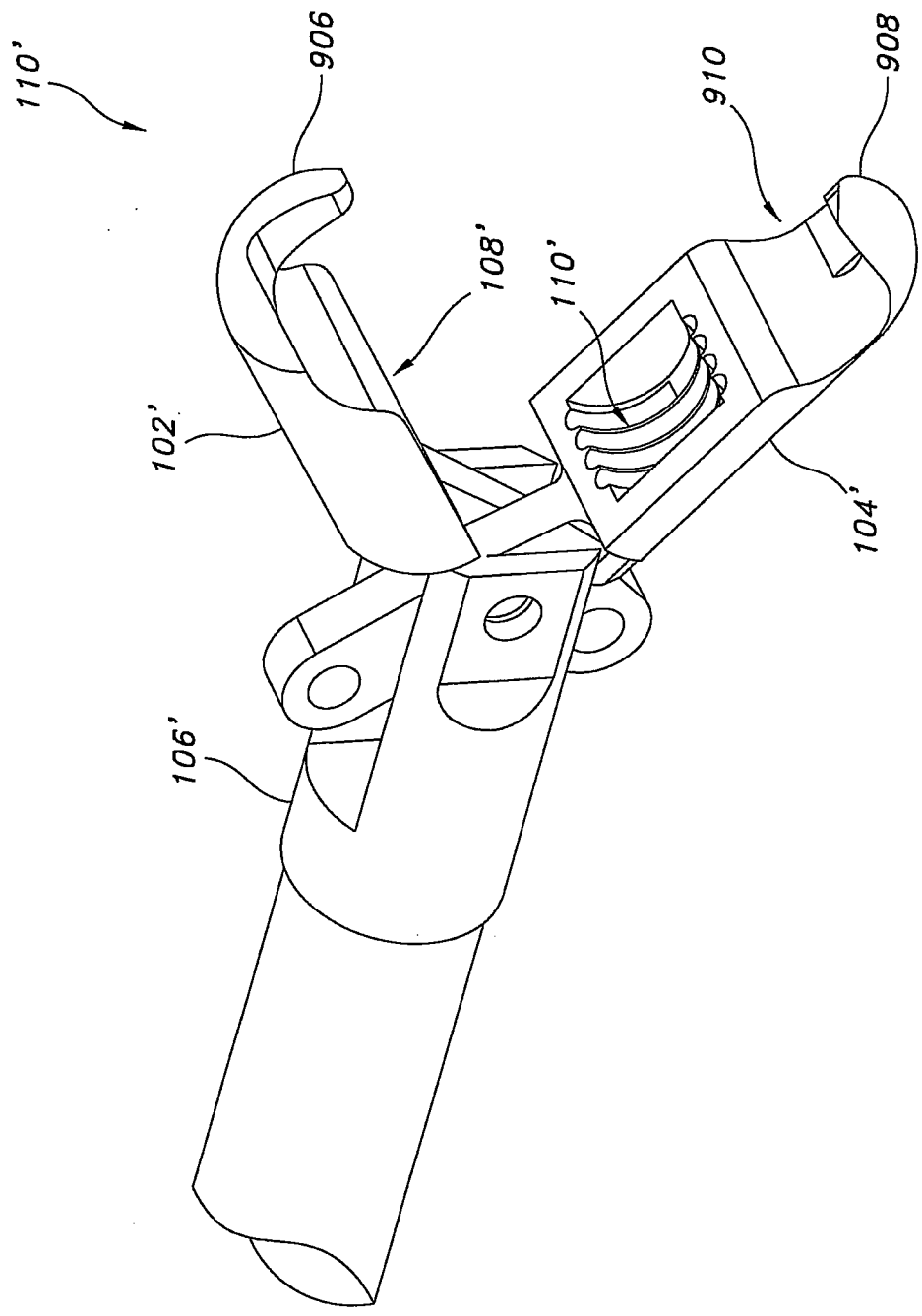
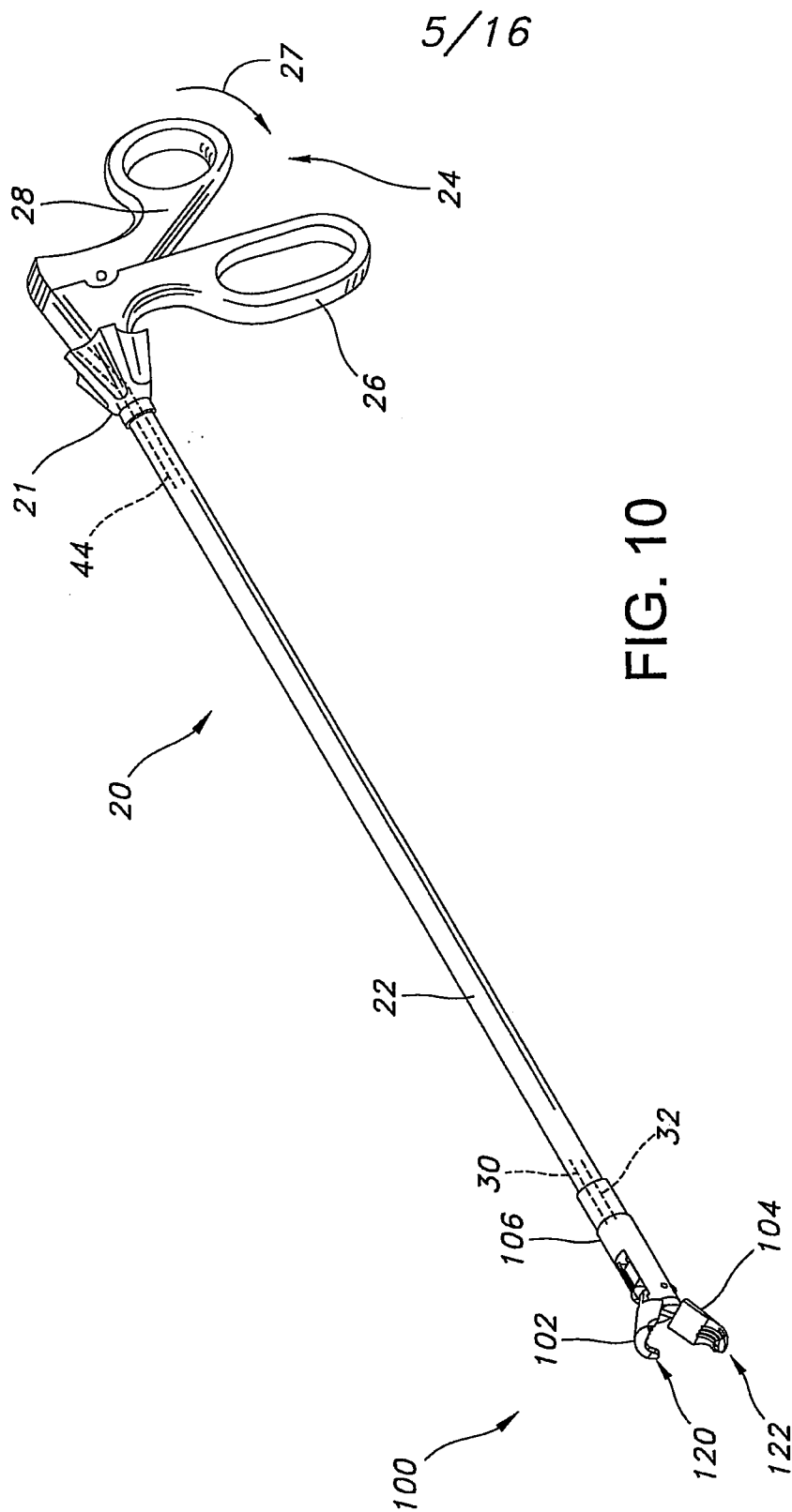


FIG. 9

+



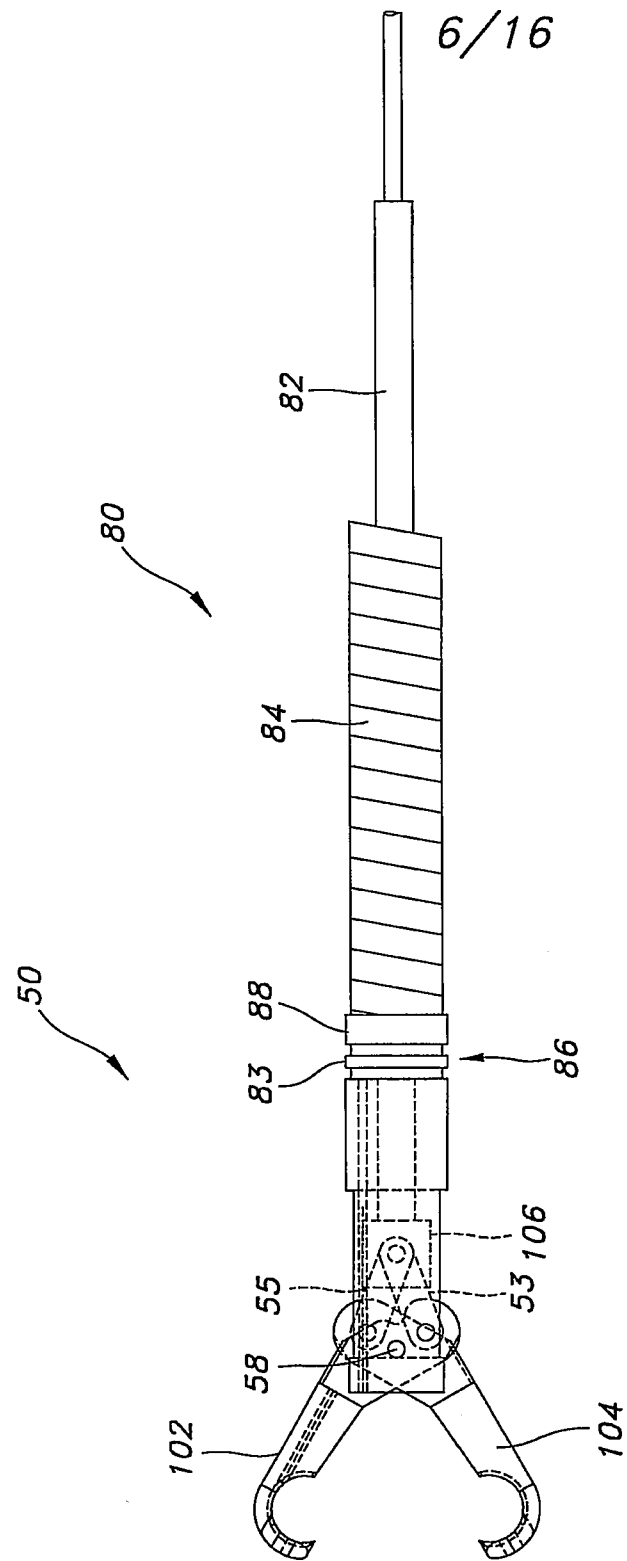


FIG. 11

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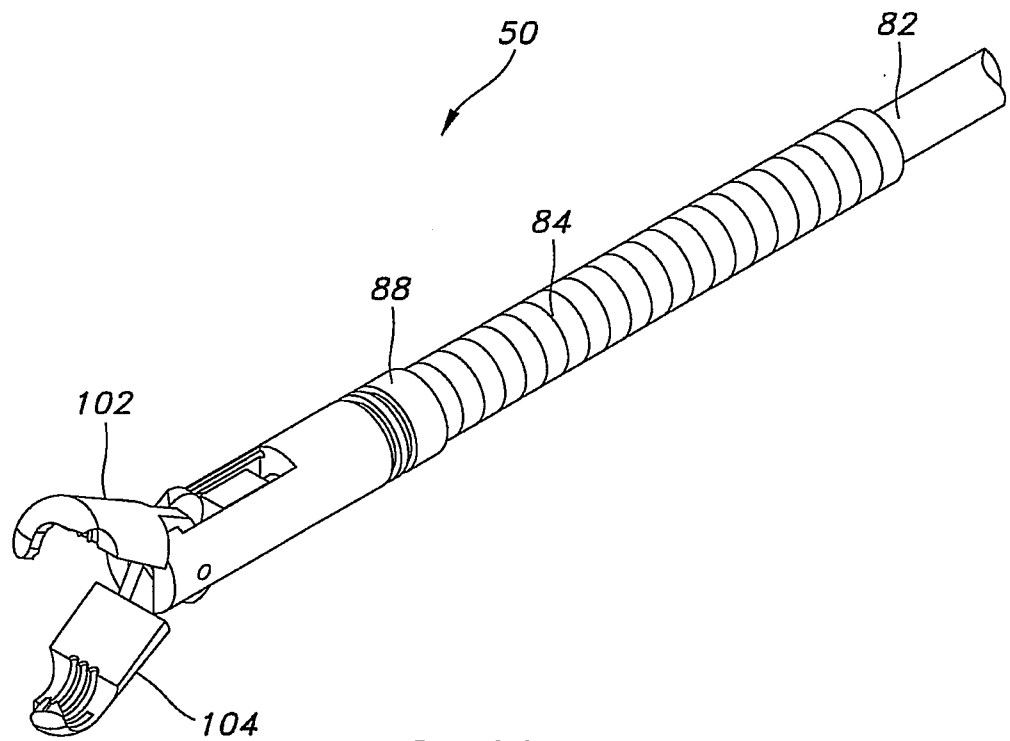


FIG. 12

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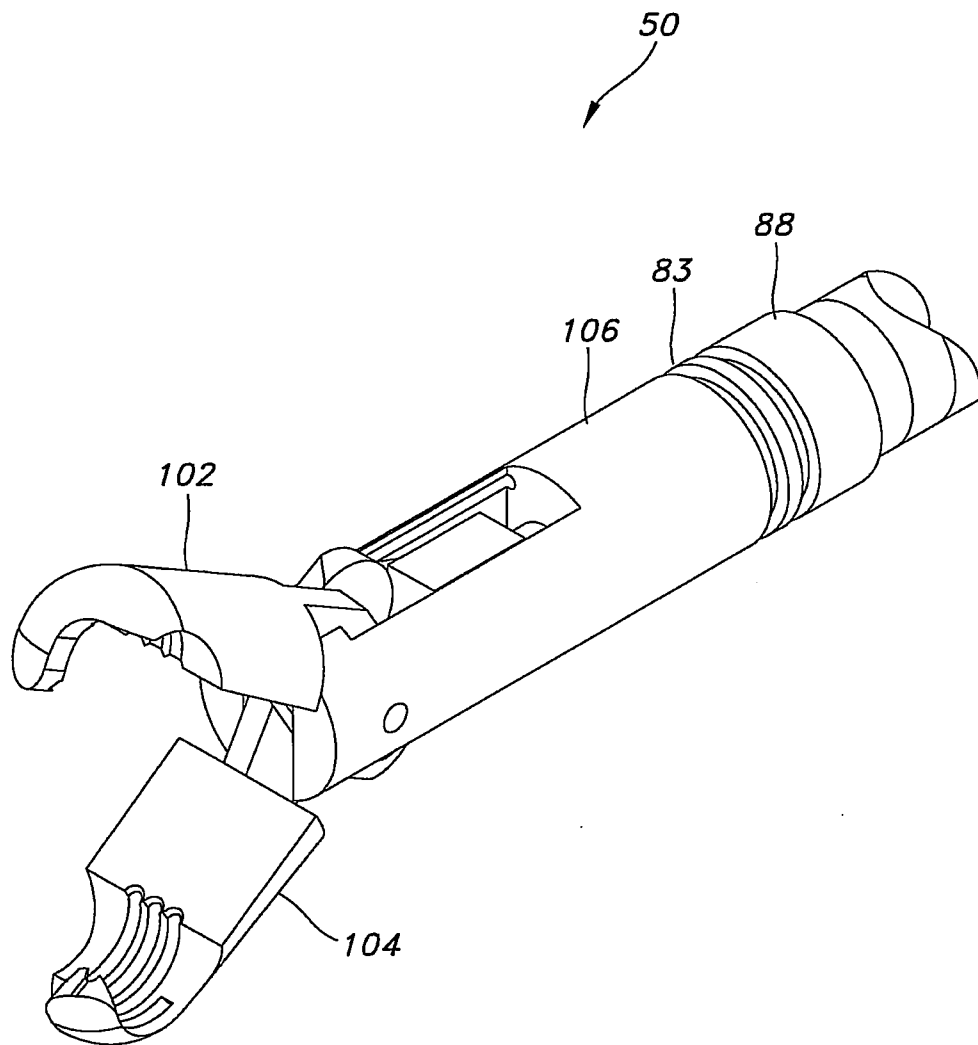


FIG. 13

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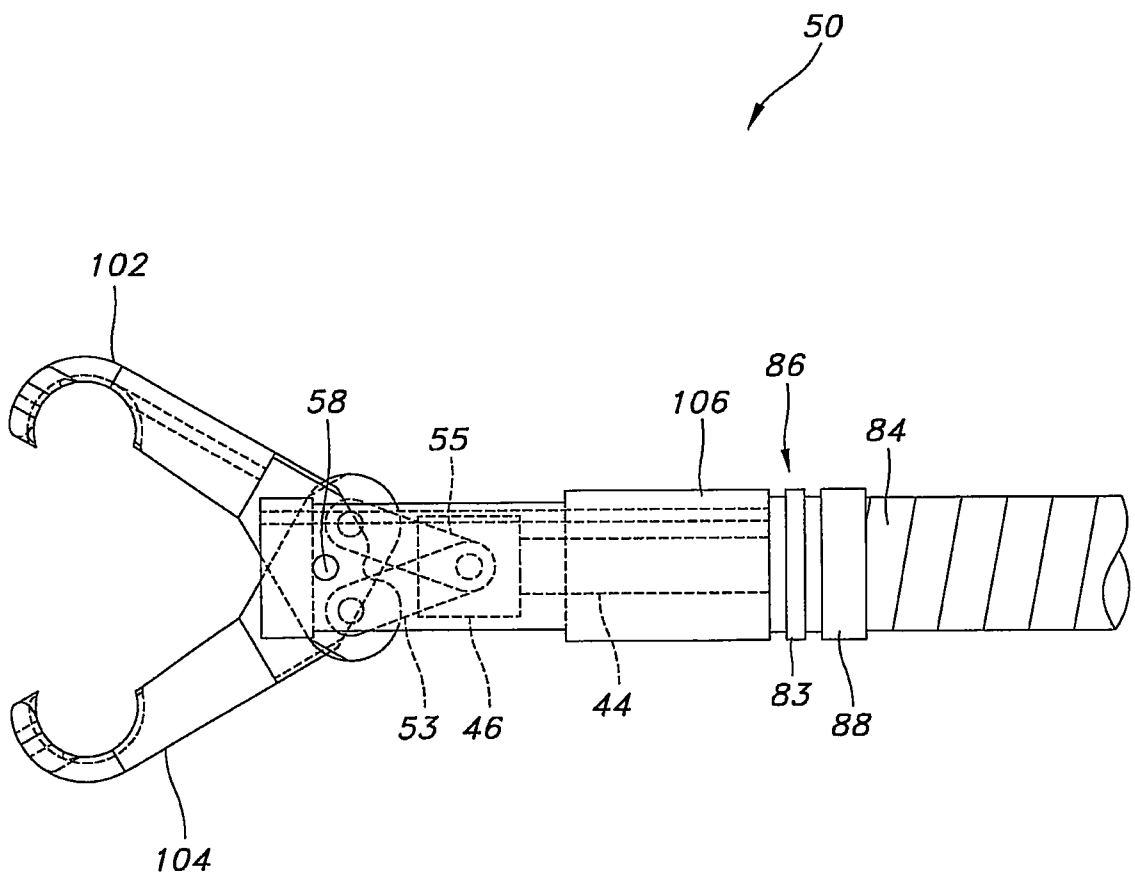


FIG. 14

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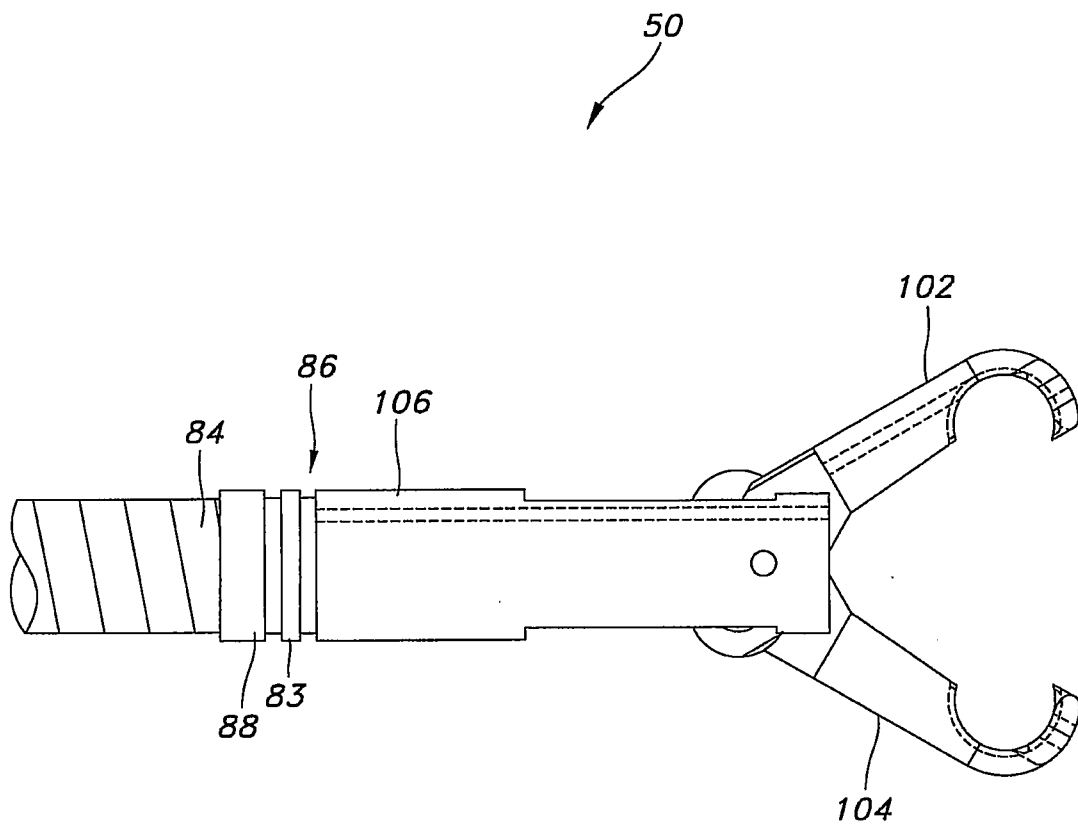


FIG. 15

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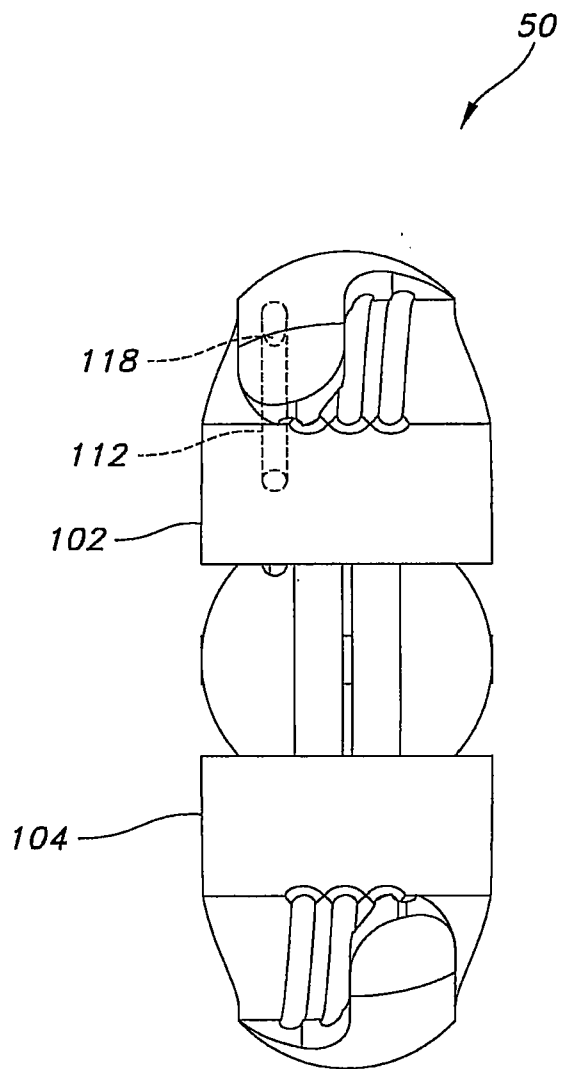


FIG. 16

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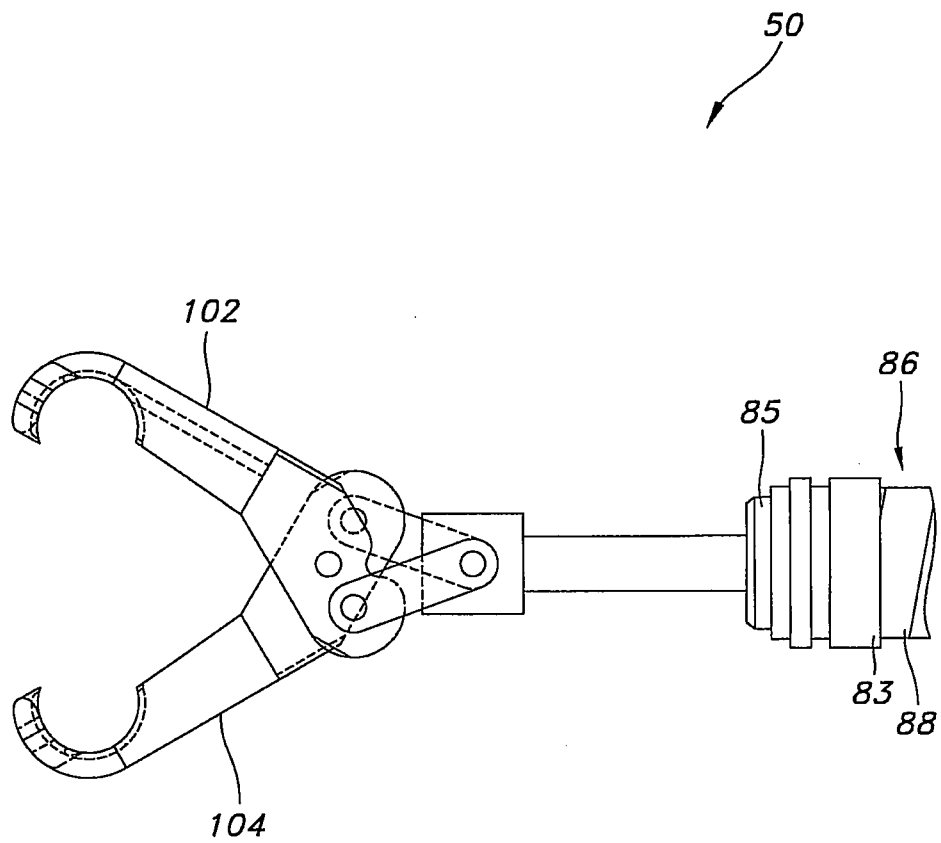


FIG. 17

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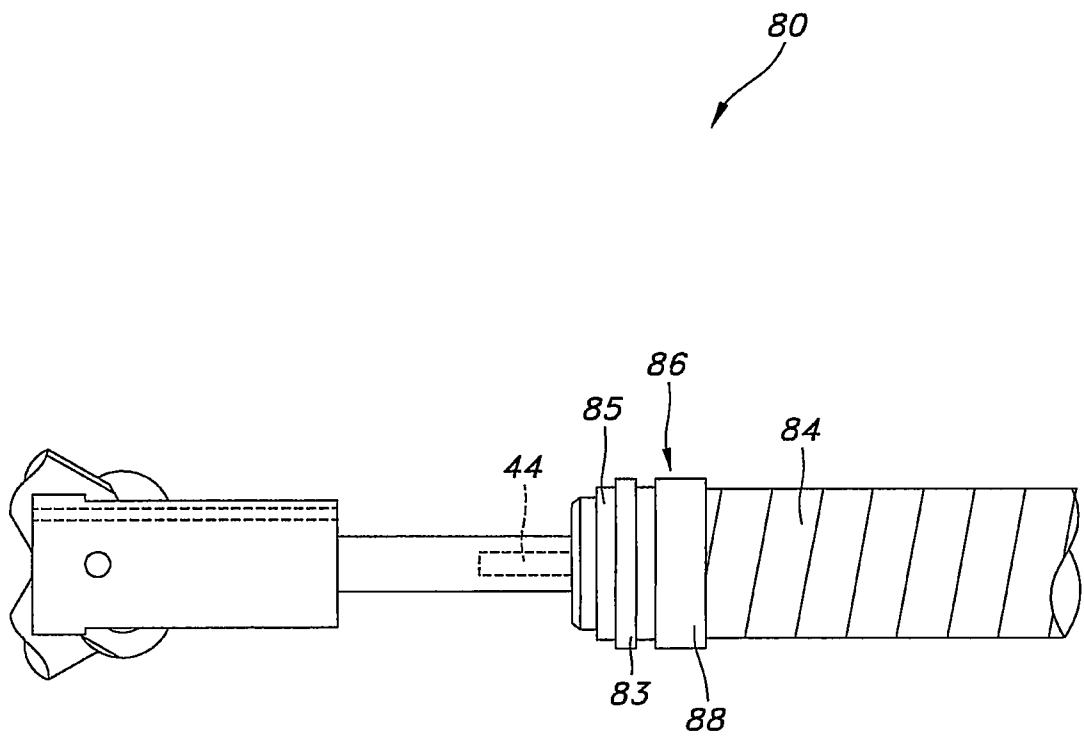


FIG. 18

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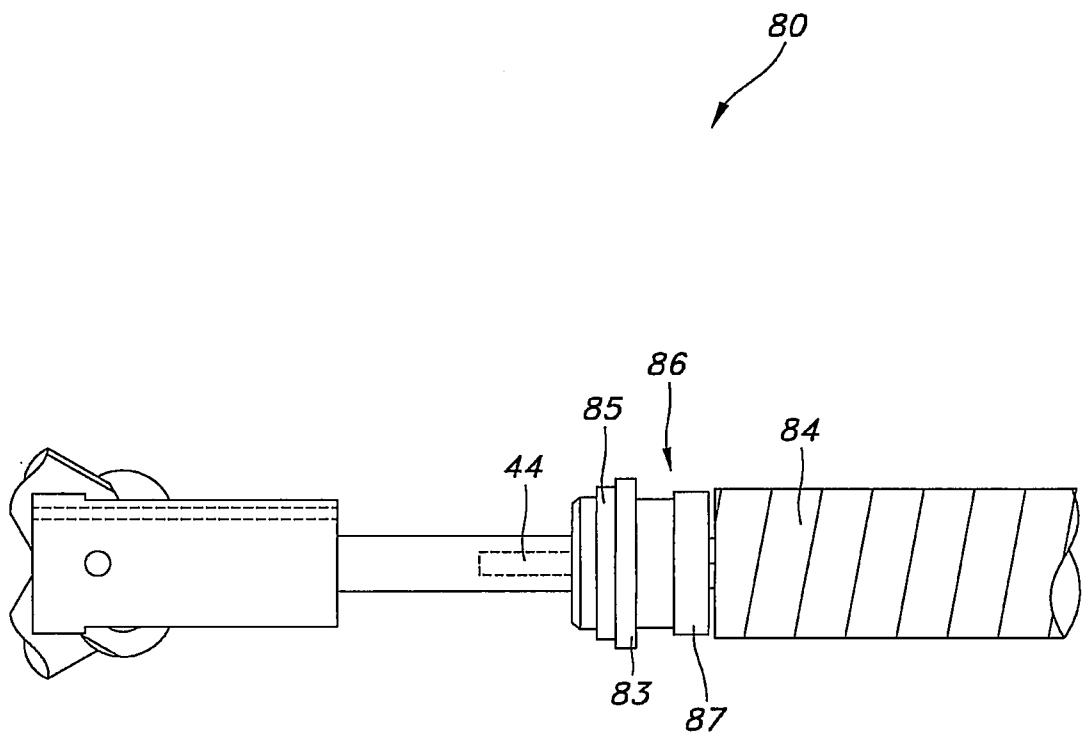
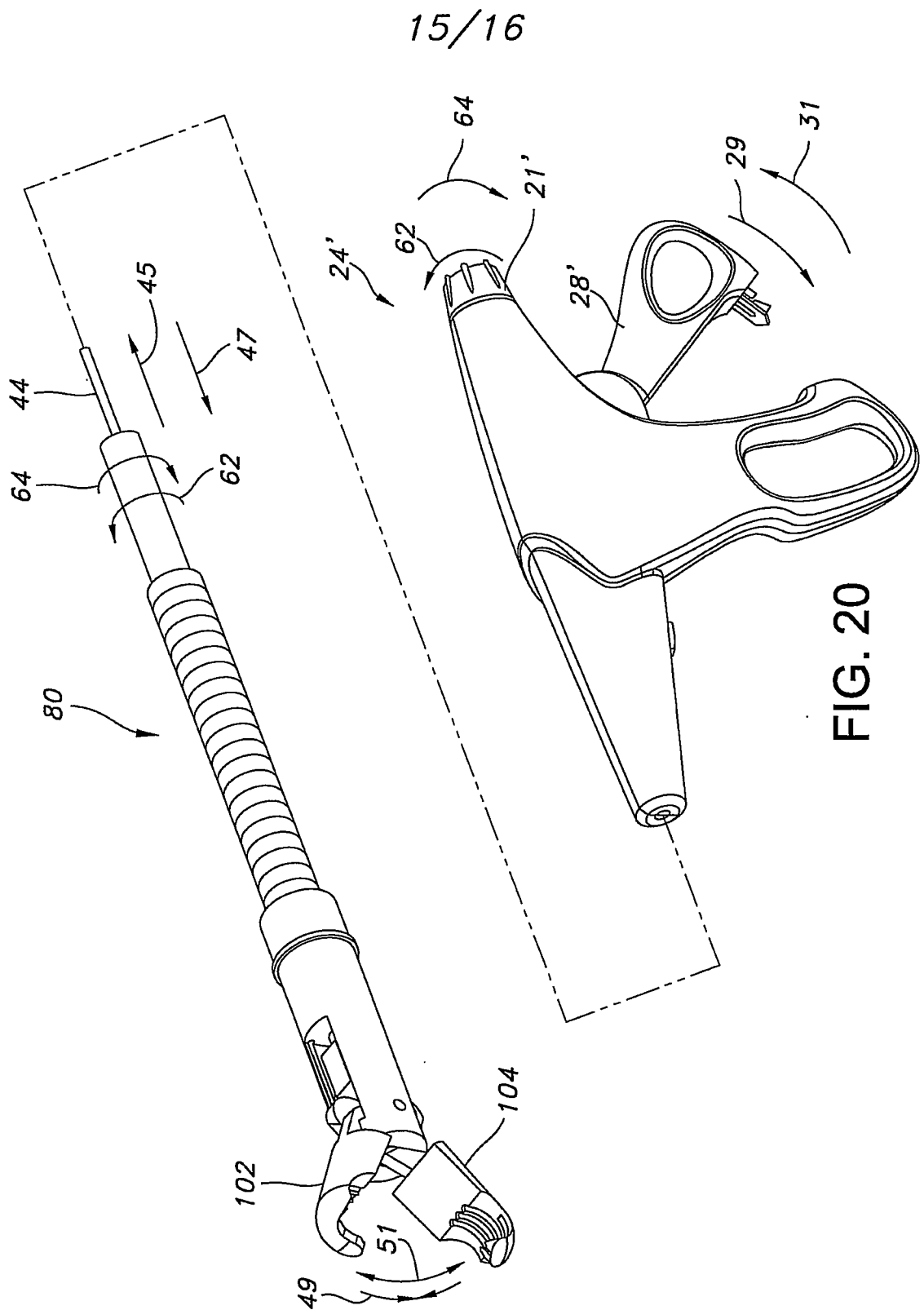


FIG. 19



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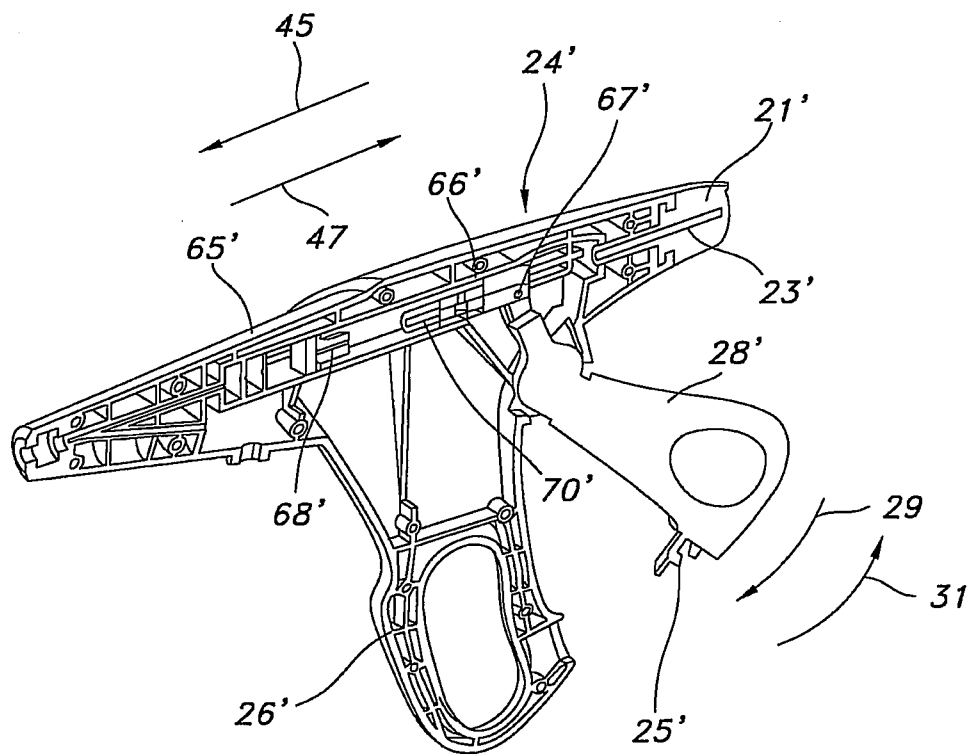


FIG. 21

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2009/045580

A. CLASSIFICATION OF SUBJECT MATTER

INV. A61B17/00 A61B17/04
 ADD. A61B17/12 A61B17/064

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A61B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 836 971 A (ETHICON ENDO SURGERY INC [US]) 26 September 2007 (2007-09-26) column 5, paragraph 66 - column 11, paragraph 95 figures	1, 3-8
A	WO 02/34122 A (ONUX MEDICAL INC [US]) 2 May 2002 (2002-05-02) page 56 - page 61 figures 44-48	1

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- * & * document member of the same patent family

Date of the actual completion of the international search

12 August 2009

Date of mailing of the international search report

21/08/2009

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
 NL - 2280 HV Rijswijk
 Tel. (+31-70) 340-2040,
 Fax: (+31-70) 340-3016

Authorized officer

Compos, Fabien

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2009/045580

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☒ Claims Nos.: 9-20
because they relate to subject matter not required to be searched by this Authority, namely:
Rule 39.1(iv) PCT - Method for treatment of the human or animal body by surgery
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers allsearchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search reportcovers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; It is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2009/045580

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 1836971	A	26-09-2007	AU 2007201111 A1	11-10-2007
			CA 2582140 A1	21-09-2007
			CN 101040786 A	26-09-2007
			JP 2007252907 A	04-10-2007
			US 2007225737 A1	27-09-2007
WO 0234122	A	02-05-2002	AU 3414002 A	06-05-2002
			US 2003009195 A1	09-01-2003
			US 2005043747 A1	24-02-2005