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DUMBAULD et al.(10) **Pub. No.: US 2015/0245847 A1**(43) **Pub. Date: Sep. 3, 2015**(54) **IN VIVO ATTACHABLE AND DETACHABLE
END EFFECTOR ASSEMBLY AND
LAPAROSCOPIC SURGICAL INSTRUMENT
AND METHODS THEREFOR****Publication Classification**(51) **Int. Cl.***A61B 17/28* (2006.01)*A61B 18/14* (2006.01)(52) **U.S. Cl.**CPC *A61B 17/2812* (2013.01); *A61B 18/1445*(2013.01); *A61B 18/1482* (2013.01); *A61B**2017/2946* (2013.01)(71) Applicant: **COVIDIEN LP, MANSFIELD, MA
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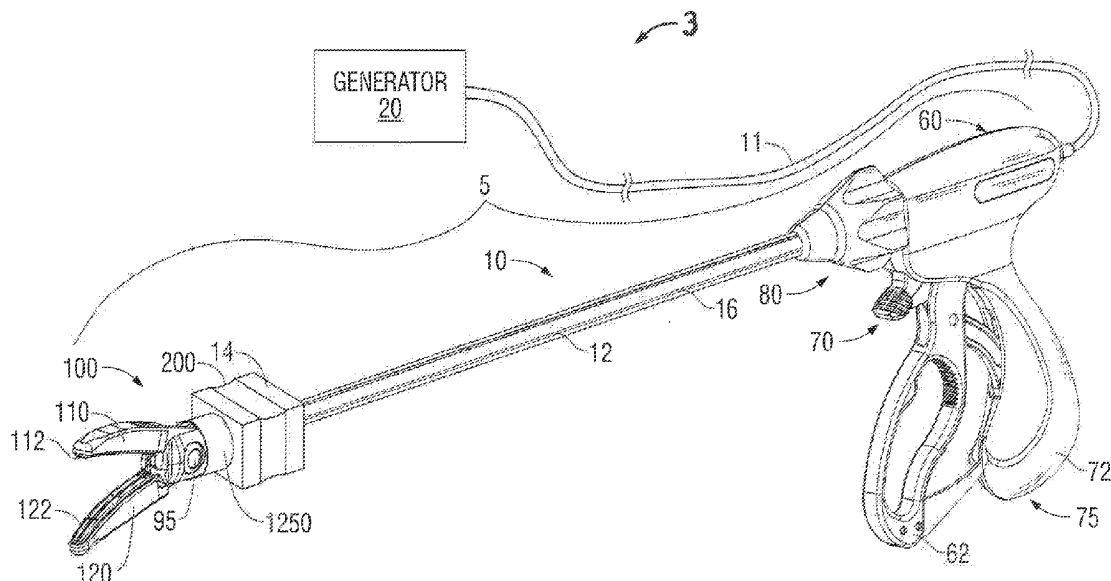
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ABSTRACT

A method of performing surgery includes the steps of providing a forceps having a housing including a shaft that extends therefrom and at least one handle moveable relative to the housing and providing an end effector assembly configured to selectively engage a distal end of the shaft. The method also includes the steps of inserting the forceps through a first opening formed in a body; inserting the end effector assembly through a second opening formed in the body; engaging the end effector assembly with the distal end of the shaft in vivo; and actuating the end effector assembly by moving the handle relative to the housing. The method may also include the steps of providing a coupling at the distal end of the shaft, and engaging, via the coupling, the distal end of the shaft with the end effector assembly.

(21) Appl. No.: **14/708,950**(22) Filed: **May 11, 2015****Related U.S. Application Data**

(63) Continuation of application No. 13/415,639, filed on Mar. 8, 2012, now Pat. No. 9,028,493, which is a continuation of application No. 12/562,281, filed on Sep. 18, 2009, now Pat. No. 8,133,254.



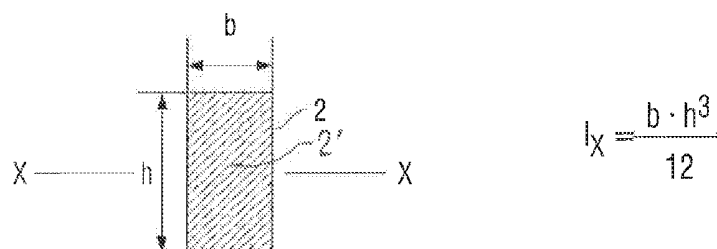


FIG. 1A

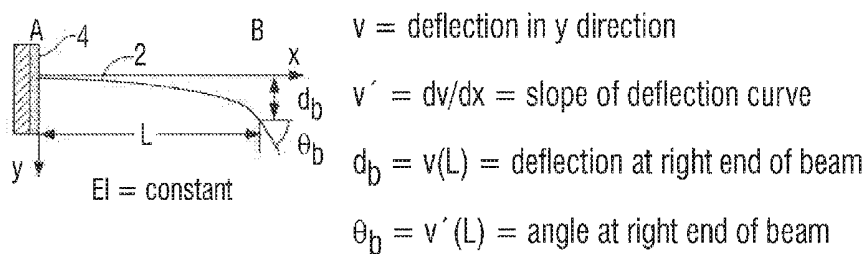


FIG. 1B

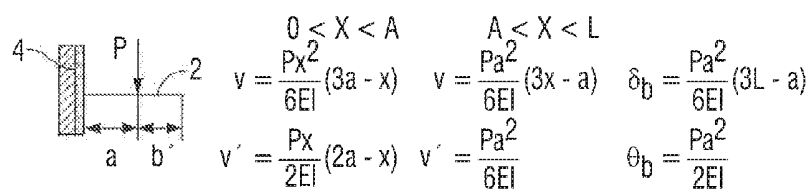


FIG. 1C

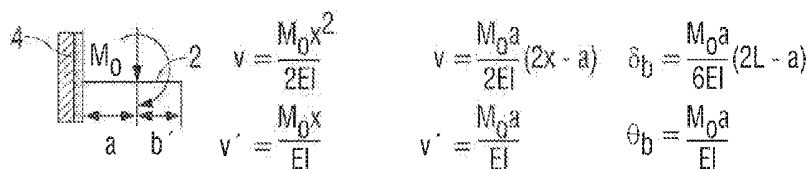
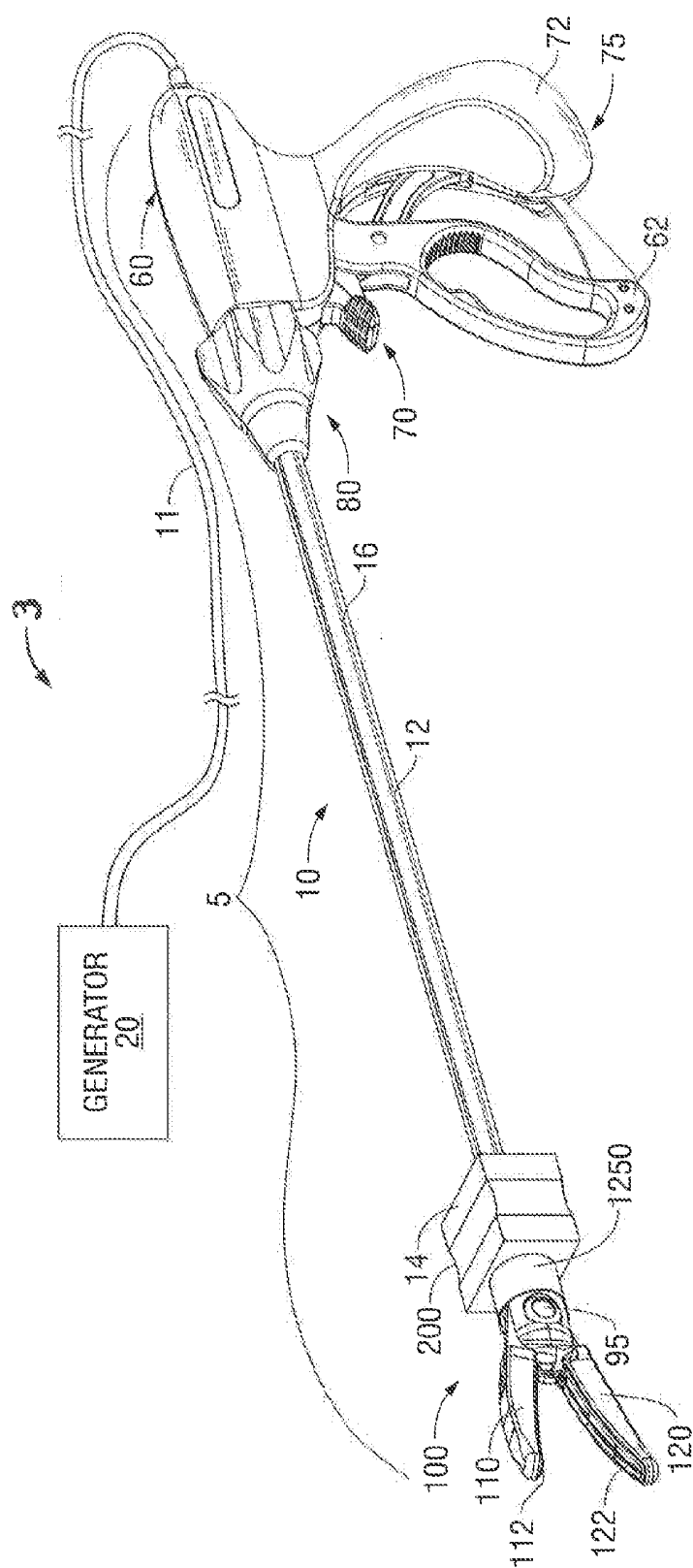
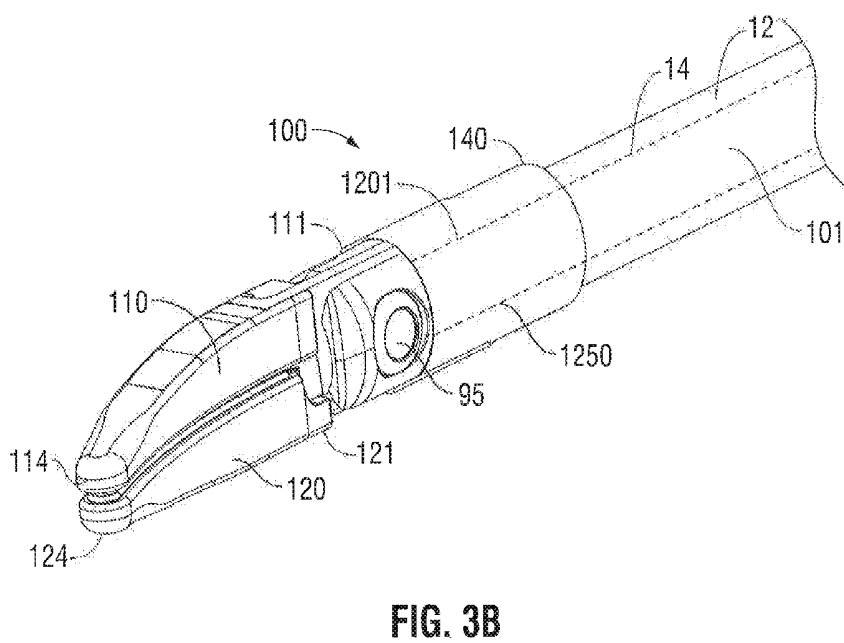
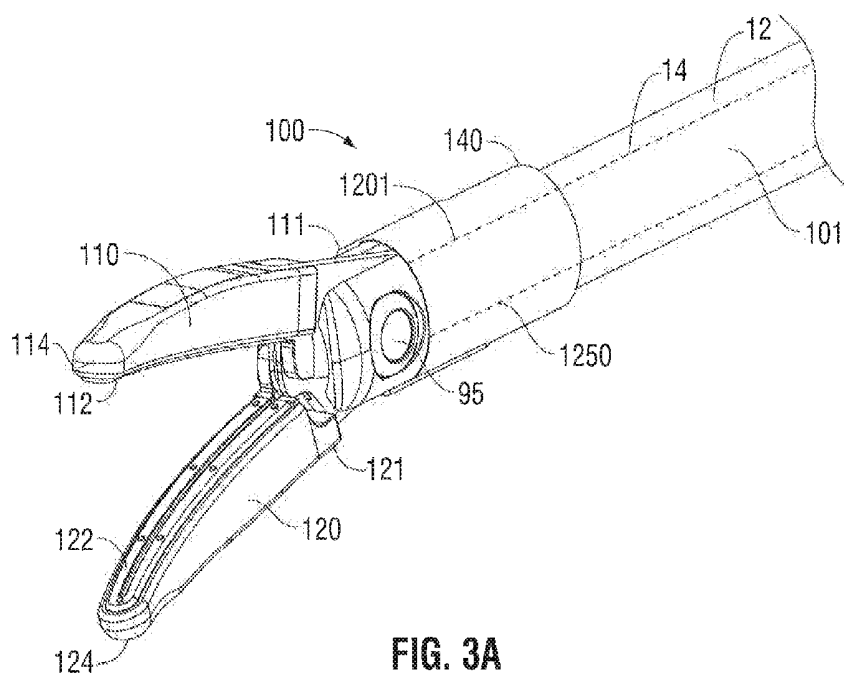


FIG. 1D



25
6
0
4



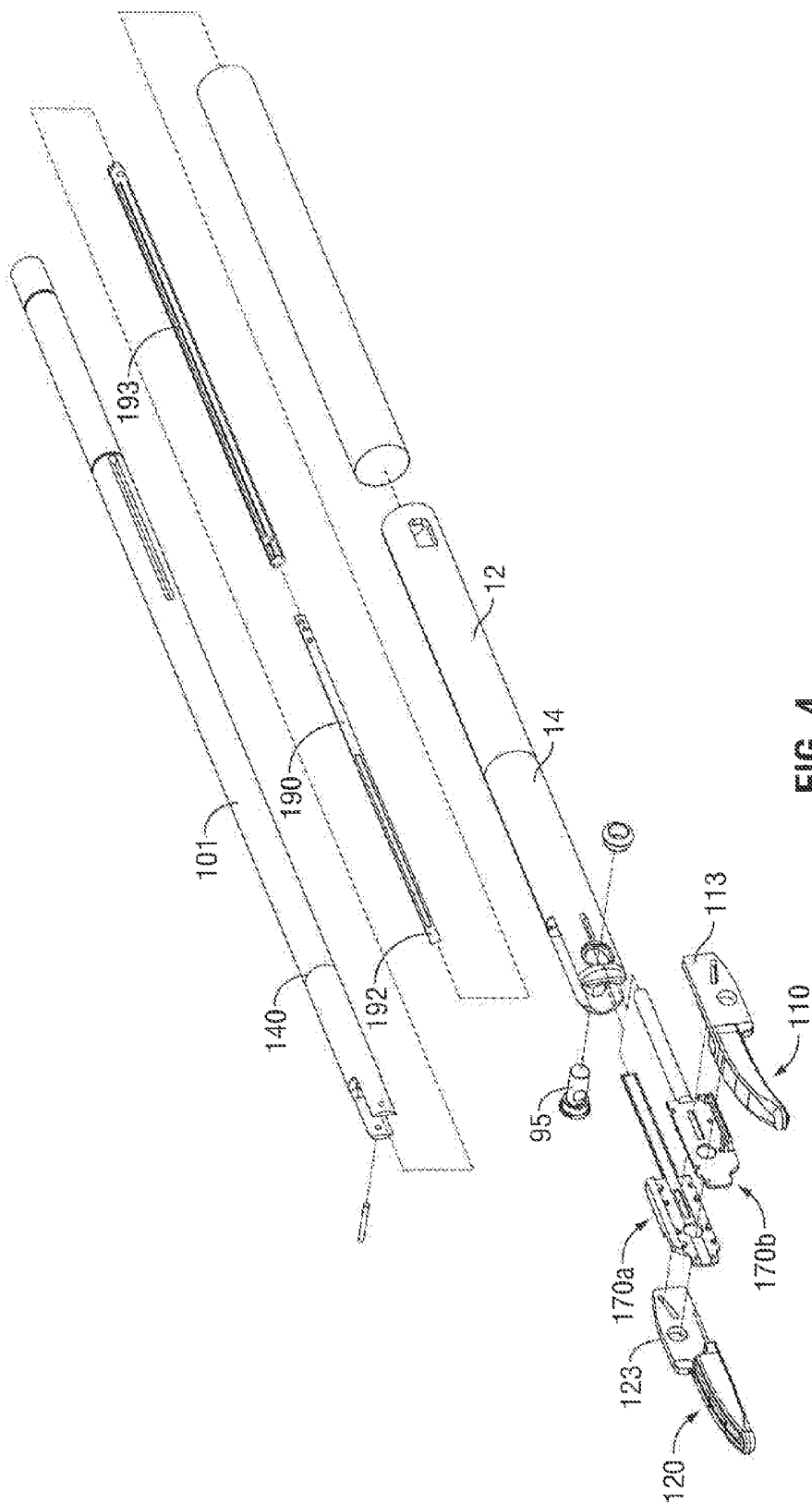


FIG. 4

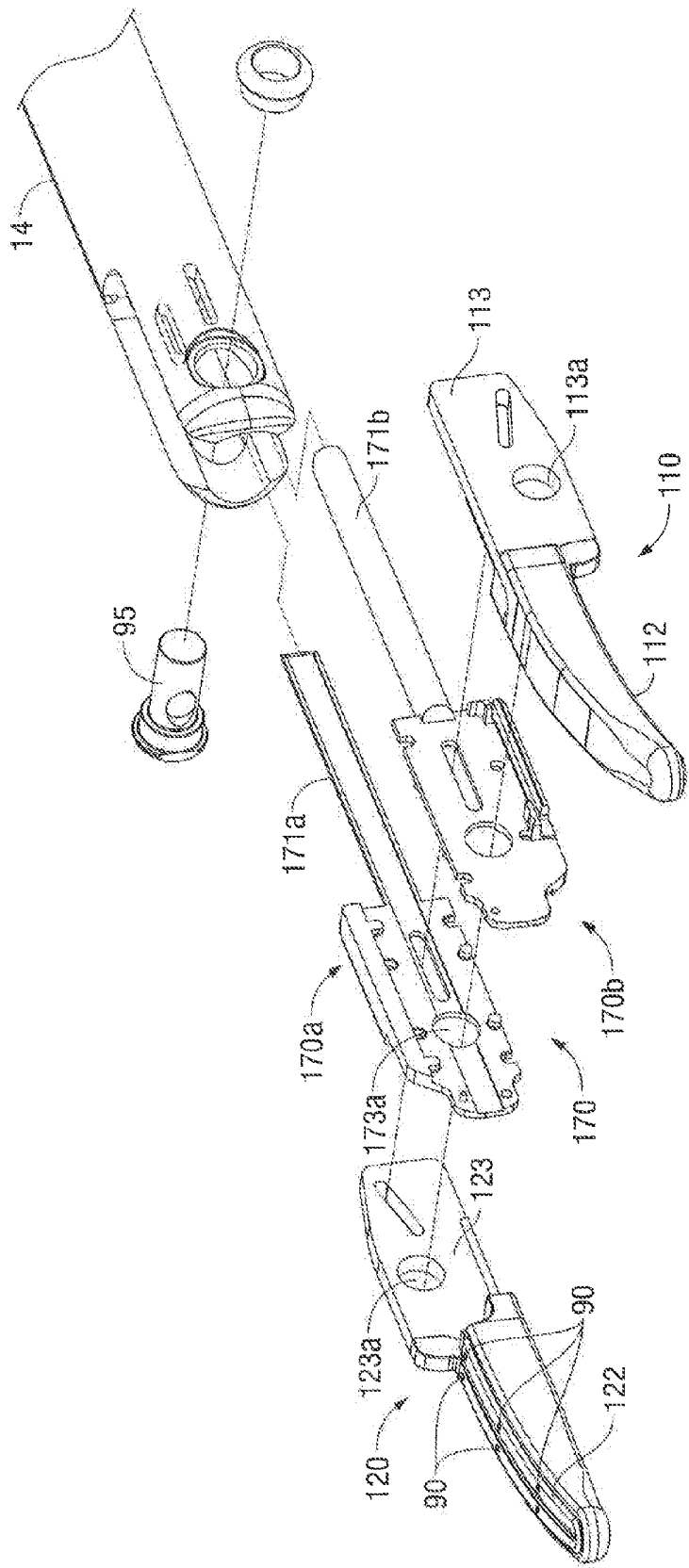
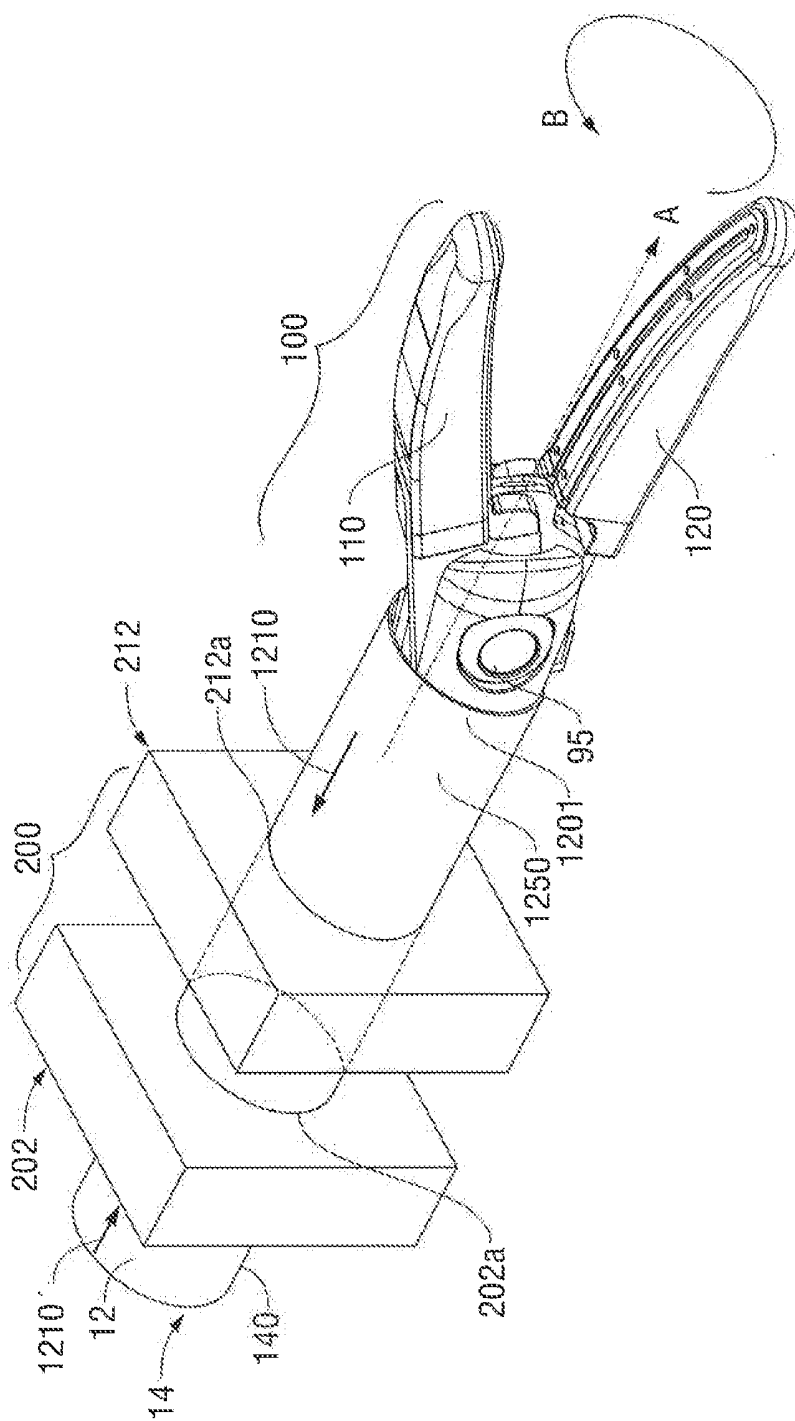
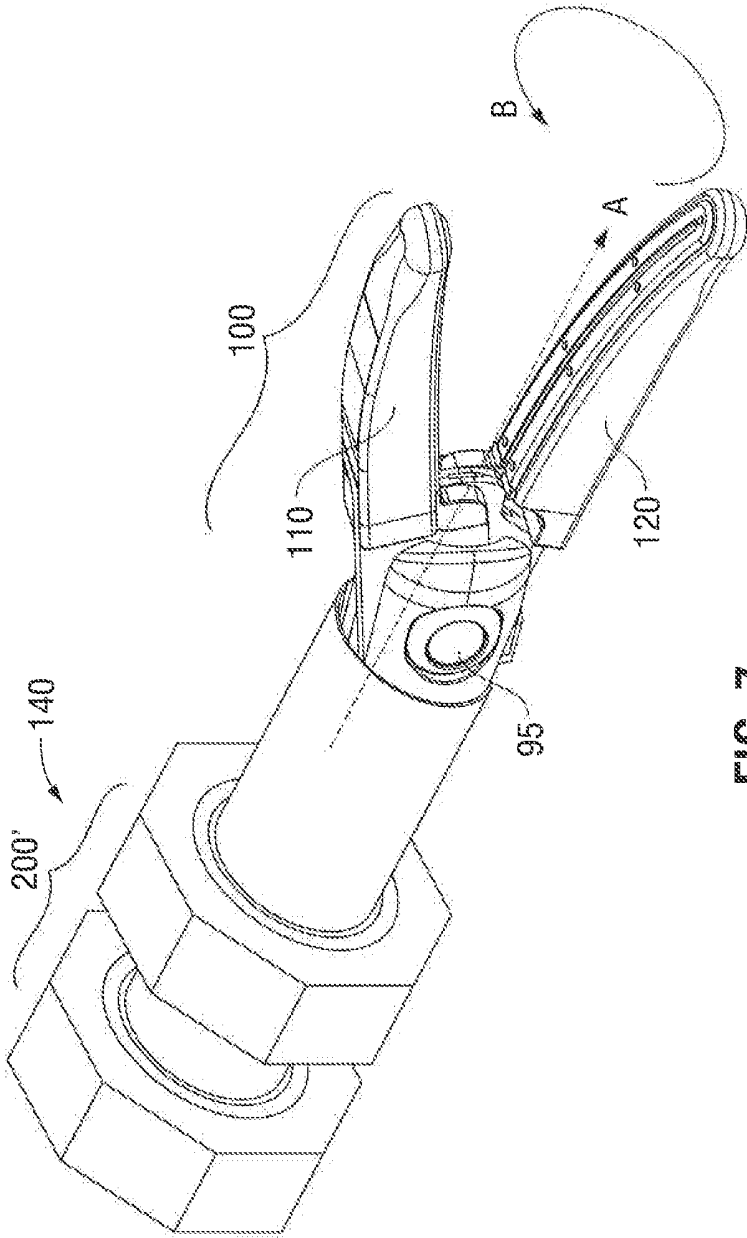


FIG. 5



சென்னை



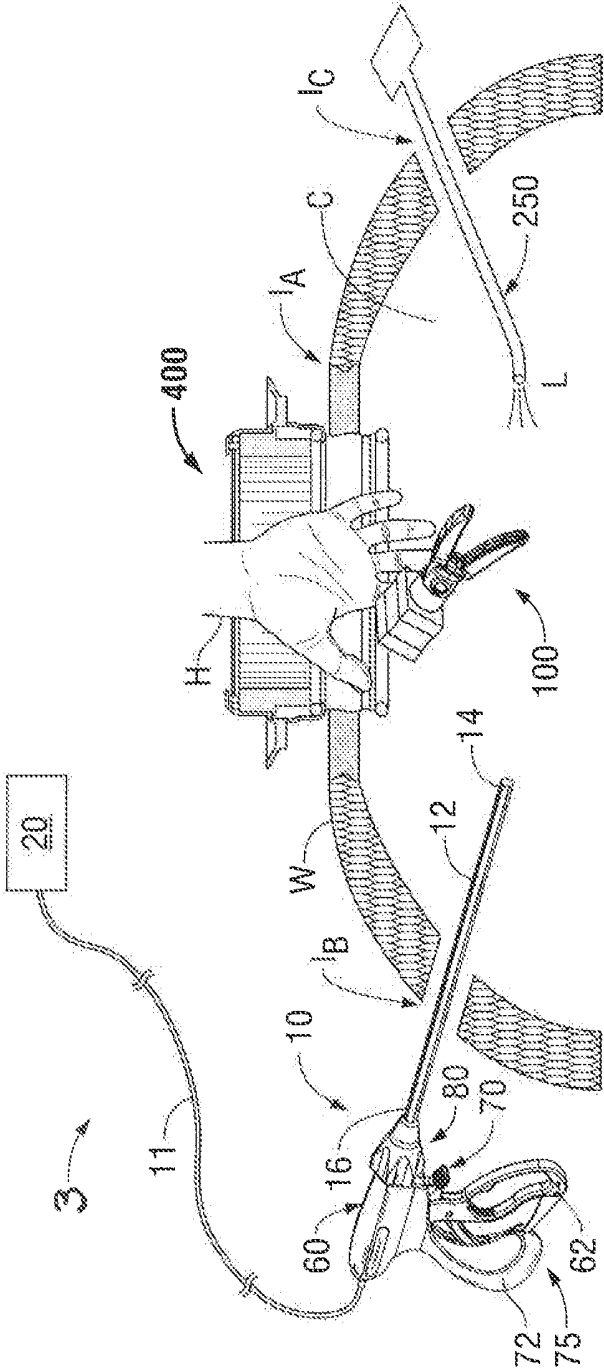
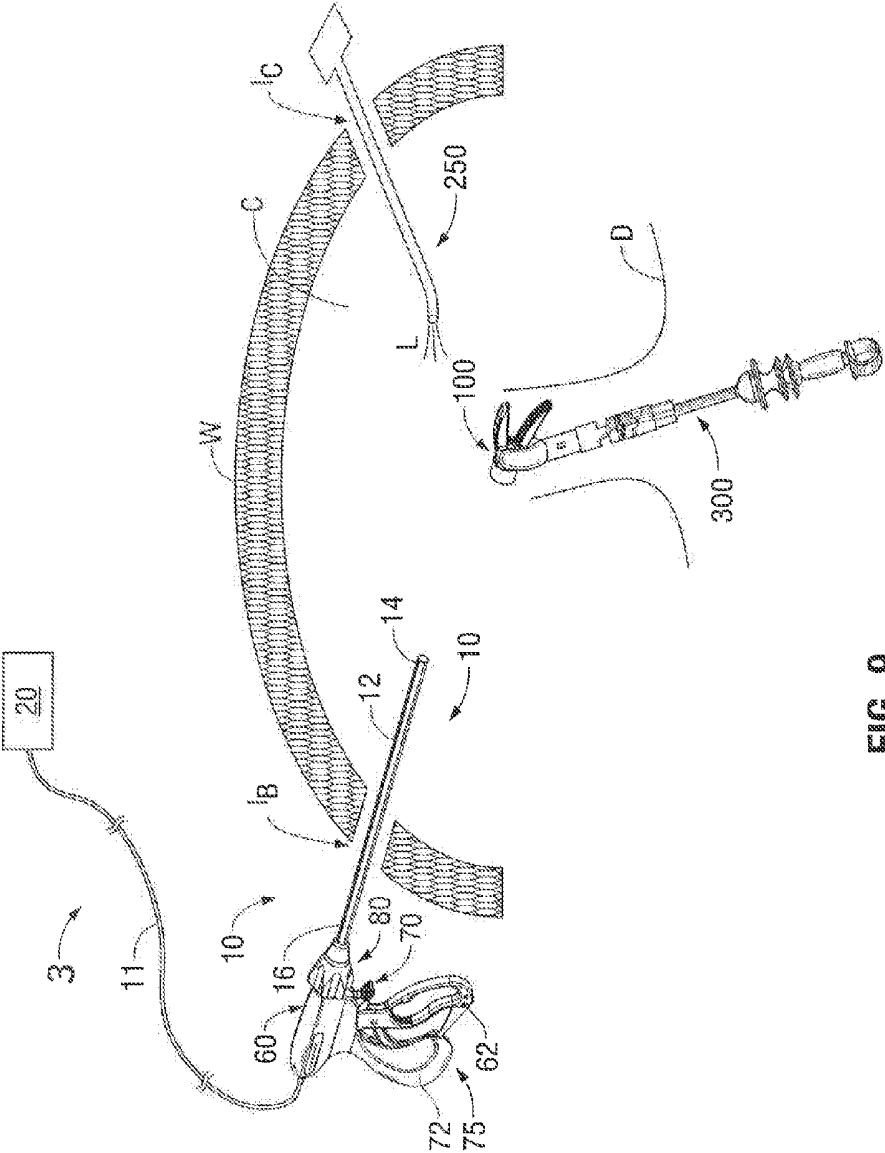


FIG. 8



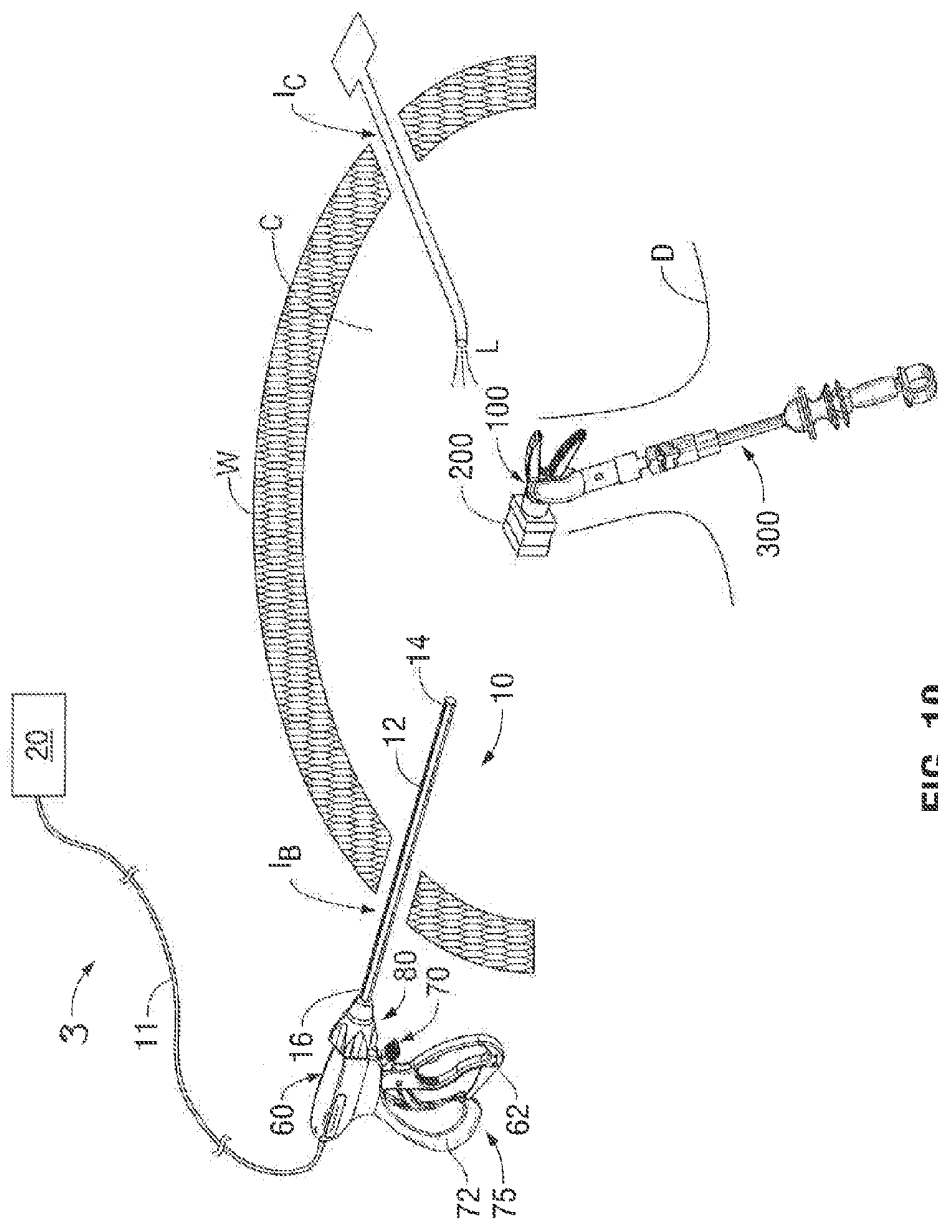


FIG. 10

IN VIVO ATTACHABLE AND DETACHABLE END EFFECTOR ASSEMBLY AND LAPAROSCOPIC SURGICAL INSTRUMENT AND METHODS THEREFOR

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of U.S. patent application Ser. No. 12/562,281 by Dumbauld et al., "IN VIVO ATTACHABLE AND DETACHABLE END EFFECTOR ASSEMBLY AND LAPAROSCOPIC SURGICAL INSTRUMENT AND METHODS THEREFOR", filed on Sep. 18, 2009, and published as U.S. Patent Application Publication US 2011/0071522 A1 "IN VIVO ATTACHABLE AND DETACHABLE END EFFECTOR ASSEMBLY AND LAPAROSCOPIC SURGICAL INSTRUMENT AND METHODS THEREFOR", the entire contents of each of which is incorporated by reference herein.

BACKGROUND

[0002] 1. Technical Field

[0003] The present disclosure relates to endoscopic or laparoscopic surgery and more particularly to end effector assemblies for surgical instruments used therein.

[0004] 2. Description of the Related Art

[0005] The trend in surgical procedures is to reduce the invasiveness of the procedure by reducing the size of the surgical incision. More and more frequently, the surgical incision is performed in the navel of the patient. For a laparoscopic surgical instrument, the outer shaft diameter is determined by the inner diameter of the ports (cannulae) with which the instrument will be used. As port size decreases to accommodate the reduced size of the surgical incision, the diameter/cross-sectional area of the end effectors of the surgical instrument must be reduced while the length of the end effectors must also be reduced to provide greater rigidity to reduce the susceptibility of the end effectors to deflection.

[0006] The resulting rigidity of the end effectors of the instrument thereby necessitates tight dimensional tolerances and a corresponding increase in material and manufacturing costs to provide the necessary rigidity.

SUMMARY

[0007] To advance the state of the art of surgery, the present disclosure relates to a method of performing surgery that includes the steps of providing a forceps having a housing including a shaft that extends therefrom and at least one handle moveable relative to the housing and providing an end effector assembly configured to selectively engage a distal end of the shaft. The method also includes the steps of inserting the forceps through a first opening formed in a body; inserting the end effector assembly through a second opening formed in the body; engaging the end effector assembly with the distal end of the shaft in vivo; and actuating the end effector assembly by moving the handle relative to the housing.

[0008] The method may include the step of providing a coupling at the distal end of the shaft, and may further include the step of engaging, via the coupling, the distal end of the shaft with the end effector assembly.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Various embodiments of the present disclosure are described herein with reference to the drawings wherein:

[0010] FIG. 1A illustrates a beam having a rectangular cross-section and the corresponding equation and dimensions to calculate the moment of inertia of the beam around a particular axis;

[0011] FIG. 1B illustrates a cantilevered beam and the corresponding mathematical factors related to calculating the deflection of the beam along the length of the beam with respect to the anchor point;

[0012] FIG. 1C illustrates the cantilevered beam of FIG. 1B and the equations to calculate the deflection of the beam under a load as a function of the distance along the length of the beam with respect to the anchor point;

[0013] FIG. 1D illustrates the cantilevered beam of FIG. 1B and the equations to calculate the deflection of the beam under a bending moment as a function of the distance along the length of the beam with respect to the anchor point;

[0014] FIG. 2 is a left, perspective view of an endoscopic bipolar forceps showing a housing, a shaft and an in vivo detachable end effector assembly according to one embodiment of the present disclosure;

[0015] FIG. 3A is an enlarged, left, perspective view of the end effector assembly and shaft of FIG. 1 in which the in vivo detachable end effector assembly is in an open position;

[0016] FIG. 3B is an enlarged, left, perspective view of the end effector assembly and shaft of FIG. 1 in which the in vivo detachable end effector assembly is in a closed position;

[0017] FIG. 4 is a left, perspective, exploded view of the shaft and push rod of the in vivo detachable end effector assembly;

[0018] FIG. 5 is a detailed, left, perspective, exploded view of the jaw members of the in vivo detachable end effector assembly;

[0019] FIG. 6 is a right, perspective view of the in vivo detachable end effector assembly and the shaft generally joined by a coupling according to one embodiment of the present disclosure;

[0020] FIG. 7 is a right, perspective view of the in vivo detachable end effector assembly and the shaft joined by a compression coupling according to one embodiment of the present disclosure;

[0021] FIG. 8 is a simplified view of an abdominal cavity in a subject illustrating an in vivo method of attaching a detachable end effector assembly to an endoscopic surgical instrument during a laparoscopic procedure according to one embodiment of the present disclosure;

[0022] FIG. 9 is a simplified view of an abdominal cavity in a subject illustrating an in vivo method of attaching, via a grasping device, a detachable end effector assembly to an endoscopic surgical instrument during a laparoscopic procedure according to another embodiment of the present disclosure; and

[0023] FIG. 10 is a simplified view of an abdominal cavity in a subject illustrating an in vivo method of attaching a detachable end effector assembly to an endoscopic surgical instrument during a laparoscopic procedure via a coupling that is configured to interface with the end effector assembly and the endoscopic surgical instrument according to still another embodiment of the present disclosure.

DETAILED DESCRIPTION

[0024] Various embodiments of the present disclosure are described hereinbelow with reference to the accompanying drawings. Well-known functions or constructions are not described in detail to avoid obscuring the present disclosure in unnecessary detail.

[0025] The present disclosure relates to a laparoscopic surgical instrument having a mating joint to enable attachment and detachment of a detachable end effector. The detachable end effector may be introduced into the abdominal cavity through a surgical incision such as at the navel while the laparoscopic surgical instrument is introduced, without the detachable end effector, into the abdominal cavity through another surgical incision. Alternatively, the detachable end effector may be introduced through a natural orifice such as the anal canal, while the laparoscopic surgical instrument is introduced, without the detachable end effector, through a surgical incision in the abdominal cavity.

[0026] The detachable end effector may be introduced by a second instrument, such as a grasper, which is used to attach or connect the detachable end effector to the mating joint of the instrument.

[0027] As compared to conventional laparoscopic surgical instruments, since the detachable end effector is introduced through a natural orifice of the patient, the length and the diameter of the detachable end effector of the laparoscopic surgical instrument according to the embodiments of the present disclosure may be increased.

[0028] Removal of the diameter and length constraints of the end effectors of the prior art generally allows for looser tolerances and more cost effective end effector fabrication processes. As the diameter is a significant factor in determining the necessary rigidity of the end effector assembly, a larger-diameter end effector assembly can be a longer end effector assembly because the end effector assembly will be less susceptible to deflection and thus provide a more uniform distribution of sealing pressure to the tissue.

[0029] As is well-known in the art, deflection of a cantilevered beam, which can approximate the deflection of the end effector assembly with respect to the shaft of the endoscopic instrument, is directly proportional to the distance of the applied load from an anchor point, in this case, the joint between the end effector assembly and the shaft, and inversely proportional to Young's modulus of elasticity E and the moment of inertia I of the end effector assembly, as illustrated in FIGS. 1A-1D. For an assumed rectangular cross-section 2' of the beam 2 as illustrated in FIG. 1A, since the moment of inertia I_x around the x-axis is proportional to the width b times the cube of the height h , i.e., h^3 , it can be seen that an increase in height h , while b remains constant, significantly increases the moment of inertia I_x . As can then be seen from FIGS. 1B-1C, if the beam 2 is assumed to be a cantilevered beam anchored at anchor point 4, representing the distal end of a shaft of an endoscopic instrument, the deflection v in the y-direction is directly proportional to the applied load P and the cube of the distance a from the anchor point 4, i.e., a^3 . Since the load P and the cube of the distance a are independent of the moment of inertia I_x , it can then be understood that any increase in moment of inertia I_x (while the other factors remain the same) will reduce the deflection v . FIG. 1D simply illustrates the same effect if one assumes a bending moment M_0 around anchor point 4 instead of load P .

[0030] Following completion of the surgical procedure, the detachable end effector having an enlarged moment of inertia

and rigidity is detached from the mating joint via the second instrument, which may again be introduced through the natural orifice and used to withdraw the detachable end effector from the abdominal cavity while the laparoscopic surgical instrument is withdrawn through the surgical incision.

[0031] In the drawings and in the descriptions which follow, the term "proximal", as is traditional, will refer to the end of the forceps 10 which is closer to the user, while the term "distal" will refer to the end which is further from the user. It should be noted that with respect to the end effector assembly 100, reference to proximal end and distal end will be with respect to configuration of the end effector assembly 100 following attachment to the distal end 14 of the shaft 12 and corresponding actual use via the endoscopic bipolar forceps 10 during the surgical procedure, as opposed to the position of the end effector assembly 100 during the attachment process.

[0032] Referring now to FIG. 2, a tissue sealing system 3 having a combination forceps and in vivo detachable end effector assembly 5 according to the present disclosure is shown. The combination forceps and in vivo detachable end effector assembly 5 includes a forceps 10 coupled to a generator 20. Upon attachment and engagement of end effector assembly 100, as described in more detail below, the combination forceps and in vivo detachable end effector assembly 5 is adapted to seal tissue using electrosurgical energy. The generator 20 may be configured to output various types of electrosurgical energy (e.g., from about 300 MHz to about 10,000 MHz).

[0033] The forceps 10 is coupled to the generator 20 via a cable 11 adapted to transmit energy and control signals thereto. Various embodiments of the forceps 10 utilizing the aforementioned types of energy are discussed in more detail below.

[0034] As indicated, the forceps 10 is configured to support an in vivo detachable end effector assembly 100. Forceps 10 typically includes various conventional features (e.g., a housing 60, a handle assembly 75, a rotating assembly 80, a trigger assembly 70) which enable forceps 10 and detachable end effector assembly 100 to mutually cooperate to grasp, seal and, if warranted, divide tissue. Forceps 10 generally includes housing 60 and handle assembly 75, which includes moveable handle 62 and handle 72 that is integral with housing 60. Handle 62 is moveable relative to handle 72 to actuate detachable end effector assembly 100 to grasp and treat tissue. Forceps 10 also includes a shaft 12 that has distal end 14 that mechanically engages detachable end effector assembly 100 and proximal end 16 that mechanically engages housing 60 proximate rotating assembly 80 disposed at the distal end of housing 60. Rotating assembly 80 is mechanically associated with shaft 12. Movement of rotating assembly 80 imparts similar rotational movement to shaft 12 which, in turn, rotates detachable end effector assembly 100.

[0035] Referring also to FIGS. 3A-3B, detachable end effector assembly 100 includes a proximal end 1250 comprising a shaft 1201 at proximal end 1250 that is configured to engage distal end 14 of the shaft 12 of the forceps 10 at interface joint 140. The engagement between the shaft 12 and the shaft 1201 at interface joint 140 enables the attachment and detachment of the end effector assembly 100 with the forceps 10.

[0036] Detachable end effector assembly 100 also includes two jaw members 110 and 120 having proximal ends 111, 121 and distal ends 114, 124. Jaw members 110 and 120 are pivotable about a post or pivot pin 95 and are movable from a

first position wherein jaw members 110 and 120 are spaced relative to another, to a second position wherein jaw members 110 and 120 are closed and cooperate to grasp tissue therebetween. As discussed in more detail below, the detachable end effector assembly 100 may be adapted for use with various energy sources.

[0037] In the illustrated embodiment, the shaft 12 houses a pushrod 101 that is operatively coupled to the movable handle 62 such that when the handle 62 is moved relative to the handle 72 the pushrod 101 moves longitudinally, either proximally or distally within the shaft 12. The pushrod 101 may include one or more pins disposed at the distal end 16 of shaft 12. Each of the jaw members 110 and 120 includes a corresponding slot disposed at the proximal ends thereof that mechanically cooperates with the push pins in a cam-follower mechanical arrangement. Motion of the pushrod 101 causes the pins to slide within respective slots 105 to actuate the jaw members. Other ways of opening/closing the jaws 110 and 120 are contemplated such as any known combinations of mechanical or electro-mechanical arrangement of gears, cams, pulleys, springs and sleeves.

[0038] The forceps 10 may also include a trigger assembly 70 that advances a knife 190 disposed within the detachable end effector assembly 100. Once a tissue seal is formed, the user activates the trigger assembly 70 to separate the tissue along the tissue seal.

[0039] Each jaw member 110 and 120 also includes a sealing surface 112 and 122, respectively, disposed on an inner-facing surface thereof. Sealing surfaces 112 and 122 cooperate to seal tissue held therebetween upon the application of energy. Sealing surfaces 112 and 122 are connected to generator 20 that communicates energy through the tissue held therebetween.

[0040] As best seen in FIG. 2, forceps 10 also includes an electrosurgical cable 11 which connects the forceps 10 to generator 20. Cable 11 is internally divided into cable leads (not shown) which each transmit electrosurgical energy through their respective feed paths through the forceps 10 to the detachable end effector assembly 100.

[0041] As mentioned above, detachable end effector assembly 100 is attached at the distal end 14 of shaft 12 and includes a pair of opposing jaw members 110 and 120. As described above, movable handles 62 and 72 mechanically cooperate to impart movement of the jaw members 110 and 120 from an open position, wherein the jaw members 110 and 120 are disposed in spaced relation relative to one another, to a clamping or closed position wherein the jaw members 110 and 120 cooperate to grasp tissue therebetween.

[0042] As shown best in FIGS. 3A-3B, 4 and 5, the detachable end effector assembly 100 is designed as a bilateral assembly, i.e., both jaw members 110 and 120 pivot relative to one another about a pivot pin 95 disposed therethrough. The jaw members 110 and 120 are curved to facilitate manipulation of tissue and to provide better "line of sight" for accessing organs and large tissue structures. In other embodiments, the jaw members 110 and 120 may have a straight configuration.

[0043] Push rod 101, which ultimately connects to a drive assembly (not shown), is dimensioned to slidably receive knife drive rod 193, knife 190 and posts 171a and 171b of halves 170a and 170b of knife guide 170. Push rod 101, in turn, is received within shaft 12. Upon actuation of the drive assembly, the push rod 101 reciprocates which, in turn, causes the pins to ride within slots to open and close the jaw members

110 and 120 as desired. The jaw members 110 and 120, in turn, pivot about pivot pin 95 disposed through respective pivot holes 113a and 123a disposed within flanges 113 and 123.

[0044] Jaw members 110 and 120 are electrically isolated from one another such that electrosurgical energy can be effectively transferred through the tissue to form a tissue seal. Jaw members 110 and 120 are engaged to the end of rotating shaft 12 by pivot pin 95 such that rotation of the rotating assembly 80 correspondingly rotates shaft 12 (along with push rod 101 and knife 190) which, in turn, rotates detachable end effector assembly 100 (See FIG. 2).

[0045] FIG. 6 illustrates the in vivo detachable end effector assembly 100 and the distal end 14 of shaft 12 of the endoscopic surgical instrument or forceps 10 that is generally joined by a coupling 200 according to one embodiment of the present disclosure. The coupling 200 has an orifice 202a at proximal end 202 and an orifice 212a at distal end 212. The orifice 202a at proximal end 202 is configured to receive the distal end 14 of shaft 12 of the endoscopic surgical instrument or forceps 10 while the orifice 212a at distal end 212 is configured to receive proximal end 1250 of the shaft 1201 of the detachable end effector assembly 100. As previously described above with respect to FIGS. 3A and 3B, detachable end effector assembly 100 includes proximal end 1250 comprising shaft 1201 at proximal end 1250 that is configured to engage distal end 14 of the shaft 12 of the forceps 10 at interface joint 140. The engagement between the shaft 12 and the shaft 1201 enables the attachment and detachment of the end effector assembly 100 with the forceps 10 during an in vivo surgical procedure. The installation of the coupling 200 during the in vivo surgical procedure thereby secures the joint 140 and enables the attachment of the end effector assembly 100 to the shaft 12 of the forceps 10. Conversely, release of the coupling 200 upon completion of activities required using the forceps 10 during the in vivo surgical procedure enables the detachment of the end effector assembly 100 from the shaft 12 of the forceps 10. To assist in the installation of the coupling 200, one or more alignment indicators, e.g., an arrow 1210 formed at an appropriate location on the shaft 1201 of the end effector assembly 100 and a corresponding arrow 1210' formed on the shaft 12 of the forceps 10, facilitate engagement of the end effector assembly 100 with the forceps 10 during an in vivo surgical procedure.

[0046] FIG. 7 illustrates the in vivo detachable end effector assembly 100 and the shaft 12 of forceps 10 joined at interface joint 140 by an example coupling, e.g., a compression coupling 200' that may have a compression fitting at one or both ends or a compression fitting at one end and another type of fitting such as a screw threaded fitting at the other end, according to one embodiment of the present disclosure. Numerous other suitable couplings may be employed to perform the joining of the end effector assembly 100 and the shaft 12, including, but not limited to, Luer lock fittings, snap-fit coupling, ball and socket fittings and the like.

[0047] The shaft 12 and the end effector assembly 100 are configured such that engagement of the end effector assembly 100 with the distal end 14 of the shaft 12 establishes electrical communication between the forceps 10 and the tissue sealing surface 112 and/or 122 of the end effector assembly 100.

[0048] As also described above previously, the distal end 14 of the shaft 12 is configured to interface with coupling 200. The coupling 200 is configured to interface with the end effector assembly 100. The end effector assembly 100 is

configured to detachably engage and disengage from the distal end **14** of the shaft **12** via engagement of the end effector assembly **100** with the coupling **200**.

[0049] The shaft **12** and the end effector assembly **100** are configured such that engagement of the end effector assembly **100** with the distal end **14** of the shaft **12** via the coupling **200** establishes electrical communication between the forceps **10** and the end effector assembly **100**.

[0050] To accomplish the intended purpose of the combination forceps and in vivo detachable end effector assembly **5** (see FIG. **2**), the end effector assembly **100** may be configured to vary the ratio between the moment of inertia of the cross-section of the end effector assembly and the moment of inertia of the cross-section of the shaft **12** depending on any particular surgical purpose.

[0051] In addition, coupling **200** may be configured to selectively engage a first end effector assembly having a cross-sectional moment of inertia value and a second end effector assembly having a cross-sectional moment of inertia value that differs from the cross-sectional moment of inertia value of the first end effector assembly. That is, the coupling may be a universal type coupling configured to selectively engage end effector assemblies of different or various sizes.

[0052] FIGS. **8-10** illustrate simplified views of portions of the in vivo method of attaching the detachable end effector assembly **100** to the forceps **10** to form the combination forceps and end effector assembly **5** (see FIG. **2**) for use during the surgical procedure to seal and cut tissue.

[0053] More particularly, FIG. **8** is a simplified view of an abdominal cavity **C** in a subject illustrating the in vivo method of attaching detachable end effector assembly **100** to forceps **10** during a laparoscopic procedure according to one embodiment of the present disclosure. A surgical hand access apparatus **400** is shown installed within an opening or surgical incision I_A in abdominal wall **W** located at a position such as at the navel of the subject as shown. Such a surgical hand access apparatus and the method of installation are described in commonly-owned U.S. Patent Application Publication US 2006/0229501 A1, by Jensen et al., entitled "SURGICAL HAND ACCESS APPARATUS", now U.S. Pat. No. 7,766, 824 issued on Aug. 3, 2010. The hand **H** of a surgeon is illustrated grasping the in vivo detachable end effector assembly **100** and inserting or positioning the end effector assembly **100** through the incision I_A and into the abdominal cavity **C**. The end effector assembly **100** is grasped and oriented in a position to facilitate attachment and engagement of the end effector assembly **100** with the forceps **10**.

[0054] The forceps **10** is provided and inserted, minus the detachable end effector assembly **100**, through another opening or incision I_B in the body that allows the surgeon to position the distal end **14** of the shaft **12** such that upon attachment and engagement of the end effector assembly **100** to the shaft **12**, the resulting combination forceps and end effector assembly **5** (see FIG. **2**) is advantageously positioned to perform the desired surgical procedure.

[0055] Although not shown, the method further includes the step of engaging the end effector assembly **100** with the distal end **14** of the shaft **12**. The step of engaging the end effector assembly **100** with the distal end **14** of the shaft **12** enables establishment of electrical communication between the forceps **10** and the tissue sealing surface **112** and/or **122** of jaw members **110** and/or **120** of the end effector assembly **100**.

[0056] When at least one jaw member, e.g., lower jaw member **120**, of the end effector assembly **100** further includes a mechanical cutting element, e.g., knife blade **190**, the step of engaging the end effector assembly **100** with the distal end **14** of the shaft **12** also enables establishment of mechanical communication between the forceps **10** and the mechanical cutting element of the jaw member **120** to enable mechanical cutting of tissue.

[0057] As described above to assist in the installation of the coupling **200**, the method may include providing one or more alignment indicators, e.g., arrow **1210** formed at an appropriate location on the shaft **1201** of the end effector assembly **100** and/or corresponding arrow **1210'** formed on the shaft **12** of the forceps **10**, to facilitate engagement of the end effector assembly **100** with the forceps **10** during an in vivo surgical procedure. The step of aligning the end effector assembly **100** with the forceps **10** may include rotating the end effector assembly **100**, in the direction indicated by arrow **B** around longitudinal axis **A** of the end effector assembly **100**, and also translating the end effector assembly **100** in the direction of the longitudinal axis **A**, as illustrated in FIGS. **6** and **7**.

[0058] To further assist the surgeon in implementing the attachment and engagement of the end effector assembly **100** to the shaft **12** and in implementing the surgical procedure, an endoscopic camera **250** may be positioned and inserted through the abdominal wall **W** into the abdominal cavity **C** through another opening or incision I_C in the body at an opposite side of the abdominal wall **W** to facilitate transmission of light **L** towards the end effector assembly **100** and the distal end **14** of the shaft **12** and to facilitate reception of cinematic images.

[0059] FIG. **9** is a simplified view of the abdominal cavity **C** in a subject illustrating an in vivo method of attaching, via a grasping device, the detachable end effector assembly **100** to the forceps **10** during a laparoscopic procedure according to another embodiment of the present disclosure. A grasping device **300**, such as the endoscopic surgical device having an articulating handle assembly that is disclosed in commonly-owned U.S. patent application Ser. No. 12/193,864 by De Santis et al., filed on Aug. 19, 2008, entitled "ENDOSCOPIC SURGICAL DEVICE", published on Feb. 26, 2009 as U.S. Patent Application Publication No. US 2009/0054734 A1, the entire contents of which are hereby incorporated by reference herein, is positioned and inserted through an opening in the body such as a natural orifice **D**. Again, the end effector assembly **100** is grasped and oriented in a position to facilitate attachment and engagement of the end effector assembly **100** with the forceps **10**.

[0060] In a similar manner as described above with respect to FIG. **8**, the forceps **10** is provided and inserted, minus the detachable end effector assembly **100**, through opening or incision I_B in the body that allows the surgeon to position the distal end **14** of the shaft **12** such that upon attachment and engagement of the end effector assembly **100** to the shaft **12**, the resulting combination forceps and end effector assembly **5** (see FIG. **2**) is advantageously positioned to perform the desired surgical procedure.

[0061] Again, although not shown, the method may further include the step of engaging the end effector assembly **100** with the distal end **14** of the shaft **12**. The step of engaging the end effector assembly **100** with the distal end **14** of the shaft **12** enables establishment of electrical communication between the forceps **10** and the end effector assembly **100**.

[0062] In a similar manner, when at least one jaw member, e.g., lower jaw member 120, of the end effector assembly 100 further includes a mechanical cutting element, e.g., knife blade 190, the step of engaging the end effector assembly 100 with the distal end 14 of the shaft 12 also enables establishment of mechanical communication between the forceps 10 and the mechanical cutting element (knife blade 190) of the jaw member 120 to enable mechanical cutting of tissue.

[0063] FIG. 10 is a simplified view of the abdominal cavity C in a subject illustrating an alternative in vivo method of attaching the detachable end effector assembly 100 to forceps 10 during a laparoscopic procedure, as compared to the in vivo method described above with respect to FIG. 9, via the coupling 200 that is configured to interface with the end effector assembly 100 and the forceps 10, according to still another embodiment of the present disclosure.

[0064] As described previously above with respect to FIGS. 6 and 7, the end effector assembly 100 and the distal end 14 of the shaft 12 of the forceps 10 are configured to interface with the coupling 200. As can be appreciated, the previous steps of implementing the method of engaging the forceps 10 with the end effector assembly 100 described above with respect to FIG. 9 are each implemented by interfacing the coupling 200 with the end effector assembly 100 and with the distal end 14 of the shaft 12.

[0065] The methods described above with respect to FIGS. 8-10 may be implemented wherein forceps 10 includes trigger assembly 70 (that includes a trigger—see FIG. 2) operably coupled to the housing 60 and the end effector assembly 100 includes a knife 192 (see FIG. 4) and the method includes the step of actuating the trigger 70 to advance the knife 192 to separate tissue disposed in the end effector assembly 100.

[0066] Additionally, the method may be implemented by providing coupling 200 configured to selectively engage a first end effector assembly having a cross-sectional moment of inertia value and a second end effector assembly having a cross-sectional moment of inertia value that differs from the cross-sectional moment of inertia value of the first end effector assembly depending on a surgical need. That is, as described previously, the coupling 200 may be a universal type coupling configured to selectively engage end effector assemblies of different or various sizes depending on the requirements for a particular surgical procedure or need.

[0067] Actuation of the handles 62 and 72 closes the jaw members 110 and 120 about tissue with a pre-determinable and consistent closure pressure to effect a tissue seal. Closure pressures for sealing large tissue structures fall within the range of about 3 kg/cm² to about 16 kg/cm².

[0068] Stop members 90 which extend from the sealing surface 122 provide a consistent and accurate gap distance “G” (not shown) between the electrically conductive sealing surfaces 112 and in the range from about 0.001 inches (about 0.0254 millimeters) to about 0.006 inches (about 0.1524 millimeters) which is also effective for sealing tissue.

[0069] After the tissue is grasped between jaw members 110 and 120, the forceps 10 is ready for selective application of electrosurgical energy and subsequent separation of the tissue. By controlling the intensity, frequency and duration of the electrosurgical energy and pressure applied to the tissue, the user can effectively seal tissue.

[0070] Referring to FIG. 2, it can be appreciated from the foregoing that the embodiments of the present disclosure may include a kit for an in vivo surgical procedure that includes forceps 10 having housing 60 including shaft 12 that extends

therefrom and at least one handle 62 that is movable relative to the housing 60. The kit also includes the selectively engageable end effector assembly 100 that is configured to selectively engage the distal end 14 of the shaft 12. The kit may further include coupling 200 that is configured to facilitate engagement of the end effector assembly 100 to the forceps 10.

[0071] The state of the art of endoscopic surgery is advanced by the embodiments of the present disclosure, since the embodiments of the present disclosure enable removing the diameter and length constraints of the end effectors of the prior art to generally allow for looser tolerances and more cost effective end effector fabrication processes. As described above, the diameter is a significant factor in determining the necessary rigidity of the end effector assembly, so that a larger-diameter end effector assembly can be a longer end effector assembly because the end effector assembly will be less susceptible to deflection and thus will provide a more uniform distribution of sealing pressure to the tissue.

[0072] While several embodiments of the disclosure have been shown in the drawings and/or discussed herein, 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.

1-18. (canceled)

19. A kit for an in vivo surgical procedure, comprising:
a forceps including:

a housing having a shaft that extends therefrom, the shaft including a proximal end that is configured to operably couple to the housing and a distal end that extends therefrom; and

a handle operably associated with the housing and selectively movable relative thereto;

a selectively engageable end effector assembly configured to selectively engage the distal end of the shaft in vivo; and

a coupling configured to facilitate engagement and disengagement of the end effector assembly in vivo to and from the shaft, respectively.

20. The kit according to claim 19, wherein the coupling is configured to selectively engage a first end effector assembly having a cross-sectional moment of inertia value and the coupling is configured to selectively engage a replacement, second end effector assembly having a cross-sectional moment of inertia value that is the same as the cross-sectional moment of inertia value of the first end effector assembly.

21. The kit according to claim 19, wherein the coupling is configured to selectively engage a first end effector assembly having a cross-sectional moment of inertia value and the coupling is configured to selectively engage a replacement, second end effector assembly having a cross-sectional moment of inertia value that is different from the cross-sectional moment of inertia value of the first end effector assembly.

22. The kit according to claim 19, wherein the coupling is a compression coupling that includes first and second ends that are compression fittings.

23. The kit according to claim 19, wherein the coupling includes a first end that is a compression coupling and a second end that is a threaded fitting.

24. The kit according to claim **19**, wherein the coupling includes first and second ends that are selected from the group consisting of Luer lock fittings, snap-fit couplings, and ball and socket fittings.

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专利名称(译)	体内可附接和可拆卸的末端执行器组件和腹腔镜手术器械及其方法		
公开(公告)号	US20150245847A1	公开(公告)日	2015-09-03
申请号	US14/708950	申请日	2015-05-11
[标]申请(专利权)人(译)	柯惠有限合伙公司		
申请(专利权)人(译)	COVIDIEN LP		
当前申请(专利权)人(译)	COVIDIEN LP		
[标]发明人	DUMBAULD PATRICK L COSGRIFF EDWARD		
发明人	DUMBAULD, PATRICK L. COSGRIFF, EDWARD		
IPC分类号	A61B17/28 A61B18/14		
CPC分类号	A61B17/2812 A61B18/1445 A61B2017/2947 A61B2017/2946 A61B18/1482 A61B2017/00473 A61B2017/2931 A61B2017/2945 A61B2018/00601 A61B2018/0063 A61B2018/1412 A61B2018/1432 A61B2018/1455		
其他公开文献	US9931131		
外部链接	Espacenet USPTO		

摘要(译)

一种执行手术的方法包括以下步骤：提供具有壳体的钳子，所述壳体包括从其延伸的轴和至少一个可相对于壳体移动的手柄，并提供端部执行器组件，所述端部执行器组件构造成选择性地接合轴的远端。该方法还包括将镊子穿过形成在主体中的第一开口的步骤；将末端执行器组件插入穿过主体中形成的第二开口；使末端执行器组件与轴的远端在体内接合；通过相对于壳体移动手柄来致动末端执行器组件。该方法还可包括以下步骤：在轴的远端处提供联接，以及经由联接器将轴的远端与端部执行器组件接合。

