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(54) SURGICAL DEVICE WITH REMOVABLE END EFFECTOR

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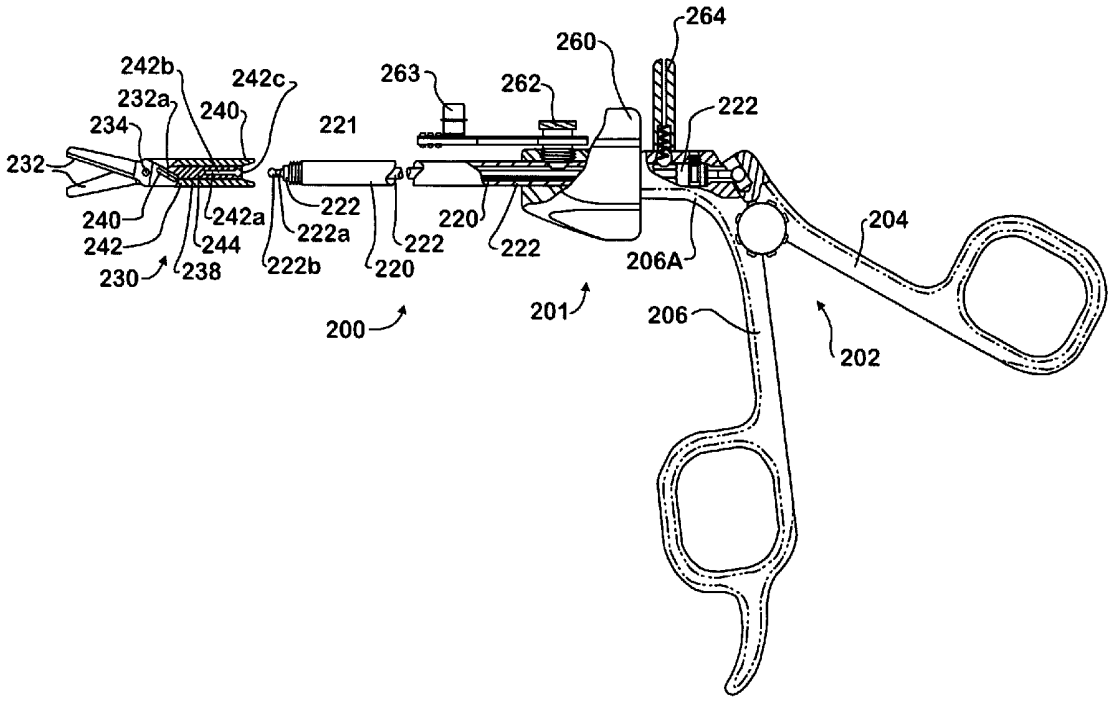
(52) **U.S. Cl.** **600/129**

(57) **ABSTRACT**

A surgical device and end effector connection system therefor include an easy-to-engage mechanism for connecting a handle/shaft/actuation rod unit to an end effector. This mechanism may utilize an axially engageable inner ball/socket inner connection with a threaded outer connection, or an inner bayonet connection with either an outer bayonet connection or an outer threaded connection. In each of the embodiments, an outer portion of the end effector preferably is statically engaged with the shaft, and an inner portion of the end effector is engaged with the actuation rod such that axial movement of the actuation rod can actuate a tool end of the end effector. The present invention further relates to methods of use for the laparoscopy device.



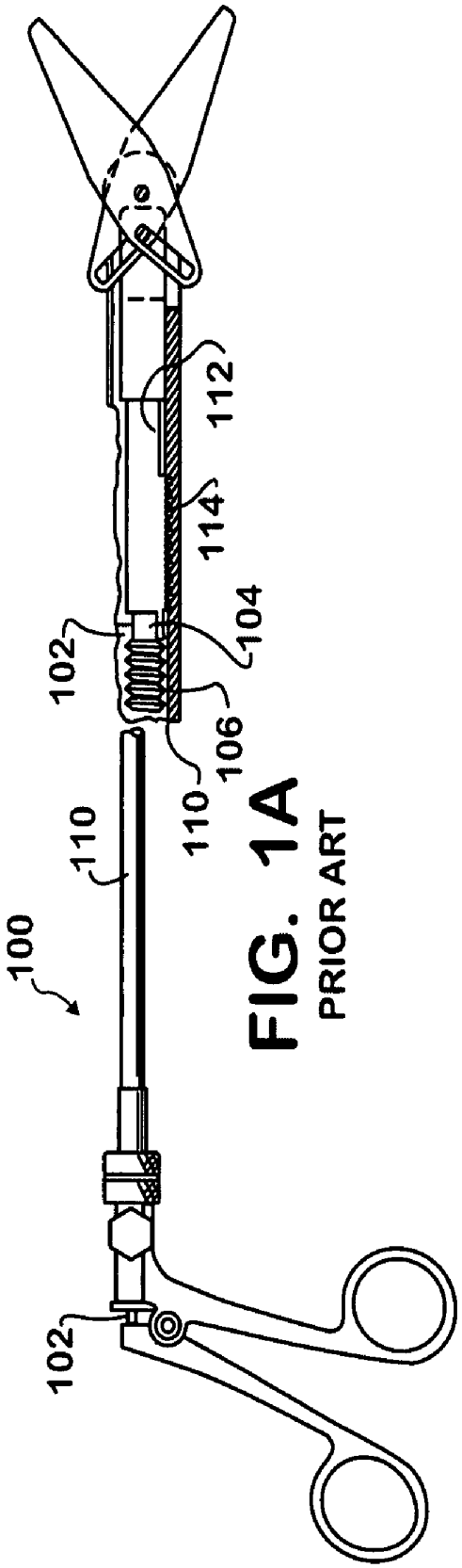


FIG. 1A
PRIOR ART

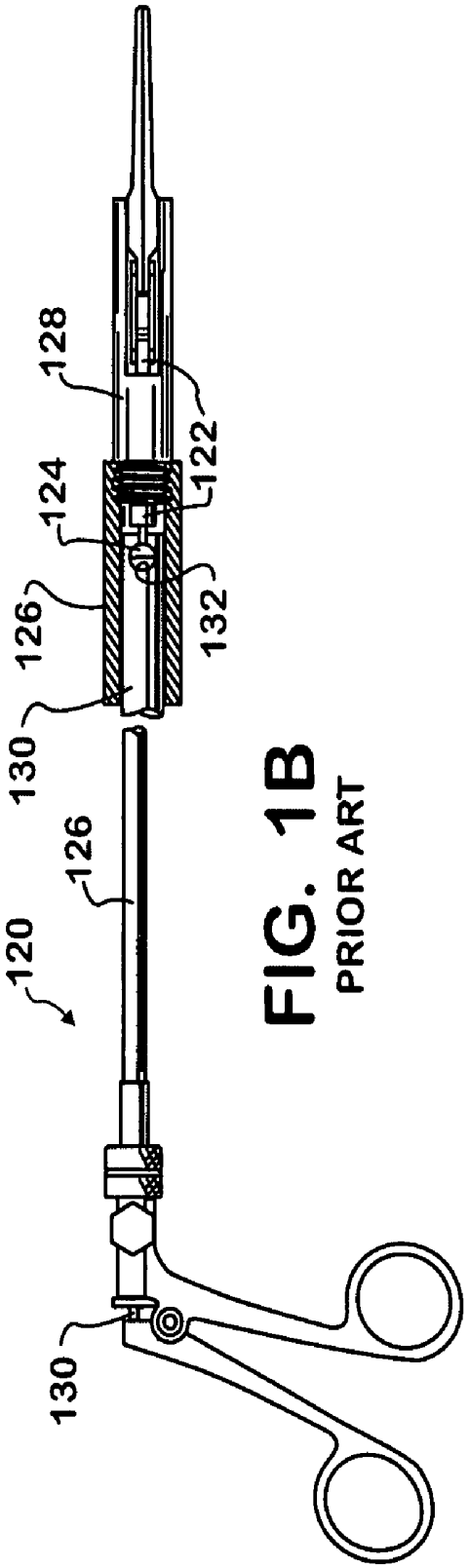


FIG. 1B
PRIOR ART

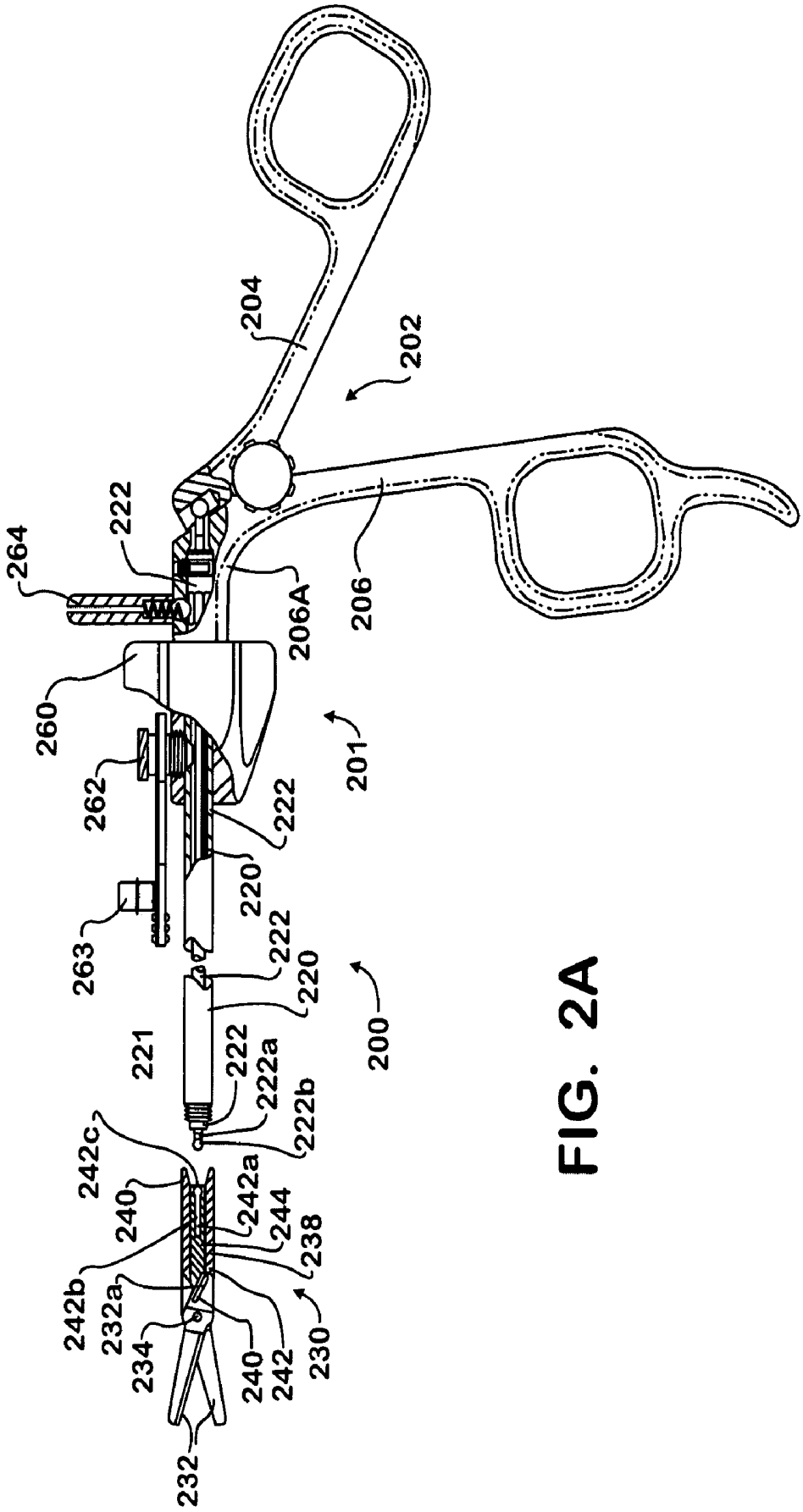

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FIG. 2A

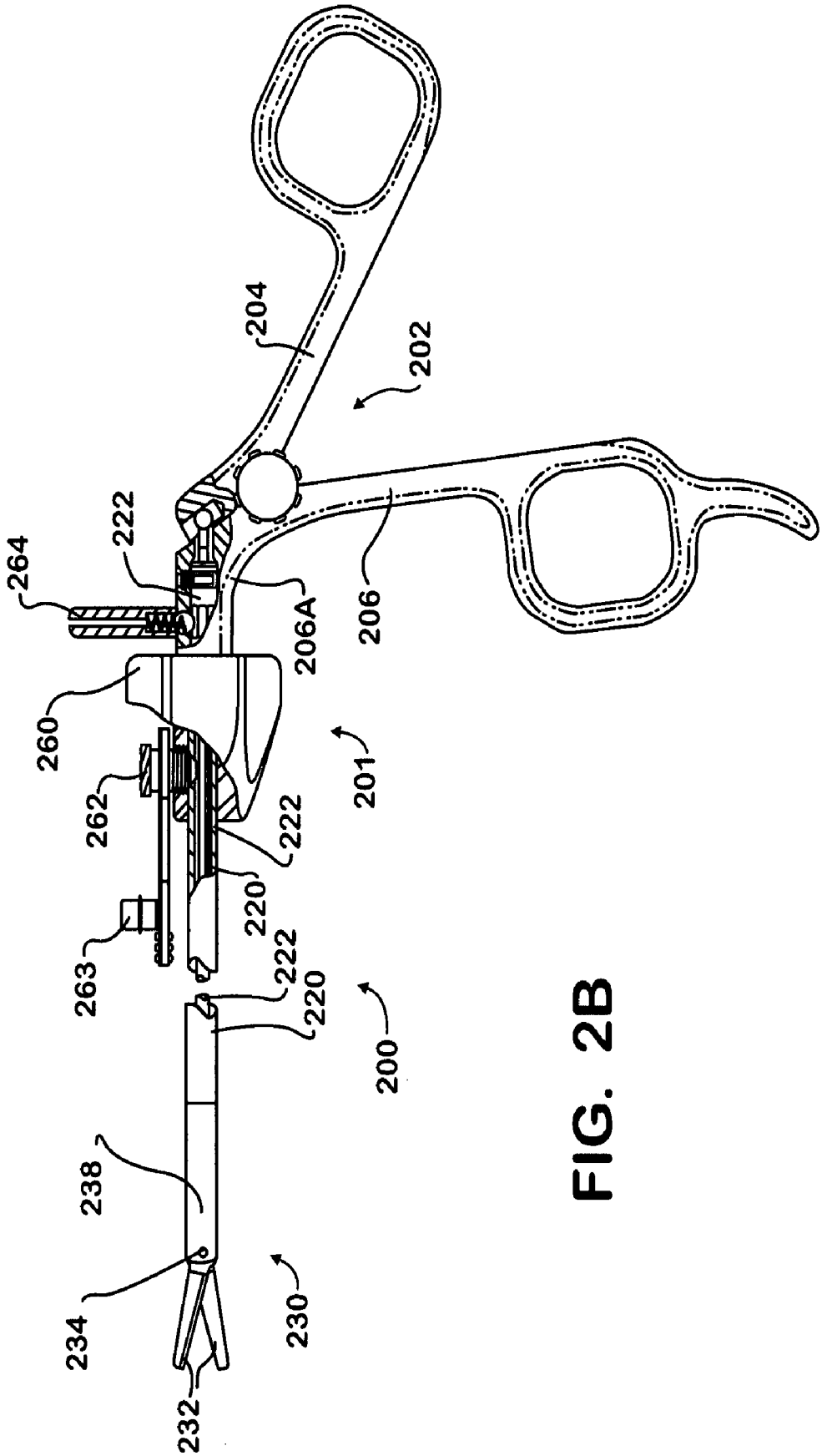
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FIG. 2B

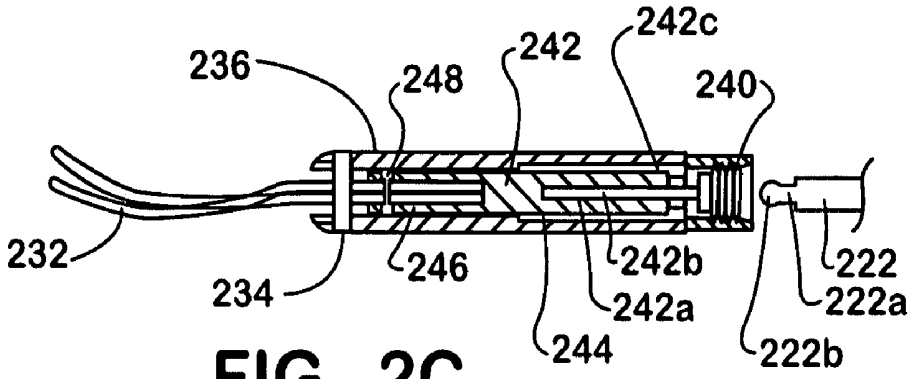

FIG. 2C

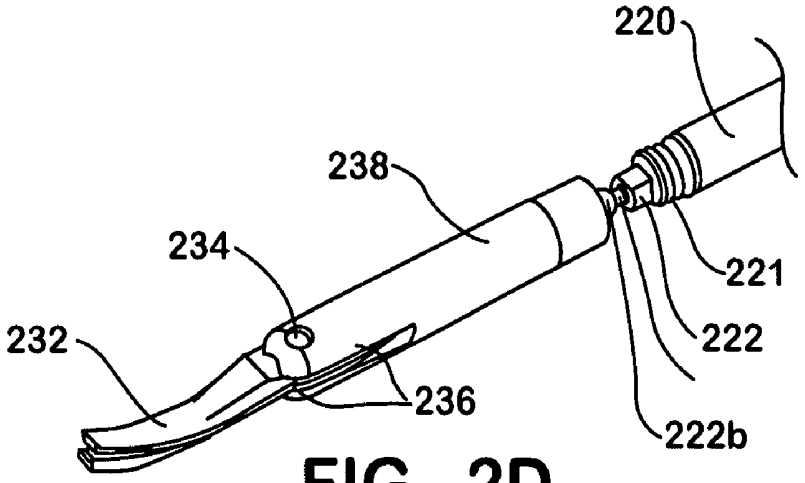

FIG. 2D

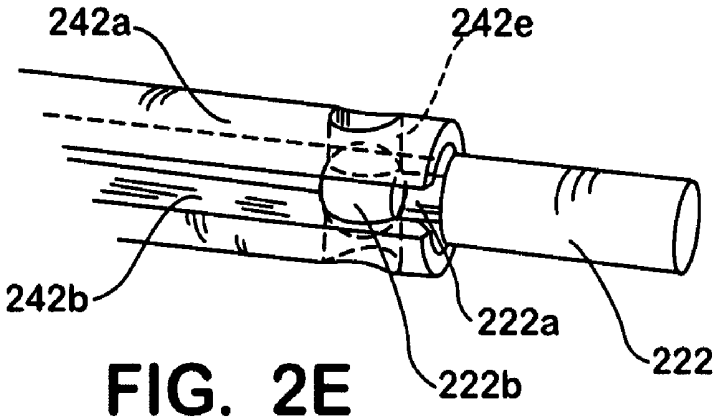

FIG. 2E

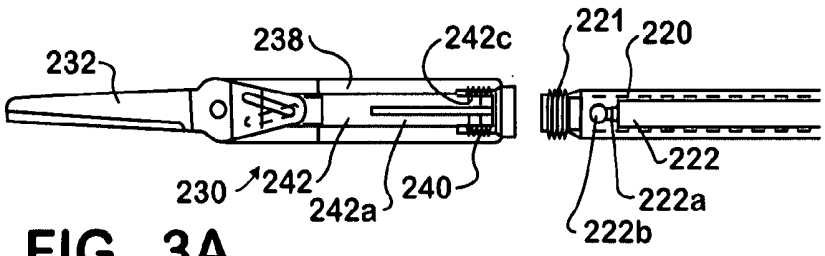

FIG. 3A

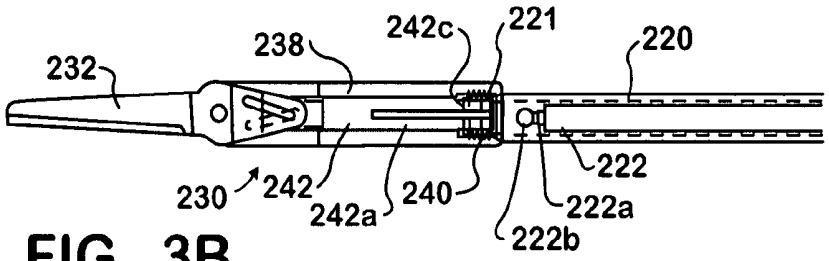

FIG. 3B

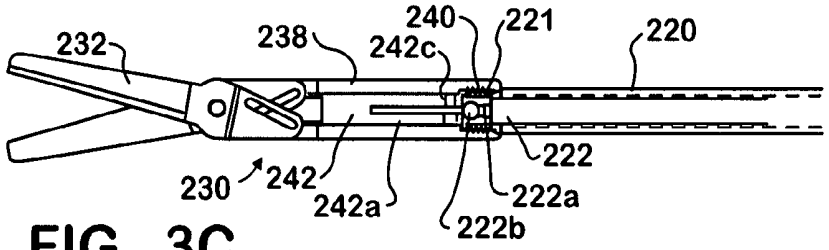

FIG. 3C

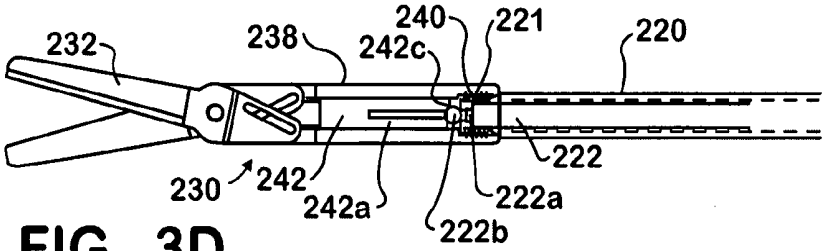

FIG. 3D

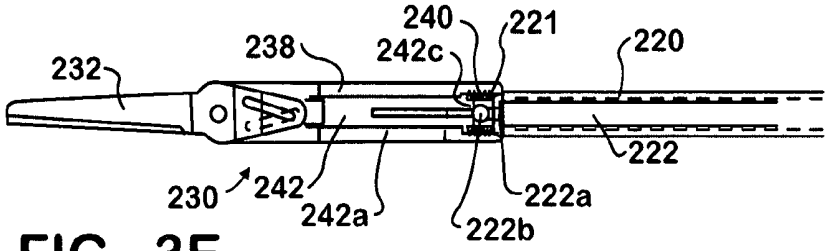

FIG. 3E

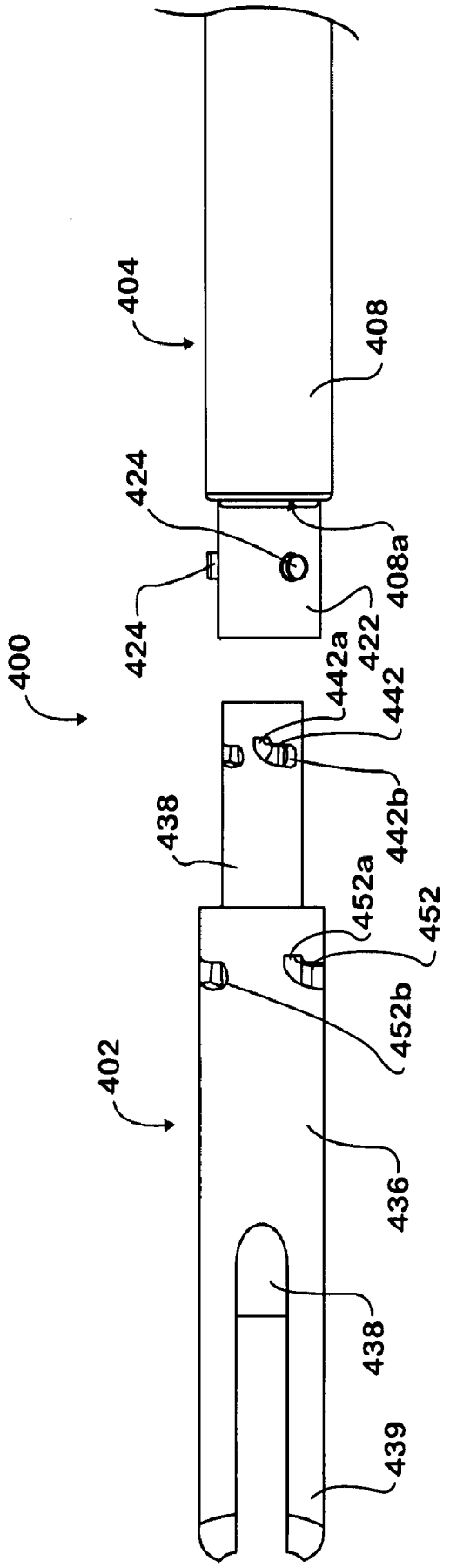
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FIG. 4A

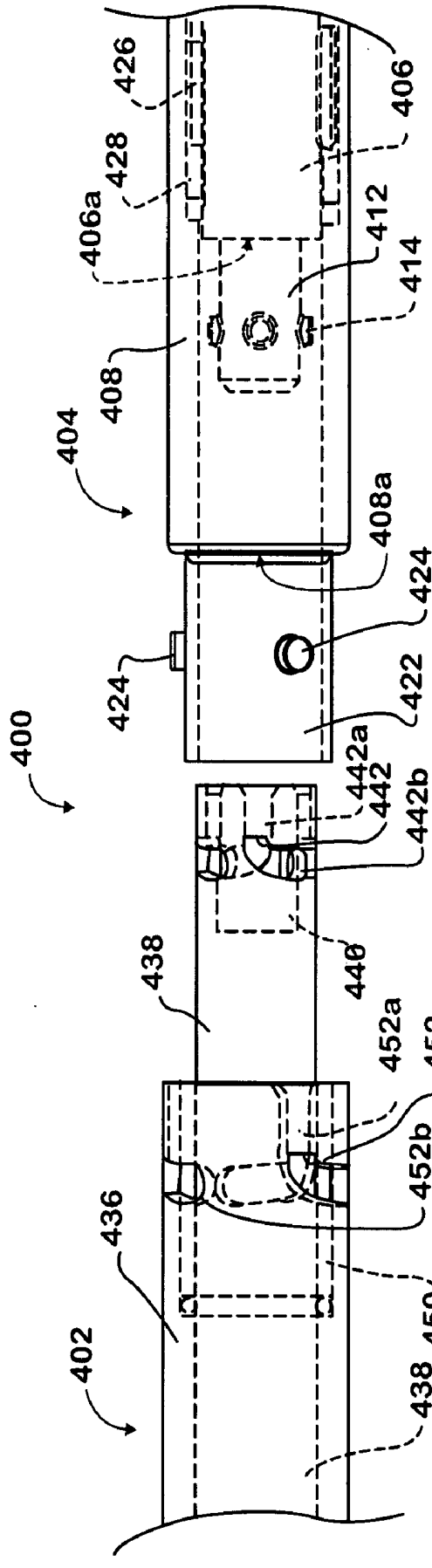
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FIG. 4B

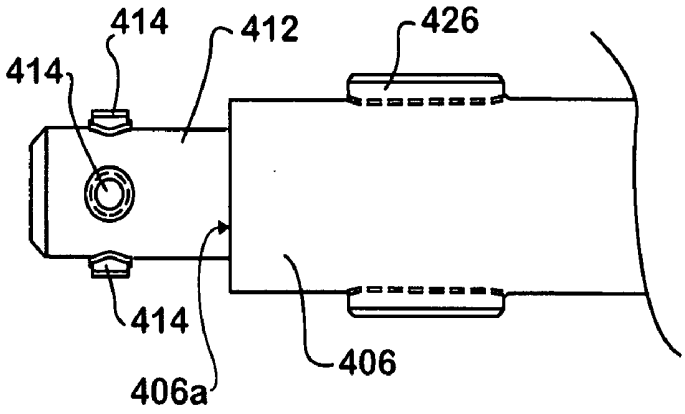

FIG. 4C

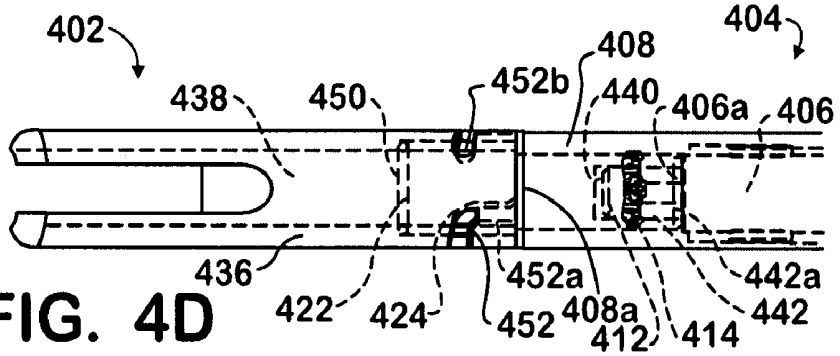

FIG. 4D

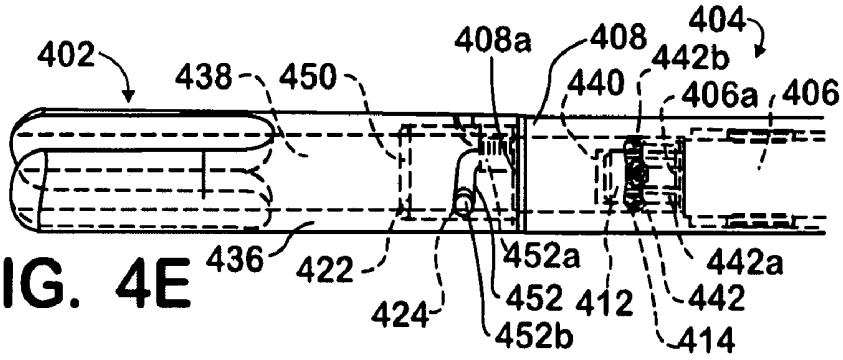

FIG. 4E

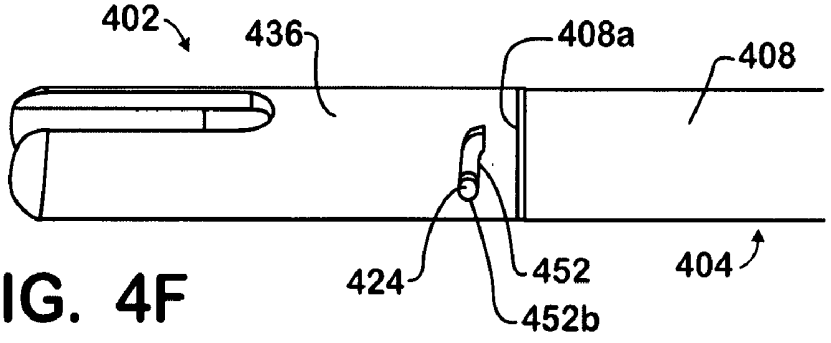

FIG. 4F

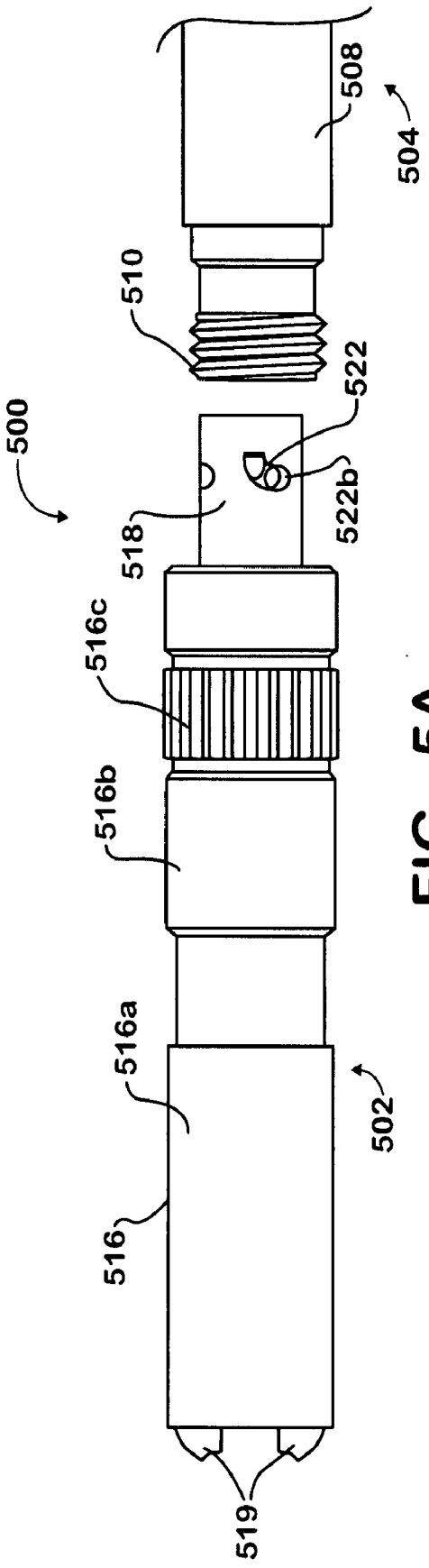

FIG. 5A

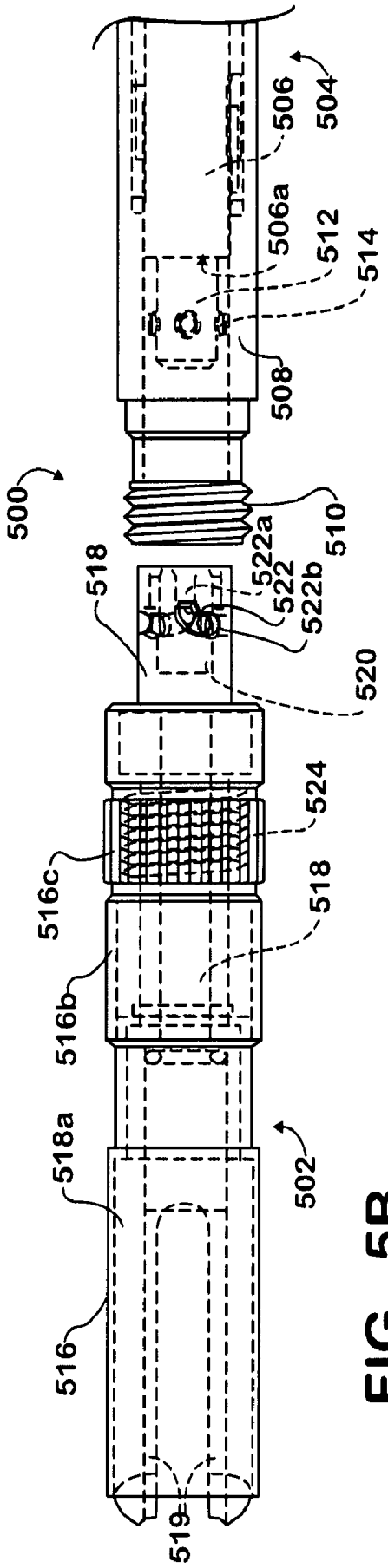
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FIG. 5B

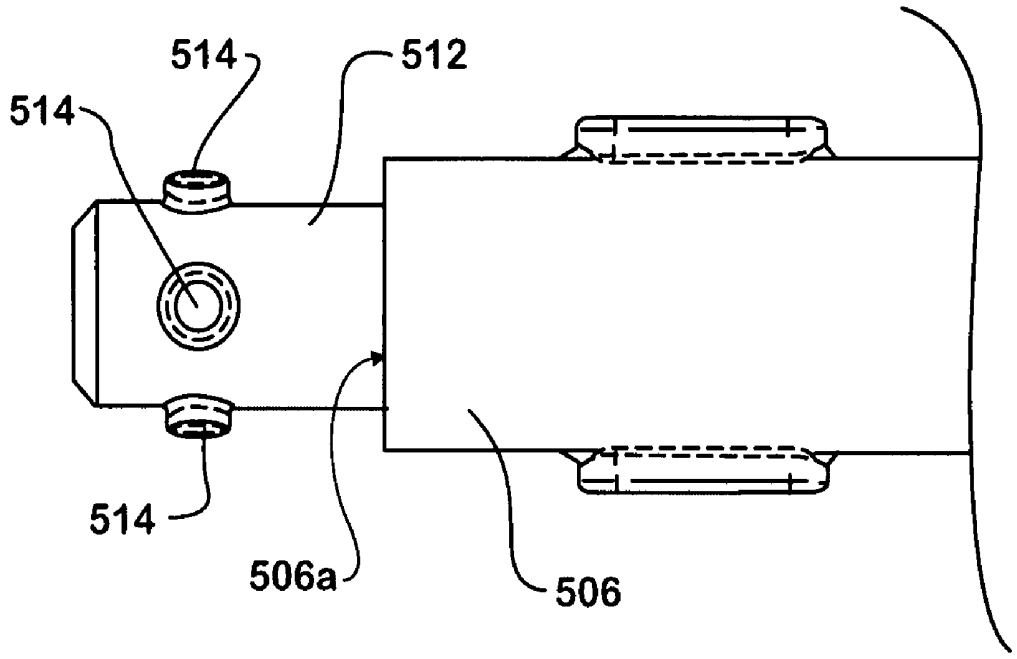

FIG. 5C

SURGICAL DEVICE WITH REMOVABLE END EFFECTOR

FIELD OF THE INVENTION

[0001] The present invention relates generally to medical devices, and more specifically to a surgical device useful in laparoscopic procedures and having a removable end effector, as well as methods of use for the device.

BACKGROUND

[0002] A wide variety of instruments are presently known and employed in the art of laparoscopic surgery, which typically involves gaining access to a patient's peritoneal cavity by way of an endoscope and/or trocars passing through the patient's abdominal wall. Many such medical instruments include an operable end effector in the form of cutting blades, forceps or other devices wherein the device is passed through a discrete opening providing access to the patient's interior. The opening may be surgically created (e.g. using a trocar) or naturally occurring (e.g., via the anterior or posterior openings of the alimentary canal). In such devices the surgeon must be able to manipulate adequately a distal, internally disposed end of the laparoscopic instrument to perform the required surgical routine. For this reason, laparoscopic devices are often designed such that a movable rod extending coaxially through a distally-projecting elongate shaft may be manipulated from the proximal, operative end of the instrument to manipulate a distal end effector of the instrument (e.g., forceps, scissor-type blades or the like).

[0003] It is well known that in many such laparoscopic instruments, such as those employing cutting blades, it is periodically necessary to replace the blades by new and sharper blades, in which case it is often economically expedient merely to remove the tip of the instrument and replace it with a new tip, rather than discarding the entire instrument. Likewise, in order to promote device sterility and economy, it is often useful to provide a re-usable handle portion with disposable and/or interchangeable end effectors, collectively known as a resposable device.

[0004] In a typical device wherein an actuation rod is proximally actuated to effect actuation of an end effector, a rod portion of the newly replaced end effector is connected to the actuation rod, and the outer shaft of the device upon which the end effector is to be assembled is attached to a casing portion of the end effector such that proper movement of the instrument occurs. Specifically, it is generally desirable that movement of the actuation rod within the outer shaft cause opening, closing, or other actuating movement of the end effector.

[0005] As it may be desirable to replace an end effector during a surgical procedure, it is most desirable that the disconnection of an end effector to be discarded and that the connection of a new end effector be a relatively simple and economical operation. At the same time, it is desirable that the connection be secure to avoid risk of the end effector becoming loose during use in a patient body and that the connection provide for effective actuation of the end effector. Thus, prior art devices have employed a variety of connections. For example, some devices—an example of which is shown as device **100** in FIG. **1**A (the distal portion of which is shown schematically in magnified longitudinal cross-section)—use a threaded engagement **106** between the actuation rod **102** and the end effector rod **104** as well as a threaded engagement **114** between the outer shaft **110** and the end effector casing portion **112**. Other devices—an example of which is shown as device **120** in FIG. **1**A (the distal portion of which is shown in magnified longitudinal cross-section)—use a connection wherein the end effector casing **128** is threadedly connected to the device shaft **126**, and the end effector rod **122** includes a ball or hemispherical proximal tip **124** that fits from the side into a keyhole aperture **132** of the actuation rod **130**. It is preferable that the removal and replacement of an end effector require no special mechanical knowledge or capability on the part of the operator of the instrument, and that it may be done quickly and with a high degree of reliability, including in the low-light conditions commonly present in an operating suite during laparoscopic procedures.

[0006] In some of the arrangements set forth above, problems may arise in the initial engagement of the end effector with the actuation rod and shaft. For example, with a dual threaded connection such as illustrated in FIG. **1**A, a user may experience difficulty in properly aligning and engaging both sets of threads in beginning the attachment of the new end effector to the instrument. As another example, with a side-mounted ball/socket inner connection such as illustrated in FIG. **1**B (the distal portion of which is shown schematically in magnified longitudinal cross-section and rotated longitudinally 90° from the orientation of FIG. **1**A), a user must spread the device handles to extend the actuation rod from the shaft, then align and place a ball structure on the end effector laterally into a side-opening keyhole aperture. Given the low-light conditions commonly present in a laparoscopy operating suite, this exacting operation can consume valuable time when replacing an end effector during a surgical procedure.

[0007] Each of the threaded and the ball/socket types of connection provide desirably secure mounting and functional capacity for laparoscopic instruments. However, previous attempts to combine these connection means require exacting lateral motion during engagement. It is therefore desirable to provide a laparoscopic instrument assembly having a disposable end effector wherein an end effector rod is disposed for axial movement within a tubular tip casing structure, with the end effector rod and casing structure, and the actuation rod and shaft, containing complementary ball/socket and threaded means for attachment, in which the attachment is simple in construction and economical to produce. It is also desirable to provide a laparoscopic instrument assembly of the type described wherein a replaceable end effector is easily and quickly assembled onto the instrument assembly in low-light conditions without requiring special instructions to the user, one aspect of which is providing for axial assembly (i.e., where an end effector is generally moved only within the longitudinal axis of the laparoscopic instrument rather than requiring, for example, lateral alignment of some components). Bayonet-type connections may also provide similar advantages for axial connection of both the inner (end effector rod to actuation rod) and outer (end effector casing to shaft) connections, and are therefore also be desirable.

BRIEF SUMMARY

[0008] In one aspect, the present invention provides a laparoscopy device having an easy-to-engage mechanism for connecting a handle/shaft/actuation rod unit to an end

effector. This mechanism may utilize an axially engageable inner ball/socket inner connection with a threaded outer connection, or an inner bayonet connection with either an outer bayonet connection or an outer threaded connection. In each of the embodiments, an outer portion of the end effector preferably is statically engaged with the shaft, and an inner portion of the end effector is engaged with the actuation rod such that axial movement of the actuation rod can actuate a tool end of the end effector. The present invention further relates to methods of use for the laparoscopy device.

[0009] In another aspect, the invention includes a surgical device. The surgical device includes a first handle member pivotably mounted to a second handle member, a generally tubular elongate shaft projecting distally from the second handle member, and an actuation rod disposed axially through the elongate shaft. The actuation rod is operatively connected near its proximal end to the first handle member, and a distal end portion of the actuation rod includes one of a ball member or a socketed prong assembly. The surgical device also includes an end effector assembly with an outer casing, an end effector rod disposed axially through the outer casing, and an actuatable tool end, with the end effector rod operably connected to the actuatable tool end. The outer casing is threadedly connectable to the elongate shaft and a proximal end portion of the end effector rod includes the other of a ball member or a socketed prong assembly which is complementary to and axially connectable to the opposite of a ball member or socketed prong assembly of the actuation rod.

[0010] In a further aspect, the present invention includes an end effector connection system. The end effector connection system includes a first surgical device component and a second surgical device component and is configured for axially connecting the first surgical device component to the second surgical device component. The first surgical device component includes a generally tubular first member having a first rod disposed axially therethrough. The first rod includes a socketed prong assembly with a plurality of prongs, at least one of which includes an indented socket. The generally tubular first member includes a first threaded surface. The second surgical device component includes a generally tubular second member having a second rod disposed axially therethrough. The second rod includes a ball structure, sized to be axially engagingly received between the plurality of prongs and at least partially into the indented socket, and the generally tubular second member includes a second threaded surface complementary to and engageable with the first threaded surface.

[0011] In yet another aspect, the invention includes an end effector connection system that includes a first surgical device component and a second surgical device component, with the system being configured for axially connecting the first surgical device component to the second surgical device component. The first surgical device component includes a generally tubular first member having a first rod disposed axially therethrough, and that first rod includes a male bayonet assembly comprising at least one boss extending from the first rod. The generally tubular first member also includes a first threaded surface. The second surgical device component includes a generally tubular second member having a second rod disposed axially therethrough. The second rod includes a female bayonet assembly, configured to axially engagingly receive the male bayonet assembly and the generally tubular second member includes a second threaded surface complementary to and engageable with the first threaded surface.

[0012] In still another aspect, the invention includes an end effector connection system configured for axially connecting a first surgical device component to a second surgical device component. The first surgical device component includes a generally tubular first member having a first rod disposed axially therethrough. The first rod includes a first male bayonet assembly comprising at least one boss extending laterally from the first rod, and the generally tubular first member includes a second male bayonet assembly comprising at least one boss extending laterally from the generally tubular first member. The second surgical device component includes a generally tubular second member having a second rod disposed axially therethrough. The second rod includes a first female bayonet assembly, configured to axially engagingly receive the first male bayonet assembly, and the generally tubular second member includes a second female bayonet assembly, which is configured to axially engagingly receive the second male bayonet assembly.

[0013] In still yet another aspect, the invention includes an end effector connection system comprising axially engageable first and second connecting means wherein the first connecting means includes an inner connecting means between an end effector rod and an actuation rod, and the second connecting means includes an outer connecting means between an end effector casing and an outer shaft. In order to lockingly engage the end effector rod with the actuation rod, the first connecting means requires no rotation greater than 360°.

[0014] In another aspect, the invention includes an end effector connection system that includes axially engageable first and second inner connecting members and axially engageable first and second outer connecting members. The first and second inner connecting members are generally axially disposed in the first and second outer connecting members, respectively. The first inner connecting member includes a generally cylindrical body having a laterally protruding portion disposed near its distal end, and the second inner connecting member has a receiving aperture configured to axially receive the first inner connecting member.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] FIGS. **1**A and **1**B illustrate a illustrate prior art end effector connection systems;

[0016] FIG. **2**A illustrates a side view with partial cross-section of a surgical device of the present invention, disassembled;

[0017] FIGS. **2**B depicts a side view with partial cross-section of a surgical device of the present invention, assembled;

[0018] FIG. **2**C shows a longitudinal section view of an end effector embodiment of the present invention, with connecting means therefor;

[0019] FIG. **2**D illustrates a perspective view of an end effector embodiment of the present invention, with connecting means therefor;

[0020] FIG. **2**E shows a schematic view of ball/socket connecting means for an end effector of the present invention,

[0021] FIGS. **3**A-**3**E depict a method of using an end effector connection system of the present invention;

[0022] FIGS. **4**A-**4**F illustrate schematically the components of another end effector connection system of the present invention; and

[0023] FIGS. **5**A-**5**C show schematically components of yet another end effector connection system of the present invention.

DETAILED DESCRIPTION

[0024] A first embodiment of a laparoscopy device **200** is illustrated with reference to FIGS. **2**A-**2**E. FIG. **2**A shows a side view with partial cross-section of the disassembled device, FIG. **2**B shows the same side view with partial cross-section of the assembled device, and FIG. **2**D shows a partial perspective view of the distal end of the device. As illustrated in FIGS. **2**A-**2**E, the laparoscopy device includes two main components: a main body **201** and an end effector **230**. FIGS. **2**C and **2**E show detail views of the connection between the main body **201** and the end effector **230**. In a preferred embodiment, the main body **201** is reusable, and the end effector **230** is disposable and replaceable. The main body **201** includes a handle **202** and a shaft **220** extending distally therefrom. The handle **202** includes a thumb ring member **204** pivotably attached at a pivot pin **208** to a finger ring member **206**, which includes an upper barrel portion **206**a. The elongate tubular shaft **220** extends distally from the upper barrel portion **206**a of the finger ring member **206**. An actuation rod **222** extends distally from an upper portion of the thumb ring member **204** through the shaft **220**. This configuration provides for reciprocating axial movement of the actuation rod **222** in the shaft **220** upon pivoting the thumb ring member **204** relative to the finger ring member **206**. (Those of skill in the art will appreciate that the handle may be configured such that the thumb ring handle is static with a barrel portion attached to a shaft, and that the finger ring handle be pivotable relative to the thumb ring handle.) At the distal end of the shaft **220**, the end effector **230** is operably connected both to the shaft **220** and the actuation rod **222**. The distal end of the main body shaft **220** includes an outer threaded surface **221** that is complementary to the inner threaded surface **240** of the end effector casing **238**. The distal end portion of the actuation rod **222** includes a narrow portion **222***a* and a distal ball member **222***b*.

[0025] In the preferred embodiment illustrated in FIGS. **2**A-**2**E, the end effector **230** includes two cutting blade members **232** mounted pivotably on a pivot pin **234**. In other embodiments, one of the blade members may be fixed, or both may be replaced with, for example, forceps, graspers, needle holders, clamps, dissectors, and spreaders, or another actuatable tool end. The pivot pin **234** is mounted between distal arms **236** of a generally cylindrical end effector casing **238**. The blade members **232** each include a proximal camming aperture **232***a*. The proximal end of the end effector casing **238** includes an inner threaded surface **240**. In a preferred embodiment, the end effector casing **238** includes an electro-insulative outer coating that forms a seal with an electro-insulative outer coating of the main body shaft **220**. A generally cylindrical end effector rod **242** is mounted in a longitudinal central cavity **244** of the end effector casing **238**.

[0026] The distal end portion of the end effector rod **242** includes a pair of forks **246**, between which is disposed a camming pin **248**. In the illustrated embodiment, the camming pin **248** is disposed through the camming apertures **232***a* of the blade members **232** such that distal axial movement of the end effector rod **242** cams the blade members **232** such that their distal ends move open/apart from each other, and proximal axial movement of the end effector rod **242** cams the blade members **232** such that their distal ends move closed/toward each other. The proximal end portion of the end effector rod **242** includes a socketed prong assembly having a pair of generally semi-cylindrical, proximally-extending prongs **242***a* biased toward each other. At least one of the generally flat inner prong surfaces **242***b* include one or more generally matching indentations or openings **242***c* that effectively form a socket for receiving the distal ball member **222***b* of the actuation rod **222**. In a preferred embodiment shown most clearly in FIGS. **2**C and **2**E, a socket is provided by a generally cylindrical aperture **242***e* disposed perpendicular to a plane between the prongs **242***a* and disposed adjacent their distal ends. The intersection of the aperture **242***e* with the inner prong surfaces **242***b* provides a matched pair of ball-receiving openings **242***c* that form a socket for receiving the distal ball member **222***b* of the actuation rod **222**. In alternative embodiments (e.g., those embodiments with a similar or different ball member geometry), the openings **242***c* may be, for example, generally semi-cylindrical or hemi-spherical. In the embodiment shown in FIG. **2**E, the proximal ends of the generally flat inner prong surfaces **242***b* each also include a depression **242***d* configured to aid passage of the distal ball member **222***b* of the actuation rod **222** into engagement with the openings **242***c*. The ball member **222***b* may have different geometries in different embodiments within the present invention such that it may be, for example, generally spherical, generally cylindrical, or frustoconical. Also, in other embodiments within the scope of the present invention, the socketed prong assembly may include three or more prongs, at least one of which has an indentation for engaging and retaining the ball member.

[0027] Together, the end effector **230** and the main body **201** include an end effector connection system. In other words, the end effector **230** is operably connectable to the main body **201** using a connecting means of the present invention as described below. When the end effector **230** is engaged with the main body **201**, the inner threaded surface **240** of the end effector casing **238** is threadedly engaged with the outer threaded surface **221** of the shaft **220**, and the distal ball member **222***b* of the actuation rod **222** is in a "snap-fit" engagement with the depressions **242***d* of the end effector proximal prongs **242**. However, those of skill in the art will appreciate that, in alternative embodiments within the scope of the present invention, the relative position of the ball and prongs may be reversed such that a proximal ball member on the end effector rod may be engagingly received by distal prongs on the actuation rod.

[0028] The illustrated embodiment depicts the handle members **204**, **206** opening in scissors-like fashion to actuate the end effector **230**. Specifically, when the handle members **204**, **206** are together, the actuation rod **222** is retracted proximally and the blade members **232** are together in a closed state. And, as shown in FIG. **2**A, when the handle members **204**, **206** are spread apart, the actuation rod **222** is extended distally and the blade members **232** are spread apart in an open state. This configuration allows the blade members **232** actively to be controlled for an opening motion (e.g., such as for spreading tissue) and for a closing motion (e.g., such as for grasping or cutting tissue).

[0029] The above-described embodiment preferably is configured for ease of engagement by use of the following method, which is able to be conducted in low-light conditions, and which is described with reference to FIGS. **3**A-**3**E. First, as shown in FIG. **3**A-**3**B, with the device handle members **204**, **206** (not shown) drawn together and the actuation rod **222** retracted accordingly, a user places the proximal end of the end effector casing **238** over the distal end of the main body shaft **220** and twists the end effector **220** to engage the inner end effector threads **240** with the outer shaft threads **221**. (Those of skill in the art will appreciate that, in other embodiments, the inner threads may be on the end effector, and the outer threads may be on the shaft.) Next, as shown in FIGS. **3**C-**3**D, the user spreads the handle members **204**, **206** (not shown), which moves the actuation rod **222** distally such that the distal ball member **222***b* is forced axially between the prongs **242***a* of the end effector rod **242** until it is engaged by the openings **242***c* and a proximal portion of the prongs **242***a* biasedly closes about the narrow portion **222***a* of the actuation rod **222**. In a preferred embodiment, during the transition shown from FIG. **3**C, to FIG. **3**D, the user will have a tactile sensation of the snap-fit engagement of the ball member **222***b* with the socket formed by the depressions **242***d* of prongs **242***a*, and may also hear an audible click of engagement. Thereafter, as shown in FIG. **3**E, the interface of ball member **222***b* with prongs **242***a* maintains an operative engagement between the main body **201** and the end effector **230**. Specifically, the proximal ends of prongs **242***a* are captured by the main body shaft **220**, the end effector casing **238** is held generally static relative to the main body shaft **220**, and the end effector rod **242** is operatively connected to the actuation rod **222** such that actuation of the handles **204**, **206** transmits axial movement through the actuation rod **222** to the end effector **230** to open and close the end effector blade members **232** while the end effector **230** is secured to the main body shaft **220** and actuation rod **222**.

[0030] In an alternative method, the actuation rod ball member **222***b* may first be axially engaged with the end effector prongs **242***a*, and then the end effector casing **238** may be threadedly engaged with the main body shaft **220**.

[0031] In preferred embodiments of the present device (such as illustrated in FIGS. **2**A-**2**E), the shaft **220** includes indexed rotating means such as a rotation knob **260** with corresponding internal structure of a type known in the art, so that it can be rotated about its (**220**) longitudinal axis in an indexed fashion. The shaft **220** also preferably includes means for flushing its internal portion, such as a Luer port **262** with a cap **263**. Preferred embodiments of the present device **200** are configured for use with monopolar-type electrosurgical apparatus such that the exterior of the main body **201** and the end effector casing **238** are insulated, and an electrode such as a Bovie post **264** is provided to direct current from an electrosurgical generator (not shown) through the actuation rod to the tool end (e.g., blade members **232**) where it may be used, for example, in cutting and coagulation. Those of skill in the art will also appreciate that the "ball/socket plus threaded" end effector connection system described above is also useful within the scope of the present invention for connecting a first and second surgical device component in a non-laparoscopic tool device.

[0032] FIGS. **4**A-**4**C depict another end effector connector system **400** embodiment of the present invention. As shown in these figures, this embodiment of an end effector connection system includes an inner bayonet connection and an outer bayonet connection for connecting an end effector **402** to the main body **404** of a surgical instrument of the type shown in FIG. **2**A.

[0033] The proximal portion of the instrument main body **404**, including its handle, is not shown. The main body **404** includes an actuation rod **406** disposed axially through an outer shaft **408**. A distal portion of the outer shaft **408** includes a male bayonet structure with a distal outer shaft portion **422** having an outer diameter less than that of the major length of the outer shaft **408**. The border of the distal portion **422** with the larger outer diameter of the outer shaft **408** is defined by a lip **408***a*, the surface of which is in a plane generally perpendicular to the longitudinal axis. A plurality of outer shaft bosses **424** extends radially from that distal outer shaft portion **422**. The illustrated embodiment includes four outer shaft bosses **424**, but those of skill in the art will appreciate that more or fewer bosses may be used in other embodiments. Although it is preferable to have a plurality of bosses, a single outer shaft boss may be used within the scope of the present invention. As is shown most clearly in FIG. **4**C, a distal portion of the actuation rod **406** includes a male bayonet structure with a distal actuation rod portion **412** having an outer diameter less than that of the major length of the actuation rod **406**. The border of the distal actuation rod portion **412** with the larger outer diameter of the actuation rod **406** is defined by a lip **406***a*, the surface of which is in a plane generally perpendicular to the longitudinal axis. A plurality of actuation rod bosses **414** extends radially from that distal actuation rod portion **412**, and preferably is radially offset relative to the plurality of outer shaft bosses **424**. The illustrated embodiment includes four actuation rod bosses **414**, but those of skill in the art will appreciate that more or fewer bosses may be used in other embodiments. Although it is preferable to have a plurality of bosses, a single actuation rod boss may be used within the scope of the present invention.

[0034] The end effector **402** includes an outer casing **436**. A generally cylindrical end effector rod **438** is disposed in the outer casing **436** in a manner allowing axial (but not rotational) sliding movement to actuate a tool end in the same manner as described with reference to the embodiment of FIG. **2**A, or in another manner known to those of skill in the art. The tool end (e.g., blade members) is not shown, but a forked distal end **439** is provided for mounting the tool end. The proximal portion of the end effector rod **438** includes a female bayonet structure, which includes an inner receiving channel **440** and a plurality of curved, L-shaped boss-receiving slots **442**. The number of boss-receiving slots **442** preferably is the same as the number of bosses **414** on the actuation rod **406**. The proximal portion of each receiving slot is a groove **442***a* on the inner surface of the inner receiving channel **440**. The groove **442***a* preferably is generally parallel to the central longitudinal axis of the end effector **402**. The distal portion **442***b* of each slot **442** curves radially with the outer contour of the end effector rod **438**, and preferably is nearly perpendicular to the proximal slot portion **442***a*, but is slightly angled toward the distal end of the end effector **402**. In the illustrated embodiment, the distal slot portion **442***b* is open to the exterior of the end effector rod **438**.

[0035] The outer casing **436** includes a female bayonet structure, which includes a generally cylindrical shaft-receiving channel **450** and a plurality of curved, L-shaped

boss-receiving slots **452**. The number of boss-receiving slots **452** preferably is the same as the number of outer shaft bosses **424** on the outer shaft **408**. The proximal portion of each boss-receiving slot **452** is a groove **452***a* on the inner surface of the generally cylindrical shaft-receiving channel **450**. The groove **452***a* preferably is generally parallel to the central longitudinal axis of the end effector **402**. The distal portion **452***b* of each slot **452** curves radially with the outer contour of the outer casing **436**, and preferably is nearly perpendicular to the proximal slot portion **452***a*, but is slightly angled toward the distal end of the end effector **402**. In the illustrated embodiment, the distal slot portion **452***b* is open to the exterior of the end effector rod **438**. This open portion allows for visual verification of full engagement, as shown in FIG. **4**F.

[0036] The actuation rod **406** preferably includes a longitudinal fin **426** projecting radially therefrom and engaging a complementarily-sized fin-receiving groove **428** on the inner surface of the outer shaft **408** in a manner allowing axial, but not rotational movement of the actuation rod **406** relative to the outer shaft **408**. In this manner, the rotational orientation of the actuation rod bosses **414** and the outer shaft bosses **424** is held consistently so that the female bayonet structures of the end effector **402** may readily be axially engaged with the male bayonet structures of the main body **404**. This configuration allows the outer shaft **408** and the actuation rod **406** to be rotated together, and permits axial actuation of the actuation rod **406** for transmitting movement to the tool end (not shown).

[0037] A method of engaging the double bayonet end effector connection system **400** is described with reference to FIGS. **4**A-**4**C. To engage the end effector **402** to the main body **404**, a user axially inserts the proximal portion of the end effector rod **438** into the distal end of the main body's outer shaft **408**. The user then rotates the end effector **402** relative to the outer shaft **408** (or vice versa) to align the outer boss-receiving slots **452** of the end effector outer casing **436** with the outer shaft bosses **424** of the outer shaft **408**. This action simultaneously aligns the female bayonet member of the end effector **402** with the male bayonet member of the actuation rod **406**. As shown in FIG. **4**D, once aligned, the user moves the end effector **402** and the main body **404** axially together such that the distal end of the actuation rod **406** enters the end effector rod's inner receiving channel **440**, the outer shaft bosses **424** slide into the proximal groove portion **452***a* of each boss-receiving slot **452** of the end effector outer casing **436**, and the actuation rod bosses **414** slide into the proximal groove portion **442***a* of each boss-receiving slot **442** of the end effector rod **438**. Next, as shown in FIG. **4**E, the user rotates the end effector **402** counterclockwise relative to the outer shaft **408** (or vice versa). This rotation engages the main body bosses **414**, **424** into the respective distal slot portions **442***b*, **452***b* of the end effector. Because each of the distal slot portions **442***b*, **452***b* of the end effector is slightly distally angled, this boss-slot engagement forms a frictional lock as the proximal end of the end effector rod **438** is forced against the actuation rod lip **406***a* and the proximal end of the end effector outer casing is forced against the outer shaft lip **408***a*. Each of the lips **406***a*, **408***a* may alternatively include a surface-mounted gasket (not shown) that is compressed and that helps to provide a frictional lock. As shown in the illustrated embodiment, this engagement method requires only a small rotational motion after the initial axial engagement. In the illustrated embodiment, the rotation required to lock in the engagement is less than **900**. In other embodiments, including those with more or fewer bosses, the rotation required is less than 360°.

[0038] For the end effector system of the surgical device embodiment illustrated in FIGS. **2**A-**2**E, engaging the inner connecting means (i.e., those means connecting the end effector rod with the actuation rod) does not require any rotation of either the end effector or the main body. Other connection systems including means that do require rotation to engage the inner connecting means are disclosed below, but such embodiments require rotation of less than 360°, preferably less than 180°, and most preferably less than 90°. All such connection systems provide the advantage of minimizing the amount of movement a user must employ to securely engage an end effector to a main body in a surgical device, even when some rotation (e.g., for a bayonet or threaded connection) is required to secure the outer shaft to the end effector casing. Those of skill in the art will appreciate that the ball/socket inner connection means described with reference to FIGS. **2**A-**2**E may be used with an outer bayonet connector as described with reference to FIGS. **4**A-**4**C.

[0039] FIGS. **5**A-**5**C illustrate another end effector connection system **500** embodiment of the present invention. As shown in these figures, this embodiment of an end effector connection system includes an inner bayonet connection and an outer threaded connection for connecting an end effector **502** to the main body **504** of a surgical instrument of the type shown in FIG. **2**A.

[0040] The proximal portion of the instrument main body **504**, including its handle, is not shown. The main body **504** includes an actuation rod **506** and an outer shaft **508**. A distal portion of the outer shaft **508** includes an outer threaded surface **510**. As is shown in FIGS. **5**B-**5**C, a distal portion of the actuation rod **506** includes a male bayonet structure including a distal actuation rod portion **512** having an outer diameter less than that of the major length of the actuation rod **506**. The border of the distal actuation rod portion **512** with the larger outer diameter of the actuation rod **506** is defined by a lip **506***a*, the surface of which is in a plane generally perpendicular to the longitudinal axis. A plurality of bosses **514** extends radially from that distal actuation rod portion **512**. The illustrated embodiment includes four bosses **514**, but those of skill in the art will appreciate that more or fewer bosses may be used in other embodiments. Although it is preferable to have a plurality of bosses, a single boss may be used within the scope of the present invention.

[0041] The end effector **502** includes an outer casing **516**. A generally cylindrical end effector rod **518** is disposed in the outer casing **516** in a manner allowing axial sliding movement to actuate a tool end in the same manner as described with reference to the embodiment of FIG. **2**A, or in another manner known to those of skill in the art. The tool end (e.g., blade members) is not shown, but a forked distal end **519** is provided for mounting the tool end. The proximal portion of the end effector rod **518** includes a female bayonet structure, which includes an inner receiving channel **520** and a plurality of curved, L-shaped boss-receiving slots **522**. The number of boss-receiving slots **522** preferably is the same as the number of bosses **514** on the actuation rod **506**. The proximal portion of each receiving slot is a groove **522***a* on the surface of the inner receiving channel **520**. The groove

522*a* preferably is generally parallel to the central longitudinal axis of the end effector **502**. The distal portion **522***b* of each slot **522** curves radially with the outer contour of the end effector rod **518**, and preferably is nearly perpendicular to the proximal slot portion **522***a*, but is slightly angled toward the distal end of the end effector **502**. In the illustrated embodiment, the distal slot portion **522***b* is open to the exterior of the end effector rod **518**.

[0042] The end effector outer casing **516** includes two portions. A distal casing portion **516***a* is attached to the forked distal end **519** in a manner allowing axial movement as described above. A proximal casing portion **516***b* is rotatably connected to the distal casing portion **516***a* such that it can be rotated about the central longitudinal axis of the end effector **502** without moving significantly axially. The proximal casing portion **516***b* includes an inner threaded surface **524** that is complementary to the outer threaded surface **510** of the main body's outer shaft **508**. And, the proximal casing portion **516***b* preferably includes a textured outer surface **516***c* that provides enhanced friction for gripping the proximal casing portion **516***b* and rotating it (e.g., to engage the inner threaded surface **524** with the outer threaded surface **510** of the main body's outer shaft **508**).

[0043] A method of engaging the threaded-plus-bayonet end effector connection system **500** is described with reference to FIGS. **5**A-**5**C. To engage the end effector **502** to the main body **504**, a user axially inserts the proximal portion of the end effector rod **538** into the distal end of the main body's outer shaft **508**. The user then rotates the end effector **502** relative to the outer shaft **508** (or vice versa) to align the boss-receiving slots **522** of the end effector rod **518** with the bosses **514** of the actuation rod **506**. Once aligned, the user moves the end effector **502** and the main body **504** axially together such that the distal end of the actuation rod **506** enters the end effector rod's inner receiving channel **520**, the actuation rod bosses **514** slide into the proximal groove portion **522***a* of each boss-receiving slot **522** of the end effector rod **518**. Next, the user rotates the end effector **402** counterclockwise relative to the outer shaft **408** (or vice versa). This rotation engages the bosses **514** into the distal slot portions **522***b* of the end effector rod **518**. Because each of the distal slot portions **522***b* of the end effector is slightly distally angled, this boss-slot engagement forms a frictional lock as the proximal end of the end effector rod **518** is forced against the actuation rod lip **506***a*. As shown in the illustrated embodiment, this engagement method requires only a small rotational motion after the initial axial engagement. In the illustrated embodiment, the rotation required to lock in the engagement is less than 90°. In other embodiments, including those with more or fewer bosses, the rotation required is less than 360°. Finally, the user rotates the proximal casing portion **516***b* to engage its inner threaded surface **524** with the outer threaded surface **510** of the main body's outer shaft **508**. Those of skill in the art will appreciate that the male and female bayonet portions described herein may be reversed in orientation in other embodiments, within the scope of the present invention.

[0044] Those of skill in the art will also appreciate that other variants of the surgical device and end effector connector system embodiments described herein may also be practiced within the scope of the present application. It is therefore intended that the foregoing detailed description be regarded as illustrative rather than limiting. It should be understood that the following claims, including all equivalents, are intended to define the spirit and scope of this invention.

We claim:

1. A surgical device, comprising:
- a first handle member pivotably mounted to a second handle member;
- a generally tubular elongate shaft projecting distally from the second handle member, the elongate shaft comprising a distal threaded surface;
- an actuation rod disposed axially through the elongate shaft, the actuation rod operatively connected near its proximal end to the first handle member, and a distal end portion of the actuation rod comprising one of a ball member or a socketed prong assembly; and
- an end effector assembly comprising
  - an outer casing having a proximal threaded surface complementary to the distal threaded surface of the elongate shaft,
  - an end effector rod disposed axially through the outer casing, and
  - an actuatable tool end, the end effector rod operably connected to the actuatable tool end;
  - wherein a proximal end portion of the end effector rod includes the other of a ball member or a socketed prong assembly which is complementary to and axially connectable with the opposite of a ball member or socketed prong assembly of the actuation rod.

2. The surgical device of claim **1**, wherein the distal end portion of the actuation rod comprises a ball member, and the proximal end portion of the end effector comprises a socketed prong assembly.

3. The surgical device of claim **1**, wherein the distal end portion of the actuation rod comprises a socketed prong assembly, and the proximal end portion of the end effector comprises a ball member.

4. The surgical device of claim **1**, wherein the actuation rod and the actuatable tool end each comprise an electroconductive material.

5. The surgical device of claim **1**, further comprising an electroinsulative covering disposed on at least an external surface portion of the device.

6. The surgical device of claim **1**, wherein the actuatable tool end is selected from a group consisting of cutting blade members, forceps, graspers, needle holders, clamps, dissectors, and spreaders.

7. The surgical device of claim **1**, wherein the socketed prong assembly comprises two prongs biased toward each other, each prong including a ball-receiving opening disposed adjacent an end thereof.

8. The surgical device of claim **1**, wherein the elongate shaft is configured to be rotated about its central longitudinal axis relative to the second handle member.

9. A method for assembling the surgical device of claim **1**, the method comprising:
- providing the surgical device of claim **1**;
- threadedly engaging the outer casing to the elongate shaft;
- actuating the first handle member in a manner extending the actuation rod distally such that the one of a ball member or a socketed prong assembly axially engages the other of a ball member or socketed prong assembly.

10. An end effector connection system comprising a first surgical device component and a second surgical device component, the connection system being configured for

axially connecting the first surgical device component to the second surgical device component,

the first surgical device component comprising

a generally tubular first member having a first rod disposed axially therethrough;

wherein the first rod includes a socketed prong assembly comprising a plurality of prongs, at least one of which includes an indented socket; and

wherein the generally tubular first member includes a first threaded surface;

the second surgical device component comprising

a generally tubular second member having a second rod disposed axially therethrough;

wherein the second rod includes a ball structure, sized to be axially engagingly received between the plurality of prongs and at least partially into the indented socket; and

wherein the generally tubular second member includes a second threaded surface complementary to and engageable with the first threaded surface.

11. The end effector connector system of claim **10**, wherein the first surgical device component comprises a main body of a laparoscopic tool device, said main body comprising an actuatable handle assembly; said generally tubular first member comprising an outer shaft projecting distally from the handle assembly and said first rod operably connected to the actuatable handle assembly in a manner configured to provide for reciprocating axial movement of the first rod in the outer shaft upon actuation of the handle assembly.

12. The end effector connector system of claim **10**, wherein the first surgical device component comprises an end effector assembly, said end effector assembly comprising at least one actuatable end effector member operably connected to the first rod.

13. The end effector connector system of claim **10**, wherein the second surgical device component comprises a main body of a laparoscopic tool device, said main body comprising a handle assembly and said generally tubular second member comprising an outer shaft projecting distally from the handle assembly.

14. An end effector connection system comprising a first surgical device component and a second surgical device component, the connection system being configured for axially connecting the first surgical device component to the second surgical device component,

the first surgical device component comprising

a generally tubular first member having a first rod disposed axially therethrough;

wherein the first rod includes a male bayonet assembly comprising at least one boss extending from the first rod; and

wherein the generally tubular first member includes a first threaded surface;

the second surgical device component comprising

a generally tubular second member having a second rod disposed axially therethrough;

wherein the second rod includes a female bayonet assembly, configured to axially engagingly receive the male bayonet assembly; and

wherein the generally tubular second member includes a second threaded surface complementary to and engageable with the first threaded surface.

15. An end effector connection system comprising a first surgical device component and a second surgical device component, the connection system being configured for axially connecting the first surgical device component to the second surgical device component,

the first surgical device component comprising

a generally tubular first member having a first rod disposed axially therethrough;

wherein the first rod includes a first male bayonet assembly comprising at least one boss extending laterally from the first rod; and

wherein the generally tubular first member includes a second male bayonet assembly comprising at least one boss extending laterally from the generally tubular first member;

the second surgical device component comprising

a generally tubular second member having a second rod disposed axially therethrough;

wherein the second rod includes a first female bayonet assembly, configured to axially engagingly receive the first male bayonet assembly; and

wherein the generally tubular second member includes a second female bayonet assembly, configured to axially engagingly receive the second male bayonet assembly.

16. An end effector connection system comprising axially engageable first and second connecting means,

wherein the first connecting means comprises an inner connecting means between an end effector rod and an actuation rod and the second connecting means comprises an outer connecting means between an end effector casing and an outer shaft;

said first connecting means requiring no rotation greater than 360° to lockingly engage the end effector rod with the actuation rod.

17. The end effector connection system of claim **16**, wherein a rotation of less than 180° is required to lockingly engage the end effector rod with the actuation rod.

18. The end effector connection system of claim **17**, wherein the second connecting means is selected from one of a threaded connecting means and a bayonet connecting means.

19. The end effector connection system of claim **16**, wherein a rotation of less than 90° is required to lockingly engage the end effector rod with the actuation rod.

20. The end effector connection system of claim **19**, wherein the second connecting means is selected from one of a threaded connecting means and a bayonet connecting means.

21. The end effector connection system of claim **16**, wherein the first connecting means comprises a ball member disposed adjacent a distal end portion of the actuation rod and a socketed prong assembly disposed adjacent a proximal end portion of the end effector rod, said socketed prong assembly configured to engagingly receive the ball member.

22. The end effector connection system of claim **21**, wherein the second connecting means is selected from one of a threaded connecting means and a bayonet connecting means.

23. The end effector connection system of claim **16**, wherein the first connecting means comprises a ball member disposed adjacent a proximal end portion of the end effector rod and a socketed prong assembly disposed adjacent a

distal end portion of the actuation rod, said socketed prong assembly configured to engagingly receive the ball member.

24. The end effector connection system of claim **23**, wherein the second connecting means is selected from one of a threaded connecting means and a bayonet connecting means.

25. The end effector connection system of claim **16**, wherein the first connecting means comprises a female bayonet assembly disposed adjacent a proximal end portion of the end effector rod and a male bayonet assembly disposed adjacent a distal end portion of the actuation rod, said female bayonet assembly configured to engagingly receive the male bayonet assembly.

26. The end effector connection system of claim **25**, wherein the second connecting means is selected from one of a threaded connecting means and a bayonet connecting means.

27. The end effector connection system of claim **16**, wherein the first connecting means comprises a male bayonet assembly disposed adjacent a proximal end portion of the end effector rod and a female bayonet assembly disposed adjacent a distal end portion of the actuation rod, said female bayonet assembly configured to engagingly receive the male bayonet assembly.

28. The end effector connection system of claim **27**, wherein the second connecting means is selected from one of a threaded connecting means and a bayonet connecting means.

30. An end effector connection system comprising:

Axially engageable first and second inner connecting members and axially engageable first and second outer connecting members, wherein the first and second inner connecting members are generally axially disposed in the first and second outer connecting members, respectively;

Said first inner connecting member comprising a generally cylindrical body having a laterally protruding portion disposed near its distal end and said second inner connecting member having a receiving aperture configured to axially receive the first inner connecting member.

31. The end effector connection system of claim **30**, wherein the first outer connecting member is a male bayonet member and the second outer connecting member is a female bayonet member configured to engagingly receive the male bayonet member.

32. The end effector connection system of claim **30**, wherein the first outer connecting member comprises a first threaded surface and the second outer connecting member comprises a second threaded surface that is configured to engage the first threaded surface.

33. An end effector for a surgical device, the end effector comprising:

an outer casing comprising a threaded surface;

a distal tool end; and

an end effector rod disposed at least partially through the outer casing, wherein a proximal end of the end effector rod comprises a connecting member that is selected from one of a male bayonet member, a female bayonet member, a ball member, and a socket member, and wherein the connecting member is configured to be axially connected to a surgical device.

* * * * *

专利名称(译)	具有可拆卸末端执行器的手术装置		
公开(公告)号	US20080021278A1	公开(公告)日	2008-01-24
申请号	US11/724041	申请日	2007-03-14
[标]申请(专利权)人(译)	LEONARD ROBERT˚F 凯斯特SCOTT BOOTH大卫· 冯DAVID		
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外部链接	Espacenet USPTO		

摘要(译)

外科手术装置和端部执行器连接系统包括易于接合的机构，用于将手柄/轴/致动杆单元连接到末端执行器。该机构可以利用具有螺纹外部连接的轴向可接合的内部球窝内部连接，或者具有外部卡口连接或外部螺纹连接的内部卡口连接。在每个实施例中，端部执行器的外部部分优选地与轴静态接合，并且端部执行器的内部部分与致动杆接合，使得致动杆的轴向移动可致动端部执行器的工具端部。末端效应器。本发明还涉及腹腔镜检查装置的使用方法。