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(54) **CUTTING MECHANISMS FOR SURGICAL END EFFECTOR ASSEMBLIES, INSTRUMENTS, AND SYSTEMS**

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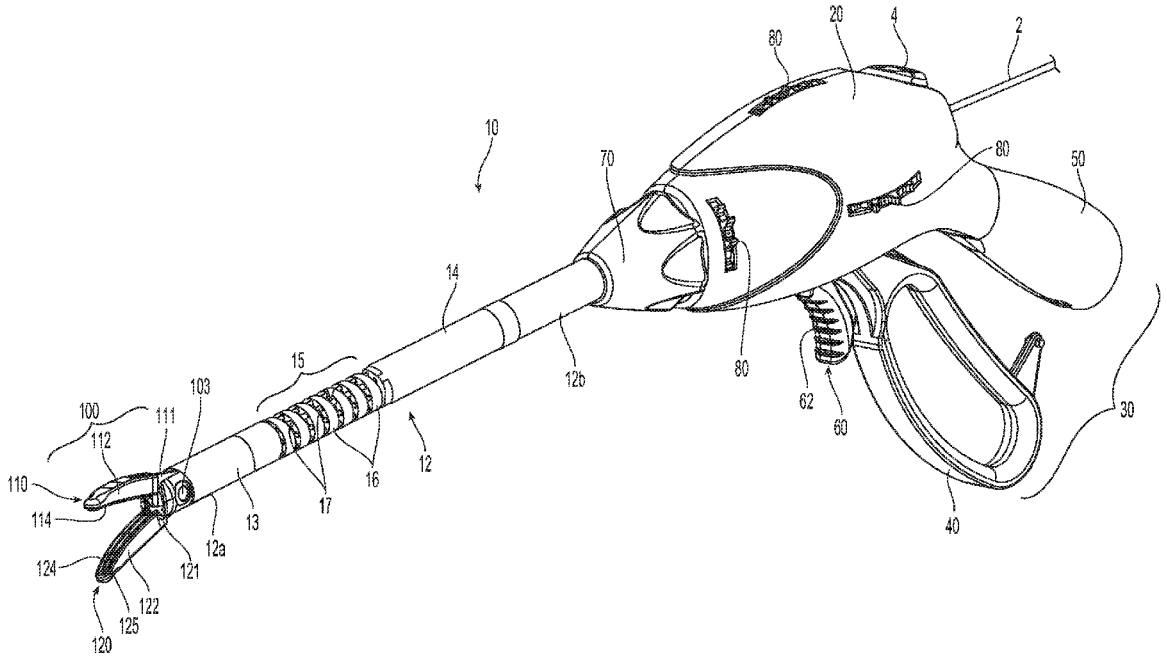
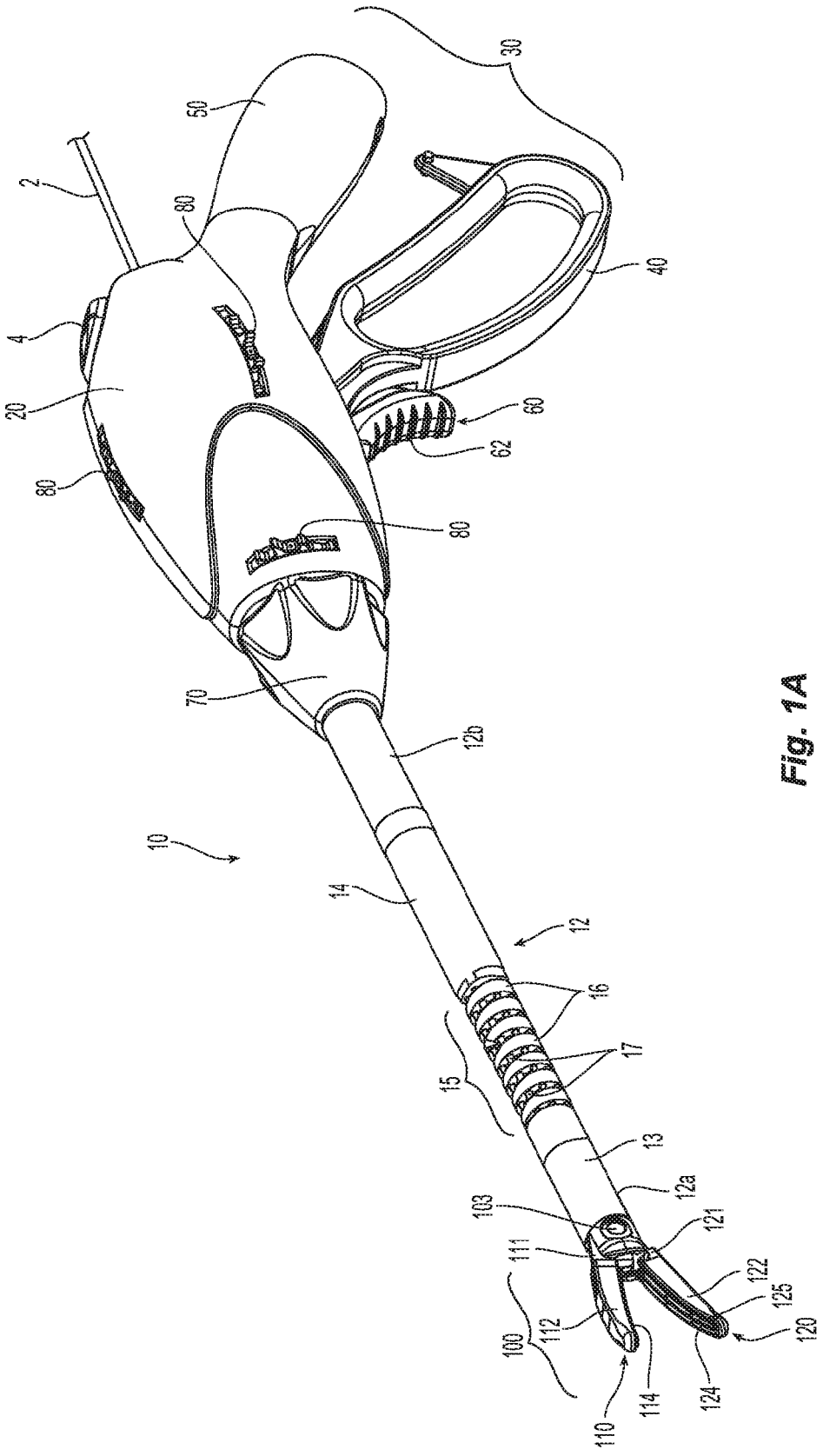
(57) **ABSTRACT**

An end effector assembly for a surgical instrument includes first and second jaw members each including a jaw housing, an electrically-conductive tissue-treatment plate, and a longitudinally-extending channel. The first and/or second jaw member is movable relative to the other between a spaced-apart position and an approximated position. A cutting mechanism is disposed at least partially within the second jaw member. The cutting mechanism may include an inflatable bladder, a fluid line coupled to the inflatable bladder, and a knife coupled to the inflatable bladder. The cutting mechanism may alternatively include a fluid line, a knife, and a sealing member that defines a variable-volume sealed chamber within the longitudinally-extending channel of the second jaw member. The cutting mechanism may alternatively include at least one electromagnet, at least one electrical wire coupled to the at least one electromagnet, and a knife operably coupled to the at least one electromagnet.

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12b
10
14
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12a
103
121
111
122
125
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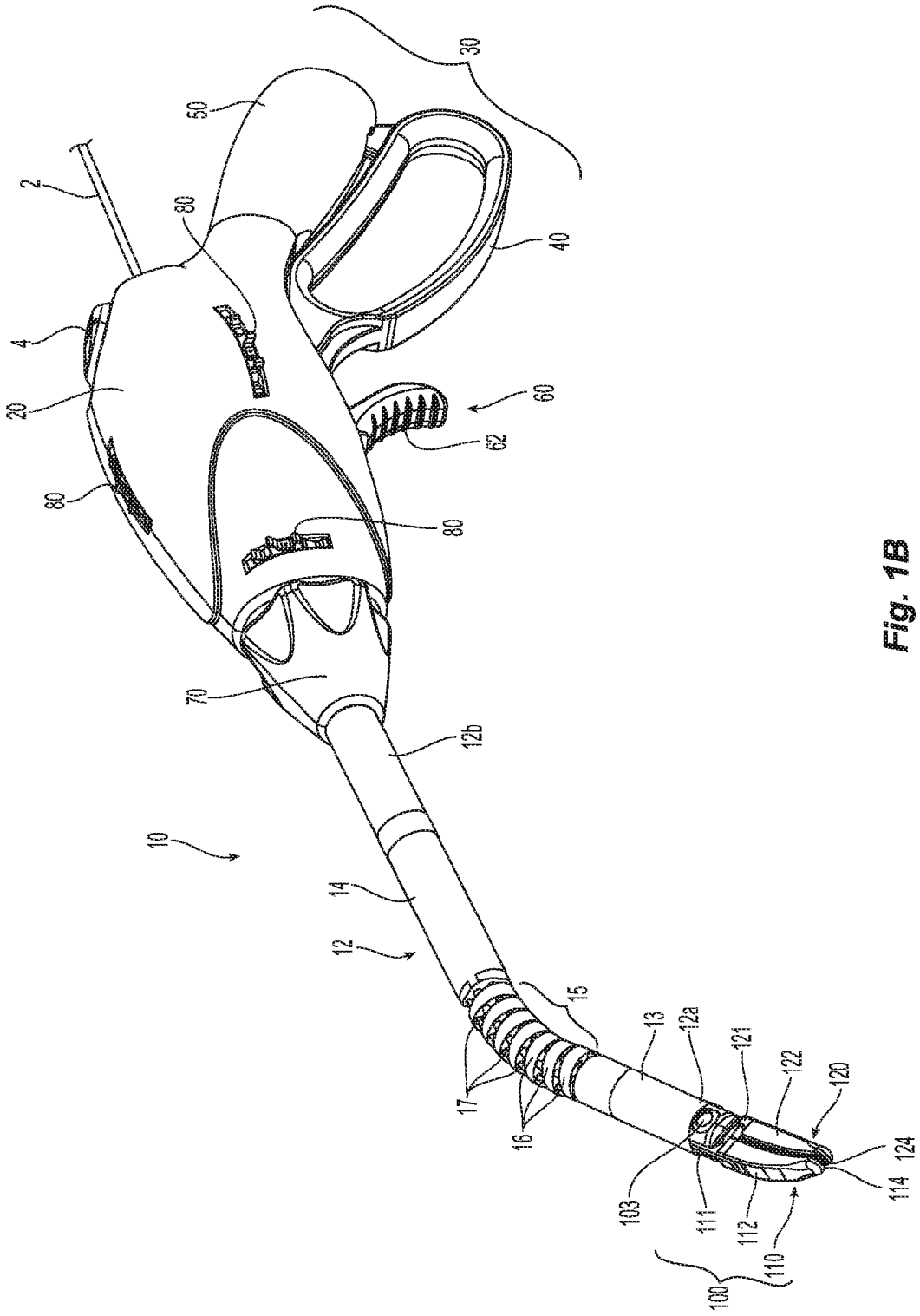
100
112
110
114
124

Fig. 1A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120
124
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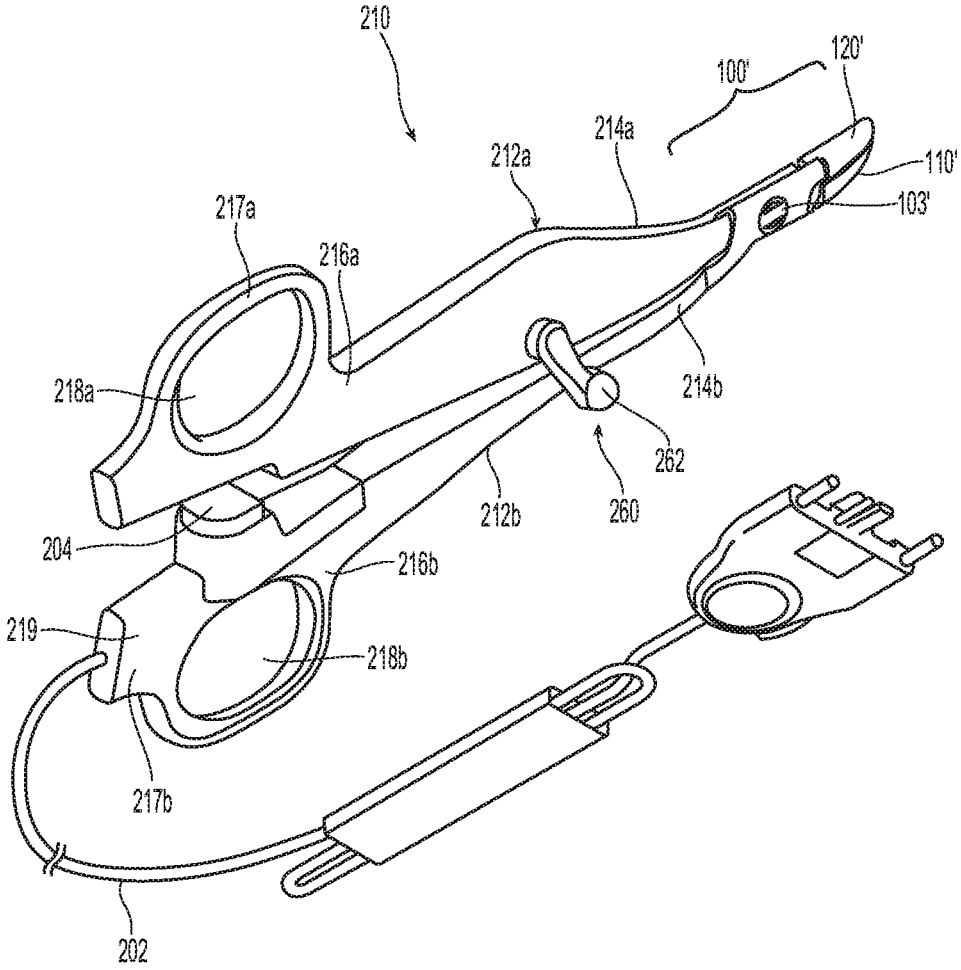
16
103
111
112
110
100

Fig. 1B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214a
212a
110'
103'
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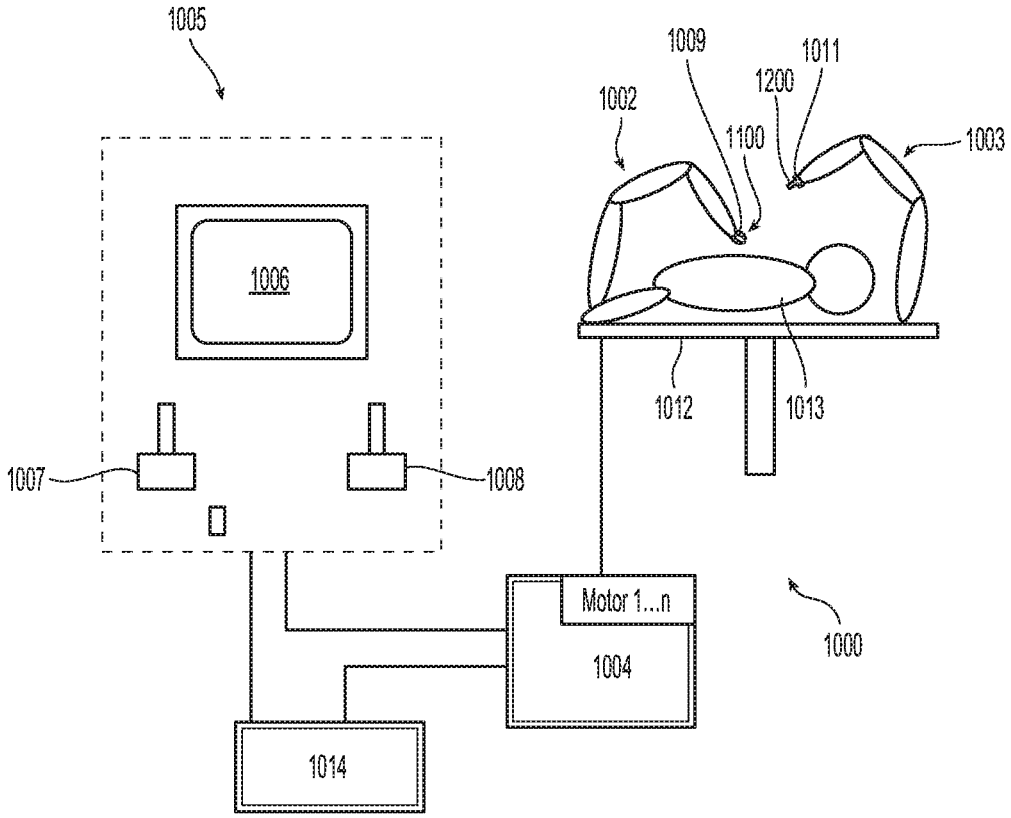
216a
218a
214b
262
260
212b
204
216b
219
218b
217b
202

Fig. 2


1005
1009
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1200
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1012
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Motor 1...n
1004
1000
1014

Fig. 3

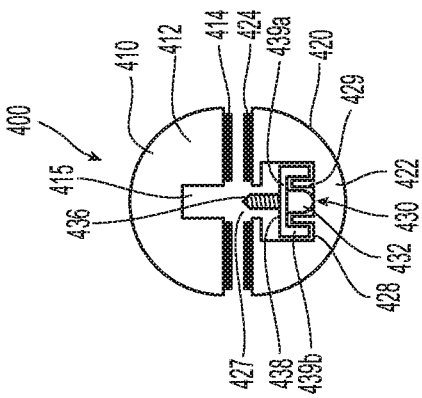

Fig. 6

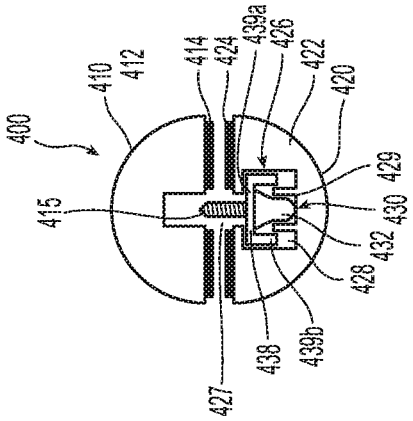

Fig. 7

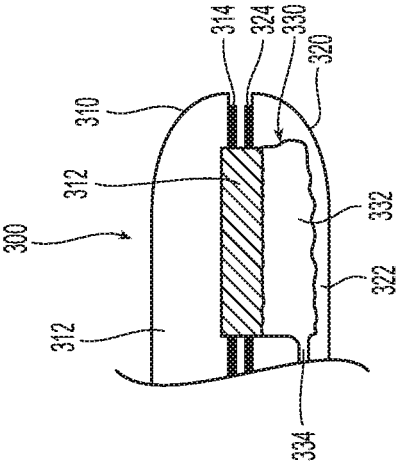

Fig. 5A

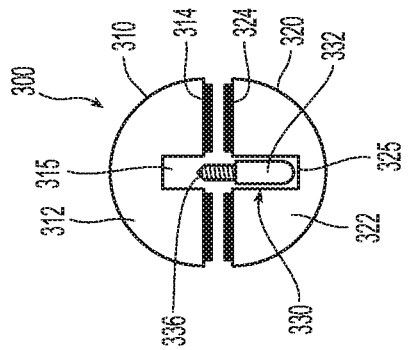

Fig. 5B

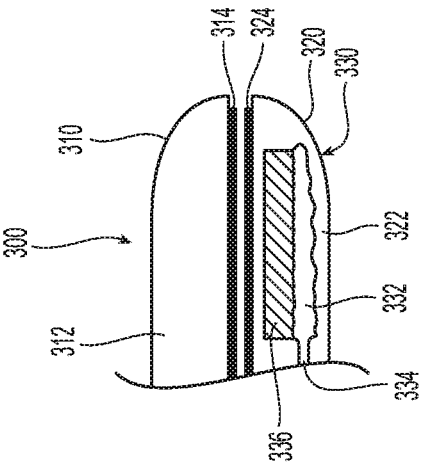

Fig. 4A

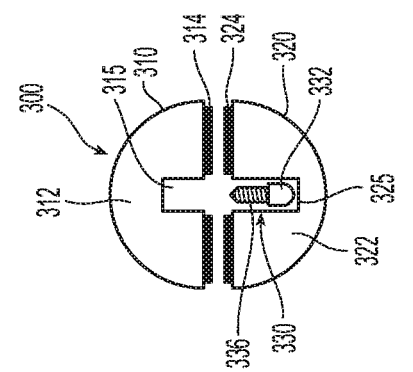

Fig. 4B

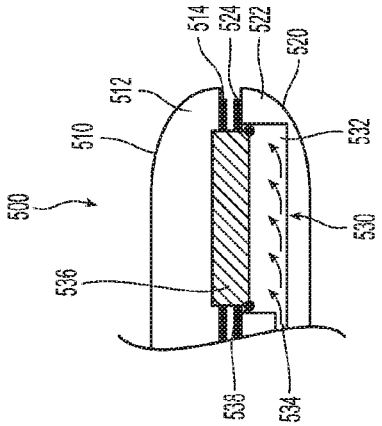

Fig. 9A

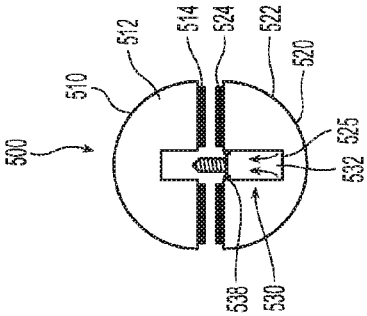

Fig. 9B

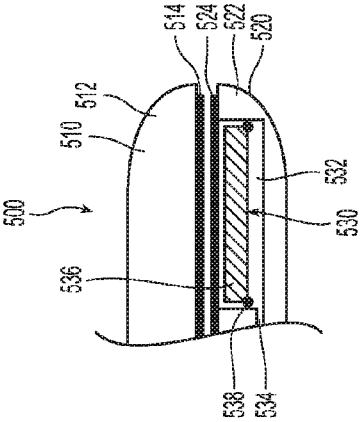

Fig. 8A

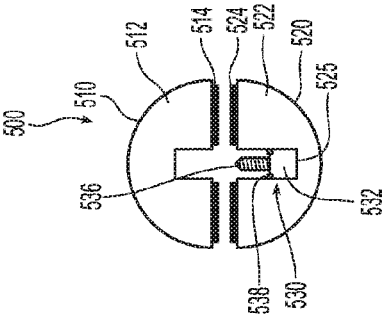

Fig. 8B

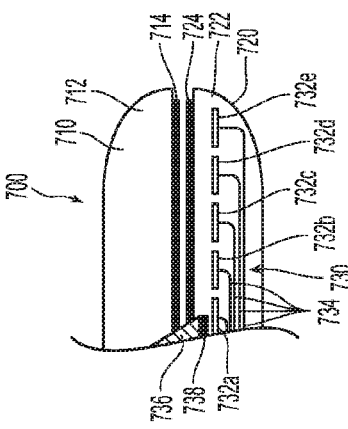

Fig. 12

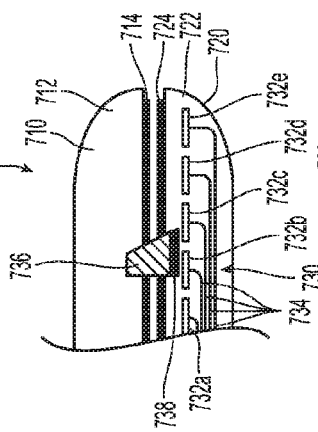

Fig. 13

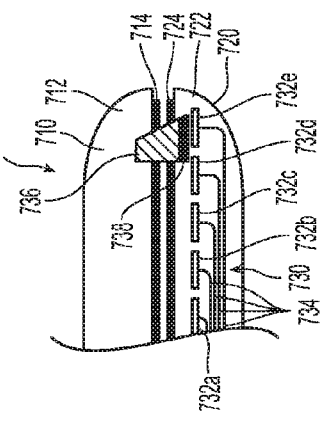

Fig. 14

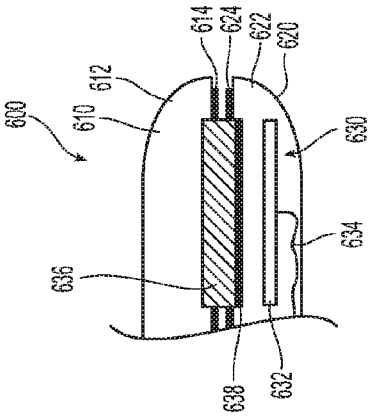

Fig. 11A

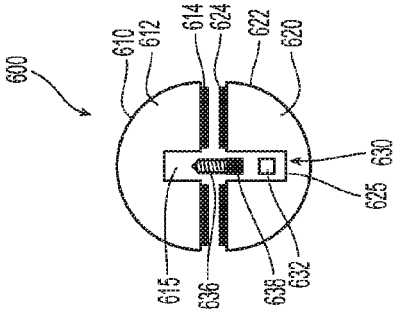

Fig. 11B

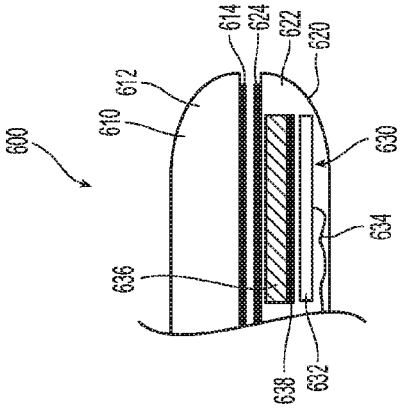

Fig. 10A

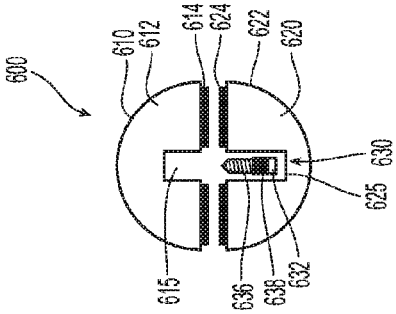

Fig. 10B

CUTTING MECHANISMS FOR SURGICAL END EFFECTOR ASSEMBLIES, INSTRUMENTS, AND SYSTEMS

CROSS REFERENCE TO RELATED APPLICATION

[0001] The present application claims the benefit of and priority to U.S. Provisional Application Ser. No. 62/343,883, filed on Jun. 1, 2016, the entire contents of which are incorporated herein by reference.

BACKGROUND

Technical Field

[0002] The present disclosure relates to surgical devices and, more particularly, to cutting mechanisms for use with surgical end effector assemblies, instruments, and systems.

Background of Related Art

[0003] A surgical forceps is a pliers-like instrument that relies on mechanical action between its jaw members to grasp, clamp, and constrict tissue. Electrosurgical forceps utilize both mechanical clamping action and energy to heat tissue to treat, e.g., coagulate, cauterize, or seal, tissue. Typically, once tissue is treated, the surgeon has to accurately sever the treated tissue. Accordingly, many electrosurgical forceps are designed to incorporate a knife or cutting member utilized to effectively sever the treated tissue.

SUMMARY

[0004] As used herein, the term "distal" refers to the portion that is being described which is further from a user, while the term "proximal" refers to the portion that is being described which is closer to a user. Further, to the extent consistent, any or all of the aspects detailed herein may be used in conjunction with any or all of the other aspects detailed herein.

[0005] In accordance with aspects of the present disclosure, an end effector assembly for a surgical instrument is provided including first and second jaw members each including a jaw housing, an electrically-conductive tissue-treatment plate, and a longitudinally-extending channel. At least one of the first or second jaw member is movable relative to the other between a spaced-apart position and an approximated position. The end effector assembly further includes a cutting mechanism disposed within the second jaw member. The cutting mechanism includes an inflatable bladder disposed within the longitudinally-extending channel of the second jaw member, a fluid line fluidly coupled to the inflatable bladder and extending proximally from the end effector assembly, and a knife. The fluid line is adapted to connect to a source of fluid for supplying fluid to and removing fluid from the inflatable bladder to transition the inflatable bladder between a deflated condition and an inflated condition. The knife is operably coupled to the inflatable bladder and is movable between a retracted position, corresponding to the deflated condition of the inflatable bladder, wherein the knife is fully disposed within the longitudinally-extending channel of the second jaw member, and an extended position, corresponding to the inflated condition of the inflatable bladder, wherein the knife extends from the longitudinally-extending channel of the second jaw member, between the first and second jaw members, and at least partially into the longitudinally-extending channel of the first jaw member.

[0006] In an aspect of the present disclosure, the knife is mounted on the inflatable bladder.

[0007] In another aspect of the present disclosure, a guide platform is disposed within the longitudinally-extending channel of the second jaw member. In such aspects, the guide platform includes the knife mounted thereon and is configured such that, upon inflation of the inflatable bladder, the inflatable bladder urges the guide platform to urge the knife from the retracted position to the extended position.

[0008] In yet another aspect of the present disclosure, the guide platform includes a support surface having the knife disposed thereon and at least one leg extending therefrom.

[0009] In still another aspect of the present disclosure, the at least one leg is slidably disposed within at least one guide track portion of the longitudinally-extending channel of the second jaw member.

[0010] Another end effector assembly for a surgical instrument provided in accordance with aspects of the present disclosure includes first and second jaw members each including a jaw housing, an electrically-conductive tissue-treatment plate, and a longitudinally-extending channel. At least one of the first or second jaw members is movable relative to the other between a spaced-apart position and an approximated position. A cutting mechanism is disposed within the second jaw member and includes a fluid line extending proximally from the end effector assembly and adapted to connect to a source of fluid, a knife, and a sealing member engaged to the knife and sealing engaged within the longitudinally-extending channel of the second jaw member so as to define a sealed chamber therein. The fluid line is configured to supply fluid to the sealed chamber to thereby urge the knife and the sealing member from a retracted position, corresponding to a minimum-volume condition of the sealed chamber, wherein the knife is fully disposed within the longitudinally-extending channel of the second jaw member, to an extended position, corresponding to a maximum-volume condition of the sealed chamber, wherein the knife extends from the longitudinally-extending channel of the second jaw member, between the first and second jaw members, and at least partially into the longitudinally-extending channel of the first jaw member.

[0011] In an aspect of the present disclosure, the fluid line is configured to supply high-pressure pulses of fluid to the sealed chamber to move the knife from the retracted position to the extended position.

[0012] In another aspect of the present disclosure, the fluid line is configured to withdraw fluid from the sealed chamber to return the knife from the extended position to the retracted position under suction.

[0013] Another end effector assembly for a surgical instrument provided in accordance with aspects of the present disclosure includes first and second jaw members each including a jaw housing, an electrically-conductive tissue-treatment plate, and a longitudinally-extending channel. At least one of the first or second jaw members is movable relative to the other between a spaced-apart position and an approximated position. A cutting mechanism is disposed within the second jaw member and includes at least one electromagnet disposed within the jaw housing of the second jaw member, at least one electrical wire coupled to the at least one electromagnet and extending proximally from the

end effector assembly to connect to a source of energy for energizing the at least one electromagnet to produce a magnetic field, and a knife at least partially disposed within the longitudinally-extending channel of the second jaw member. The knife includes a magnetic portion or has a magnetic base engaged thereto and is repelled from or attracted to the at least one electromagnet in response to magnetization of the at least one electromagnet to thereby move the knife from a retracted position to an extended position.

[0014] In an aspect of the present disclosure, in the retracted position, the knife is fully disposed within the longitudinally-extending channel of the second jaw member, and, in the extended position, the knife extends from the longitudinally-extending channel of the second jaw member, between the first and second jaw members, and at least partially into the longitudinally-extending channel of the first jaw member.

[0015] In another aspect of the present disclosure, upon magnetization of the at least one electromagnet, the knife is repelled therefrom such that the knife is urged from the retracted position to the extended position.

[0016] In yet another aspect of the preset disclosure, in the retracted position, the knife is disposed partially within the longitudinally-extending channels of the first and second jaw members at proximal ends thereof, and, in the extended position, the knife is disposed partially within the longitudinally-extending channels of the first and second jaw members at distal ends thereof.

[0017] In still another aspect of the present disclosure, the at least one electromagnet includes a series of electromagnets arranged longitudinally between the proximal and distal ends of the first and second jaw members.

[0018] In still yet another aspect of the present disclosure, the series of electromagnets are successively activated and deactivated in a proximal-to-distal direction to move the knife from the retracted position to the extended position.

[0019] In another aspect of the present disclosure, the series of electromagnets are successively activated and deactivated in a distal-to-proximal direction to return the knife from the extended position to the retracted position.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] The above and other aspects and features of the present disclosure will become more apparent in view of the following detailed description when taken in conjunction with the accompanying drawings wherein like reference numerals identify similar or identical elements and:

[0021] FIG. **1**A is a perspective view of endoscopic surgical forceps exemplifying the aspects and features of the present disclosure, wherein the shaft of the endoscopic surgical forceps is disposed in a non-articulated position and wherein the jaw members of the endoscopic surgical forceps are disposed in a spaced-apart position;

[0022] FIG. **1**B is a perspective view of the endoscopic surgical forceps of FIG. **1**A, wherein the shaft of the endoscopic surgical forceps is disposed in an articulated position and wherein the jaw members of the endoscopic surgical forceps are disposed in an approximated position;

[0023] FIG. **2** is a perspective view of an open surgical forceps exemplifying the aspects and features of the present disclosure;

[0024] FIG. **3** is a schematic illustration of a robotic surgical system exemplifying the aspects and features of the present disclosure;

[0025] FIG. **4**A is a longitudinal, cross-sectional view of an end effector assembly configured for use with the forceps of FIG. **1**A, the forceps of FIG. **2**, and/or the system of FIG. **3**, wherein the knife thereof is disposed in a retracted position;

[0026] FIG. **4**B is a transverse, cross-sectional view of the end effector assembly of FIG. **4**A, wherein the knife is disposed in the retracted position;

[0027] FIG. **5**A is a longitudinal, cross-sectional view of the end effector assembly of FIGS. **4**A, wherein the knife is disposed in an extended position;

[0028] FIG. **5**B is a transverse, cross-sectional view of the end effector assembly of FIG. **4**A, wherein the knife is disposed in the extended position;

[0029] FIG. **6** is a transverse, cross-sectional view of another end effector assembly configured for use with the forceps of FIG. **1**A, the forceps of FIG. **2**, and/or the system of FIG. **3**, wherein the knife thereof is disposed in a retracted position;

[0030] FIG. **7** is a transverse, cross-sectional view of the end effector assembly of FIG. **6**, wherein the knife is disposed in an extended position;

[0031] FIG. **8**A is a longitudinal, cross-sectional view of another end effector assembly configured for use with the forceps of FIG. **1**A, the forceps of FIG. **2**, and/or the system of FIG. **3**, wherein the knife thereof is disposed in a retracted position;

[0032] FIG. **8**B is a transverse, cross-sectional view of the end effector assembly of FIG. **8**A, wherein the knife is disposed in the retracted position;

[0033] FIG. **9**A is a longitudinal, cross-sectional view of the end effector assembly of FIG. **8**A, wherein the knife is disposed in an extended position;

[0034] FIG. **9**B is a transverse, cross-sectional view of the end effector assembly of FIG. **8**A, wherein the knife is disposed in the extended position;

[0035] FIG. **10**A is a longitudinal, cross-sectional view of another end effector assembly configured for use with the forceps of FIG. **1**A, the forceps of FIG. **2**, and/or the system of FIG. **3**, wherein the knife thereof is disposed in a retracted position;

[0036] FIG. **10**B is a transverse, cross-sectional view of the end effector assembly of FIG. **10**A, wherein the knife is disposed in the retracted position;

[0037] FIG. **11**A is a longitudinal, cross-sectional view of the end effector assembly of FIG. **10**A, wherein the knife is disposed in an extended position;

[0038] FIG. **11**B is a transverse, cross-sectional view of the end effector assembly of FIG. **10**A, wherein the knife is disposed in the extended position;

[0039] FIG. **12** is a longitudinal, cross-sectional view of another end effector assembly configured for use with the forceps of FIG. **1**A, the forceps of FIG. **2**, and/or the system of FIG. **3**, wherein the knife thereof is disposed in a retracted position;

[0040] FIG. **13** is a longitudinal, cross-sectional view of the end effector assembly of FIG. **12**, wherein the knife is disposed in an intermediate position; and

[0041] FIG. **14** is a longitudinal, cross-sectional view of the end effector assembly of FIG. **12**, wherein the knife is disposed in an extended position.

DETAILED DESCRIPTION

[0042] Referring generally to FIGS. **1**A and **1**B, an endoscopic surgical forceps exemplifying the aspects and features of the present disclosure is shown generally identified by reference numeral **10**. For the purposes herein, endoscopic surgical forceps **10** is generally described. Aspects and features of endoscopic surgical forceps **10** not germane to the understanding of the present disclosure are omitted to avoid obscuring the aspects and features of the present disclosure in unnecessary detail.

[0043] Forceps **10** includes a housing **20**, a handle assembly **30**, a trigger assembly **60**, a rotating assembly **70**, a plurality of articulation actuators **80**, an activation switch **4**, and an end effector assembly **100**. Forceps **10** further includes a shaft **12** having a distal end **12***a* configured to mechanically engage end effector assembly **100** and a proximal end **12***b* that mechanically engages housing **20**. Forceps **10** also includes cable **2** that connects forceps **10** to an energy source (not shown), e.g., a generator or other suitable power source, although forceps **10** may alternatively be configured as a battery-powered device. Cable **2** includes a wire (or wires) (not shown) extending therethrough that has sufficient length to extend through shaft **12** in order to provide energy to one or both tissue-treating plates **114**, **124** of jaw members **110**, **120**, respectively, of end effector assembly **100**. Activation switch **4** is coupled to tissue-treating plates **114**, **124** and the source of energy for selectively activating the supply of energy to jaw members **110**, **120** for treating, e.g., cauterizing, coagulating/desiccating, and/or sealing, tissue.

[0044] Shaft **12** of forceps **10** defines a distal segment **13** positioned towards distal end **12***a* thereof, a proximal segment **14** positioned towards proximal end **12***b* thereof, and an articulating section **15** disposed between the distal and proximal segments **13**, **14**, respectively. Articulating section **15** includes a plurality of articulating links **16** having a plurality of articulation cables **17** extending therethrough. Each cable **17** is operably engaged at its distal end to distal segment **13** and at its proximal end to one of the articulation actuators **80** so as to enable articulation of distal segment **13** and, thus, end effector assembly **100**, relative to proximal segment **14** upon actuation of one or more of articulation actuators **80**. In some embodiments, articulating section **15** and articulation actuators **80** are omitted, such that shaft **12** of forceps **10** does not articulate. In either configuration, rotating assembly **70** operably couples shaft **12** to housing **20** so as to enable selective rotation of shaft **12** and, thus, end effector assembly **100**, relative to housing **20**.

[0045] Handle assembly **30** of forceps **10** includes a fixed handle **50** and a movable handle **40**. Fixed handle **50** is integrally associated with housing **20** and handle **40** is movable relative to fixed handle **50**. Movable handle **40** of handle assembly **30** is operably coupled to a drive assembly (not shown) that, together, mechanically cooperate to impart movement of one or both of jaw members **110**, **120** of end effector assembly **100** about a pivot **103** between a spaced-apart position (FIG. **1**A) and an approximated position (FIG. **1**B) to grasp tissue between jaw members **110**, **120**. As shown in FIG. **1**A, movable handle **40** is initially spaced-apart from fixed handle **50** and, correspondingly, jaw members **110**, **120** of end effector assembly **100** are disposed in the spaced-apart position. Movable handle **40** is depressible from this initial position to a depressed position corresponding to the approximated position of jaw members **110**, **120** (FIG. **1**B).

[0046] Trigger assembly **60** includes a trigger **62** coupled to housing **20** and movable relative thereto between an un-actuated position and an actuated position. Trigger **62** is operably coupled to a cutting mechanism, various embodiments of which are detailed below, so as to actuate the cutting mechanism to cut tissue grasped between jaw members **110**, **120** of end effector assembly **100** upon actuation of trigger **62**. As an alternative to a pivoting trigger **62**, a slide trigger, push-button, toggle switch, or other suitable actuator may be provided.

[0047] End effector assembly **100**, as noted above, includes first and second jaw members **110**, **120**. Each jaw member **110**, **120** includes a proximal flange portion **111**, **121**, an outer insulative jaw housing **112**, **122** disposed about the distal portion (not explicitly shown) of each jaw member **110**, **120**, and a tissue-treating plate **114**, **124**, respectively. Proximal flange portions **111**, **121** are pivotably coupled to one another about pivot **103** for moving jaw members **110**, **120** between the spaced-apart and approximated positions, although other suitable mechanisms for pivoting jaw members **110**, **120** relative to one another are also contemplated. The distal portions (not explicitly shown) of the jaw members **110**, **120** are configured to support jaw housings **112**, **122**, and tissue-treating plates **114**, **124**, respectively, thereon.

[0048] Outer insulative jaw housings **112**, **122** of jaw members **110**, **120** support and retain tissue-treating plates **114**, **124** on respective jaw members **110**, **120** in opposed relation relative to one another. Tissue-treating plates **114**, **124** are formed from an electrically conductive material, e.g., for conducting electrical energy therebetween for treating tissue, although tissue-treating plates **114**, **124** may alternatively be configured to conduct any suitable energy, e.g., thermal, microwave, light, ultrasonic, etc., through tissue grasped therebetween for energy-based tissue treatment. As mentioned above, tissue-treating plates **114**, **124** are coupled to activation switch **4** and the source of energy (not shown), e.g., via the wires (not shown) extending from cable **2** through forceps **10**, such that energy may be selectively supplied to tissue-treating plate **114** and/or tissue-treating plate **124** and conducted therebetween and through tissue disposed between jaw members **110**, **120** to treat tissue. One or both of jaw members **110**, **120** may further define a longitudinally-extending channel **125** (only the channel of jaw member **120** is shown).

[0049] Referring to FIG. **2**, an open surgical forceps exemplifying the aspects and features of the present disclosure is shown generally identified by reference numeral **210**. For the purposes herein, open surgical forceps **210** is generally described. Aspects and features of open surgical forceps **210** not germane to the understanding of the present disclosure are omitted to avoid obscuring the aspects and features of the present disclosure in unnecessary detail.

[0050] Forceps **210** includes two elongated shaft members **212***a*, **212***b*, each having a proximal end **216***a*, **216***b*, and a distal end **214***a*, **214***b*, respectively. Forceps **210** is configured for use with an end effector assembly **100'** similar to end effector assembly **100** (FIGS. **1**A and **1**B). More specifically, end effector assembly **100'** includes first and second jaw members **110'**, **120'** attached to respective distal ends **214***a*, **214***b* of shaft members **212***a*, **212***b*. Jaw members

110', **120'** are pivotably connected about a pivot **103'**. Each shaft member **212***a*, **212***b* includes a handle **217***a*, **217***b* disposed at the proximal end **216***a*, **216***b* thereof. Each handle **217***a*, **217***b* defines a finger hole **218***a*, **218***b* therethrough for receiving a finger of the user. As can be appreciated, finger holes **218***a*, **218***b* facilitate movement of the shaft members **212***a*, **212***b* relative to one another to, in turn, pivot jaw members **110'**, **120'** from the spaced-apart position, wherein jaw members **110'**, **120'** are disposed in spaced relation relative to one another, to the approximated position, wherein jaw members **110'**, **120'** cooperate to grasp tissue therebetween.

[0051] One of the shaft members **212***a*, **212***b* of forceps **210**, e.g., shaft member **212***b*, includes a proximal shaft connector **219** configured to connect forceps **210** to a source of energy (not shown), e.g., a generator. Proximal shaft connector **219** secures a cable **202** to forceps **210** such that the user may selectively supply energy to jaw members **110'**, **120'** for treating tissue and for energy-based tissue cutting. More specifically, an activation switch **204** is provided for supplying energy to jaw members **110'**, **120'** to treat tissue upon sufficient approximation of shaft members **212***a*, **212***b*, e.g., upon activation of activation switch **204** via shaft member **212***a*.

[0052] Forceps **210** further includes a trigger assembly **260** including a trigger **262** coupled to one of the shaft members, e.g., shaft member **212***a*, and movable relative thereto between an un-actuated position and an actuated position. Trigger **262** is operably coupled to a cutting mechanism, various embodiments of which are detailed below, so as to actuate the cutting mechanism to cut tissue grasped between jaw members **110**,' **120'** of end effector assembly **100'** upon movement of trigger **262** to the actuated position. Similarly as noted above, other suitable actuators for the cutting mechanism are also contemplated.

[0053] Referring generally to FIG. **3**, a robotic surgical system exemplifying the aspects and features of the present disclosure is shown generally identified by reference numeral **1000**. For the purposes herein, robotic surgical system **1000** is generally described. Aspects and features of robotic surgical system **1000** not germane to the understanding of the present disclosure are omitted to avoid obscuring the aspects and features of the present disclosure in unnecessary detail.

[0054] Robotic surgical system **1000** includes a plurality of robot arms **1002**, **1003**; a control device **1004**; and an operating console **1005** coupled with control device **1004**. Operating console **1005** may include a display device **1006**, which may be set up in particular to display three-dimensional images; and manual input devices **1007**, **1008**, by means of which a surgeon may be able to telemanipulate robot arms **1002**, **1003** in a first operating mode. Robotic surgical system **1000** may be configured for use on a patient **1013** lying on a patient table **1012** to be treated in a minimally invasive manner. Robotic surgical system **1000** may further include a database **1014**, in particular coupled to control device **1004**, in which are stored, for example, pre-operative data from patient **1013** and/or anatomical atlases.

[0055] Each of the robot arms **1002**, **1003** may include a plurality of members, which are connected through joints, and an attaching device **1009**, **1011**, to which may be attached, for example, an end effector assembly **1100**, **1200**, respectively. End effector assembly **1100** is similar to end effector assemblies **100**, **100'** (FIGS. **1**A-**1**B and **2**, respectively), although other suitable end effector assemblies for coupling to attaching device **1009** are also contemplated. End effector assembly **1200** may be any end effector assembly, e.g., an endoscopic camera, other surgical tool, etc. Robot arms **1002**, **1003** and end effector assemblies **1100**, **1200** may be driven by electric drives, e.g., motors, that are connected to control device **1004**. Control device **1004** (e.g., a computer) may be configured to activate the motors, in particular by means of a computer program, in such a way that robot arms **1002**, **1003**, their attaching devices **1009**, **1011**, and end effector assemblies **1100**, **1200** execute a desired movement and/or function according to a corresponding input from manual input devices **1007**, **1008**, respectively. Control device **1004** may also be configured in such a way that it regulates the movement of robot arms **1002**, **1003** and/or of the motors.

[0056] Referring generally to FIGS. **4**A-**14**, as can be appreciated, design challenges are presented in incorporating cutting mechanisms, particularly those including elongated cutting elements, into surgical instruments having articulating shafts, e.g., forceps **10** (FIGS. **1**A and **1**B), open surgical instruments, e.g., forceps **210** (FIG. **2**), and/or robotic surgical systems, e.g., robotic surgical system **1000** (FIG. **3**). Accordingly, the various embodiments of cutting mechanisms detailed below with respect to FIGS. **4**A-**14** are configured to eliminate the need for elongated cutting elements, thus enabling use with articulating surgical instruments, open surgical instruments, robotic surgical systems, and any other suitable surgical instrument or system.

[0057] With reference to FIGS. **4**A-**5**B, an end effector assembly provided in accordance with the present disclosure and configured for use with forceps **10** (FIGS. **1**A-**1**B), forceps **210** (FIG. **2**), robotic surgical system **1000** (FIG. **3**), and/or any other suitable surgical instrument or system is shown generally identified by reference numeral **300**.

[0058] End effector assembly **300** is similar to end effector assemblies **100**, **100'**, **1100** (FIGS. **1**A-**1**B, **2**, **3**, respectively) and, thus, only differences therebetween will be described in detail below for purposes of brevity. End effector assembly **300** includes first and second jaw members **310**, **320** each including a jaw housing **312**, **322**, a tissue-treating plate **314**, **324**, and a longitudinally-extending channel **315**, **325** (FIGS. **4**B and **5**B).

[0059] One of the jaw members, e.g., jaw member **320**, includes a cutting mechanism **330** housed within jaw housing **322** thereof. Cutting mechanism **330** includes an inflatable bladder **332** fluidly coupled to a fluid line **334** for supplying fluid to and/or removing fluid from inflatable bladder **332**. Fluid, as utilized herein may refer to a liquid (e.g., water or saline), gas (e.g., air), other flowable substance, or combinations thereof. Inflatable bladder **332** is disposed within longitudinally-extending channel **325** of jaw member **320**. Fluid line **334** may extend proximally from end effector assembly **300** through and/or around articulating components, pivoting components, and/or other components of the surgical instrument used with end effector assembly **300**. Fluid line **334** defines a flexible configuration so as not to be interrupted by or interrupt articulation, pivoting, etc. of the surgical instrument. Fluid line **334** may ultimately be coupled to a fluid source (not shown) within the housing of the surgical instrument, an external fluid source, or other suitable fluid source. The actuator, e.g., trigger, of the surgical instrument may be operably coupled

to the fluid source and/or fluid line **334** so as to supply fluid to fluid line **334** and, thus, to inflatable bladder **332**, upon actuation of the trigger and to withdraw fluid from fluid line **334** and, thus, inflatable bladder **332**, upon return of the trigger to an un-actuated position.

[0060] Cutting mechanism **330** further includes a knife **336** mounted on inflatable bladder **332** and disposed within longitudinally-extending channel **325** of jaw member **320**. Knife **336** may define a length that extends a substantial portion of the length of jaw member **320**, e.g., between 50% and 90% of the length thereof. Knife **336** is initially disposed in a retracted position (FIGS. **4**A and **4**B), corresponding to the deflated condition of inflatable bladder **332**, wherein knife **336** is disposed within longitudinally-extending channel **325** and does not extend beyond tissue-treating plate **324**. Knife **336** is deployable, upon inflation of inflatable bladder **332**, from the retracted position to an extended position (FIGS. **5**A and **5**B), corresponding to the inflated condition of inflatable bladder **332**, wherein inflatable bladder **332** urges knife **336** to extend from longitudinally-extending channel **325**, between tissue-treating plates **314**, **324**, and at least partially into longitudinally-extending channel **315** of jaw member **310** to cut tissue grasped between jaw members **310**, **320**. More specifically, upon the supply of fluid via fluid line **334** to inflatable bladder **332**, e.g., in response to actuation of the trigger of the surgical instrument used with end effector assembly **300**, inflatable bladder **332** is expanded towards the open end of longitudinally-extending channel **325** due to inflatable bladder **332** being confined within longitudinally-extending channel **325**. The expansion of inflatable bladder **332**, in turn, urges knife **336** from the retracted position (FIGS. **4**A and **4**B) to the extended position (FIGS. **5**A and **5**B) to cut tissue grasped between jaw members **310**, **320**.

[0061] With reference to FIGS. **6** and **7**, an end effector assembly provided in accordance with the present disclosure and configured for use with forceps **10** (FIGS. **1**A-**1**B), forceps **210** (FIG. **2**), robotic surgical system **1000** (FIG. **3**), and/or any other suitable surgical instrument or system is shown generally identified by reference numeral **400**.

[0062] End effector assembly **400** is similar to end effector assembly **300** (FIGS. **4**A-**5**B) and, thus, only differences therebetween will be described in detail below for purposes of brevity. End effector assembly **400** includes first and second jaw members **410**, **420** each including a jaw housing **412**, **422**, a tissue-treating plate **414**, **424**, and a longitudinally-extending channel **415**, **425**. The longitudinally-extending channel of one of the jaw members, e.g., longitudinally-extending channel **425** of jaw member **420**, defines an enlarged base **426** and a narrowed opening **427**. Enlarged base **426** defines a pair of outer guide tracks **428** and a central track **429** disposed between guide tracks **428**.

[0063] One of the jaw members, e.g., jaw member **420**, includes a cutting mechanism **430** housed within jaw housing **422** thereof. Cutting mechanism **430** includes an inflatable bladder **432** fluidly coupled to a fluid line (not shown), a knife **436**, and a guide platform **438**. Inflatable bladder **432** is disposed within longitudinally-extending channel **425** of jaw member **420** and, more specifically, central track **429** thereof. Guide platform **438** defines a support surface **439***a* and a pair of spaced-apart legs **439***b* extending from support surface **439***a* and is disposed within longitudinally-extending channel **425** of jaw member **420**. More specifically, legs **439***b* are disposed within outer guide tracks **428** of enlarged base **426** of longitudinally-extending channel **425** so as to confine movement of guide platform **438** to towards and away from jaw member **410** in generally perpendicular orientation relative to support surface **439***a*.

[0064] Knife **436** is mounted on support surface **439***a* of guide platform **438** and is positioned to extend through narrowed opening **427** of longitudinally-extending channel **425** upon deployment of knife **436**. More specifically, knife **436** is initially disposed in a retracted position (FIG. **6**), corresponding to the lowered condition of guide platform **438** and the deflated condition of inflatable bladder **432**, wherein knife **436** does not extend beyond tissue-treating plate **424**. Upon inflation of inflatable bladder **432** and, as a result, movement of guide platform **428**, knife **436** is deployed from the retracted position to an extended position (FIG. **7**), corresponding to the raised condition of guide platform **438** and the inflated condition of inflatable bladder **432**. That is, upon inflation of inflatable bladder **432**, inflatable bladder **432** urges support surface **439***a* of guide platform **438** towards the raised condition which, in turn, urges knife **436** to extend through narrowed opening **427** of longitudinally-extending channel **425**, between tissue-treating plates **414**, **424**, and at least partially into longitudinally-extending channel **415** of jaw member **410** to cut tissue grasped between jaw members **410**, **420**. Guide platform **438**, in cooperation with enlarged base **426** of longitudinally-extending channel **425**, helps ensure consistent and smooth movement of knife **436** between the retracted and extended positions (FIGS. **6** and **7**, respectively) in generally perpendicular orientation relative to support surface **439***a* and the cutting edge of knife **436**.

[0065] With reference to FIGS. **8**A-**9**B, an end effector assembly provided in accordance with the present disclosure and configured for use with forceps **10** (FIGS. **1**A-**1**B), forceps **210** (FIG. **2**), robotic surgical system **1000** (FIG. **3**), and/or any other suitable surgical instrument or system is shown generally identified by reference numeral **500**.

[0066] End effector assembly **500** is similar to end effector assemblies **100**, **100'**, **1100** (FIGS. **1**A-**1**B, **2**, **3**, respectively) and, thus, only differences therebetween will be described in detail below for purposes of brevity. End effector assembly **500** includes first and second jaw members **510**, **520** each including a jaw housing **512**, **522**, a tissue-treating plate **514**, **524**, and a longitudinally-extending channel **515**, **525** (FIGS. **8**B and **9**B).

[0067] One of the jaw members, e.g., jaw member **520**, includes a cutting mechanism **530** housed within jaw housing **522** thereof. Cutting mechanism **530** includes a fluid line **534** for supplying fluid to and/or removing fluid from longitudinally-extending channel **525** of jaw member **520**. Fluid line **534** may be configured similarly as fluid line **334** of cutting mechanism **330** (FIGS. **4**A-**5**B). Cutting mechanism **530** further includes a knife **536** disposed within longitudinally-extending channel **525**, and a sealing member **538**, e.g., an elastomeric ring, gasket, or other suitable sealing member, engaged about the base of knife **536** and configured to establish a fluid-tight seal between the base of knife **536** the walls of jaw housing **522** that define longitudinally-extending channel **525** of jaw member **520**. As such, a sealed chamber **532** is defined within longitudinally-extending channel **525** by the walls of jaw housing **522**, sealing member **538**, and knife **536**. Fluid line **534** is fluidly coupled to sealed chamber **532** for supplying fluid to and removing fluid from sealed chamber **532**.

[0068] Knife **536** is initially disposed in a retracted position (FIGS. **8**A and **8**B), corresponding to the minimum-volume condition of sealed chamber **532**, wherein knife **536** is disposed within longitudinally-extending channel **525** and does not extend beyond tissue-treating plate **524**. Knife **536** is deployable from the retracted position to an extended position (FIGS. **9**A and **9**B), corresponding to the maximum-volume condition of sealed chamber **532**, wherein fluid is supplied to sealed chamber **532** to raise the pressure within sealed chamber **532** such that sealing member **538** and knife **536** are urged towards the open end of longitudinally-extending channel **525**, thereby expanding the volume of sealed chamber **532**. In some embodiments, the supply of fluid to sealed chamber **532** is in the form of one or more high-pressure bursts. Alternatively, a continuous supply of fluid may be provided. In either configuration, sealed chamber **532** is expanded in volume via the supply of fluid thereto and, as a result, the movement of sealing member **538** and knife **536**, to the maximum-volume condition, wherein knife **536** extends from longitudinally-extending channel **525**, between tissue-treating plates **514**, **524**, and at least partially into longitudinally-extending channel **515** of jaw member **510** to cut tissue grasped between jaw members **510**, **520**. Knife **536** may be returned to the retracted position, thereby returning sealed chamber **532** to the minimum-volume condition, under suction due to the withdrawal of fluid from sealed chamber **532** via fluid line **534**, using a biasing member (not shown) biasing knife **536** towards the retracted position, or in any other suitable manner.

[0069] With reference to FIGS. **10**A-**11**B, an end effector assembly provided in accordance with the present disclosure and configured for use with forceps **10** (FIGS. **1**A-**1**B), forceps **210** (FIG. **2**), robotic surgical system **1000** (FIG. **3**), and/or any other suitable surgical instrument or system is shown generally identified by reference numeral **600**.

[0070] End effector assembly **600** is similar to end effector assemblies **100**, **100'**, **1100** (FIGS. **1**A-**1**B, **2**, **3**, respectively) and, thus, only differences therebetween will be described in detail below for purposes of brevity. End effector assembly **600** includes first and second jaw members **610**, **620** each including a jaw housing **612**, **622**, a tissue-treating plate **614**, **624**, and a longitudinally-extending channel **615**, **625** (FIGS. **10**B and **11**B).

[0071] One of the jaw members, e.g., jaw member **620**, includes a cutting mechanism **630** housed within jaw housing **622** thereof. Cutting mechanism **630** includes an electromagnet **632** coupled to an electrical wire **634** for energizing electromagnet **632** to produce a magnetic field about electromagnet **632**. Electrical wire **634** may extend proximally from end effector assembly **600** through and/or around articulating components, pivoting components, and/or other components of the surgical instrument used with end effector assembly **600**. Electrical wire **634** defines a flexible configuration so as not to be interrupted by or interrupt articulation, pivoting, etc. of the surgical instrument. Electrical wire **634** may ultimately be coupled to an energy source (not shown) within the housing of the surgical instrument, an external energy source, or other suitable energy source. The actuator, e.g., trigger, of the surgical instrument may be operably coupled to the energy source and/or electrical wire **634** so as to supply energy to electrical wire **634** and, thus, to electromagnet **632**, upon actuation of the trigger and to stop the supply of energy to electrical wire **634** and, thus, electromagnet **632**, upon return of the trigger to an un-actuated position.

[0072] Cutting mechanism **630** further includes a knife **636** disposed within longitudinally-extending channel **625** of jaw member **620**. Knife **636** may be formed from a magnetic material, or may include a base **638** engaged thereto that is formed from a magnetic material. Knife **636** may define a length that extends a substantial portion of the length of jaw member **620**, e.g., between 50% and 90% of the length thereof. Knife **636** is initially disposed in a retracted position (FIGS. **10**A and **10**B), corresponding to the un-energized or deactivated condition of electromagnet **632**, wherein knife **636** is disposed within longitudinally-extending channel **625** and does not extend beyond tissue-treating plate **624**. Knife **636** is deployable, upon energization or activation of electromagnet **632**, from the retracted position to an extended position (FIGS. **11**A and **11**B), corresponding to the energized or activated condition of electromagnet **632**, wherein electromagnet **632** produces a magnet field that repels knife **636** or base **638** thereof to thereby urge knife **636** to extends from longitudinally-extending channel **625**, between tissue-treating plates **614**, **624**, and at least partially into longitudinally-extending channel **615** of jaw member **610** to cut tissue grasped between jaw members **610**, **620**. Upon deactivation of electromagnet **632**, knife **636** is returned to the retracted position. Return of knife **636** may be accomplished using a biasing member (not shown) biasing knife **636** towards the retracted position, via gravity, or in any other suitable fashion.

[0073] With reference to FIGS. **12-14**, an end effector assembly provided in accordance with the present disclosure and configured for use with forceps **10** (FIGS. **1**A-**1**B), forceps **210** (FIG. **2**), robotic surgical system **1000** (FIG. **3**), and/or any other suitable surgical instrument or system is shown generally identified by reference numeral **700**.

[0074] End effector assembly **700** is similar to end effector assemblies **100**, **100'**, **1100** (FIGS. **1**A-**1**B, **2**, **3**, respectively) and, thus, only differences therebetween will be described in detail below for purposes of brevity. End effector assembly **700** includes first and second jaw members **710**, **720** each including a jaw housing **712**, **722**, a tissue-treating plate **714**, **724**, and a longitudinally-extending channel (not shown).

[0075] One of the jaw members, e.g., jaw member **720**, includes a cutting mechanism **730** at least partially housed within jaw housing **722** thereof. Cutting mechanism **730** includes a series of electromagnets **732***a-e* (although greater or fewer than five (5) electromagnets are also contemplated) extending longitudinally along jaw member **720** from the proximal end to the distal end thereof. Cutting mechanism **730** further includes a plurality of electrical wires **734**, one of which is coupled to each of the electromagnets **732***a-e* to provide energy thereto to produce a magnetic field about that electromagnet **732***a-e*. Electrical wires **734** may extend proximally from end effector assembly **700** similarly as detailed above with respect to electrical wire **634** (see FIGS. **10**A and **11**A) so as to couple to an energy source (not shown) and the actuator, e.g., trigger, of the surgical instrument used with end effector assembly **700**.

[0076] Cutting mechanism **730** further includes a knife **736** extending between jaw members **710**, **720** with a portion thereof disposed within each of the longitudinally-extending channels of jaw members **710**, **720**. Knife **736**

may be formed from a magnetic material, or may include a base **738** engaged thereto that is formed from a magnetic material. Knife **736** is initially disposed in a retracted position (FIG. **12**), corresponding to the un-energized or deactivated condition of electromagnets **732***a-e,* wherein knife **736** is disposed at the proximal ends of jaw members **710**, **720**. Knife **736** is deployable, upon successive energization or activation (and subsequent successive deactivation) of electromagnets **732***a-e* in the proximal-to-distal direction, from the retracted position, through an intermediate position (FIG. **13**), to an extended position (FIG. **14**). Such deployment of knife **736** is effected via electromagnets **732***a-e* being successively activated and deactivated to produce magnet fields that attract knife **736** or base **738** thereof to thereby urge knife **736** to translate longitudinally from the proximal ends of jaw members **710**, **720** to the distal ends thereof to cut tissue grasped between jaw members **710**, **720**. Knife **736** is returned to the retracted position by successively activating (and subsequently successively deactivating) electromagnetics **732***a-e* in the distal-to-proximal direction, using a biasing member (not shown) biasing knife **736** towards the retracted position, or in any other suitable fashion.

[0077] While several embodiments of the disclosure have been shown in the drawings, it is not intended that the disclosure be limited thereto, as it is intended that the disclosure be as broad in scope as the art will allow and that the specification be read likewise. Therefore, the above description should not be construed as limiting, but merely as exemplifications of particular embodiments. Those skilled in the art will envision other modifications within the scope and spirit of the claims appended hereto.

What is claimed is:

1. An end effector assembly for a surgical instrument, comprising:

first and second jaw members each including a jaw housing, an electrically-conductive tissue-treatment plate, and a longitudinally-extending channel, at least one of the first or second jaw members movable relative to the other between a spaced-apart position and an approximated position; and

a cutting mechanism disposed within the second jaw member, the cutting mechanism including:

an inflatable bladder disposed within the longitudinally-extending channel of the second jaw member;

a fluid line fluidly coupled to the inflatable bladder and extending proximally from the end effector assembly, the fluid line adapted to connect to a source of fluid for supplying fluid to and removing fluid from the inflatable bladder to transition the inflatable bladder between a deflated condition and an inflated condition; and

a knife operably coupled to the inflatable bladder, the knife movable between a retracted position, corresponding to the deflated condition of the inflatable bladder, wherein the knife is fully disposed within the longitudinally-extending channel of the second jaw member, and an extended position, corresponding to the inflated condition of the inflatable bladder, wherein the knife extends from the longitudinally-extending channel of the second jaw member, between the first and second jaw members, and at least partially into the longitudinally-extending channel of the first jaw member.

2. The end effector assembly according to claim **1**, wherein the knife is mounted on the inflatable bladder.

3. The end effector assembly according to claim **1**, further comprising a guide platform disposed within the longitudinally-extending channel of the second jaw member and having the knife mounted thereon, wherein upon inflation of the inflatable bladder, the inflatable bladder urges the guide platform to urge the knife from the retracted position to the extended position.

4. The end effector assembly according to claim **3**, wherein the guide platform includes a support surface having the knife disposed thereon and at least one leg extending therefrom.

5. The end effector assembly according to claim **4**, wherein the at least one leg is slidably disposed within at least one guide track portion of the longitudinally-extending channel of the second jaw member.

6. An end effector assembly for a surgical instrument, comprising:

first and second jaw members each including a jaw housing, an electrically-conductive tissue-treatment plate, and a longitudinally-extending channel, at least one of the first or second jaw members movable relative to the other between a spaced-apart position and an approximated position; and

a cutting mechanism disposed within the second jaw member, the cutting mechanism including:

a fluid line extending proximally from the end effector assembly, the fluid line adapted to connect to a source of fluid;

a knife; and

a sealing member engaged to the knife and sealing engaged within the longitudinally-extending channel of the second jaw member so as to define a sealed chamber therein, wherein the fluid line is configured to supply fluid to the sealed chamber to thereby urge the knife and the sealing member from a retracted position, corresponding to a minimum-volume condition of the sealed chamber, wherein the knife is fully disposed within the longitudinally-extending channel of the second jaw member, to an extended position, corresponding to a maximum-volume condition of the sealed chamber, wherein the knife extends from the longitudinally-extending channel of the second jaw member, between the first and second jaw members, and at least partially into the longitudinally-extending channel of the first jaw member.

7. The end effector assembly according to claim **6**, wherein the fluid line is configured to supply high-pressure pulses of fluid to the sealed chamber to move the knife from the retracted position to the extended position.

8. The end effector assembly according to claim **6**, wherein the fluid line is configured to withdraw fluid from the sealed chamber to return the knife from the extended position to the retracted position under suction.

9. An end effector assembly for a surgical instrument, comprising:

first and second jaw members each including a jaw housing, an electrically-conductive tissue-treatment plate, and a longitudinally-extending channel, at least one of the first or second jaw members movable relative to the other between a spaced-apart position and an approximated position; and

a cutting mechanism disposed within the second jaw member, the cutting mechanism including:

at least one electromagnet disposed within the jaw housing of the second jaw member;

at least one electrical wire coupled to the at least one electromagnet and extending proximally from the end effector assembly, the at least one electrical wire adapted to connect to a source of energy for energizing the at least one electromagnet to produce a magnetic field; and

a knife at least partially disposed within the longitudinally-extending channel of the second jaw member, the knife including a magnetic portion or having a magnetic base engaged thereto, wherein the knife is repelled from or attracted to the at least one electromagnet in response to magnetization of the at least one electromagnet to thereby move the knife from a retracted position to an extended position.

10. The end effector assembly according to claim **9**, wherein, in the retracted position, the knife is fully disposed within the longitudinally-extending channel of the second jaw member, and wherein, in the extended position, the knife extends from the longitudinally-extending channel of the second jaw member, between the first and second jaw members, and at least partially into the longitudinally-extending channel of the first jaw member.

11. The end effector assembly according to claim **10**, wherein, upon magnetization of the at least one electromagnet, the knife is repelled therefrom such that the knife is urged from the retracted position to the extended position.

12. The end effector assembly according to claim **9**, wherein, in the retracted position, the knife is disposed partially within the longitudinally-extending channels of the first and second jaw members at proximal ends thereof, and wherein, in the extended position, the knife is disposed partially within the longitudinally-extending channels of the first and second jaw members at distal ends thereof.

13. The end effector assembly according to claim **12**, wherein the at least one electromagnet includes a series of electromagnets arranged longitudinally between the proximal and distal ends of the first and second jaw members.

14. The end effector assembly according to claim **13**, wherein the series of electromagnets are successively activated and deactivated in a proximal-to-distal direction to move the knife from the retracted position to the extended position.

15. The end effector assembly according to claim **14**, wherein the series of electromagnets are successively activated and deactivated in a distal-to-proximal direction to return the knife from the extended position to the retracted position.

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