



- (51) **International Patent Classification:**
A61B 18/14 (2006.01) *A61B 18/00* (2006.01)
- (21) **International Application Number:**
PCT/US2014/040118
- (22) **International Filing Date:**
30 May 2014 (30.05.2014)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**
13/909,576 4 June 2013 (04.06.2013) US
- (71) **Applicant:** ETHICON ENDO-SURGERY, INC.
[US/US]; 4545 Creek Road, Cincinnati, Ohio 45242 (US).
- (72) **Inventors:** MILLER, Matthew C.; 2221 Washington Ave, Cincinnati, Ohio 45212 (US). WITT, David A.; 1187 Chaucer Place, Maineville, Ohio 45039 (US).
- (74) **Agents:** PLANTZ, Bernard F. et al.; Johnson & Johnson, One Johnson & Johnson Plaza, New Brunswick, New Jersey 08933 (US).
- (81) **Designated States** (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR,

KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

- (84) **Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

- as to the identity of the inventor (Rule 4.17(i))
- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))

Published:

- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))

(54) **Title:** ELECTROSURGICAL FORCEPS WITH TRANSLATING BLADE DRIVER

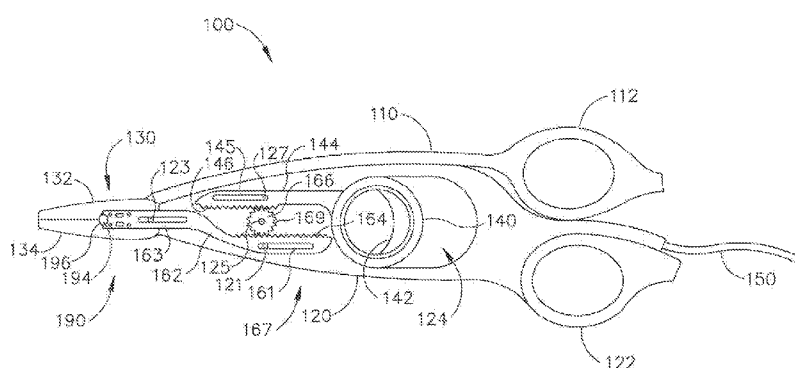


Fig. 7A

(57) **Abstract:** An apparatus for operating on tissue comprises a body, a lever, an end effector, and a tissue severing assembly. The end effector has a pair of jaws configured to open and close on tissue. The end effector is also capable of delivering RF energy to the tissue. The lever is configured to drive the pair of jaws. The tissue severing assembly comprises a trigger having at least one elongate member, at least one gear, and a firing beam. The trigger may also comprise a button operable to activate the RF energy. The firing beam is operable to sever tissue captured between the jaws. The at least one elongate member, at least one gear, and firing beam are associated such that longitudinal movement of the trigger in a first direction causes longitudinal movement of the firing beam in a second direction.

ELECTROSURGICAL FORCEPS WITH TRANSLATING BLADE DRIVER

Matthew C. Miller

David A. Witt

BACKGROUND

[0001] A variety of surgical instruments include a tissue cutting element and one or more elements that transmit radio frequency (RF) energy to tissue (e.g., to coagulate or seal the tissue). An example of such an electrosurgical instrument is the ENSEAL® Tissue Sealing Device by Ethicon Endo-Surgery, Inc., of Cincinnati, Ohio. Further examples of such devices and related concepts are disclosed in U.S. Pat. No. 6,500,176 entitled "Electrosurgical Systems and Techniques for Sealing Tissue," issued December 31, 2002, the disclosure of which is incorporated by reference herein; U.S. Pat. No. 7,112,201 entitled "Electrosurgical Instrument and Method of Use," issued September 26, 2006, the disclosure of which is incorporated by reference herein; U.S. Pat. No. 7,125,409, entitled "Electrosurgical Working End for Controlled Energy Delivery," issued October 24, 2006, the disclosure of which is incorporated by reference herein; U.S. Pat. No. 7,169,146 entitled "Electrosurgical Probe and Method of Use," issued January 30, 2007, the disclosure of which is incorporated by reference herein; U.S. Pat. No. 7,186,253, entitled "Electrosurgical Jaw Structure for Controlled Energy Delivery," issued March 6, 2007, the disclosure of which is incorporated by reference herein; U.S. Pat. No. 7,189,233, entitled "Electrosurgical Instrument," issued March 13, 2007, the disclosure of which is incorporated by reference herein; U.S. Pat. No. 7,220,951, entitled "Surgical Sealing Surfaces and Methods of Use," issued May 22, 2007, the disclosure of which is incorporated by reference herein; U.S. Pat. No. 7,309,849, entitled "Polymer Compositions Exhibiting a PTC Property and Methods of Fabrication," issued December 18, 2007, the disclosure of which is incorporated by reference herein; U.S. Pat. No. 7,311,709, entitled "Electrosurgical Instrument and Method of Use," issued December 25, 2007, the disclosure of which is incorporated by reference herein; U.S. Pat. No. 7,354,440, entitled "Electrosurgical Instrument and Method of Use," issued April 8,

2008, the disclosure of which is incorporated by reference herein; U.S. Pat. No. 7,381,209, entitled "Electrosurgical Instrument," issued June 3, 2008, the disclosure of which is incorporated by reference herein.

[0002] Additional examples of electrosurgical cutting instruments and related concepts are disclosed in U.S. Pub. No. 2011/0087218, entitled "Surgical Instrument Comprising First and Second Drive Systems Actuatable by a Common Trigger Mechanism," published April 14, 2011, the disclosure of which is incorporated by reference herein; U.S. Pub. No. 2012/0083783, entitled "Surgical Instrument with Jaw Member," published April 5, 2012, the disclosure of which is incorporated by reference herein; U.S. Pub. No. 2012/0116379, entitled "Motor Driven Electrosurgical Device with Mechanical and Electrical Feedback," published May 10, 2012, the disclosure of which is incorporated by reference herein; U.S. Pub. No. 2012/0078243, entitled "Control Features for Articulating Surgical Device," published March 29, 2012, the disclosure of which is incorporated by reference herein; U.S. Pub. No. 2012/0078247, entitled "Articulation Joint Features for Articulating Surgical Device," published March 29, 2012, the disclosure of which is incorporated by reference herein; U.S. Pub. No. 2013/0030428, entitled "Surgical Instrument with Multi-Phase Trigger Bias," published January 31, 2013, the disclosure of which is incorporated by reference herein; and U.S. Pub. No. 2013/0023868, entitled "Surgical Instrument with Contained Dual Helix Actuator Assembly," published January 31, 2013, the disclosure of which is incorporated by reference herein.

[0003] While a variety of surgical instruments have been made and used, it is believed that no one prior to the inventors has made or used the invention described in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] While the specification concludes with claims which particularly point out and distinctly claim this technology, it is believed this technology will be better understood from the following description of certain examples taken in conjunction with the accompanying drawings, in which like reference numerals identify the same elements and in which:

- [0005] FIG. 1 depicts a side elevational view of an exemplary electrosurgical medical instrument;
- [0006] FIG. 2 depicts a perspective view of the end effector of the instrument of FIG. 1, in an open configuration;
- [0007] FIG. 3 depicts another perspective view of the end effector of the instrument of FIG. 1, in an open configuration;
- [0008] FIG. 4 depicts a cross-sectional end view of the end effector of FIG. 2, in a closed configuration and with the blade in a distal position;
- [0009] FIG. 5 depicts a partial perspective view of the distal end of an exemplary alternative firing beam suitable for incorporation in the instrument of FIG. 1;
- [00010] FIG. 6A depicts a side elevational view of an exemplary electrosurgical forceps variation of the instrument of FIG. 1 in a closed position;
- [00011] FIG. 6B depicts a side elevational view of the electrosurgical forceps of FIG. 6A in an open position;
- [00012] FIG. 7A depicts a side cross-sectional view of the electrosurgical forceps of FIG. 6A, showing an exemplary knife activation apparatus in a first position;
- [00013] FIG. 7B depicts a side cross-sectional view of the electrosurgical forceps of FIG. 6A, showing the exemplary knife activation apparatus of FIG. 7A in a second position;
- [00014] FIG. 8A depicts a side cross-sectional view of another exemplary electrosurgical forceps variation of the instrument of FIG. 1, showing an exemplary alternative knife activation apparatus in a first position;
- [00015] FIG. 8B depicts a side cross-sectional view of the electrosurgical forceps of FIG. 8A, showing the knife activation apparatus of FIG. 8A in a second position;
- [00016] FIG. 9A depicts a side cross-sectional view of yet another exemplary electrosurgical forceps variation of the instrument of FIG. 1, showing another exemplary alternative knife activation apparatus in a first position; and

[00017] FIG. 9B depicts a side cross-sectional view of the electrosurgical forceps of FIG. 9A, showing the knife activation apparatus of FIG. 9A in a second position.

[00018] The drawings are not intended to be limiting in any way, and it is contemplated that various embodiments of the technology may be carried out in a variety of other ways, including those not necessarily depicted in the drawings. The accompanying drawings incorporated in and forming a part of the specification illustrate several aspects of the present technology, and together with the description serve to explain the principles of the technology; it being understood, however, that this technology is not limited to the precise arrangements shown.

DETAILED DESCRIPTION

[00019] The following description of certain examples of the technology should not be used to limit its scope. Other examples, features, aspects, embodiments, and advantages of the technology will become apparent to those skilled in the art from the following description, which is by way of illustration, one of the best modes contemplated for carrying out the technology. As will be realized, the technology described herein is capable of other different and obvious aspects, all without departing from the technology. Accordingly, the drawings and descriptions should be regarded as illustrative in nature and not restrictive.

[00020] It is further understood that any one or more of the teachings, expressions, embodiments, examples, etc. described herein may be combined with any one or more of the other teachings, expressions, embodiments, examples, etc. that are described herein. The following-described teachings, expressions, embodiments, examples, etc. should therefore not be viewed in isolation relative to each other. Various suitable ways in which the teachings herein may be combined will be readily apparent to those of ordinary skill in the art in view of the teachings herein. Such modifications and variations are intended to be included within the scope of the claims.

[00021] For clarity of disclosure, the terms “proximal” and “distal” are defined herein relative to a surgeon or other operator grasping a surgical instrument having a distal surgical end effector. The term “proximal” refers the position of an element closer to the

surgeon or other operator and the term “distal” refers to the position of an element closer to the surgical end effector of the surgical instrument and further away from the surgeon or other operator.

[00022] I. Exemplary Electrosurgical Device with Articulation Feature

[00023] FIGS. 1-4 show an exemplary electrosurgical instrument (10) that is constructed and operable in accordance with at least some of the teachings of U.S. Pat. No. 6,500,176; U.S. Pat. No. 7,112,201; U.S. Pat. No. 7,125,409; U.S. Pat. No. 7,169,146; U.S. Pat. No. 7,186,253; U.S. Pat. No. 7,189,233; U.S. Pat. No. 7,220,951; U.S. Pat. No. 7,309,849; U.S. Pat. No. 7,311,709; U.S. Pat. No. 7,354,440; U.S. Pat. No. 7,381,209; U.S. Pub. No. 2011/0087218; U.S. Pub. No. 2012/0083783; U.S. Pub. No. 2012/0116379; U.S. Pub. No. 2012/0078243; U.S. Pub. No. 2012/0078247; U.S. Pub. No. 2013/0030428; and/or U.S. Pub. No. 2013/0023868. As described therein and as will be described in greater detail below, electrosurgical instrument (10) is operable to cut tissue and seal or weld tissue (e.g., a blood vessel, etc.) substantially simultaneously. In other words, electrosurgical instrument (10) operates similar to an endocutter type of stapler, except that electrosurgical instrument (10) provides tissue welding through application of bipolar RF energy instead of providing lines of staples to join tissue. It should also be understood that electrosurgical instrument (10) may have various structural and functional similarities with the ENSEAL® Tissue Sealing Device by Ethicon Endo-Surgery, Inc., of Cincinnati, Ohio. Furthermore, electrosurgical instrument (10) may have various structural and functional similarities with the devices taught in any of the other references that are cited and incorporated by reference herein. To the extent that there is some degree of overlap between the teachings of the references cited herein, the ENSEAL® Tissue Sealing Device by Ethicon Endo-Surgery, Inc., of Cincinnati, Ohio, and the following teachings relating to electrosurgical instrument (10), there is no intent for any of the description herein to be presumed as admitted prior art. Several teachings below will in fact go beyond the scope of the teachings of the references cited herein and the ENSEAL® Tissue Sealing Device by Ethicon Endo-Surgery, Inc., of Cincinnati, Ohio.

[00024] A. Exemplary Handpiece and Shaft

[00025] Electrosurgical instrument (10) of the present example includes a handpiece (20), a shaft (30) extending distally from handpiece (20), and an end effector (40) disposed at a distal end of shaft (30). Handpiece (20) of the present example includes a pistol grip (22), a pivoting trigger (24), an activation button (26), and an articulation control (28). Trigger (24) is pivotable toward and away from pistol grip (22) to selectively actuate end effector (40) as will be described in greater detail below. Activation button (26) is operable to selectively activate RF circuitry that is in communication with end effector (40), as will also be described in greater detail below. In some versions, activation button (26) also serves as a mechanical lockout against trigger (24), such that trigger (24) cannot be fully actuated unless button (26) is being pressed simultaneously. Examples of how such a lockout may be provided are disclosed in one or more of the references cited herein. In addition or in the alternative, trigger (24) may serve as an electrical and/or mechanical lockout against button (26), such that button (26) cannot be effectively activated unless trigger (24) is being squeezed simultaneously. It should be understood that pistol grip (22), trigger (24), and button (26) may be modified, substituted, supplemented, etc. in any suitable way, and that the descriptions of such components herein are merely illustrative.

[00026] Shaft (30) of the present example includes a rigid outer sheath (32) and an articulation section (36). Articulation section (36) is operable to selectively laterally deflect end effector (40) at various angles relative to the longitudinal axis defined by sheath (32). In some versions, articulation section (36) and/or some other portion of outer sheath (32) includes a flexible outer sheath (e.g., a heat shrink tube, etc.) disposed about its exterior. Articulation section (36) of shaft (30) may take a variety of forms. By way of example only, articulation section (36) may be configured in accordance with one or more teachings of U.S. Pub. No. 2012/0078247, the disclosure of which is incorporated by reference herein. As another merely illustrative example, articulation section (36) may be configured in accordance with one or more teachings of U.S. Pub. No. 2012/0078248, entitled "Articulation Joint Features for Articulating Surgical Device," published March 29, 2012, the disclosure of which is incorporated by reference herein. Various other suitable forms that articulation section (36) may take will be apparent to those of ordinary skill in the art in view of the teachings herein. It should

also be understood that some versions of instrument (10) may simply lack articulation section (36).

[00027] In some versions, shaft (30) is also rotatable about the longitudinal axis defined by sheath (32), relative to handpiece (20), via a knob (34). Such rotation may provide rotation of end effector (40) and shaft (30) unitarily. In some other versions, knob (34) is operable to rotate end effector (40) without rotating articulation section (36) or any portion of shaft (30) that is proximal of articulation section (36). As another merely illustrative example, electrosurgical instrument (10) may include one rotation control that provides rotatability of shaft (30) and end effector (40) as a single unit; and another rotation control that provides rotatability of end effector (40) without rotating articulation section (36) or any portion of shaft (30) that is proximal of articulation section (36). Other suitable rotation schemes will be apparent to those of ordinary skill in the art in view of the teachings herein. Of course, rotatable features may simply be omitted if desired.

[00028] Articulation control (28) of the present example is operable to selectively control articulation section (36) of shaft (30), to thereby selectively laterally deflect end effector (40) at various angles relative to the longitudinal axis defined by shaft (30). While articulation control (28) is in the form of a rotary dial in the present example, it should be understood that articulation control (28) may take numerous other forms. By way of example only, some merely illustrative forms that articulation control (28) and other components of handpiece (20) may take are disclosed in U.S. Pub. No. 2012/0078243, the disclosure of which is incorporated by reference herein; in U.S. Pub. No. 2012/0078244, entitled "Control Features for Articulating Surgical Device," published March 29, 2012, the disclosure of which is incorporated by reference herein; and in U.S. Pub. No. 2013/0023868, the disclosure of which is incorporated by reference herein. Still other suitable forms that articulation control (28) may take will be apparent to those of ordinary skill in the art in view of the teachings herein. It should also be understood that some versions of instrument (10) may simply lack an articulation control (28).

[00029] B. Exemplary End Effector

[00030] End effector (40) of the present example comprises a first jaw (42) and a second jaw (44). In the present example, first jaw (42) is substantially fixed relative to shaft (30); while second jaw (44) pivots relative to shaft (30), toward and away from first jaw (42). Use of the term “pivot” should not be read as necessarily requiring pivotal movement about a fixed axis. In some versions, second jaw (44) pivots about an axis that is defined by a pin (or similar feature) that slides along an elongate slot or channel as second jaw (44) moves toward first jaw (42). In such versions, the pivot axis translates along the path defined by the slot or channel while second jaw (44) simultaneously pivots about that axis. It should be understood that such sliding/translating pivotal movement is encompassed within terms such as “pivot,” “pivots,” “pivotal,” “pivotable,” “pivoting,” and the like. Of course, some versions may provide pivotal movement of second jaw (44) about an axis that remains fixed and does not translate within a slot or channel, etc.

[00031] In some versions, actuators such as rods or cables, etc., may extend through sheath (32) and be joined with second jaw (44) at a pivotal coupling (43), such that longitudinal movement of the actuator rods/cables/etc. through shaft (30) provides pivoting of second jaw (44) relative to shaft (30) and relative to first jaw (42). Of course, jaws (42, 44) may instead have any other suitable kind of movement and may be actuated in any other suitable fashion. By way of example only, and as will be described in greater detail below, jaws (42, 44) may be actuated and thus closed by longitudinal translation of a firing beam (60), such that actuator rods/cables/etc. may simply be eliminated in some versions.

[00032] As best seen in FIGS. 2-4, first jaw (42) defines a longitudinally extending elongate slot (46); while second jaw (44) also defines a longitudinally extending elongate slot (48). In addition, the top side of first jaw (42) presents a first electrode surface (50); while the underside of second jaw (44) presents a second electrode surface (52). Electrode surfaces (50, 52) are in communication with an electrical source (80) via one or more conductors (not shown) that extend along the length of shaft (30). These conductors are coupled with electrical source (80) and a controller (82) via a cable (84), which extends proximally from handpiece (20). Electrical source (80) is operable to deliver RF energy to first electrode surface (50) at an active polarity while second

electrode surface (52) serves as a reference/return passive electrode, such that RF current flows between electrode surfaces (50, 52) and thereby through tissue captured between jaws (42, 44). There are instances where the active signal crosses zero potential that the reference is at the same potential so there is no current flow. In some versions, firing beam (60) serves as an electrical conductor that cooperates with electrode surfaces (50, 52) (e.g., as a ground return) for delivery of bipolar RF energy captured between jaws (42, 44). Electrical source (80) may be external to electrosurgical instrument (10) or may be integral with electrosurgical instrument (10) (e.g., in handpiece (20), etc.), as described in one or more references cited herein or otherwise. A controller (82) regulates delivery of power from electrical source (80) to electrode surfaces (50, 52). Controller (82) may also be external to electrosurgical instrument (10) or may be integral with electrosurgical instrument (10) (e.g., in handpiece (20), etc.), as described in one or more references cited herein or otherwise. It should also be understood that electrode surfaces (50, 52) may be provided in a variety of alternative locations, configurations, and relationships.

[00033] By way of example only, power source (80) and/or controller (82) may be configured in accordance with at least some of the teachings of U.S. Provisional Pat. App. No. 61/550,768, entitled "Medical Instrument," filed October 24, 2011, the disclosure of which is incorporated by reference herein; U.S. Pub. No. 2011/0082486, entitled "Devices and Techniques for Cutting and Coagulating Tissue," published April 7, 2011, the disclosure of which is incorporated by reference herein; U.S. Pub. No. 2011/0087212, entitled "Surgical Generator for Ultrasonic and Electrosurgical Devices," published April 14, 2011, the disclosure of which is incorporated by reference herein; U.S. Pub. No. 2011/0087213, entitled "Surgical Generator for Ultrasonic and Electrosurgical Devices," published April 14, 2011, the disclosure of which is incorporated by reference herein; U.S. Pub. No. 2011/0087214, entitled "Surgical Generator for Ultrasonic and Electrosurgical Devices," published April 14, 2011, the disclosure of which is incorporated by reference herein; U.S. Pub. No. 2011/0087215, entitled "Surgical Generator for Ultrasonic and Electrosurgical Devices," published April 14, 2011, the disclosure of which is incorporated by reference herein; U.S. Pub. No. 2011/0087216, entitled "Surgical Generator for Ultrasonic and Electrosurgical Devices,"

published April 14, 2011, the disclosure of which is incorporated by reference herein; and/or U.S. Pub. No. 2011/0087217, entitled "Surgical Generator for Ultrasonic and Electrosurgical Devices," published April 14, 2011, the disclosure of which is incorporated by reference herein. Other suitable configurations for power source (80) and controller (82) will be apparent to those of ordinary skill in the art in view of the teachings herein.

[00034] As best seen in FIG. 4, the lower side of first jaw (42) includes a longitudinally extending recess (58) adjacent to slot (46); while the upper side of second jaw (44) includes a longitudinally extending recess (59) adjacent to slot (48). FIG. 2 shows the upper side of first jaw (42) including a plurality of teeth serrations (46). It should be understood that the lower side of second jaw (44) may include complementary serrations that nest with serrations (46), to enhance gripping of tissue captured between jaws (42, 44) without necessarily tearing the tissue. In other words, it should be understood that serrations may be generally blunt or otherwise atraumatic. FIG. 3 shows an example of serrations (46) in first jaw (42) as mainly recesses; with serrations (48) in second jaw (44) as mainly protrusions. Of course, serrations (46, 48) may take any other suitable form or may be simply omitted altogether. It should also be understood that serrations (46, 48) may be formed of an electrically non-conductive, or insulative, material, such as plastic, glass, and/or ceramic, for example, and may include a treatment such as polytetrafluoroethylene, a lubricant, or some other treatment to substantially prevent tissue from getting stuck to jaws (42, 44). In some versions, serrations (46, 48) are electrically conductive.

[00035] With jaws (42, 44) in a closed position, shaft (30) and end effector (40) are sized and configured to fit through trocars having various inner diameters, such that electrosurgical instrument (10) is usable in minimally invasive surgery, though of course electrosurgical instrument (10) could also be used in open procedures if desired. By way of example only, with jaws (42, 44) in a closed position, shaft (30) and end effector (40) may present an outer diameter of approximately 5 mm. Alternatively, shaft (30) and end effector (40) may present any other suitable outer diameter (e.g., between approximately 2 mm and approximately 20 mm, etc.).

[00036] As another merely illustrative variation, either jaw (42, 44) or both of jaws (42, 44) may include at least one port, passageway, conduit, and/or other feature that is operable to draw steam, smoke, and/or other gases/vapors/etc. from the surgical site. Such a feature may be in communication with a source of suction, such as an external source or a source within handpiece (20), etc. In addition, end effector (40) may include one or more tissue cooling features (not shown) that reduce the degree or extent of thermal spread caused by end effector (40) on adjacent tissue when electrode surfaces (50, 52) are activated. Various suitable forms that such cooling features may take will be apparent to those of ordinary skill in the art in view of the teachings herein.

[00037] In some versions, end effector (40) includes one or more sensors (not shown) that are configured to sense a variety of parameters at end effector (40), including but not limited to temperature of adjacent tissue, electrical resistance or impedance of adjacent tissue, voltage across adjacent tissue, forces exerted on jaws (42, 44) by adjacent tissue, etc. By way of example only, end effector (40) may include one or more positive temperature coefficient (PTC) thermistor bodies (54, 56) (e.g., PTC polymer, etc.), located adjacent to electrodes (50, 52) and/or elsewhere. Data from sensors may be communicated to controller (82). Controller (82) may process such data in a variety of ways. By way of example only, controller (82) may modulate or otherwise change the RF energy being delivered to electrode surfaces (50, 52), based at least in part on data acquired from one or more sensors at end effector (40). In addition or in the alternative, controller (82) may alert the user to one or more conditions via an audio and/or visual feedback device (e.g., speaker, lights, display screen, etc.), based at least in part on data acquired from one or more sensors at end effector (40). It should also be understood that some kinds of sensors need not necessarily be in communication with controller (82), and may simply provide a purely localized effect at end effector (40). For instance, a PTC thermistor bodies (54, 56) at end effector (40) may automatically reduce the energy delivery at electrode surfaces (50, 52) as the temperature of the tissue and/or end effector (40) increases, thereby reducing the likelihood of overheating. In some such versions, a PTC thermistor element is in series with power source (80) and electrode surface (50, 52); and the PTC thermistor provides an increased impedance (reducing flow of current) in response to temperatures exceeding a threshold. Furthermore, it should be understood

that electrode surfaces (50, 52) may be used as sensors (e.g., to sense tissue impedance, etc.). Various kinds of sensors that may be incorporated into electrosurgical instrument (10) will be apparent to those of ordinary skill in the art in view of the teachings herein. Similarly various things that can be done with data from sensors, by controller (82) or otherwise, will be apparent to those of ordinary skill in the art in view of the teachings herein. Other suitable variations for end effector (40) will also be apparent to those of ordinary skill in the art in view of the teachings herein.

[00038] C. Exemplary Firing Beam

[00039] As also seen in FIGS. 2-4, electrosurgical instrument (10) of the present example includes a firing beam (60) that is longitudinally movable along part of the length of end effector (40). Firing beam (60) is coaxially positioned within shaft (30), extends along the length of shaft (30), and translates longitudinally within shaft (30) (including articulation section (36) in the present example), though it should be understood that firing beam (60) and shaft (30) may have any other suitable relationship. In some versions, a proximal end of firing beam (60) is secured to a firing tube or other structure within shaft (30); and the firing tube or other structure extends through the remainder of shaft (30) to handpiece (20) where it is driven by movement of trigger (24). Firing beam (60) includes a sharp distal blade (64), an upper flange (62), and a lower flange (66). As best seen in FIG. 4, distal blade (64) extends through slots (46, 48) of jaws (42, 44), with upper flange (62) being located above jaw (44) in recess (59) and lower flange (66) being located below jaw (42) in recess (58). The configuration of distal blade (64) and flanges (62, 66) provides an "I-beam" type of cross section at the distal end of firing beam (60). While flanges (62, 66) extend longitudinally only along a small portion of the length of firing beam (60) in the present example, it should be understood that flanges (62, 66) may extend longitudinally along any suitable length of firing beam (60). In addition, while flanges (62, 66) are positioned along the exterior of jaws (42, 44), flanges (62, 66) may alternatively be disposed in corresponding slots formed within jaws (42, 44). For instance, each jaw (42, 44) may define a "T"-shaped slot, with parts of distal blade (64) being disposed in one vertical portion of each "T"-shaped slot and with flanges (62, 66) being disposed in the horizontal portions of the "T"-shaped slots. Various other suitable

configurations and relationships will be apparent to those of ordinary skill in the art in view of the teachings herein.

[00040] Distal blade (64) is substantially sharp, such that distal blade (64) will readily sever tissue that is captured between jaws (42, 44). Distal blade (64) is also electrically grounded in the present example, providing a return path for RF energy as described elsewhere herein. In some other versions, distal blade (64) serves as an active electrode.

[00041] The “I-beam” type of configuration of firing beam (60) provides closure of jaws (42, 44) as firing beam (60) is advanced distally. In particular, flange (62) urges jaw (44) pivotally toward jaw (42) as firing beam (60) is advanced from a proximal position (FIGS. 1-3) to a distal position (FIG. 4), by bearing against recess (59) formed in jaw (44). This closing effect on jaws (42, 44) by firing beam (60) may occur before distal blade (64) reaches tissue captured between jaws (42, 44). Such staging of encounters by firing beam (60) may reduce the force required to squeeze trigger (24) to actuate firing beam (60) through a full firing stroke. In other words, in some such versions, firing beam (60) may have already overcome an initial resistance required to substantially close jaws (42, 44) on tissue before encountering resistance from severing the tissue captured between jaws (42, 44). Of course, any other suitable staging may be provided.

[00042] In the present example, flange (62) is configured to cam against a ramp feature at the proximal end of jaw (44) to open jaw (44) when firing beam (60) is retracted to a proximal position and to hold jaw (44) open when firing beam (60) remains at the proximal position. This camming capability may facilitate use of end effector (40) to separate layers of tissue, to perform blunt dissections, etc., by forcing jaws (42, 44) apart from a closed position. In some other versions, jaws (42, 44) are resiliently biased to an open position by a spring or other type of resilient feature. While jaws (42, 44) close or open as firing beam (60) is translated in the present example, it should be understood that other versions may provide independent movement of jaws (42, 44) and firing beam (60). By way of example only, one or more cables, rods, beams, or other features may extend through shaft (30) to selectively actuate jaws (42, 44) independently of firing beam (60). Such jaw (42, 44) actuation features may be separately controlled by a dedicated feature of handpiece (20). Alternatively, such jaw actuation features may be controlled by

trigger (24) in addition to having trigger (24) control firing beam (60). It should also be understood that firing beam (60) may be resiliently biased to a proximal position, such that firing beam (60) retracts proximally when a user relaxes their grip on trigger (24).

[00043] FIG. 5 shows an exemplary alternative firing beam (70), which may be readily substituted for firing beam (60). In this example, firing beam (70) comprises a blade insert (94) that is interposed between two beam plates (90, 92). Blade insert (94) includes a sharp distal edge (96), such that blade insert (94) will readily sever tissue that is captured between jaws (42, 44). Sharp distal edge (96) is exposed by a proximally extending recess (93) formed in plates (90, 92). A set of pins (72, 74, 76) are transversely disposed in plates (90, 92). Pins (72, 74) together effectively serve as substitutes for upper flange (62); while pin (76) effectively serves as a substitute for lower flange (66). Thus, pins (72, 74) bear against channel (59) of jaw (44), and pin (76) bears against channel (58) of jaw (42), as firing beam (70) is translated distally through slots (46, 48). Pins (72, 74, 76) of the present example are further configured to rotate within plates (90, 92), about the axes respectively defined by pins (72, 74, 76). It should be understood that such rotatability of pins (72, 74, 76) may provide reduced friction with jaws (42, 44), thereby reducing the force required to translate firing beam (70) distally and proximally in jaws (42, 44). Pin (72) is disposed in an angled elongate slot (98) formed through plates (90, 92), such that pin (72) is translatable along slot (98). In particular, pin (72) is disposed in the proximal portion of slot (98) as firing beam (70) is being translated distally. When firing beam (70) is translated proximally, pin (72) slides distally and upwardly in slot (98), increasing the vertical separation between pins (72, 76), which in turn reduces the compressive forces applied by jaws (42, 44) and thereby reduces the force required to retract firing beam (70). Pins (72, 74, 76) may be pinged, upended, or otherwise configured to provide further retention in the body of firing beam (70). Of course, firing beam (70) may have any other suitable configuration. By way of example only, firing beam (70) may be configured in accordance with at least some of the teachings of U.S. Pub. No. 2012/0083783, the disclosure of which is incorporated by reference herein.

[00044] D. Exemplary Operation

[00045] In an exemplary use, end effector (40) is inserted into a patient via a trocar. Articulation section (36) is substantially straight when end effector (40) and part of shaft (30) are inserted through the trocar. Articulation control (28) may then be manipulated to pivot or flex articulation section (36) of shaft (30) in order to position end effector (40) at a desired position and orientation relative to an anatomical structure within the patient. Two layers of tissue of the anatomical structure are then captured between jaws (42, 44) by squeezing trigger (24) toward pistol grip (22). Such layers of tissue may be part of the same natural lumen defining anatomical structure (e.g., blood vessel, portion of gastrointestinal tract, portion of reproductive system, etc.) in a patient. For instance, one tissue layer may comprise the top portion of a blood vessel while the other tissue layer may comprise the bottom portion of the blood vessel, along the same region of length of the blood vessel (e.g., such that the fluid path through the blood vessel before use of electrosurgical instrument (10) is perpendicular to the longitudinal axis defined by end effector (40), etc.). In other words, the lengths of jaws (42, 44) may be oriented perpendicular to (or at least generally transverse to) the length of the blood vessel. As noted above, flanges (62, 66) cammingly act to pivot jaw (42) toward jaw (44) when firing beam (60) is actuated distally by squeezing trigger (24) toward pistol grip (22). Jaws (42, 44) may be substantially clamping tissue before trigger (24) has swept through a full range of motion toward pistol grip (22), such that trigger (24) may continue pivoting toward pistol grip (22) through a subsequent range of motion after jaws (42, 44) have substantially clamped on the tissue.

[00046] With tissue layers captured between jaws (42, 44) firing beam (60) continues to advance distally by the user squeezing trigger (24) further toward pistol grip (22). As firing beam (60) continues to advance distally, distal blade (64) simultaneously severs the clamped tissue layers, resulting in separated upper layer portions being apposed with respective separated lower layer portions. In some versions, this results in a blood vessel being cut in a direction that is generally transverse to the length of the blood vessel. It should be understood that the presence of flanges (62, 66) immediately above and below jaws (42, 44), respectively, help keep jaws (42, 44) in a closed and tightly clamping position. In particular, flanges (62, 66) help maintain a significantly compressive force between jaws (42, 44). With severed tissue layer portions being compressed between

jaws (42, 44), bipolar RF energy is applied to the tissue through electrode surfaces (50, 52) by the user depressing activation button (26). Thus, a bipolar RF current flows through the compressed regions of severed tissue layer portions. The bipolar RF energy delivered by power source (80) ultimately thermally welds the tissue layer portions on one side of firing beam (60) together and the tissue layer portions on the other side of firing beam (60) together.

[00047] In certain circumstances, the heat generated by activated electrode surfaces (50, 52) can denature the collagen within the tissue layer portions and, in cooperation with clamping pressure provided by jaws (42, 44), the denatured collagen can form a seal within the tissue layer portions. Thus, the severed ends of the natural lumen defining anatomical structure are hemostatically sealed shut, such that the severed ends will not leak bodily fluids. In some versions, electrode surfaces (50, 52) may be activated with bipolar RF energy before firing beam (60) even begins to translate distally and thus before the tissue is even severed. For instance, such timing may be provided in versions where button (26) serves as a mechanical lockout relative to trigger (24) in addition to serving as a switch between power source (80) and electrode surfaces (50, 52). Other suitable ways in which instrument (10) may be operable and operated will be apparent to those of ordinary skill in the art in view of the teachings herein.

[00048] II. Exemplary Electrosurgical Forceps

[00049] As a variation of instrument (10) discussed above, instrument (10) may be arranged as an electrosurgical forceps. For instance, handpiece (20) may be reconfigured from a pistol grip configuration to a scissor grip configuration. In addition, shaft (30) may be reconfigured as a pair of pivoting scissor arms. Various examples of how instrument (10) may be reconfigured as an electrosurgical forceps will be described in greater detail below; while other examples will be apparent to those of ordinary skill in the art according to the teachings herein. It should be understood that the electrosurgical forceps examples described below may function substantially similar to instrument (10) described above. In particular, the electrosurgical forceps described below may be used to grasp and clamp tissue, seal the tissue with bipolar RF energy, and cut the tissue with a translating firing beam.

[00050] One merely exemplary variation of an electrosurgical forceps (100) is shown in FIG.S 6A-7B. Forceps (100) of the present example comprise a body (120), a lever (110), an end effector (130), and a trigger (140). End effector (130) is disposed at a distal end of body (120). Body (120) of the present example includes a grip (122) at a proximal end of body (120). Lever (110) of the present example includes a grip (112) at a proximal end of lever (110). Lever (110) is pivotable toward and away from body (120) to selectively open and close end effector (130) as will be described in greater detail below. An activation button (142) is operable to selectively activate RF circuitry that is in communication with end effector (130), as will also be described in greater detail below. In some versions, button (142) also serves as a mechanical lockout against trigger (140), such that trigger (140) cannot be actuated unless button (142) is being pressed simultaneously. As shown in FIG. 6A-6B, trigger (140) is slidably disposed with an elongate slot (124) of body (120). It should be understood that trigger (140) may slide longitudinally relative to body (120) within elongate slot (124). Longitudinal channels (not shown), although not necessary, may be defined within the internal surface of elongate slot (124) such that trigger (140) may be guided within the longitudinal channels. Forceps (100) may be coupled with an electrical source (not shown) and a controller (not shown) via a cable (150), which extends proximally from body (120).

[00051] A. Exemplary End Effector

[00052] End effector (130) of the present example comprises a first jaw (134) and a second jaw (132). First jaw (134) is configured to operate substantially similar to first jaw (42) as discussed above with reference to instrument (10) and second jaw (132) is configured to operate substantially similar to second jaw (44) as discussed above with reference to instrument (10), except for the differences discussed below. In the present example, second jaw (132) is substantially fixed relative to body (120); while first jaw (134) pivots relative to body (120), toward and away from second jaw (132). Lever (110) is configured to pivot about an axis that is defined by a pin (or similar feature) (136). First jaw (134) also pivots about the axis that is defined by pin (136). As shown in FIG. 6B, first jaw (134) is coupled to lever (110) at a distal end of lever (110) such that as lever (110) pivots about the axis that is defined by pin (136), first jaw (134) pivots as

well. During an exemplary operation, lever (110) may drive first jaw (134) from a closed position as shown in FIG. 6A, to an open position as shown in FIG. 6B, and back to the closed position as shown in FIG. 6A. In some versions, lever (110) also serves as a mechanical lockout against trigger (140) and/or button (142), such that trigger (140) and/or button (142) cannot be actuated unless lever (110) is in the closed position as shown in FIG. 6A.

[00053] B. Exemplary Firing Beam

[00054] 1. Exemplary Activation Apparatus

[00055] As seen in FIGS. 7A-7B, forceps (100) of the present example include a firing beam (162) that is longitudinally movable along part of the length of end effector (130). Firing beam (162) is configured to operate substantially similar to firing beam (70) as discussed above with reference to instrument (10). Firing beam (162) is positioned within body (120) and translates longitudinally within body (120). Firing beam (162) comprises a proximal portion (167) and a distal portion (190). Distal portion (190) of firing beam (162) comprises a blade insert (194) having a sharp distal edge (196) such that blade insert (194) will readily sever tissue that is captured between first jaw (134) and second jaw (132) as firing beam (162) is advanced distally. Firing beam (162) presents a first slot (161) within proximal portion (167) and a second slot (163) within distal portion (190). Body (120) presents a first pin (121) and a second pin (123). Pins (121, 123) are slidably disposed within respective slots (161, 163) such that firing beam (162) may slide longitudinally within body (120). Although the present example utilizes slots (161, 163) and pins (121, 123) to guide firing beam (162), it should be understood that other methods of guiding firing beam (162) may be utilized and would be apparent to those of ordinary skill in the art in view of the teachings herein. For instance, body (120) may present a series of channels (not shown) within which firing beam (162) could slide.

[00056] As shown in FIG. 7A, proximal portion (167) of firing beam (162) also comprises a plurality of teeth (164) that form a rack. A gear (166) is disposed within body (120) and rotates about a third pin (125). Gear (166) comprises a plurality of teeth (169). Teeth (169) of gear (166) engage teeth (164) of firing beam (162) in a rack and pinion

relationship. An elongate member (144) extends distally from trigger (140). Elongate member (144) presents a third slot (145). Body (120) presents a fourth pin (127). Fourth pin (127) is slidably disposed within third slot (145) such that elongate member (144) may slide longitudinally within body (120). Although the present example utilizes slot (145) and pin (127) to guide elongate member (144), it should be understood that other methods of guiding elongate member (144) may be utilized and would be apparent to those of ordinary skill in the art in view of the teachings herein. For instance, body (120) may present a channel within which elongate member (144) could slide. Elongate member (144) comprises a plurality of teeth (146). Teeth (169) of gear (166) engage teeth (146) of elongate member (144) in a rack and pinion relationship. As shown in FIG. 7A, teeth (164) of firing beam (162) and teeth (146) of elongate member (144) engage teeth (169) of gear (166) on opposite sides of gear (166). Therefore, it should be understood that longitudinal movement of elongate member (144) in a first direction will cause longitudinal movement of firing beam (162) in a second direction.

[00057] As discussed above, trigger (140) may slide longitudinally relative to body (120) within elongate slot (124). Initially, trigger (140) remains in a distal position as shown in FIG. 7A. When trigger (140) is in this distal position, firing beam (162) remains in a proximal position as shown in FIG. 7A. Once tissue has been captured between first jaw (134) and second jaw (132), the user may begin to pull trigger (140) in a proximal direction within elongate slot (124). As the user begins to pull trigger (140) proximally, the force required to do so will cause button (142) to be depressed thereby causing RF energy to be delivered into the tissue captured between first jaw (134) and second jaw (132) via electrodes in jaws (132, 134). Therefore it should be understood that RF energy will be delivered into the tissue captured between first jaw (134) and second jaw (132) prior to the tissue being severed by blade insert (194). As the user continues to pull trigger (140) proximally, button (142) remains depressed and RF energy is continually delivered to the tissue captured between first jaw (134) and second jaw (132).

[00058] As trigger (140) is moved into a proximal position as shown in FIG. 7B, the longitudinal movement of trigger (140) causes elongate member (144) to be moved proximally as well. This proximal longitudinal movement of elongate member (144)

causes gear (166) to be rotated in a clock-wise (CW) direction about third pin (125). This CW rotation of gear (166) causes distal longitudinal movement of firing beam (162). Such distal longitudinal movement of firing beam (162) will drive blade insert (194) to sever the tissue captured between first jaw (134) and second jaw (132). After the tissue has been severed, the user may draw firing beam (162) proximally by moving trigger (140) distally. While FIG. 7B shows a particular distance between sharp distal edge (196) and the distal tips of jaws (132, 134) upon completion of the distal advancement stroke of firing beam (162), it should be understood that forceps (100) may be configured such that this distance may be reduced relative to what is shown in FIG. 7B. For instance, forceps (100) may be configured such that sharp distal edge (196) reaches the distal tips of jaws (132, 134) (or a location just barely proximal to the distal tips of jaws (132, 134)) upon completion of the distal advancement stroke of firing beam (162). This may reduce any likelihood of tissue between jaws (132, 134) being left unsevered upon completion of the distal advancement stroke of firing beam (162).

[00059] The steps of capturing tissue between first jaw (134) and second jaw (132), severing tissue with blade insert (194), and drawing firing beam (162) from the tissue, may be repeated as many times as desired. It should be understood that, although in the present example the user manually draws firing beam (162) proximally from the tissue by moving trigger (140) distally, such proximal movement of firing beam (162) may be caused by a biasing member (not shown) which drives trigger (140) in a distal direction once the user has released trigger (140). For instance, a spring, or a plurality of springs, may be positioned to bias trigger (140) distally.

[00060] 2. First Exemplary Alternative Activation Apparatus

[00061] An exemplary alternative pair of electrosurgical forceps (200) is shown in FIG. 8A-8B. Forceps (200) and the components discussed below are configured to operate substantially similar to forceps (100) discussed above except for the differences discussed below. As seen in FIGS. 8A-8B, forceps (200) include a firing beam (262) that is longitudinally movable along part of the length of an end effector (230). Firing beam (262) is configured to operate substantially similar to firing beam (70) as discussed above with reference to instrument (10). Firing beam (262) is positioned within a body (220)

and translates longitudinally within body (220). Firing beam (262) comprises a proximal portion (267) and a distal portion (290). Distal portion (290) of firing beam (262) comprises a blade insert (294) having a sharp distal edge (296) such that blade insert (294) will readily sever tissue that is captured between a first jaw (234) and a second jaw (232) as firing beam (262) is advanced distally. Firing beam (262) presents a first slot (261) within proximal portion (267) and a second slot (263) within distal portion (290). Body (220) presents a first pin (221) and a second pin (223). Pins (221, 223) are slidably disposed within respective slots (261, 263) such that firing beam (262) may slide longitudinally within body (220). Although the present example utilizes slots (261, 263) and pins (221, 223) to guide firing beam (262), it should be understood that other methods of guiding firing beam (262) may be utilized and would be apparent to those of ordinary skill in the art in view of the teachings herein. For instance, body (220) may present a channel (not shown) within which firing beam (262) could slide.

[00062] As shown in FIG. 8A, proximal portion (267) of firing beam (262) comprises a first plurality of teeth (264A) on a first side of firing beam (262) and a second plurality of teeth (264B) on a second side of firing beam (262). A first gear (266) is disposed within body (220) and rotates about a third pin (225). First gear (266) comprises a plurality of teeth (265). A second gear (268) is disposed within body (220) and rotates about a fourth pin (226). Second gear (268) comprises a plurality of teeth (269). Teeth (265) of first gear (266) engage first plurality of teeth (264A) of firing beam (262) in a rack and pinion relationship. Teeth (269) of second gear (268) engage teeth (264B) of firing beam (262) in a rack and pinion relationship.

[00063] A first elongate member (244) extends distally from a trigger (240). First elongate member (244) comprises a plurality of teeth (245). Teeth (265) of first gear (266) engage teeth (245) of first elongate member (244) in a rack and pinion relationship. A second elongate member (246) also extends distally from trigger (240). Second elongate member (246) comprises a plurality of teeth (247). Teeth (269) of second gear (268) engage teeth (247) of second elongate member (246) in a rack and pinion relationship. Both first elongate member (244) and second elongate member (246) are inwardly biased toward firing beam (262) such that first elongate member (244) and

second elongate member (246) remain in contact with first gear (266) and second gear (268) respectively. This inward bias of first elongate member (244) and second elongate member (246) allows for a distal portion of forceps (200) to have a reduced cross-sectional area. As shown in FIG. 8A, first plurality of teeth (264A) of firing beam (262) and teeth (245) of first elongate member (244) engage teeth (265) of first gear (266) on opposites sides of first gear (266). Also as shown in FIG. 8A, second plurality of teeth (264B) of firing beam (262) and teeth (247) of second elongate member (246) engage teeth (269) of second gear (268) on opposites sides of second gear (268). Therefore, it should be understood that longitudinal movement of first elongate member (244) and second elongate member (246) in a first direction will cause longitudinal movement of firing beam (262) in a second direction.

[00064] Trigger (240) may slide longitudinally relative to body (220) within an elongate slot (224). Initially, trigger (240) remains in a distal position as shown in FIG. 8A. When trigger (240) is in this distal position, firing beam (262) remains in a proximal position as shown in FIG. 8A. Once tissue has been captured between first jaw (234) and second jaw (232), the user may begin to pull trigger (240) in a proximal direction within elongate slot (224). As the user begins to pull trigger (240) proximally, the force required to do so will cause a button (242) to be depressed thereby causing RF energy to be delivered into the tissue captured between first jaw (234) and second jaw (232) via electrodes in jaws (232, 234). Therefore, it should be understood that RF energy will be delivered into the tissue captured between first jaw (234) and second jaw (232) prior to the tissue being severed by blade insert (294). As the user continues to pull trigger (240) proximally, button (242) remains depressed and RF energy is continually delivered to the tissue captured between first jaw (234) and second jaw (232).

[00065] As trigger (240) is moved into a proximal position as shown in FIG. 8B, the longitudinal movement of trigger (240) causes first elongate member (244) and second elongate member (246) to be moved proximally as well. The resilience of first elongate member (244) and second elongate member (246) causes first elongate member (244) and second elongate member (246) to remain in contact with first gear (266) and second gear (268), respectively; while the flexibility of first elongate member (244) and second

elongate member (246) allow first elongate member (244) and second elongate member (246) to flex outwardly during the transition of trigger (240) from the position shown in FIG. 8A to the position shown in FIG. 8B. The proximal longitudinal movement of first elongate member (244) causes first gear (266) to be rotated in a CW direction about third pin (225). The proximal longitudinal movement of second elongate member (246) causes second gear (268) to be rotated in a Counter-Clockwise (CCW) direction about fourth pin (226). The combination of CW rotation of first gear (266) and CCW rotation of second gear (268) causes distal longitudinal movement of firing beam (262). Such distal longitudinal movement of firing beam (262) will drive blade insert (294) to sever the tissue captured between first jaw (234) and second jaw (232). After the tissue has been severed, the user may draw firing beam (262) proximally by moving trigger (240) distally. The resilience of first elongate member (244) and second elongate member (246) causes first elongate member (244) and second elongate member (246) to return to the inwardly biased position as shown in FIG. 8A.

[00066] While FIG. 8B shows a particular distance between sharp distal edge (296) and the distal tips of jaws (232, 234) upon completion of the distal advancement stroke of firing beam (262), it should be understood that forceps (200) may be configured such that this distance may be reduced relative to what is shown in FIG. 8B. For instance, forceps (200) may be configured such that sharp distal edge (296) reaches the distal tips of jaws (232, 234) (or a location just barely proximal to the distal tips of jaws (232, 234)) upon completion of the distal advancement stroke of firing beam (262). This may reduce any likelihood of tissue between jaws (232, 234) being left unsevered upon completion of the distal advancement stroke of firing beam (262).

[00067] The steps of capturing tissue between first jaw (234) and second jaw (232), severing tissue with blade insert (294), and drawing firing beam (262) from the tissue, may be repeated as many times as desired. It should be understood, that although in the present example the user manually draws firing beam (262) proximally from the tissue by moving trigger (240) distally, such proximal movement of firing beam (262) may be caused by a biasing member (not shown) which drives trigger (240) in a distal direction

once the user has released trigger (240). For instance, a spring, or a plurality of springs, may be positioned to bias trigger (240) distally.

[00068] 3. Second Exemplary Alternative Activation Apparatus

[00069] Another exemplary alternative pair of electrosurgical forceps (300) is shown in FIG. 9A-9B. Forceps (300) and the components discussed below are configured to operate substantially similar to forceps (100) discussed above except for the differences discussed below. As seen in FIGS. 9A-9B, forceps (300) include a firing beam (362) that is longitudinally movable along part of the length of an end effector (330). Firing beam (362) is configured to operate substantially similar to firing beam (70) as discussed above with reference to instrument (10). Firing beam (362) is positioned within a body (320) and translates longitudinally within body (320). Firing beam (362) comprises a proximal portion (367) and a distal portion (390). Proximal portion (367) of firing beam (362) includes a first arm (367A) and a second arm (367B). Distal portion (390) of firing beam (362) comprises a blade insert (394) having a sharp distal edge (396) such that blade insert (394) will readily sever tissue that is captured between a first jaw (334) and a second jaw (332) as firing beam (362) is advanced distally. Firing beam (362) presents a first slot (361) within first arm (367A) of proximal portion (367) and a second slot (363) within second arm (367B) of proximal portion (367). Body (320) presents a first pin (321) and a second pin (323). Pins (321, 323) are slidably disposed within respective slots (361, 363) such that firing beam (362) may slide longitudinally within body (320). Although the present example utilizes slots (361, 363) and pins (321, 323) to guide firing beam (362), it should be understood that other methods of guiding firing beam (362) may be utilized and would be apparent to those of ordinary skill in the art in view of the teachings herein. For instance, body (320) may present a channel (not shown) within which firing beam (362) could slide.

[00070] As shown in FIG. 9A, first arm (367A) of proximal portion (367) of firing beam (362) comprises a first plurality of teeth (364A). A first gear (366) is disposed within body (320) and rotates about a third pin (325). First gear (366) comprises a plurality of teeth (365). Teeth (365) of first gear (366) engage first plurality of teeth (364A) of firing beam (362) in a rack and pinion relationship. Second arm (367B) of proximal portion

(367) of firing beam (362) comprises a second plurality of teeth (364B). A second gear (368) is disposed within body (320) and rotates about a fourth pin (326). Second gear (368) comprises a plurality of teeth (369). Teeth (369) of second gear (368) engage teeth (364B) of firing beam (362) of firing beam (362) in a rack and pinion relationship.

[00071] An elongate member (344) extends distally from a trigger (340). Elongate member (344) presents a third slot (346). Body (320) presents a fifth pin (327). Fifth pin (327) is slidably disposed within third slot (346) such that elongate member (344) may slide longitudinally within body (320). Although the present example utilizes slot (346) and fifth pin (327) to guide elongate member (344), it should be understood that other methods of guiding elongate member (344) may be utilized and would be apparent to those of ordinary skill in the art in view of the teachings herein. For instance, body (320) may present a channel within which elongate member (344) could slide.

[00072] Elongate member (344) comprises a first plurality of teeth (345) on a first side of elongate member (344) and a second plurality of teeth (347) on a second side of elongate member (344). Teeth (365) of first gear (366) engage first plurality of teeth (345) of elongate member (344) in a rack and pinion relationship. Teeth (369) of second gear (368) engage second plurality of teeth (347) of elongate member (344) in a rack and pinion relationship. As shown in FIG. 9A, first plurality of teeth (364A) of first arm (367A) of firing beam (362) and first plurality of teeth (345) of elongate member (344) engage teeth (365) of first gear (366) on opposite sides of first gear (366). Also as shown in FIG. 9A, second plurality of teeth (364B) of second arm (367B) of firing beam (362) and teeth (347) of elongate member (344) engage teeth (369) of second gear (368) on opposite sides of second gear (368). Therefore, it should be understood that longitudinal movement of elongate member (344) in a first direction will cause longitudinal movement of firing beam (362) in a second direction.

[00073] Trigger (340) may slide longitudinally relative to body (320) within an elongate slot (324). Initially, trigger (340) remains in a distal position as shown in FIG. 9A. When trigger (340) is in this distal position, firing beam (362) remains in a proximal position as shown in FIG. 9A. Once tissue has been captured between first jaw (334) and second jaw (332), the user may begin to pull trigger (340) in a proximal direction within

elongate slot (324). As the user begins to pull trigger (340) proximally, the force required to do so will cause a button (342) to be depressed thereby causing RF energy to be delivered into the tissue captured between first jaw (334) and second jaw (332) via electrodes in jaws (332, 334). Therefore it should be understood that RF energy will be delivered into the tissue captured between first jaw (334) and second jaw (332) prior to the tissue being severed by blade insert (394). As the user continues to pull trigger (340) proximally, button (342) remains depressed and RF energy is continually delivered to the tissue captured between first jaw (334) and second jaw (332).

[00074] As trigger (340) is moved into a proximal position as shown in FIG. 9B, the longitudinal movement of trigger (340) causes elongate member (344) to be moved proximally as well. The proximal longitudinal movement of elongate member (344) causes first gear (366) to be rotated in a CCW direction about third pin (325). The proximal longitudinal movement of elongate member (344) also causes second gear (368) to be rotated in a CW direction about fourth pin (326). The combination of CCW rotation of first gear (366) and CW rotation of second gear (368) causes distal longitudinal movement of firing beam (362). Such distal longitudinal movement of firing beam (362) will drive blade insert (394) to sever the tissue captured between first jaw (334) and second jaw (332). After the tissue has been severed, the user may draw firing beam (362) proximally by moving trigger (340) distally.

[00075] While FIG. 9B shows a particular distance between sharp distal edge (396) and the distal tips of jaws (332, 334) upon completion of the distal advancement stroke of firing beam (362), it should be understood that forceps (300) may be configured such that this distance may be reduced relative to what is shown in FIG. 9B. For instance, forceps (300) may be configured such that sharp distal edge (396) reaches the distal tips of jaws (332, 334) (or a location just barely proximal to the distal tips of jaws (332, 334)) upon completion of the distal advancement stroke of firing beam (362). This may reduce any likelihood of tissue between jaws (332, 334) being left unsevered upon completion of the distal advancement stroke of firing beam (362).

[00076] The steps of capturing tissue between first jaw (334) and second jaw (332), severing tissue with blade insert (394), and drawing firing beam (362) from the tissue, may be repeated as many times as desired. It should be understood, that although in the present example the user manually draws firing beam (362) proximally from the tissue by moving trigger (340) distally, such proximal movement of firing beam (362) may be caused by a biasing member (not shown) which drives trigger (340) in a distal direction once the user has released trigger (340). For instance, a spring, or a plurality of springs, may be positioned to bias trigger (340) distally.

[00077] III. Miscellaneous

[00078] It should be understood that any of the versions of electrosurgical instrument (10) described herein may include various other features in addition to or in lieu of those described above. By way of example only, any of the devices herein may also include one or more of the various features disclosed in any of the various references that are incorporated by reference herein.

[00079] It should also be understood that any of the devices described herein may be modified to include a motor or other electrically powered device to drive an otherwise manually moved component. Various examples of such modifications are described in U.S. Pub. No. 2012/0116379, entitled "Motor Driven Electrosurgical Device with Mechanical and Electrical Feedback," published May 10, 2012, the disclosure of which is incorporated by reference herein. Various other suitable ways in which a motor or other electrically powered device may be incorporated into any of the devices herein will be apparent to those of ordinary skill in the art in view of the teachings herein.

[00080] It should also be understood that any of the devices described herein may be modified to contain most, if not all, of the required components within the medical device itself. More specifically, the devices described herein may be adapted to use an internal or attachable power source instead of requiring the device to be plugged into an external power source by a cable. Various examples of how medical devices may be adapted to include a portable power source are disclosed in U.S. Provisional Application Serial No. 61/410,603, filed November 5, 2010, entitled "Energy-Based Surgical Instruments," the

disclosure of which is incorporated by reference herein. Various other suitable ways in which a power source may be incorporated into any of the devices herein will be apparent to those of ordinary skill in the art in view of the teachings herein.

[00081] While the examples herein are described mainly in the context of electrosurgical instruments, it should be understood that various teachings herein may be readily applied to a variety of other types of devices. By way of example only, the various teachings herein may be readily applied to other types of electrosurgical instruments, tissue graspers, tissue retrieval pouch deploying instruments, surgical staplers, surgical clip applicators, ultrasonic surgical instruments, etc. It should also be understood that the teachings herein may be readily applied to any of the instruments described in any of the references cited herein, such that the teachings herein may be readily combined with the teachings of any of the references cited herein in numerous ways. Other types of instruments into which the teachings herein may be incorporated will be apparent to those of ordinary skill in the art.

[00082] In versions where the teachings herein are applied to a surgical stapling instrument, it should be understood that the teachings herein may be combined with the teachings of one or more of the following, the disclosures of all of which are incorporated by reference herein: U.S. Pat. No. 4,805,823, entitled "Pocket Configuration for Internal Organ Staplers," issued February 21, 1989; U.S. Pat. No. 5,415,334, entitled "Surgical Stapler and Staple Cartridge," issued May 16, 1995; U.S. Pat. No. 5,465,895, entitled "Surgical Stapler Instrument," issued November 14, 1995; U.S. Pat. No. 5,597,107, entitled "Surgical Stapler Instrument," issued January 28, 1997; U.S. Pat. No. 5,632,432, entitled "Surgical Instrument," issued May 27, 1997; U.S. Pat. No. 5,673,840, entitled "Surgical Instrument," issued October 7, 1997; U.S. Pat. No. 5,704,534, entitled "Articulation Assembly for Surgical Instruments," issued January 6, 1998; U.S. Pat. No. 5,814,055, entitled "Surgical Clamping Mechanism," issued September 29, 1998; U.S. Pat. No. 6,978,921, entitled "Surgical Stapling Instrument Incorporating an E-Beam Firing Mechanism," issued December 27, 2005; U.S. Pat. No. 7,000,818, entitled "Surgical Stapling Instrument Having Separate Distinct Closing and Firing Systems," issued February 21, 2006; U.S. Pat. No. 7,143,923, entitled "Surgical Stapling Instrument

Having a Firing Lockout for an Unclosed Anvil,” issued December 5, 2006; U.S. Pat. No. 7,303,108, entitled “Surgical Stapling Instrument Incorporating a Multi-Stroke Firing Mechanism with a Flexible Rack,” issued December 4, 2007; U.S. Pat. No. 7,367,485, entitled “Surgical Stapling Instrument Incorporating a Multistroke Firing Mechanism Having a Rotary Transmission,” issued May 6, 2008; U.S. Pat. No. 7,380,695, entitled “Surgical Stapling Instrument Having a Single Lockout Mechanism for Prevention of Firing,” issued June 3, 2008; U.S. Pat. No. 7,380,696, entitled “Articulating Surgical Stapling Instrument Incorporating a Two-Piece E-Beam Firing Mechanism,” issued June 3, 2008; U.S. Pat. No. 7,404,508, entitled “Surgical Stapling and Cutting Device,” issued July 29, 2008; U.S. Pat. No. 7,434,715, entitled “Surgical Stapling Instrument Having Multistroke Firing with Opening Lockout,” issued October 14, 2008; U.S. Pat. No. 7,721,930, entitled “Disposable Cartridge with Adhesive for Use with a Stapling Device,” issued May 25, 2010; U.S. Pub. No. 2010/0264193, entitled “Surgical Stapling Instrument with An Articulatable End Effector,” published October 21, 2010; and U.S. Pub. No. 2012/0239012, entitled “Motor-Driven Surgical Cutting Instrument with Electric Actuator Directional Control Assembly,” published September 20, 2012. Other suitable ways in which the teachings herein may be applied to a surgical stapling instrument will be apparent to those of ordinary skill in the art in view of the teachings herein.

[00083] In versions where the teachings herein are applied to an ultrasonic surgical instrument, it should be understood that some such instruments may lack a translating firing beam. The components described herein for translating a firing beam may instead simply translate a jaw closing member. Alternatively, such translating features may simply be omitted. In any case, it should be understood that the teachings herein may be combined with the teachings of one or more of the following: U.S. Pat. Pub. No. 2006/0079874, entitled “Tissue Pad for Use with an Ultrasonic Surgical Instrument,” published April 13, 2006, the disclosure of which is incorporated by reference herein; U.S. Pat. Pub. No. 2007/0191713, entitled “Ultrasonic Device for Cutting and Coagulating,” published August 16, 2007, the disclosure of which is incorporated by reference herein; U.S. Pat. Pub. No. 2007/0282333, entitled “Ultrasonic Waveguide and Blade,” published December 6, 2007, the disclosure of which is incorporated by

reference herein; U.S. Pat. Pub. No. 2008/0200940, entitled "Ultrasonic Device for Cutting and Coagulating," published August 21, 2008, the disclosure of which is incorporated by reference herein; U.S. Pat. Pub. No. 2011/0015660, entitled "Rotating Transducer Mount for Ultrasonic Surgical Instruments," published January 20, 2011, the disclosure of which is incorporated by reference herein; U.S. Pat. No. 6,500,176, entitled "Electrosurgical Systems and Techniques for Sealing Tissue," issued December 31, 2002, the disclosure of which is incorporated by reference herein; U.S. Pat. Pub. No. 2011/0087218, entitled "Surgical Instrument Comprising First and Second Drive Systems Actuable by a Common Trigger Mechanism," published April 14, 2011, the disclosure of which is incorporated by reference herein; and/or U.S. Pat. No. 6,783,524, entitled "Robotic Surgical Tool with Ultrasound Cauterizing and Cutting Instrument," issued August 31, 2004, the disclosure of which is incorporated by reference herein. Other suitable ways in which the teachings herein may be applied to an ultrasonic surgical instrument will be apparent to those of ordinary skill in the art in view of the teachings herein.

[00084] It should be understood that any one or more of the teachings, expressions, embodiments, examples, etc. described herein may be combined with any one or more of the other teachings, expressions, embodiments, examples, etc. that are described herein. The above-described teachings, expressions, embodiments, examples, etc. should therefore not be viewed in isolation relative to each other. Various suitable ways in which the teachings herein may be combined will be readily apparent to those of ordinary skill in the art in view of the teachings herein. Such modifications and variations are intended to be included within the scope of the claims.

[00085] It should be appreciated that 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 material does 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.

[00086] Versions of the devices described above may have application in conventional medical treatments and procedures conducted by a medical professional, as well as application in robotic-assisted medical treatments and procedures. By way of example only, various teachings herein may be readily incorporated into a robotic surgical system such as the DAVINCI™ system by Intuitive Surgical, Inc., of Sunnyvale, California. Similarly, those of ordinary skill in the art will recognize that various teachings herein may be readily combined with various teachings of U.S. Pat. No. 6,783,524, entitled “Robotic Surgical Tool with Ultrasound Cauterizing and Cutting Instrument,” published August 31, 2004, the disclosure of which is incorporated by reference herein.

[00087] Versions described above may be designed to be disposed of after a single use, or they can be designed to be used multiple times. Versions may, in either or both cases, be reconditioned for reuse after at least one use. Reconditioning may include any combination of the steps of disassembly of the device, followed by cleaning or replacement of particular pieces, and subsequent reassembly. In particular, some versions of the device may be disassembled, and any number of the particular pieces or parts of the device may be selectively replaced or removed in any combination. Upon cleaning and/or replacement of particular parts, some versions of the device may be reassembled for subsequent use either at a reconditioning facility, or by a user immediately prior to a procedure. Those skilled in the art will appreciate that reconditioning of a device may utilize a variety of 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.

[00088] By way of example only, versions described herein may be sterilized before and/or after a procedure. In one sterilization technique, the device is placed in a closed and sealed container, such as a plastic or TYVEK bag. The container and device may then be placed in a field of radiation that can penetrate the container, such as gamma radiation, x-rays, or high-energy electrons. The radiation may kill bacteria on the device

and in the container. The sterilized device may then be stored in the sterile container for later use. A device may also be sterilized using any other technique known in the art, including but not limited to beta or gamma radiation, ethylene oxide, or steam.

[00089] Having shown and described various embodiments of the present invention, further adaptations of the methods and systems described herein may be accomplished by appropriate modifications by one of ordinary skill in the art without departing from the scope of the present invention. Several of such potential modifications have been mentioned, and others will be apparent to those skilled in the art. For instance, the examples, embodiments, geometrics, materials, dimensions, ratios, steps, and the like discussed above are illustrative and are not required. Accordingly, the scope of the present invention should be considered in terms of the following claims and is understood not to be limited to the details of structure and operation shown and described in the specification and drawings.

I/We claim:

1. An apparatus for operating on tissue, the apparatus comprising:
 - (a) a body, wherein the body comprises a distal end and a proximal end, wherein the body defines an elongate opening, wherein the proximal end of the body defines a first scissor grip;
 - (b) an end effector, wherein the end effector comprises a first jaw and a second jaw, and wherein the first jaw is selectively pivotable toward and away from the second jaw;
 - (c) a lever pivotably coupled to the body, wherein the lever comprises a distal end and a proximal end, wherein the first jaw is coupled to the distal end of the lever, wherein the lever is configured to drive the first jaw toward and away from the second jaw, wherein the proximal end of the lever defines a second scissor grip; and
 - (d) a tissue severing assembly, wherein the tissue severing assembly comprises:
 - (i) a gear, wherein the gear is rotatable about a first axis,
 - (ii) a longitudinally sliding trigger, wherein the trigger is slidably disposed within the elongate opening, wherein the trigger comprises an elongate member extending distally from the trigger, wherein the elongate member is engaged with the gear, and
 - (iii) a firing beam engaged with the gear, wherein the trigger is operable to drive the firing beam.
2. The apparatus of claim 1, wherein a portion of the elongate member is positioned on one side of the gear, wherein a portion of the firing beam is positioned on the opposite side of the gear such that the gear is positioned to convert longitudinal motion of the elongate member in one direction into longitudinal motion of the firing beam in the opposite direction.
3. The apparatus of claim 1, wherein the firing beam comprises a distal end, and wherein the firing beam further comprises a blade positioned at the distal end of the firing beam,

wherein the blade is configured to sever tissue captured between the first and second jaws.

4. The apparatus of claim 1, wherein the body includes a pin, wherein the firing beam comprises a longitudinal slot, and wherein the pin is slidably disposed within the slot.

5. The apparatus of claim 1, wherein the body includes a pin, wherein the elongate member comprises a longitudinal slot, and wherein the pin is slidably disposed within the slot.

6. The apparatus of claim 1, wherein the elongate member is resiliently biased toward the gear.

7. The apparatus of claim 1, wherein the tissue severing assembly further comprises a second gear engaged with the firing beam.

8. The apparatus of claim 7, wherein the trigger further comprises a second elongate member, wherein the second elongate member is engaged with the second gear.

9. The apparatus of claim 1, wherein the end effector comprises at least one electrode operable to apply RF energy to tissue.

10. The apparatus of claim 9, wherein the trigger further comprises a button, and wherein the button is operable to selectively activate the RF energy of the end effector.

11. The apparatus of claim 10, wherein the trigger is configured to be immovable unless the button is depressed.

12. The apparatus of claim 10, wherein the button is configured to be unable to be depressed unless the end effector is in a closed position.

13. The apparatus of claim 1, wherein the trigger is configured to be immovable unless the end effector is in a closed position.

14. The apparatus of claim 1, wherein the tissue severing assembly further comprises a biasing member, and wherein the biasing member is configured to urge the trigger in a distal direction.

15. The apparatus of claim 1, wherein the trigger is positioned distal to the first and second scissor grips.

16. An apparatus for operating on tissue, the apparatus comprising:

- (a) a body, wherein the body comprises a distal end and a proximal end, wherein the body defines an elongate opening, wherein the proximal end of the body defines a first scissor grip;
- (b) an end effector, wherein the end effector comprises a first jaw and a second jaw, and wherein the first jaw is selectively pivotable toward and away from the second jaw;
- (c) a lever pivotably coupled to the body, wherein the lever comprises a distal end and a proximal end, wherein the first jaw is coupled to the distal end of the lever, wherein the lever is configured to drive the first jaw toward and away from the second jaw, wherein the proximal end of the lever defines a second scissor grip; and
- (d) a tissue severing assembly, wherein the tissue severing assembly comprises:
 - (i) a gear,
 - (ii) a longitudinally sliding trigger, wherein the trigger is slidably disposed within the elongate opening, wherein the trigger comprises an elongate member extending distally from the trigger, wherein the elongate member and the gear have a rack and pinion relationship, and
 - (iii) a longitudinally sliding firing beam, wherein the firing beam and the gear have a rack and pinion relationship,wherein the trigger is longitudinally movable in a proximal direction to

cause distal longitudinal movement of the firing beam.

17. The apparatus of claim 16, wherein the trigger is longitudinally movable in a distal direction to cause proximal longitudinal movement of the firing beam.

18. The apparatus of claim 16, wherein the end effector comprises at least one electrode operable to apply RF energy to tissue, wherein the trigger further comprises a button, wherein the button is operable to selectively activate the RF energy of the end effector when the button is depressed.

19. An apparatus for operating on tissue, the apparatus comprising:

- (a) a body, wherein the body comprises a distal end and a proximal end, wherein the body defines an elongate opening, wherein the proximal end of the body defines a first scissor grip;
- (b) an end effector, wherein the end effector comprises a first jaw and a second jaw, and wherein the first jaw is selectively pivotable toward and away from the second jaw, wherein the end effector further comprises at least one electrode operable to provide RF energy to tissue;
- (c) a lever pivotably coupled to the body, wherein the lever comprises a distal end and a proximal end, wherein the first jaw is coupled to the distal end of the lever, wherein the lever is configured to drive the first jaw toward and away from the second jaw, wherein the proximal end of the lever defines a second scissor grip; and
- (d) a tissue severing assembly, wherein the tissue severing assembly comprises:
 - (i) a longitudinally sliding trigger, wherein the trigger is slidably disposed within the elongate opening of the body, wherein the trigger defines an opening,
 - (ii) a button, wherein the button is disposed within the opening of the trigger, and wherein the button is operable to selectively activate the at least one electrode with RF energy, wherein the button is

positioned to be depressed when the trigger is moved in a proximal longitudinal direction, and

- (iii) a longitudinally sliding firing beam, wherein the trigger is operable to advance the firing beam distally in response to proximal movement of the trigger.

20. The apparatus of claim 19, further comprising a lockout feature configured to prevent proximal movement of the trigger until the button is depressed.

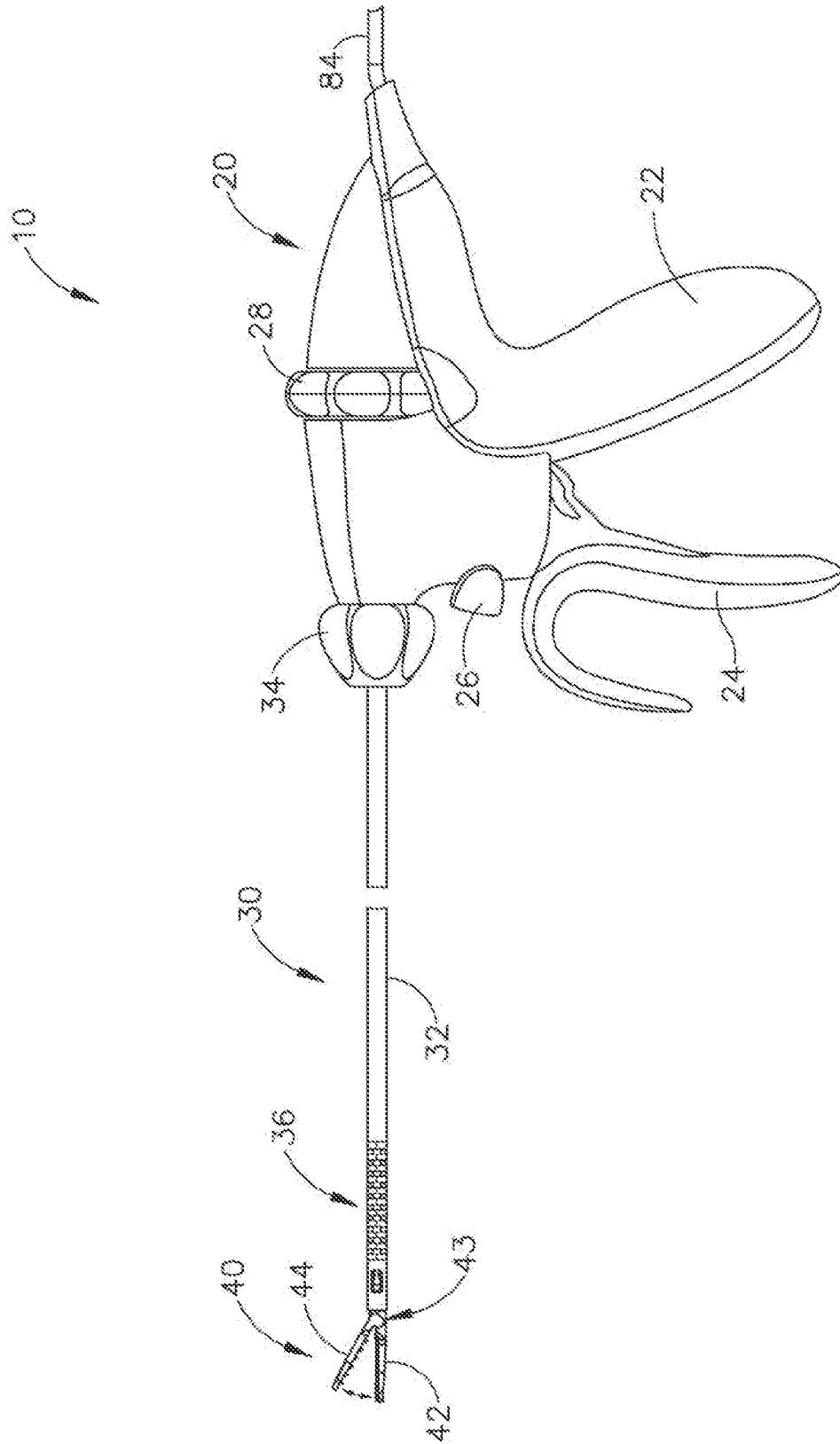
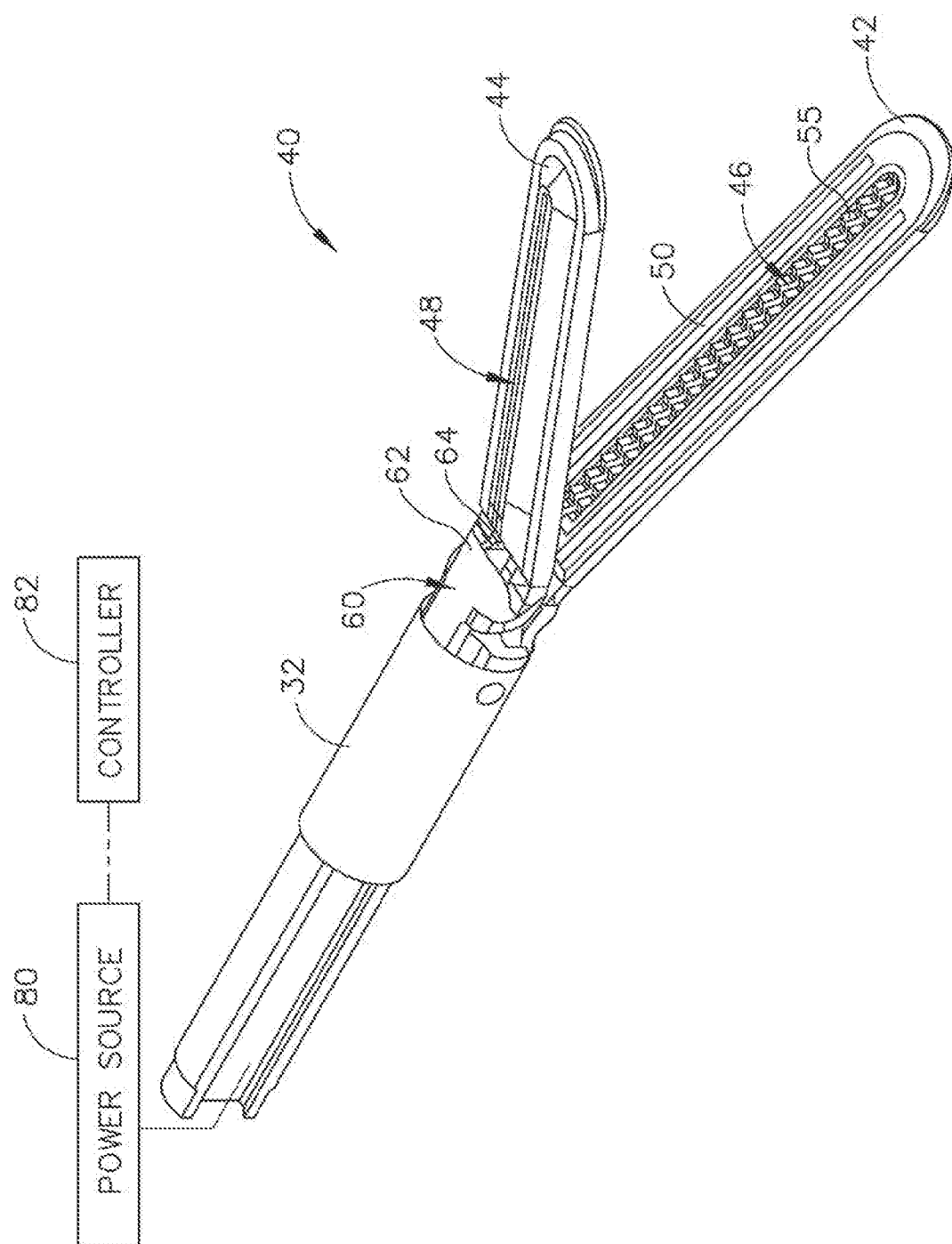


Fig. 1



29

3/13

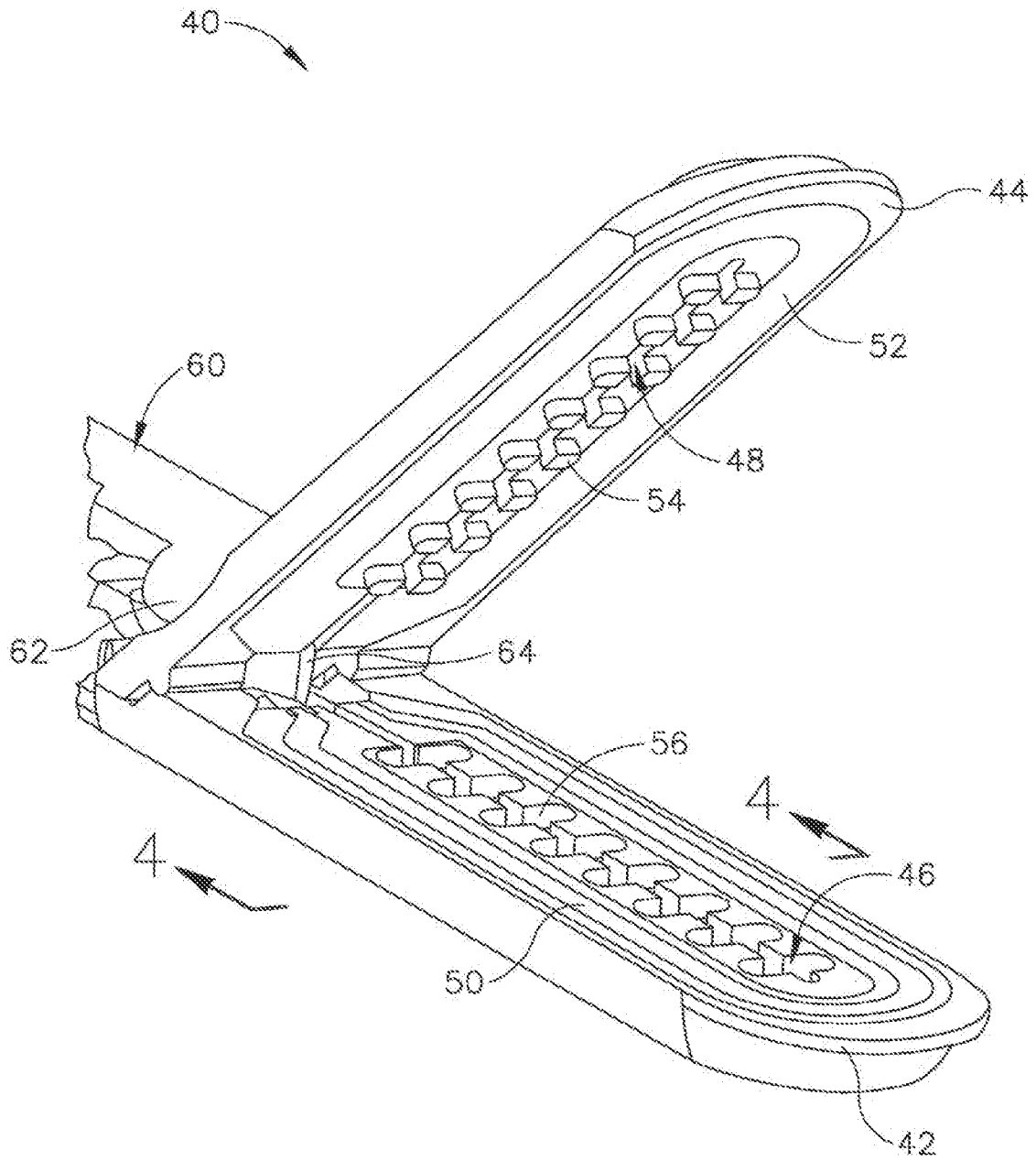


Fig.3

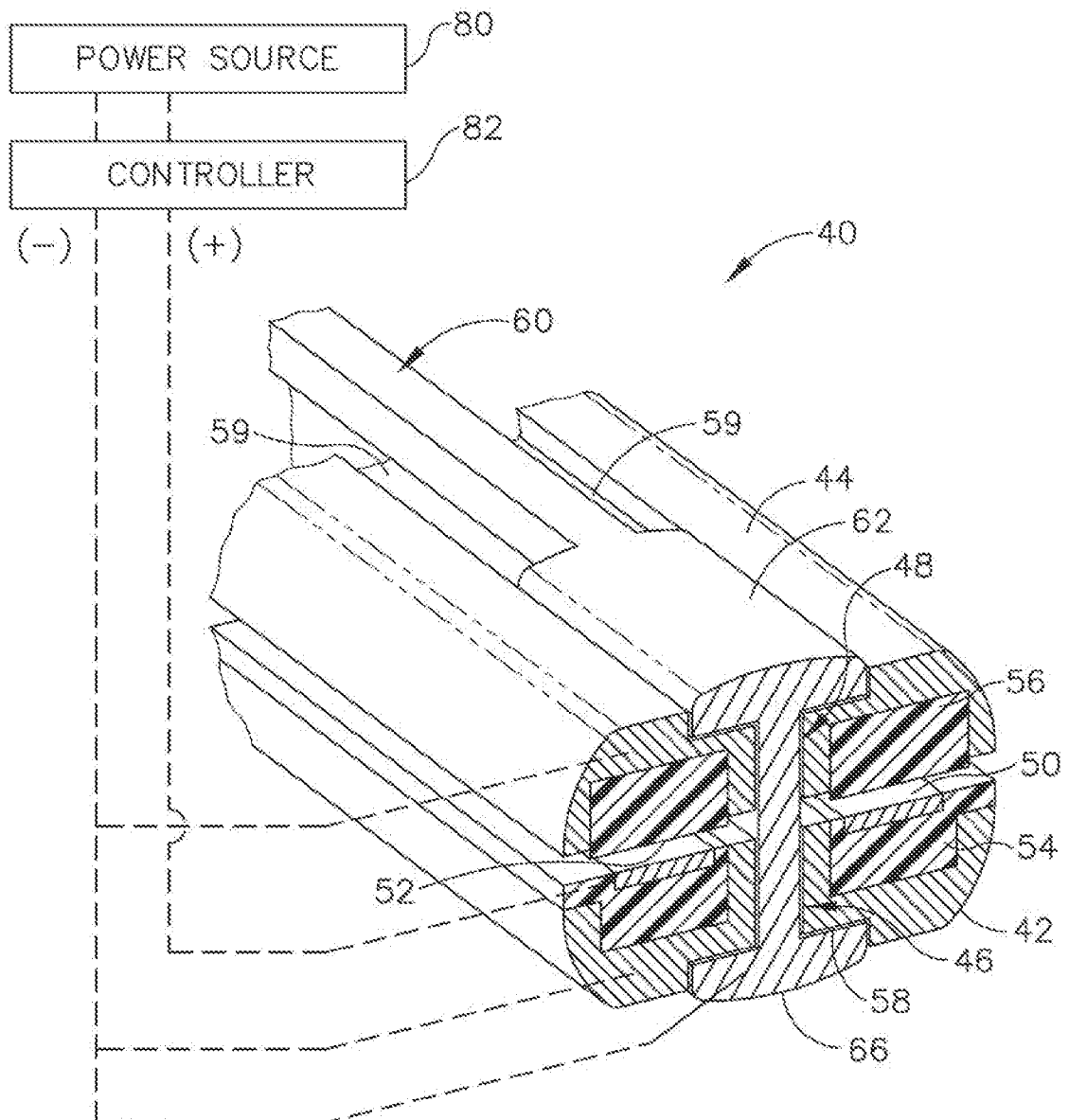


Fig. 4

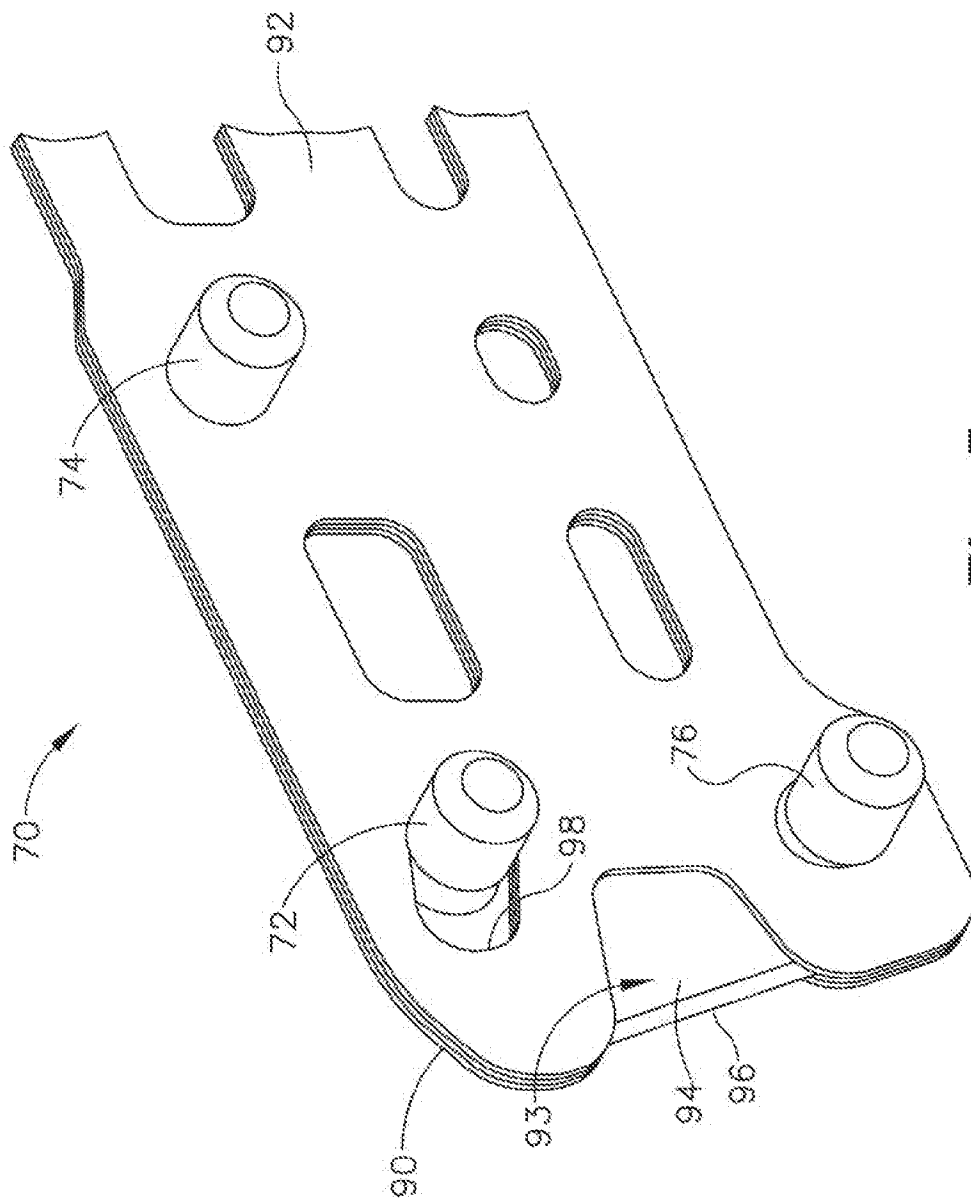


Fig. 5

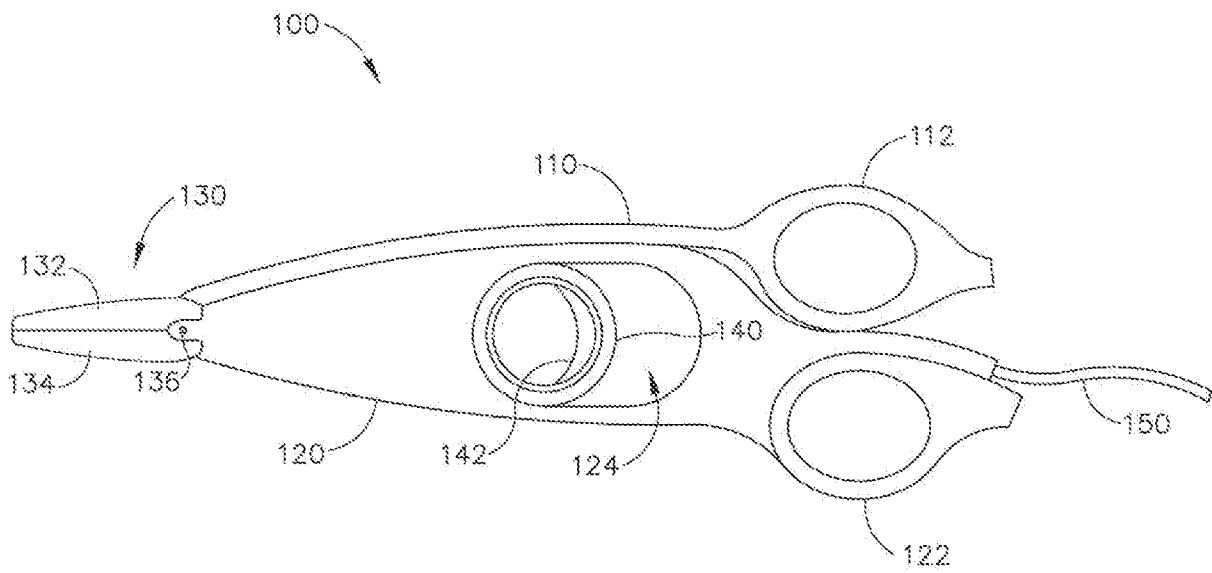


Fig.6A

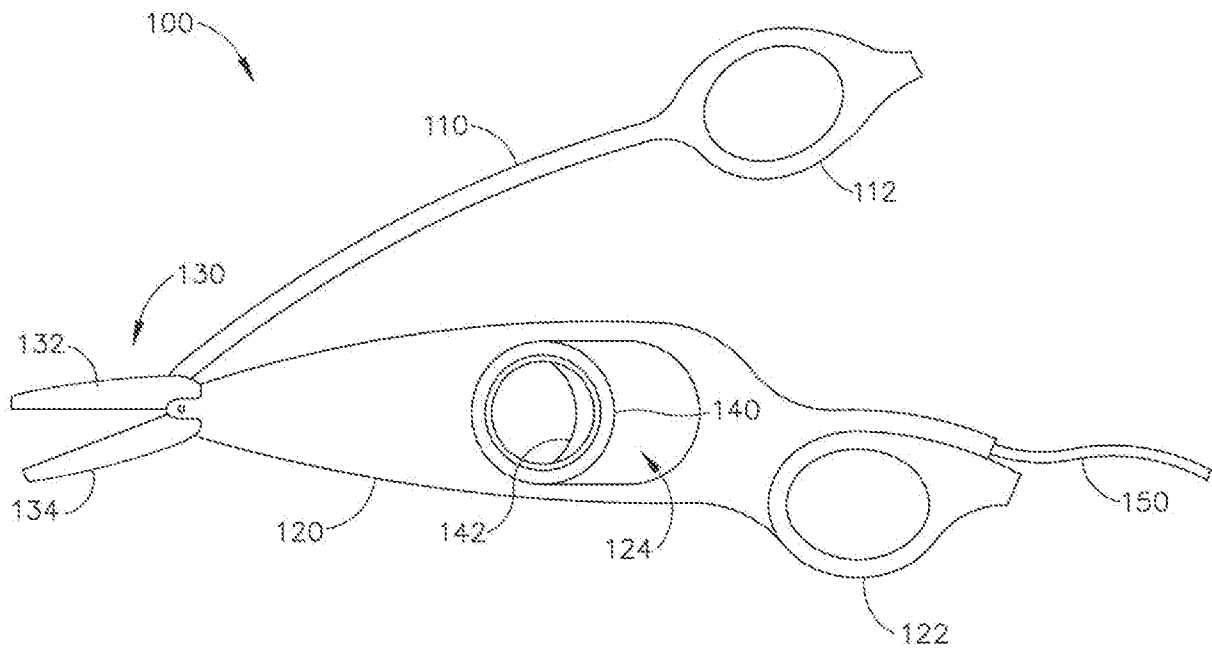


Fig. 6B

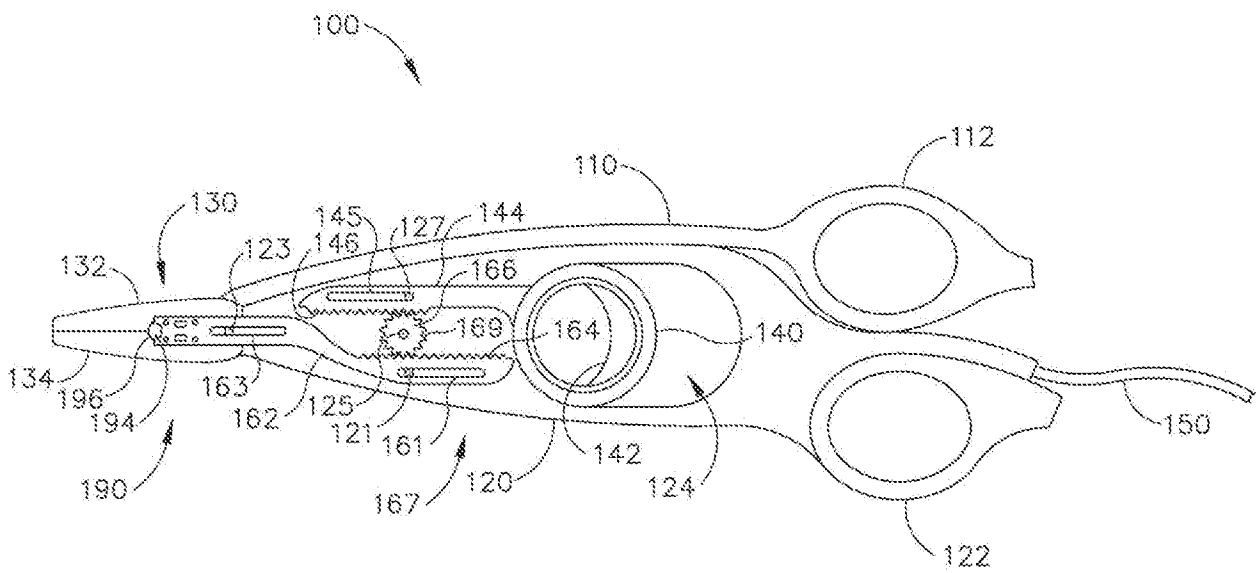


Fig. 7A

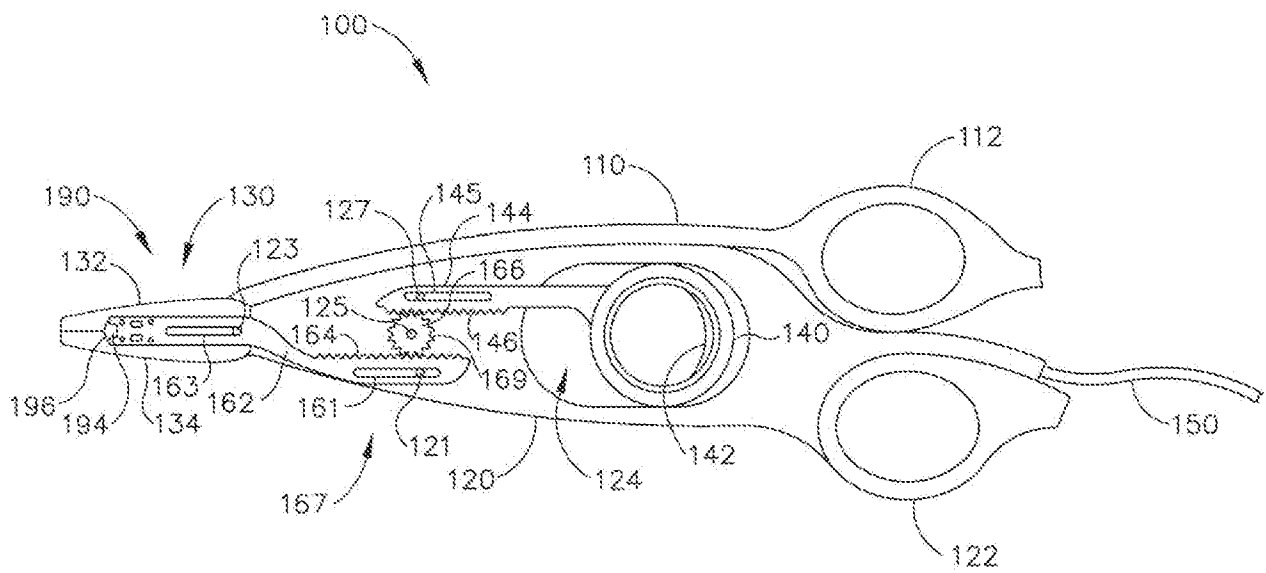


Fig. 7B

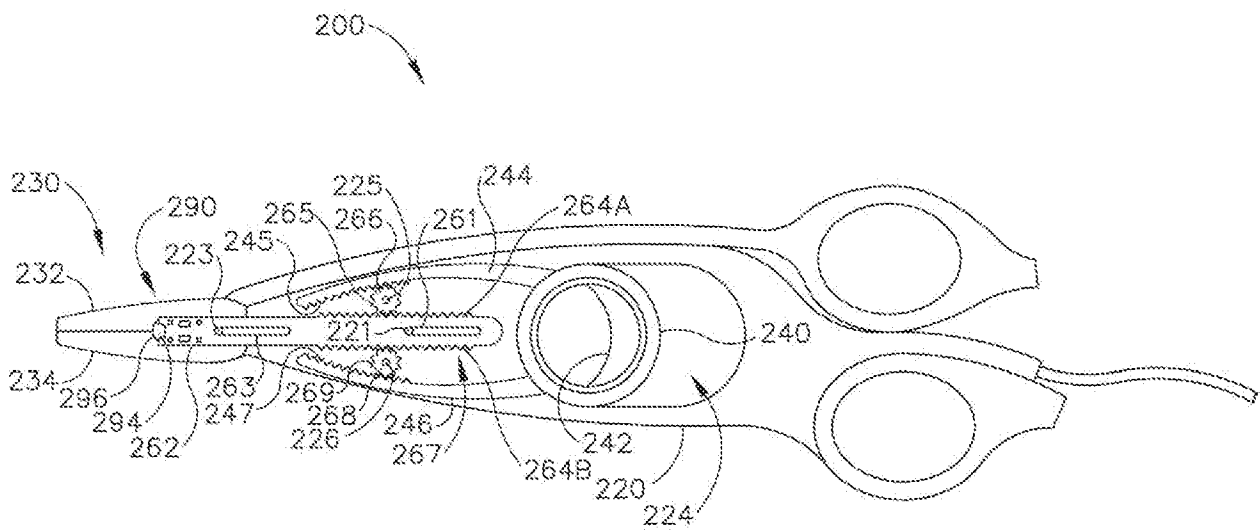


Fig. 8A

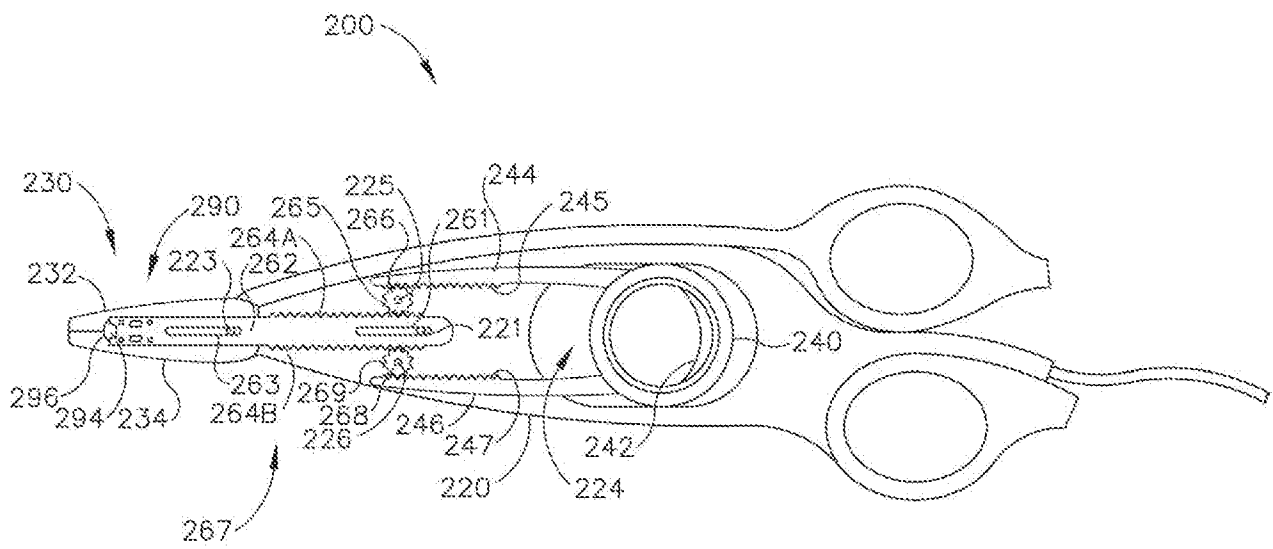


Fig.8B

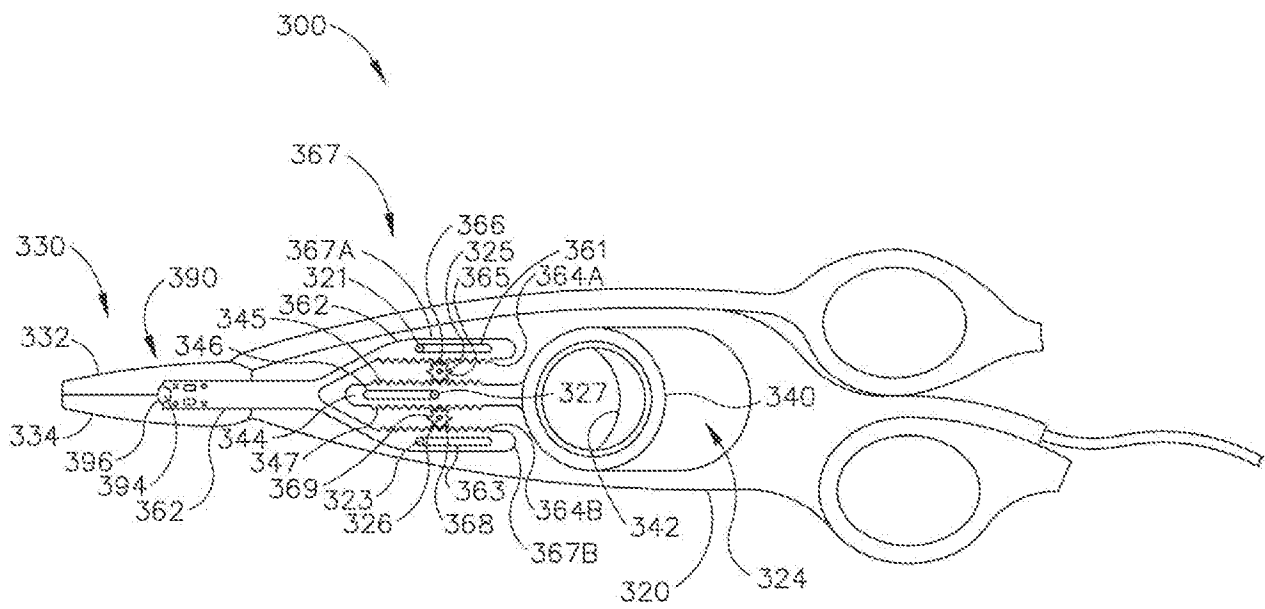


Fig. 9A

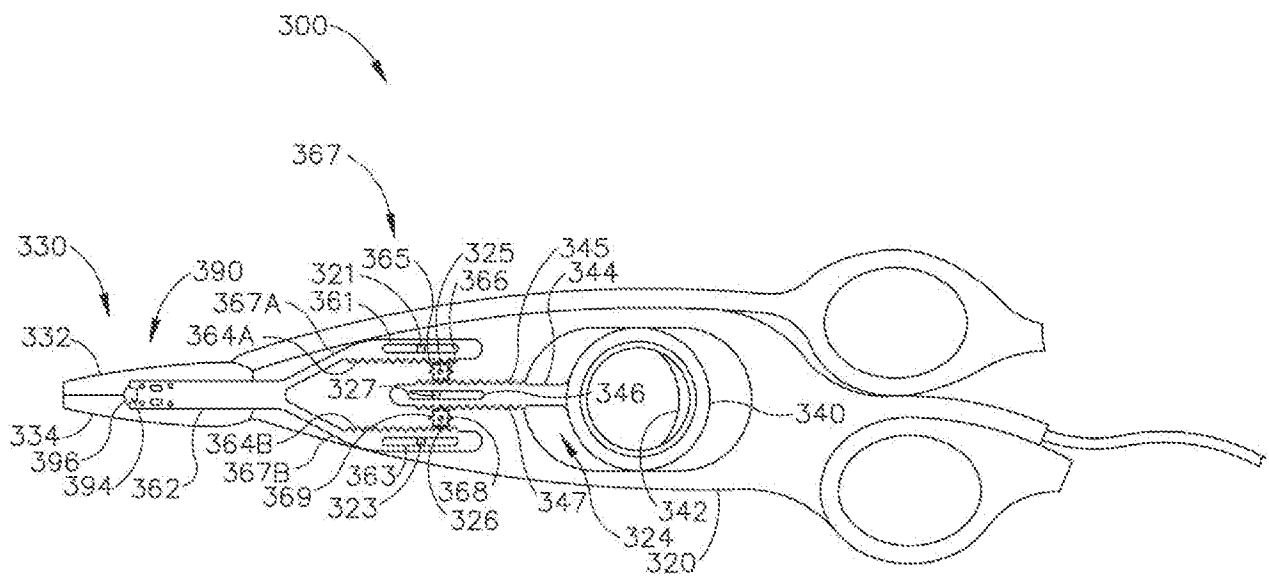


Fig.9B

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2014/040118

A. CLASSIFICATION OF SUBJECT MATTER

INV. A61B18/14

ADD. A61B18/00

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 practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2005/107784 A1 (MOSES MICHAEL C [US] ET AL) 19 May 2005 (2005-05-19)	1-7,9, 13-17
Y	abstract; figures 1-10, 23	10-12,18
A	paragraphs [0012] - [0015], [0042] - [0051], [0059] - [0069]	8
A	----- WO 2011/044343 A2 (ETHICON ENDO SURGERY INC [US]; TREES GREGORY A [US]; BOUDREAUX CHAD P) 14 April 2011 (2011-04-14)	1-18
	abstract; figures 1-6, 18,21-30, 35, 36	
	paragraphs [0074] - [0076], [0085] - [0114]	
Y	----- EP 1 897 506 A1 (ETHICON ENDO SURGERY INC [US]) 12 March 2008 (2008-03-12)	10-12,18
A	abstract; figures 1-5	1-9, 13-17
	paragraphs [0017] - [0030]	
	----- -/-	



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 application or patent 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

29 August 2014

Date of mailing of the international search report

27/11/2014

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

Mendelevitch, L

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/040118

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.:
because they relate to subject matter not required to be searched by this Authority, namely:
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:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable 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 report covers 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.:

1-18

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

International application No
PCT/US2014/040118

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2013/022928 A1 (COVIDIEN LP [US]; UNGER JEFFREY R [US]) 14 February 2013 (2013-02-14) abstract; figures 1-3 paragraphs [0033] - [0043] -----	1-18
A	US 2012/012636 A1 (BECKMAN ANDREW T [US] ET AL) 19 January 2012 (2012-01-19) abstract; figures 18-34 paragraphs [0004] - [0006], [0175] - [0201] -----	1-18

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2014/040118

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2005107784	A1	19-05-2005	AU 2005202706 A1 12-01-2006
		CA 2510247 A1 22-12-2005	
		EP 1609430 A1 28-12-2005	
		ES 2370723 T3 22-12-2011	
		JP 5116219 B2 09-01-2013	
		JP 2006006942 A 12-01-2006	
		JP 2011125731 A 30-06-2011	
		US 2005107784 A1 19-05-2005	
WO 2011044343	A2	14-04-2011	AU 2010303390 A1 03-05-2012
		CA 2777105 A1 14-04-2011	
		CN 102647949 A 22-08-2012	
		EP 2485661 A2 15-08-2012	
		EP 2679175 A1 01-01-2014	
		JP 2013507191 A 04-03-2013	
		WO 2011044343 A2 14-04-2011	
EP 1897506	A1	12-03-2008	AT 459298 T 15-03-2010
		CN 101511287 A 19-08-2009	
		EP 1897506 A1 12-03-2008	
		JP 2010502325 A 28-01-2010	
		US 2010106151 A1 29-04-2010	
		WO 2008028701 A1 13-03-2008	
WO 2013022928	A1	14-02-2013	CN 103841911 A 04-06-2014
		EP 2741703 A1 18-06-2014	
		US 2013041370 A1 14-02-2013	
		WO 2013022928 A1 14-02-2013	
US 2012012636	A1	19-01-2012	NONE

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-18

Apparatus for operating on tissue with a tissue severing assembly comprising gear features

2. claims: 19, 20

Apparatus for operating on tissue with a button disposed within the opening of a trigger and adapted to be depressed when the trigger is moved
