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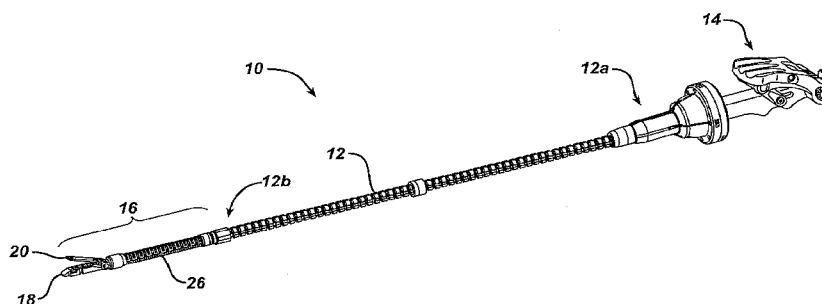
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(54) **Title:** A SURGICAL STAPLING AND CUTTING DEVICE

**FIG. 1A**



(57) **Abstract:** A surgical stapling and cutting device having an elongate shaft (12) with proximal and distal ends (12a, 12b). The distal end of the shaft has a flexible neck extending therefrom. The device includes an end effector (16) disposed on a proximal end of the flexible neck (26). The end effector includes opposed first (18) and second jaws (20) adapted to receive tissue therebetween. The first jaw has a staple cartridge attached thereto, wherein the staple cartridge has multiple staples disposed therein for being driven into tissue. The second jaw includes an anvil for deforming the staples. The device also includes a remotely controlled user interface coupled to the proximal end of the elongate tube. The interface is operatively associated with the flexible neck such that movement of the remotely controlled user interface is mimicked by the flexible neck.



## A SURGICAL STAPLING AND CUTTING DEVICE

### CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This present application is a continuation-in-part which claims benefit of U.S. Patent Application 11/277,323 entitled: "Methods and Devices for Controlling Articulation" filed on March 23, 2006;

### FIELD OF THE INVENTION

[0002] The present invention relates broadly to methods and devices for controlling movement of a working end of a surgical device.

### BACKGROUND OF THE INVENTION

[0003] Endoscopic surgical instruments are often preferred over traditional open surgical devices since the use of a natural orifice tends to reduce the post-operative recovery time and complications. Consequently, significant development has gone into a range of endoscopic surgical instruments that are suitable for precise placement of a working end of a tool at a desired surgical site through a natural orifice. These tools can be used to engage and/or treat tissue in a number of ways to achieve a diagnostic or therapeutic effect.

[0004] Endoscopic surgery requires that the shaft of the device be flexible while still allowing the working end to be articulated to angularly orient the working end relative to the tissue, and in some cases to be actuated to fire or otherwise effect movement of the working end. Integration of the controls for articulating and actuating a working end of an endoscopic device tend to be complicated by the use of a flexible shaft and by the size constraints of an endoscopic instrument. Generally, the control motions are all transferred through the shaft as longitudinal translations, which can interfere with the flexibility of the shaft. There is also a desire to lower the force necessary to articulate and/or actuate the working end to a level that all or a great majority of surgeons can handle. One known solution to lower the force-to-fire is to use electrical motors. However, surgeons typically prefer to experience feedback from the

working end to assure proper operation of the end effector. The user-feedback effects are not suitably realizable in present motor-driven devices.

[0005] Accordingly, there remains a need for improved methods and devices for controlling movement of a working end of an endoscopic surgical device.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The invention will be more fully understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

[0007] FIG. 1A is a perspective view of one embodiment of a surgical stapling and cutting device, showing a working end of the device in an initial position;

[0008] FIG. 1B is a perspective view of the surgical stapling and cutting device of FIG. 1A, showing the working end of the device in an articulated position;

[0009] FIG. 2 is a perspective view of a portion of a flexible neck of the device shown in FIGS. 1A and 1B;

[0010] FIG. 3A is a perspective view of a distal portion of the device shown in FIGS. 1A and 1B, showing an end effector and the flexible neck of FIG. 2 coupled thereto;

[0011] FIG. 3B is a cross-sectional view taken across line 3B-3B of the end effector shown in FIG. 3A;

[0012] FIG. 4A is a perspective view of a proximal portion of the device shown in FIGS. 1A and 1B, showing a handle movably coupled to a proximal end of a shaft of the device;

[0013] FIG. 4B is an exploded view of the proximal portion of the device shown in FIG. 4A;

[0014] FIG. 5 is a perspective view of coupling element disposed between the flexible neck and elongate shaft of the device shown in FIGS. 1A and 1B, showing an optical image gathering apparatus;

[0015] FIG. 6 is a perspective view of the handle of the device shown in FIGS. 1A and 1B, showing an image display screen;

[0016] FIG. 7 is a perspective view of an accessory channel for use with an endoscope;

[0017] FIG. 8A is a perspective view of a flexible neck of the device shown in FIG. 7;

[0018] FIG. 8B is a perspective view of the flexible neck shown in FIG. 8A, showing the neck articulated in a first direction;

[0019] FIG. 8C is a perspective view of the flexible neck shown in FIG. 8A, showing the neck articulated in a second direction;

[0020] FIG. 9A is a perspective view of another embodiment of a flexible neck for use with an accessory channel;

[0021] FIG. 9B is a perspective view of the flexible neck shown in FIG. 9A, showing the neck articulated in a first direction;

[0022] FIG. 9C is a perspective view of the flexible neck shown in FIG. 9A, showing the neck articulated in a second direction;

[0023] FIG. 10 is a perspective view of a plurality of cable actuators for use with the device of FIG. 7;

[0024] FIG. 11 is a cross-sectional view of a shaft of the accessory channel of FIG. 7;

[0025] FIG. 12 is a perspective view of one embodiment of an end cap for use with the accessory channel of FIG. 7;

[0026] FIG. 13A is an exploded view of the handle and a proximal portion of the elongate shaft of the device shown in FIG. 7;

[0027] FIG. 13B is a cross-sectional view of the handle and the proximal portion of the elongate shaft of FIG. 13A in an assembled configuration;

[0028] FIG. 14A is a perspective view of another embodiment of an accessory channel;

- [0029] FIG. 14B is a cross-sectional view of the accessory channel shown in FIG. 14A;
- [0030] FIG. 15A is a side view of a handle assembly of the device shown in FIGS. 14A and 14B;
- [0031] FIG. 15B is an exploded view of the handle assembly of FIG. 15A;
- [0032] FIG. 17A is a perspective view of one embodiment of a locking mechanism; and
- [0033] FIG. 17B is a perspective view of the locking mechanism of FIG. 17A coupled to the surgical stapling and cutting device of FIGS. 1A and 1B.

#### DETAILED DESCRIPTION OF THE INVENTION

[0034] Certain exemplary embodiments will now be described to provide an overall understanding of the principles of the structure, function, manufacture, and use of the devices and methods disclosed herein. One or more examples of these embodiments are illustrated in the accompanying drawings. Those of ordinary skill in the art will understand that the devices and methods specifically described herein and illustrated in the accompanying drawings are non-limiting exemplary embodiments and that the scope of the present invention is defined solely by the claims. The features illustrated or described in connection with one exemplary embodiment may be combined with the features of other embodiments. Such modifications and variations are intended to be included within the scope of the present invention.

[0035] The present invention provides method and devices for controlling a working end of an endoscopic surgical device. In general, the endoscopic surgical devices include an elongate shaft having a distal working end with a flexible neck, and a proximal end with a handle for controlling movement of the flexible neck on the distal working end. In certain exemplary embodiments, this can be achieved using, for example, one or more cables that extend between the handle and the flexible neck such that movement of the handle applies a force to one or more of the cables to cause the flexible portion to flex and thereby move the working end of the device. Various other features are also provided to facilitate use of the device. A person skilled in the art will appreciate that the particular device being controlled, and the particular configuration of the working end, can vary and that the various control

techniques described herein can be used on virtually any surgical device in which it is desirable to control movement of the working end.

[0036] FIGS. 1A and 1B illustrate one exemplary embodiment of a technique for controlling articulation of the end effector, and in particular for causing the end effector to mimic and simultaneously move with the handle. In this embodiment, the device is in the form of a linear stapling and cutting device 10 for applying multiple linear rows of staples to tissue and for cutting the stapled tissue. As shown, the device 10 generally includes an elongate shaft 12 having a proximal end 12a with a handle 14 coupled thereto, and a distal, working end 12a having an end effector 16 coupled thereto or formed thereon, as will be discussed in more detail below. In use, the end effector 16 is configured to mimic movement of the handle 14. Mimicking motion between the handle 14 and the end effector 16 can generally be achieved using an actuator (not shown) that extends between the handle 14 and the end effector 16, and that is effective to transfer forces from the handle 14 to the end effector 16. In an exemplary embodiment, the actuator is in the form of several cables that are spaced around a circumference of the elongate shaft 12, and that extend along the length of the elongate shaft 12. Movement of the handle 14 about the proximal end 12a of the shaft 12 will apply a force to one or more of the cables to cause the cables to apply a force to the end effector 16, thereby causing the end effector 16 to mimic the motion of the handle 14. Mimicking motion can include corresponding motion, whereby the end effector 16 moves in the same direction and orientation as the handle 14, or mirrored motion, whereby the end effector 16 moves in an opposite direction and orientation as the handle 14. The mimicking motion can also be proportional to the movement of the handle.

[0037] The elongate shaft 12 of the device 10 can have a variety of configurations. For example, it can be solid or hollow, and it can be formed from a single component or multiple segments. As shown in FIG. 2, the elongate shaft 12 is hollow and is formed from multiple connecting segments to allow the elongate shaft 12 to flex. The flexibility of the shaft 12, as well as a relatively small diameter, allows the shaft 12 to be used in endoscopic procedures, whereby the device is introduced translumenally through a natural orifice. The shaft can also vary in length depending on the intended application.

[0038] FIG. 2 further illustrates one exemplary embodiment of an actuator 22 in the form of several cables 34a, 34b, 34c, 34d that are spaced around a circumference of the elongate shaft 12, and that extend along the length of the elongate shaft 12. The number and location of the cables can vary. For example, three cables can be spaced approximately 120° apart from one another around the circumference of the shaft 12. In the embodiment shown in FIG. 2, four cables 34a, 34b, 34c, 34d are spaced approximately 90° apart from one another around the circumference of the shaft 12. Each cable 34a-d can extend through a pathway, such as a lumen, formed on, in, or around the elongate shaft 12. FIG. 2 illustrates each cable 34a-d extending through a cut-out formed on an external surface of each segment of the shaft 12. Thus, each segment includes four cut-outs spaced equidistant around the circumference of the shaft 12 to maintain the cables 34a-d equidistant from one another. The cut-outs preferably have a size that is effective to retain the cables 34a-d therein while allowing the cables 34a-d to freely slide relative to the shaft 12.

[0039] The distal end of the cables 34a-d can be mated to the end effector 16 to control movement of the end effector 16. While the end effector 16 can have a variety of configurations, and various end effectors known in the art can be used, FIG. 3A illustrates one exemplary embodiment of an end effector 16 which generally includes opposed first and second jaws 18, 20 that are adapted to receive tissue therebetween. The first jaw 18 is adapted to contain a staple cartridge having multiple staples disposed therein and configured to be driven into tissue, and the second jaw 20 forms an anvil for deforming the staples. The particular configuration and the basic operation of the end effector 16 can vary, and various end effectors 16 known in the art can be used. By way of non-limiting example, U.S. Patent No. 6,978,921 entitled "Surgical Stapling Instrument Incorporating an E-Beam Firing Mechanism," which is incorporated herein in its entirety, discloses one embodiment of an end effector that can be used with the present invention.

[0040] In order to allow movement of the end effector 16 relative to the elongate shaft 12, the end effector 16 can be movably coupled to the distal end 12b of the elongate shaft 12. For example, the end effector 16 can be pivotally coupled to the distal end 12b of the elongate shaft 12 by a pivoting or rotating joint. Alternatively, the end effector 16 can include a flexible neck 26 formed thereon, as shown, for allowing movement of the end effector 16 relative to the

elongate shaft 12. The flexible neck 26 can be formed integrally with the distal end 12b of the shaft 12 and/or the proximal end of the jaws 18, 20, or it can be a separate member that extends between the shaft 12 and the jaws 18, 20. As shown in FIG. 3A, the flexible neck 26 includes a first coupler 28 for mating the flexible neck 26 to the proximal end of the opposed jaws 18, 20, and a second coupler 30 for mating the flexible neck 26 to the distal end of the elongate shaft 12. The couplers 28, 30 can be removably or fixedly mated to the flexible neck 26 and/or to the jaws 18, 20 and the shaft 12. The couplers 28, 30 also function to house certain components of the end effector 16. For example, the first coupler 28 can function to anchor the cables therein, as will be discussed below, and it can also function to house a gear and driver assembly for actuating (e.g., closing and firing) the jaws 18, 20.

[0041] In order to facilitate flexion of the flexible neck 26, the neck 26 can include one or more slits 32 formed therein. The quantity, location, and size of the slits 32 can vary to obtain a desired flexibility. In the embodiment shown in FIG. 3A, the flexible neck 26 includes multiple rows of slits 32, each row extending radially around the flexible neck 26 and each row being spaced axially along the length of the flexible neck 26. Each row of slits contains two slits extending around the circumference of the neck 26, and each row of slits 32 is axially offset from one another. As a result, the flexible neck 26 includes alternating slits 32. A person skilled in the particular pattern of the slits 32 can vary, and that FIG. 3A merely illustrates one pattern for forming slits 32 to allow flexion of the flexible neck 26. Other exemplary slit configurations will be discussed in more detail below.

[0042] As indicated above, the cables 34a-d can be coupled to the end effector 16 to allow the end effector 16 to move in coordination with the handle 14. The connecting location of the cables 34a-d with the end effector 16 can vary depending on the desired movement. In the illustrated embodiment, the distal end of the cables 34a-d is connected to the distal end of the flexible neck 26, and in particular they extend into and connect to the first coupler 28. FIG. 3B illustrates a cross-sectional view of the first coupler 28 showing four bores 28a, 28b, 28c, 28d for receiving the four cables 34a, 34b, 34c, 34d, respectively. Virtually any technique known in the art can be used to connect the cables 34a-d to the coupler 28 including, for example, mechanical mating techniques such as adhesives, an interference fit, a ball-and-socket connection, threads, etc. In use, the connection of the cables 34a-d at the distal end of



the flexible neck 26 will allow the cables 34a-d to apply a tension to the flexible neck 26 when an axial force is applied to the cables 34a-d by the handle 14. This tension will cause the neck 26 to flex in a direction dictated by the amount of tension applied to each cable 34a-d, as will be discussed in more detail below.

[0043] The handle 14 of the device 10 can be used to control movement of the end effector 16, and in particular to articulate the end effector 16 and thus angularly orient it relative to a longitudinal axis *A* of the elongate shaft 12. While the handle 14 can have a variety of configurations, in one exemplary embodiment the handle 14 is movably coupled to the proximal end 12a of the elongate shaft 12 such that movement of the handle 14 can be mimicked by the end effector 16. While various techniques can be used to movably couple the handle 14 to the shaft 12, in the embodiment shown in FIGS. 4A-4C, a ball-and-socket connection is formed between the handle 14 and the proximal end 12a of the elongate shaft 12. As best shown in FIG. 4B, the proximal end 12a of the elongate shaft 12 includes a socket 24 formed therein, and the handle 14 includes a hemi-spherical ball 13a formed on a distal end thereof and configured to be rotatably seated within the socket 24. The socket 24 can be integrally formed with the proximal end 12a of the elongate shaft, or it can be formed by coupling a hollow housing 12c, as shown, to the proximal end 12a of the elongate shaft 12. The hemi-spherical ball 13a can also be formed integrally with the handle 14, or it can be a separate member that is coupled to the handle 14. In order to movably mate the handle 14 to the shaft 12, the hemi-spherical ball 13a on the handle 14 can be retained within the socket 24 using the cables 34a-d, which attach to the handle 14 as will be discussed below. However, other mating techniques can be used to movably mate the handle 14 to the shaft 12. For example, the ball 13a can be spherical and it can be captured within a spherical socket formed in the proximal end 12a of the elongate shaft 12, or a mating element, such as a pin, can extend through the ball 13a to retain the ball 13a within the socket 24. While FIG. 4B illustrates a ball 13a formed on the handle 14 and a socket 24 formed in the shaft 12, the ball-and-socket connection can be reversed such that the ball is on the shaft 12 and the socket is in the handle 14. Moreover, a person skilled in the art will appreciate that a variety of other techniques can be used to movably couple the handle 14 to the proximal end 12a of the elongate shaft 12.

[0044] In use, the handle 14 can articulate or pivotally move relative to the shaft 12 to

cause the end effector 16 to mimic the movement of the handle 14. This can be achieved by coupling the proximal end of the cables 34a-d to the handle 14. The connecting location of the cables 34a-d with the handle 14 can vary depending on the desired movement. In the illustrated embodiment, the cables (only three cables 34a, 34b and 34c are shown in FIG. 4A) extend from the elongate shaft 12, through the hollow housing 12c, and out of slots or openings formed in a proximal end of the hollow housing 12c. The cables 34a-d then extend around the ball 13a on the handle 14 and connect to a distal-facing surface on the handle 14 that surrounds the ball 13a. Virtually any technique known in the art can be used to connect the cables 34a-d to the handle 14 including, for example, mechanical mating techniques such as adhesives, an interference fit, threads, etc. As shown in FIG. 4A, the handle 14 includes openings formed therein, and the proximal ends (not shown) of the cables 34a-d can have a ball or other element formed thereon and configured to be captured within the openings. As further shown in FIG. 4A, the cables (only three cables 34a, 34b and 34c are shown) can remain spaced circumferentially around the handle 14. This will allow movement of the handle 14 to be mirrored by the end effector 16, as will be discussed in more detail below. Alternatively, the cables 34a-d can be crossed before they connect to the handle 14 to cause the end effector 16 to move in the same direction as the handle 14. For example, opposed cables 34a and 34c can cross one another and can connect to opposed sides of the handle 14, and opposed cables 34b and 34d can likewise cross one another and can connect to opposed sides of the handle 14. The cables 34a-d can be crossed at any location, such as within the hollow housing 12c on the proximal end 12a of the shaft 12.

[0045] As further shown in FIGS. 4A and 4B, the handle 14 can also include other features to facilitate use of the device. For example, the handle 14 can include a translating member 38 that is effective to close the jaws 18, 20 on the end effector 16, and a rotating member 40 that is effective to selectively rotate and actuate the end effector 16. The translating and rotating members 38, 40 are described in more detail in an application entitled "Surgical Fastener And Cutter With Single Cable Actuator" by Mark Ortiz et al. and filed on even date herewith, which is hereby incorporated by reference in its entirety. In other embodiments, the handle 14 can include triggers, knobs, etc. for rotating and/or actuating the end effector 16.

[0046] Referring back to FIG. 1B, in use the handle 14 can be pivoted or angularly oriented relative to the proximal end 12a of the elongate shaft 12 to effect mimicking movement of the end effector 16. In particular, pivoting the handle 14 about the elongate shaft 12 in a first direction will apply a force to one or more of cables 34a-d to pull the cable(s) axially. As a result, the actuated cables will apply tension to the flexible neck 26 to cause the neck 26 to flex. In order to prevent the elongate shaft 12 from flexing in response to tension applied to the cables 34a-d by the handle 14, the flexible neck 26 can have a greater flexibility than the elongate shaft 12. This can be achieved, for example, using the alternating slits 32 as previously described, or in other embodiments the material can differ, or the elongate shaft can include a stabilizing element, such as a rod extending therethrough to render the shaft more rigid than the flexible neck.

[0047] The direction of movement of the handle 14 will be mimicked by the end effector 16, either in the same direction (i.e., corresponding movement) or in an opposite direction (i.e., mirrored movement), thus allowing a user to precisely control the position of the end effector 16. In an exemplary embodiment, the particular amount of movement of the end effector 16 can be proportional to the amount of movement of the handle 14. That is, the amount of movement of the end effector 16 can be directly equivalent to the amount of movement of the handle 14, or it can be proportionally increased or decreased relative to the amount of movement of the handle 14. In certain embodiments, it may be desirable to have the amount of movement of the end effector 16 be increased relative to the amount of movement of the handle 14. As a result, only small movements of the handle 14 will be necessary to allow large movements of the end effector 16. While various techniques can be achieved to proportionally multiple or increase the movement of the end effector 16, one exemplary embodiment of a force multiplying mechanism is an eccentric cam that is coupled to the cables and that increases the mechanical advantage, either force or displacement, of the cables 34a-d as tension is applied to the cables 34a-d by the handle 14.

[0048] A person skilled in the art will appreciate that, while the movement between the handle and the working end of the device can be proportional in theory, in practice some loss of force will likely occur as the force is transferred through the elongate shaft. Accordingly, proportional movement as used herein is intended to include applications in which the handle

and working end are configured to move in proportionate amounts, but in which some loss of force may occur during actual operation of the device.

[0049] The various devices disclosed herein can also include a variety of other features to facilitate use thereof. For example, the device 10 of FIG. 1A can include an optical image gathering unit disposed on a distal end of the elongate shaft 12 and configured to acquire images during endoscopic procedures. While the location of the unit can vary, in one embodiment the optical image gathering unit can be disposed on the second coupler 30. In particular, FIG. 5 illustrates a ramp-shaped housing 42 that protrudes from an outer surface of the coupler 30, and that contains the optical image gathering unit therein. A viewing window 44 is formed on a distal-facing surface of the housing 42 to allow the unit to acquire images of the end effector 16 and surrounding surgical site. The images from the optical image gathering unit can be transferred to an external image display screen, or alternatively the device 10 can include image display screen disposed on or coupled to a proximal portion of the device. FIG. 6 illustrates one embodiment of an image display screen 46 protruding outward from the handle 14.

[0050] As previously indicated, the various techniques disclosed herein for controlling movement of a working end of an endoscopic surgical device can be used in conjunction with a variety of medical devices. FIG. 7 illustrates another embodiment of a medical device having an actuator for controlling movement of the working end thereof. In this embodiment, the medical device is in the form of an accessory channel 100 for use with an endoscope. An accessory channel 100 is an external device that can mate to and slide along an endoscope to allow other tools, such as grasper, cutters, etc., to be introduced therethrough and positioned in proximity to the viewing end of the endoscope. While the accessory channel 100 can have virtually any configuration, shape, and size, in the embodiment illustrated in FIG. 7 the accessory channel 100 includes an elongate tube or shaft 102 having an inner lumen extending between proximal and distal ends 102a, 102b thereof for receiving a tool therethrough. The accessory channel 100 can also include a mating element formed thereon for mating the accessory channel 100 directly to an endoscope or to a sleeve or other device disposed around an endoscope. While virtually any mating technique can be used, in the illustrated embodiment the mating element on the accessory channel 100 is in the form of a rail 104 that

extends along a length of the elongate shaft 102. The rail 104 is configured to be received in a complementary track formed on an endoscope or a device disposed around an endoscope, such as a sleeve. A person skilled in the art will appreciate that a variety of other techniques can be used to mate the accessory channel either directly or indirectly to an endoscope.

[0051] In order to control movement of a working end of the accessory channel 100, the device 100 can include features similar to those previously described. In particular, the device 100 can have a flexible neck 108 formed on or coupled to the distal end 102b of the elongate shaft 102, a handle 106 formed on or coupled to the proximal end 102a of the elongate shaft 102, and an actuator extending between the handle 106 and the flexible neck 108. In this embodiment, the actuator is configured to transfer forces from the handle 106 to the flexible neck 108 such that movement of the handle 106 is mimicked by the flexible neck 108, thus allowing a tool extending through the accessory channel 100 to be positioned at a desired angular orientation.

[0052] The flexible neck 108 can have a variety of configurations, and it can be a separate member that is coupled to the elongate shaft 102, or it can be formed integrally with the elongate shaft 102, as shown in FIG. 7. The neck 108 can be made flexible using various techniques. For example, the neck 108 can be formed from one or more segments that move relative to one another, and/or it can be formed from a flexible material. In the exemplary embodiment shown in FIG. 8A, the neck 108 includes several slits 112 formed therein and configured to provide maximum flexibility of the neck 108. While the size, quantity, and orientation of the slits 112 can vary to obtain the desired results, in the illustrated embodiment the flexible neck 108 includes four columns of slits (only three columns of slits, indicated by arrows 112a, 112b, 112c, are shown). Each column extends axially along a length of the flexible neck 108, and each column includes four rows of slits spaced radially around circumference of the neck 108. Each column of slits 112 is also axially offset from one another to allow the slits 112 to overlap. In use, when tension is applied to the actuator, the slits 112 will allow the neck 108 to bend or assume a curved configuration such that the neck 108 articulates relative to the remainder of the elongate shaft 102, as shown in FIGS. 8B and 8C.

[0053] In other embodiments, the slits can be positioned to allow flexion of the neck at multiple locations or bend points, or to otherwise allow the neck to flex into a predetermined position. By way of non-limiting example, FIG. 9A illustrates another embodiment of a flexible neck 108' having two regions of slits 112' formed therein. In particular, the flexible neck 108' includes a distal region of slits 112a' and a proximal region of slits 112b'. Each region 112a', 112b' can include any number of slits positioned at any location to provide a desired degree of flexibility in one or more desired directions. As shown in FIG. 9A, the proximal end distal regions of slits 112a', 112b' each include two rows of slits formed on opposed sides of and extending along the length of the flexible neck 108'. In use, when tension is applied to the flexible neck 108', as will be discussed in more detail below, the neck 108' will flex at both the proximal and distal regions 112a', 112b' and thereby articulate relative to the remainder of the elongate shaft 102'. As shown in FIG. 9B, flexion can occur first in the distal region 112a' of the neck 108'. Further tension applied to the neck 108' can then cause the proximal region 112b' to flex, as shown in FIG. 9C. In other embodiments, the slits positioning and/or size of the slits can be configured to cause flexion to occur in the proximal region 112b' before it occurs in the distal region 112a', or alternatively the slits can be configured to cause simultaneous flexion of the proximal and distal regions 112b', 112a'. A person skilled in the art will appreciate that the quantity, position, size, and shape of the slits can be adjusted to obtain the desired results. The particular configuration of the cut used to form each slit can also vary. For example, the width and length of the slit can remain constant from an outer surface of the elongate shaft to an inner surface of the elongate shaft, or alternatively the width and length can increase or decrease such that the slit tapers or otherwise varies. By way of non-limiting example, a tapering configuration can be formed by forming a slit having triangular configuration, where the length and width of the slit decrease from the outer surface to the inner surface of the elongate shaft.

[0054] As indicated above, the actuator is configured to apply tension to the flexible neck 108 to cause the neck 108 to articulate. The actuator can have a variety of configurations, but in one exemplary embodiment the actuator is similar to the aforementioned actuator and includes one or more cables that extend between the handle 106 and the distal end of the flexible neck 108 such that the handle 106 and the flexible neck 108 are operatively associated. Each cable can be configured to apply tension to the flexible neck 108 to cause the neck 108 to

articulate in a plane of motion. Thus, where the device 100 includes only one cable, the flexible neck 108 can articulate in a single plane of motion. Each additional cable can allow the neck 108 to articulate in a different plane of motion. Where multiple cables are provided, the neck 108 can articulate in multiple planes of motion. Moreover, the cables can be simultaneously tensioned, potentially allow for 360° articulation of the flexible neck 108.

[0055] While the number of cables can vary, and the device 100 can include only one cable, in the embodiment shown in FIG. 7 the device 100 includes four cables (only three cables 110a, 110b, 110c are shown). A portion of the cables 110a, 110b, 110c, 110d is shown in more detail in FIG. 10. As noted above, the cables 110a-d extend along a length of the elongate shaft 102 between the handle 106 and the flexible neck 108. The particular location of the cables 110a-d can vary, but in an exemplary embodiment the cables 110a-d are spaced radially around a circumference of the elongate shaft 102 and they extend between the distal-most end of the flexible neck 108 and the handle 106. The cables 110a-d can extend internally through or externally along the elongate shaft 102, or they can extend through lumens or pathways formed in the sidewall of the elongate shaft 102. FIG. 11 illustrates a cross-sectional view of the elongate shaft 102, showing four lumens 103a, 103b, 103c, 103d formed therein. The lumens 103a-d preferably have a size that allows the cables 110a-d to slide therein, and they are spaced circumferentially about the elongate shaft 102. The lumens 103a-d extend between the proximal and distal ends 102a, 102b of the elongate shaft 102 to allow the cables 110a-d to extend between the handle 106 and the distal-most end of the flexible neck 108.

[0056] The distal end of the cables 110a-d can mate to the distal most end of the flexible neck 108 using a variety of techniques, but in one embodiment, shown in FIG. 12, the flexible neck 108 includes an end cap 114 coupled to or formed on the distal-most end thereof. While the configuration of the end cap 114 can vary depending on the configuration of the actuator, in the illustrated embodiment the end cap 114 includes four bores 114a, 114b, 114c, 114d formed therein and spaced around a circumference of the end cap 114 such that the bores 114a-d align with the lumens 103a-d in the elongate shaft 102. Each bore 114a-d is configured to receive one of the cables 110a-d. Various mating techniques can be used to retain the cables 110a-d within the bores 114a-d. For example, FIG. 10 illustrates ball formed on the end of each cable 110a-d for retaining the ends of the cables 110a-d in the bores 114a-d in the end cap 114. The

end cap 114 can also include a central lumen 116 formed therein for receiving a tool therethrough. The lumen 116 can also function to facilitate positioning of a tool inserted through the accessory channel 100.

[0057] The proximal end of the cables 110a-d can be mated to a handle 106 that is coupled to a proximal end of the shaft 102. While the handle 106 can have a variety of configurations, in one exemplary embodiment, previously shown in FIG. 7, the handle 106 can be in the form of a joystick that is movably coupled to the proximal end 102a of the elongate shaft 102, and in particular that is configured to articulate relative to the proximal end 102a of the elongate shaft 102. The articulating movement of the handle 106 can allow the motion of the handle 106 to be mimicked by the flexible neck 108, as will be discussed below.

[0058] While articulating movement can be achieved using a variety of types of joints, in the illustrated embodiment a ball-and-socket connection is formed between the handle 106 and the elongate shaft 102. In particular, as shown in more detail in FIGS. 13A and 13B, the proximal end 102a of the elongate shaft 102 includes a housing 103 formed thereon and defining a socket 118 in a proximal end thereof. The handle 106 includes a ball 120 that is movably disposed within the socket 118, and the joystick extends proximally from the ball 120 thus allowing the handle 106 to articulate relative to the elongate shaft 102. A pin or other mechanism can be used to movably retain the ball 120 within the socket 118. A person skilled in the art will appreciate that the handle can have a variety of other shapes, and that various other techniques can be used to movably connect the handle 106 to the elongate shaft 102.

[0059] As indicated above, the proximal end of the cables 110a-d is configured to mate to the handle 106. Thus, the handle 106 can include features for mating to the cables 110a-d. While the particular mating features can vary depending on the configuration of the actuator, in an exemplary embodiment the joystick 122 on the handle 106 includes four legs 124a, 124b, 124c, 124d formed thereon. The legs 124a-d are spaced around a circumference of the joystick 122, such that they are substantially aligned with the cables, and each leg 124a-d is configured to mate to a terminal end of one of the cables 110a-d. A ball-and-socket connection, as previously described with respect to the distal ends of the cables 110a-d, can be used to mate the cables 110a-d to the legs, or alternatively any other mating technique known in the art can



be used.

[0060] Referring back to FIG. 7, in use the handle 106 can be pivoted or angularly oriented relative to the proximal end 102a of the elongate shaft 102 to effect mimicking movement of the flexible neck 108, and to thereby position a tool extending through the flexible neck 108. As shown in FIGS. 7 and 13B, the joystick on the handle 106 can include a lumen 107 formed therethrough and axially aligned with the lumen 102c in the elongate shaft 102 for allowing a tool to be introduced through the device 100. In other embodiments, the handle 106 can be offset from the proximal end 102a of the elongate shaft 102 such that the handle 106 is coupled to the cables, but does not interfere with direct access to the lumen 102c in the elongate shaft 102.

[0061] In order to control movement of the flexible neck 108 and thus a tool positioned therethrough, the handle 106 is pivoted or articulated about the proximal end 102a of the elongate shaft 102. For example, movement of the handle 106 in a first direction will cause the legs 124a-d on the handle 106 to apply a force to one or more of cables 110a-d to pull the cable(s) axially. As a result, the actuated cables will apply a tension force to the flexible neck 108 to cause the neck 108 to flex. In order to prevent the elongate shaft 102 from flexing in response to tension applied to the cables 110a-d by the handle 106, the flexible neck 108 can have a greater flexibility than the elongate shaft 102. This can be achieved, for example, using the slits as previously described, or in other embodiments the shaft 102 can include a stabilizing element, such as a rod, extending therethrough to make the shaft 102 more rigid than the flexible neck 108. The direction of movement of the handle 106 will be mimicked by the flexible neck 108, either in the same direction (i.e., corresponding movement) or in an opposite direction (i.e., mirrored movement), thus allowing a user to precisely control the position of the flexible neck 108, and thus to control the position of a tool extending through the flexible neck 108. In an exemplary embodiment, the particular amount of movement of the flexible neck 108 can be proportional to the amount of movement of the handle 106. That is, the amount of movement of the flexible neck 108 can be directly equivalent to the amount of movement of the handle 106, or it can be proportionally increased or decreased relative to the amount of movement of the handle 106. In certain embodiments, it may be desirable to have the amount of movement of the flexible neck 108 be increased relative to the amount of

movement of the handle 106. As a result, only small movements of the handle 106 will be necessary to allow large movements of the flexible neck 108. While various techniques can be achieved to proportionally multiple or increase the movement of the flexible neck 108, one exemplary embodiment of a force multiplying mechanism is an eccentric cam that is coupled to the cables and that increases the mechanical advantage, either force or displacement, of the cables 110a-d as tension is applied to the cables 110a-d by the handle 106.

[0062] As previously explained, while the movement between the handle and the working end of the device can be proportional in theory, in practice some lose of force will likely occur as the force is transferred through the elongate shaft. Accordingly, proportional movement as used herein is intended to include applications in which the handle and working end are configured to move in proportionate amounts, but in which some lose of force may occur during actual operation of the device.

[0063] While FIGS. 1A and 7 illustrate devices in which the working end mimics movement of the handle, the handle can have a variety of other configurations in which it is effective to articulate the working end of the device without having the working end of the device mimic movement of the handle. FIGS. 14A and 14B illustrate another embodiment of a device 200 having a handle 204 that includes a rotatable member that is effective to articulate a flexible neck 206 in one or more planes of motion relative to an elongate shaft 202 of the device. In general, the elongate shaft 202 of the device 200 is very similar to the elongate shaft 102 previously described, and it generally includes a flexible neck 206 coupled to or formed on a distal end thereof. Four cable actuators (not shown) extend through the elongate shaft between the handle 106 and the flexible neck 206. The shaft 102 and the cable actuators are similar to the shaft 102 and cable actuators 110a-d previously described with respect to device 100, and thus they will not be described in detail.

[0064] The handle 204 of the device 200 is shown in more detail in FIGS. 15A and 15B. In general, the handle 204 includes one or more spools rotatably disposed therein. Each spool is configured to mate to and control one of the cable actuators. Thus, rotation of each spool will wind up or release the cable, thereby causing the flexible neck 108 to flex and articulate in a particular direction. While the number of spools can vary depending on the number of cable

actuators, in the embodiment shown in FIGS. 15A and 15B, the handle 204 includes four spools 208a, 208b, 210a, 210b. The first two spools 208a, 208b are coupled to one another, and the second two spools 210a, 210b are coupled to one another. A first cable 212a is coupled to and wound around the first spool 208a, and a second cable 212b is coupled to and wound around the second spool 208b. The first and second cables 212a, 212b are positioned on and extend along opposite sides of the elongate shaft 202. As a result, tension applied to the first cable 212a will cause the flexible neck 206 to articulate in direction within a first plane of motion, and tension applied to the second cable 212b will cause the flexible neck 206 to articulate in the opposite direction within the same plane of motion. To allow tension to be applied to only one of the cables 212a, 212b, the first and second cables 212a, 212b are wound around the first and second spools 208a, 208b in opposite directions. Thus, rotation of the first and second spools 208a, 208b will wind and apply tension to one of the cables 212a, 212b while unwinding and releasing tension on the other one of the cables 212a, 212b. Third and fourth cables 212c, 212d are likewise wound around the third and fourth spools 210a, 210b such that rotation of the third and fourth and second spools 210a, 210b will wind and apply tension to one of the cables 212c, 212d while unwinding and releasing tension on the other one of the cables 212c, 212d. The third and fourth cables 212c, 212d can extend along the shaft 102 at a position that is radially offset from the first and second cables 212a, 212b such that the third and fourth cables 212c, 212d cause articulation of the flexible neck 206 in a second, different plane of motion. For example, the third and fourth cables 212c, 212d can be offset from the first and second cables 212a, 212b by about 90° such that the cables 212a-d are all spaced substantially equidistant around the circumference of the elongate shaft 202. A person skilled in the art will appreciate that the handle 204 can include any number of spools and cables to effect articulation in a desired number of planes.

[0065] In order to control the spools 208a, 208b, 210a, 210b, the device can include one or more grasping members. As shown in FIGS. 15A and 15B, a first rotatable knob 214 is coupled to the first and second spools 208a, 208b, and a second rotatable knob 216 is coupled to the third and fourth spools 210a, 210b. The knobs 214, 216 can be integrally formed with the spools 208a, 208b, 210a, 210b, or they can be coupled to the spools 208a, 208b, 210a, 210b by a shaft that extends through the spools 208a, 208b, 210a, 210b. In the illustrated embodiment, the first knob 214 is formed on or coupled directly to the first spool 208a, and the

second knob 216 is coupled to the third and fourth spools 210a, 210b by a shaft 218 that extends from the knob 216 through the first and second spools 208a, 208b, and that couples to the third and fourth spools 210a, 210b. In other words, the first and second spools 208a, 208b are rotatably disposed around the shaft 218.

[0066] In certain exemplary embodiments, the spools and the rotatable knobs can also differ in size. In the embodiment shown in FIGS. 15A and 15B, the first and second spools 208a, 208b, as well as the first rotatable knob 214, have a diameter that is greater than a diameter of the third and fourth spools 210a, 210b and the second rotatable knob 216. While not necessary, such a configuration can be advantageous as it spaces the cables 212a-d apart to prevent the cables 212a-d from coming into contact with one another.

[0067] In use, a tool can be positioned through the elongate shaft 202, and the knobs 214, 216 can be rotated to articulate the flexible neck 206 on the shaft 202 and thereby position the tool as desired. As shown in FIGS. 14A and 14B, the handle 204 can include a lumen 205 extending therethrough and in alignment with the lumen in the elongate shaft 202 for allowing a tool to be passed through the handle 204 and the shaft 202. In other embodiments, the handle 204 can be offset from the elongate shaft 202 to provide direct access to the lumen in the elongate shaft 202. Once the tool is positioned through the shaft 202, the knobs 214, 216 can be rotated to articulate the flexible neck 206 on the distal end of the elongate shaft 202. In particular, the first knob 214 can be rotated in a first direction, e.g., clockwise, to apply tension to one of the cables, e.g., the first cable 212a, while releasing or unwinding the other cable, e.g., the second cable 212b. As a result, the tension applied to the first cable 212a will pull the distal-most end of the flexible neck 206 in a proximal direction, causing the flexible neck 206 to flex and thereby articulate in a first direction. Rotation of the first knob 214 in an opposite direction, e.g., counterclockwise, will unwind the first cable 212a while winding the second cable 212b. The flexible neck 206 will return to its initial, linear configuration. Further rotation of the first knob 214 will continue to wind the second cable 212b while unwinding the first cable 212a, thereby causing the flexible neck 206 to flex and articulate in an opposite direction along the same plane of motion. The second knob 216 can be likewise rotated to articulate the flexible in a different plane of motion. The knobs 214, 216 can also optionally be rotated simultaneously to articulate the flexible neck 206 in additional planes of motion.

different than the first and second planes of motion.

[0068] In other embodiments, the various devices disclosed herein can include a locking mechanism for locking the handle(s) and/or actuator in a fixed position to maintain the working end of a device in desired articulated or angular orientation. While the locking mechanism can have a variety of configurations, in one exemplary embodiment the locking mechanism can be in the form of a clamp that is effective to clamp down onto the cables and thereby prevent movement of the cables to lock the working end in a desired orientation. The clamp can have a variety of shapes and sizes, and it can be positioned at various locations on the device. FIGS. 17A and 17B illustrate one exemplary embodiment of a clamp 300 that is disposed around the hollow housing 12c on the surgical fastening and cutting device 10 of FIGS. 1A and 1B. The clamp 300 is generally ring-shaped and can be configured to be slidably or rotatably mated to the hollow housing 12c adjacent to the openings through which the cables (only three cables 34a, 34b, 34c are shown in FIG. 17B) extend. In an initial position, the clamp 300 is spaced apart from the openings to allow free movement of the cables 34a-d therethrough. Once the working end of the device, e.g., the end effector 16, is articulated into a desired position, the clamp 300 can be moved axially along the hollow housing 12c until it extends over the openings and engages the cables 34a-d extending therefrom. The clamp 300 will thus prevent movement of the cables 34a-d when the clamp 300 is in the locked position. In order to move the clamp 300 axially and to lock the clamp 300 to the housing 12c, the clamp 300 can include a mating element formed thereon and configured to engage a corresponding mating element formed on the housing 12c. As shown in FIGS. 17A and 17B, the clamp includes threads 302 formed therein that are configured to mate with corresponding threads (not shown) formed on the housing 12c. As a result, rotation of the clamp 300 about the housing 12c will cause the clamp 300 to move between the initial and locked positions. A person skilled in the art will appreciate that various other mating techniques can be used. Moreover, the locking mechanism can have a variety of other configurations. For example, the handle can include a locking element formed thereon and configured to lock the handle in a fixed, articulated position.

[0069] In other embodiments, the cables can be used to passively allow articulation of the elongate shaft through a body lumen, and the clamp 300 or other locking mechanism can be

used to lock the working end of the device into position when desired. In such a configuration, the handle can merely be used to facilitate grasping of the device.

[0070] In other embodiments, the cable actuators disclosed herein used to effect articulation of a working end of a device can be formed from an electroactive polymer material. Electroactive polymers (EAPs), also referred to as artificial muscles, are materials that exhibit piezoelectric, pyroelectric, or electrostrictive properties in response to electrical or mechanical fields. In particular, EAPs are a set of conductive doped polymers that change shape when an electrical voltage is applied. The conductive polymer can be paired to some form of ionic fluid or gel and electrodes, and the flow of ions from the fluid/gel into or out of the conductive polymer can induce a shape change of the polymer. Typically, a voltage potential in the range of about 1V to 4kV can be applied depending on the particular polymer and ionic fluid or gel used. It is important to note that EAPs do not change volume when energized, rather they merely expand in one direction and contract in a transverse direction. Thus, the cable actuators previously disclosed herein can be replaced by EAP actuators, and the handle can be configured to activate an energy source to selectively deliver energy to one or more of the cables. In an exemplary embodiment, movement of the handle can be configured to dictate the amount of the energy source, as well as the cable(s) receiving the energy source. As a result, movement of the handle can still be mimicked by the working end of the device to provide the user with the same, precise control over the position of the working end. The energy source can be an internal source, such as a battery, or it can be an external source. In other embodiments, the EAP cable actuators can supplement the axial force applied to the cables by movement of the handle and thereby proportionally increase the amount of movement of the working end relative to the handle.

[0071] In other aspects, the cable actuators can be formed from a shape-memory material, such as Nitinol. Such a configuration allows tension to be applied to the cables to articulate the end effector, yet allows the cables to return to an initial linear configuration without having to manipulate the handle.

[0072] In yet another embodiment, the various devices disclosed herein, including portions thereof, can be designed to be disposed of after a single use, or they can be designed

to be used multiple times. In either case, the device can be reconditioned for reuse after at least one use. Reconditioning can include any combination of the steps of disassembly of the device, followed by cleaning or replacement of particular pieces, and subsequent reassembly. By way of example, the surgical stapling and fastening device shown in FIGS. 1A and 1B can be reconditioned after the device has been used in a medical procedure. The device can be disassembled, and any number of the particular pieces can be selectively replaced or removed in any combination. For example, for the surgical stapling and cutting device, a cartridge disposed within the end effector and containing a plurality of fasteners can be replaced by adding a new fastener cartridge to the end effector. Upon cleaning and/or replacement of particular parts, the device can be reassembled for subsequent use either at a reconditioning facility, or by a surgical team immediately prior to a surgical procedure. Those skilled in the art will appreciate that reconditioning of a device can utilize a variety of techniques for disassembly, cleaning/replacement, and reassembly. Use of such techniques, and the resulting reconditioned device, are all within the scope of the present application.

The above described invention also has applicability to robotic surgical systems. Such systems are well known in the art and include those available from Intuitive Surgical, Inc., Sunnyvale, CA. Examples are also disclosed in U.S. Patents 6,783,524; 7,524,320; and 7,824,401. All of which are hereby incorporated herein by reference. Generally, robotic surgical systems have a remotely controlled user interface for remotely controlling arm which are configured to interface with and operate surgical instruments and systems. The arms are controllable with an electronic control system(s) that is typically adapted to a localized console for user to interface with. The instruments can be powered either locally by the surgical system or have isolated powered systems from the overall robotic control.

The robotic surgical system includes an actuation assembly, a monitor, a robot, and at least one reliably attached loading unit attached to the robot arm having at least one surgical instrument to perform at least one surgical task and configured to be releasably attached to the distal end of the arm.

In yet another embodiment the robotic surgical system included a processor, at least one encoder to determine the location of at least one motor drive joint, a receiver for receiving electrical signals transmitted from the stapling unit and controlling its motion.

An exemplary disposable loading unit for use with a robot is disclosed U.S. Pat. No 6,231,565 to Tovey et al. An exemplary surgical robot with proportional surgeon control is disclosed in U.S. Pat No. 5,624,398 to Smith et al.

Another aspect of the present invention the robotic system has a frame, a robotic arm which is movable relative to the frame and has a stapling assembly with an elongated tube connecting the stapling assembly to the robotic arm. Both the elongated tube with the stapling assembly and the stapling assembly by itself are releasably attached and operatively coupled to the robotic arm. One configuration of the stapling assembly can be removed and a different configuration attached and operated.

Regarding figures 1. The robotic system includes a coupling member that releasably attaches to the proximal end of elongate shaft 12, in lieu of handle 14.

[0073] One skilled in the art will appreciate further features and advantages of the invention based on the above-described embodiments. Accordingly, the invention is not to be limited by what has been particularly shown and described, except as indicated by the appended claims. All publications and references cited herein are expressly incorporated herein by reference in their entirety.

[0074] What is claimed is:

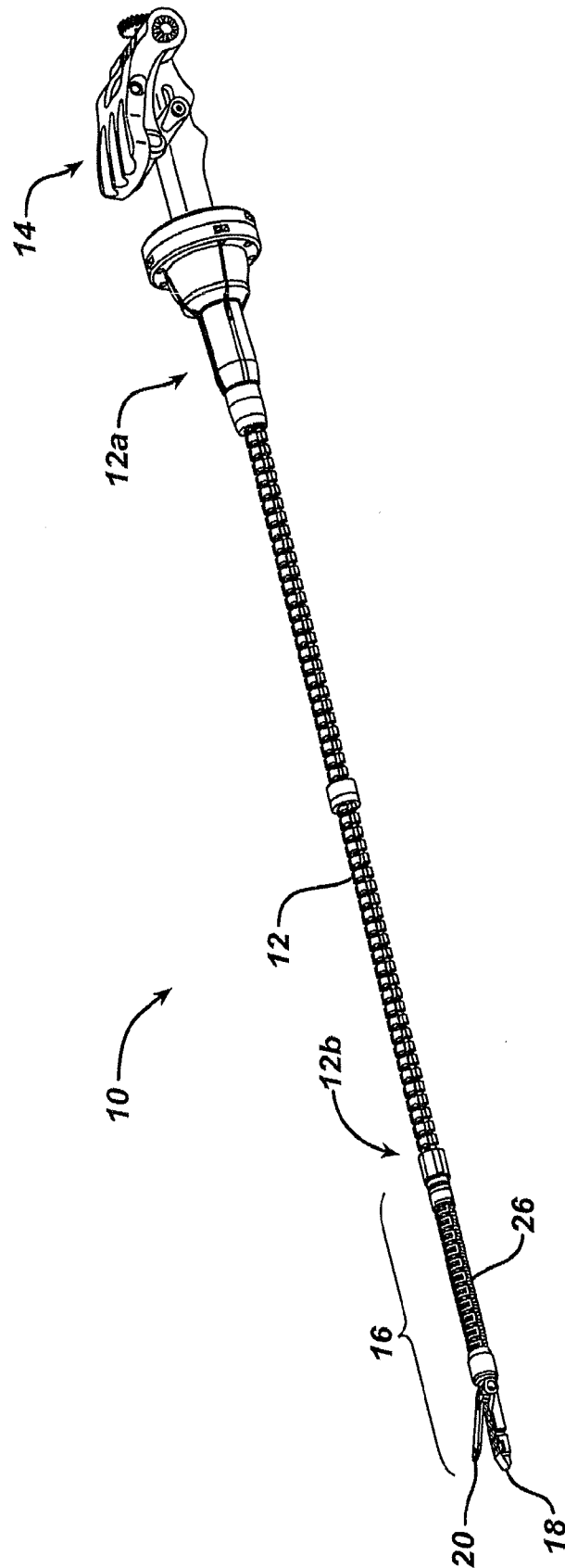


## WHAT IS CLAIMED:

1. A surgical stapling and cutting device comprising:  
an elongate shaft having proximal and distal ends, said distal end configured to facilitate articulation of said end effector in two planes that are substantially perpendicular to the shaft axis and extending therefrom;  
  
an end effector disposed on a proximal end of said flexible neck comprising opposed first and second jaws adapted to receive tissue therebetween, said first jaw having a staple cartridge attached thereto, said staple cartridge having multiple staples disposed therein and configured to be driven into tissue, said second jaw comprising an anvil for deforming the staples; and  
remotely controlled user interface coupled to the proximal end of the elongate tube and being operatively associated with the flexible neck such that movement of the remotely controlled user interface is mimicked by the flexible neck.
2. The device of claim 1, wherein the flexible neck include a plurality of slits formed therein to facilitate flexion thereof.
3. The device of claim 2, wherein the flexible neck includes a distal region of slits and a proximal region of slits, and wherein the slits are configured such that tension applied to the flexible neck will cause the flexible neck to bend at the proximal and distal regions.

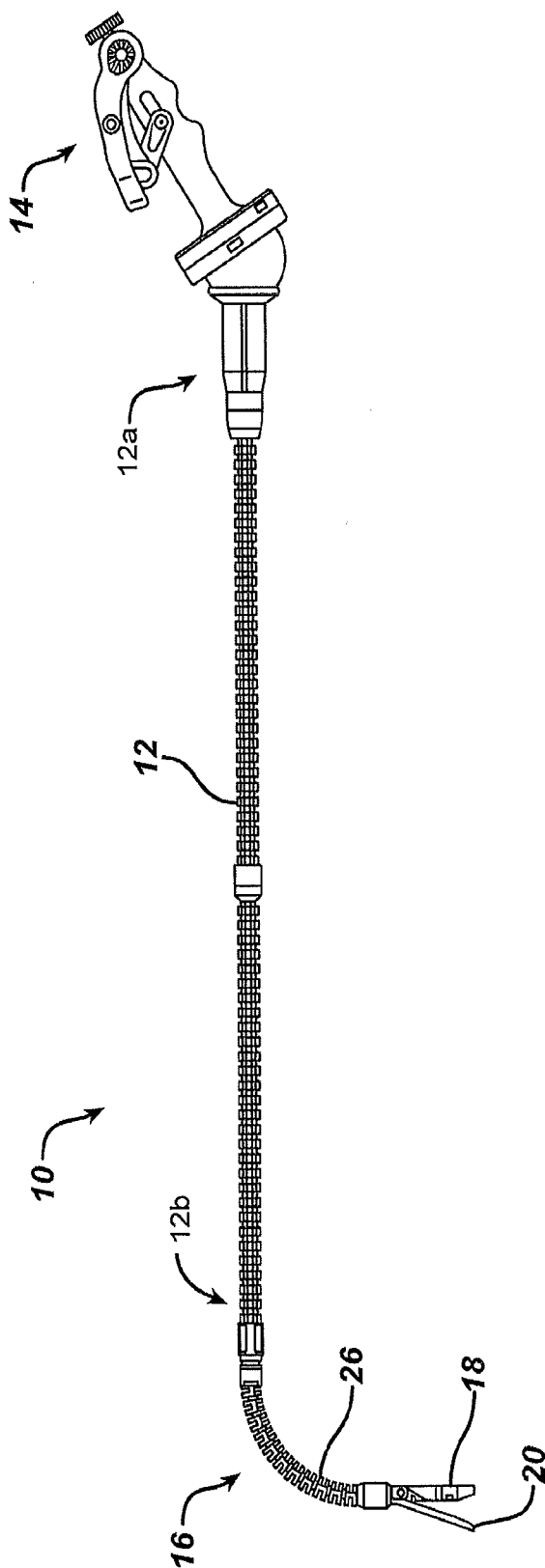
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FIG. 1A



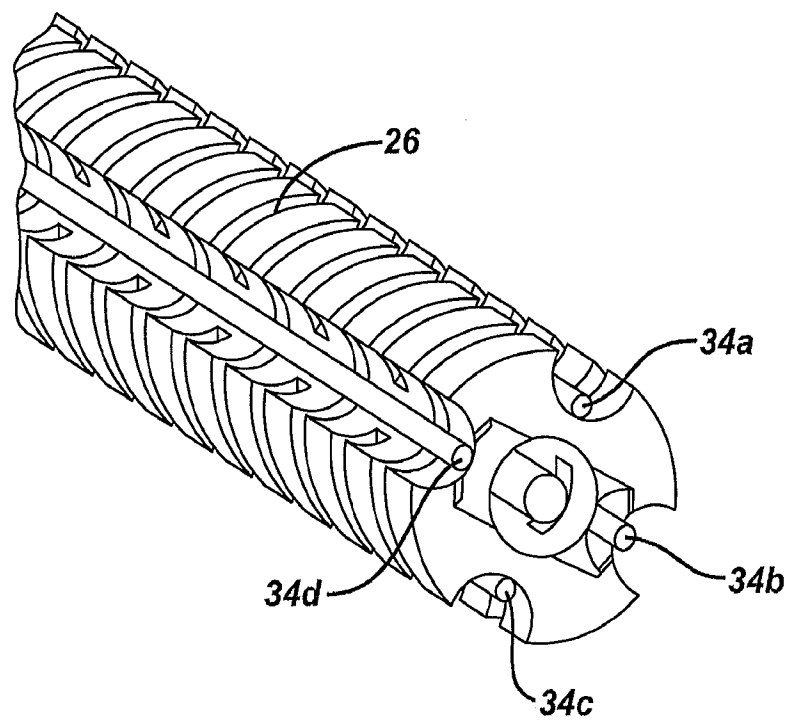
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**FIG. 1B**

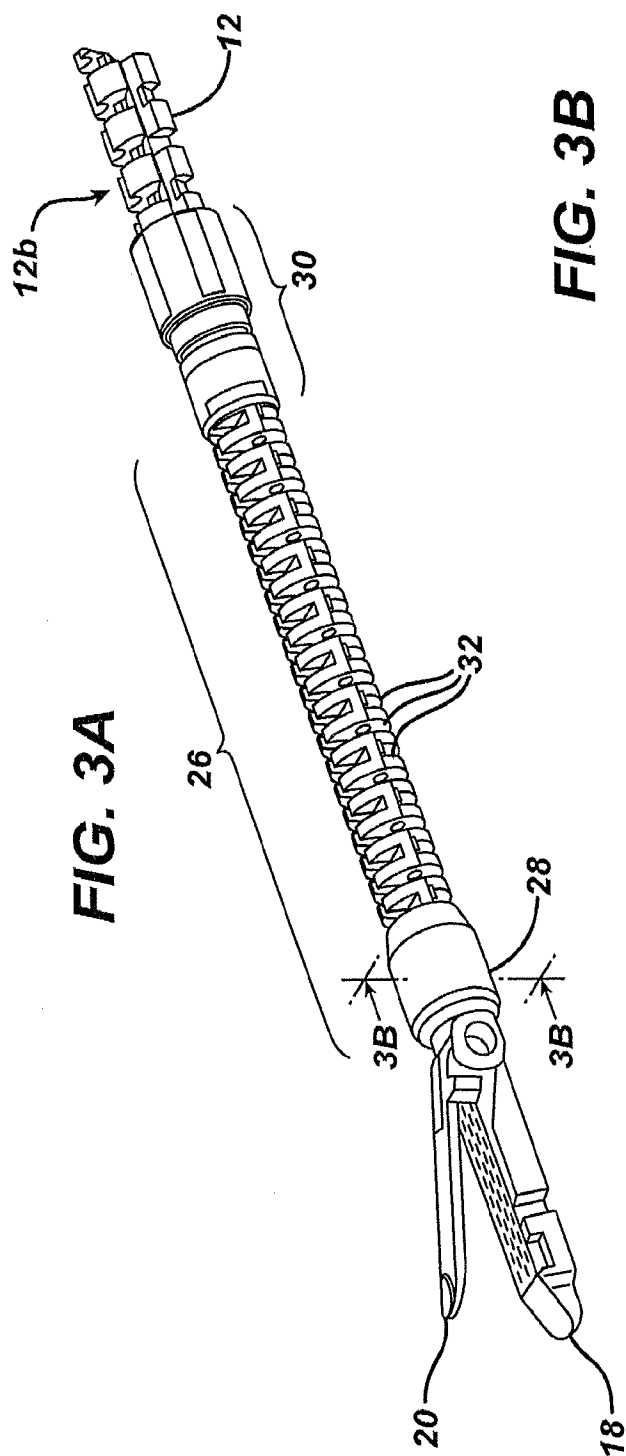


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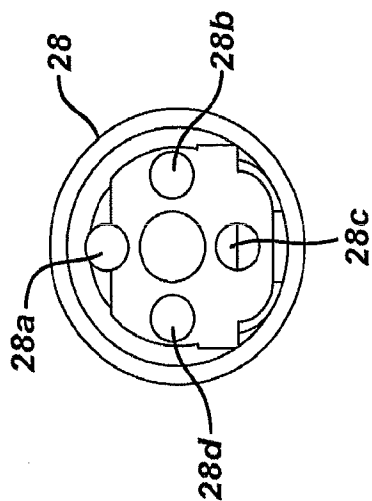
**FIG. 2**



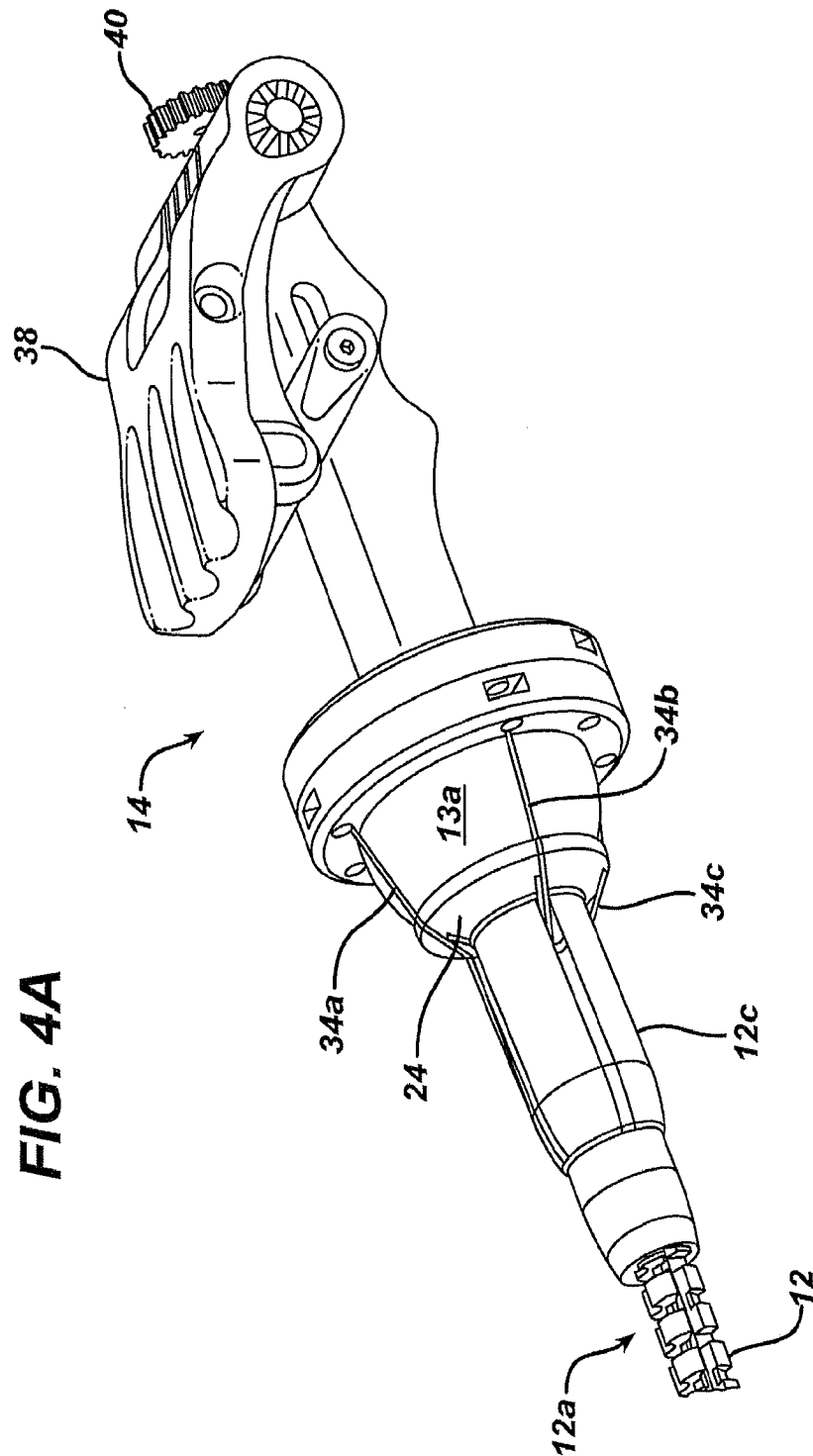
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**FIG. 3B**

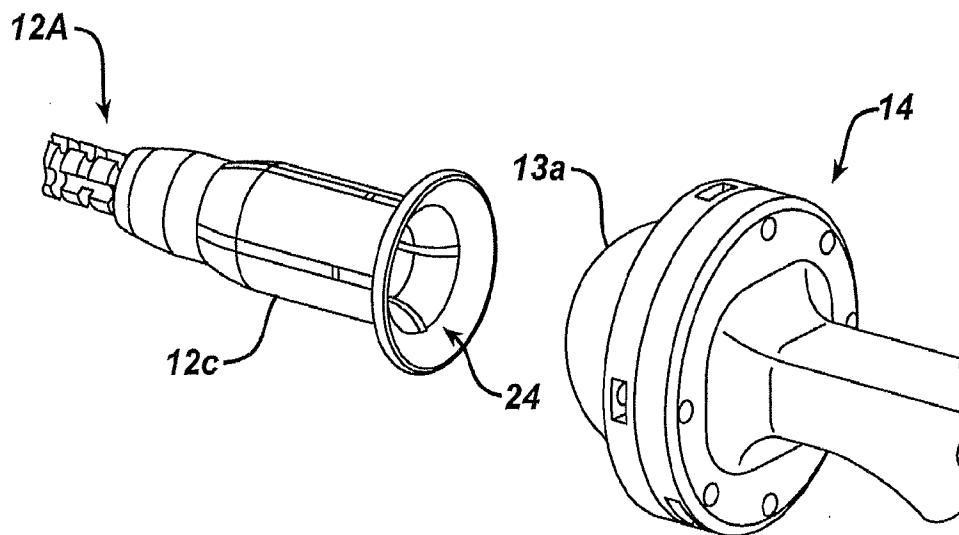


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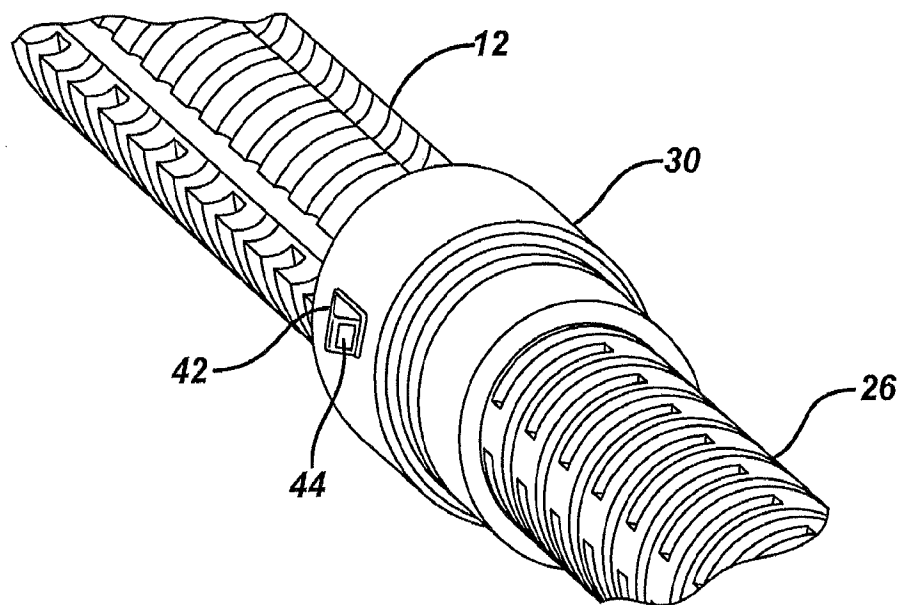
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**FIG. 4B**



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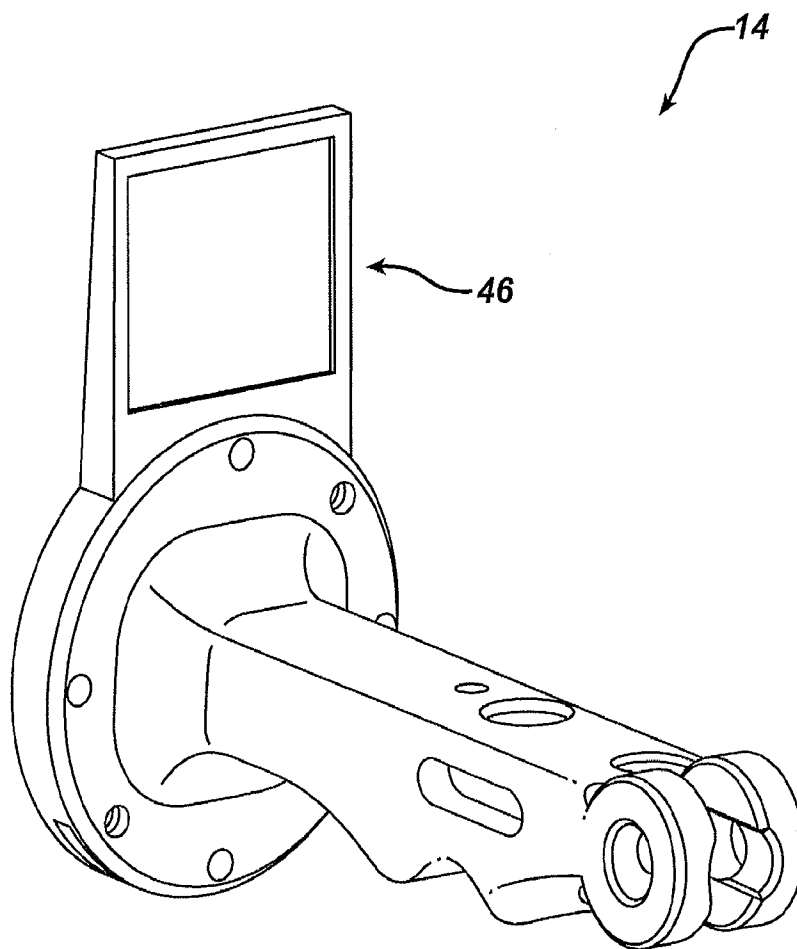
**FIG. 5**



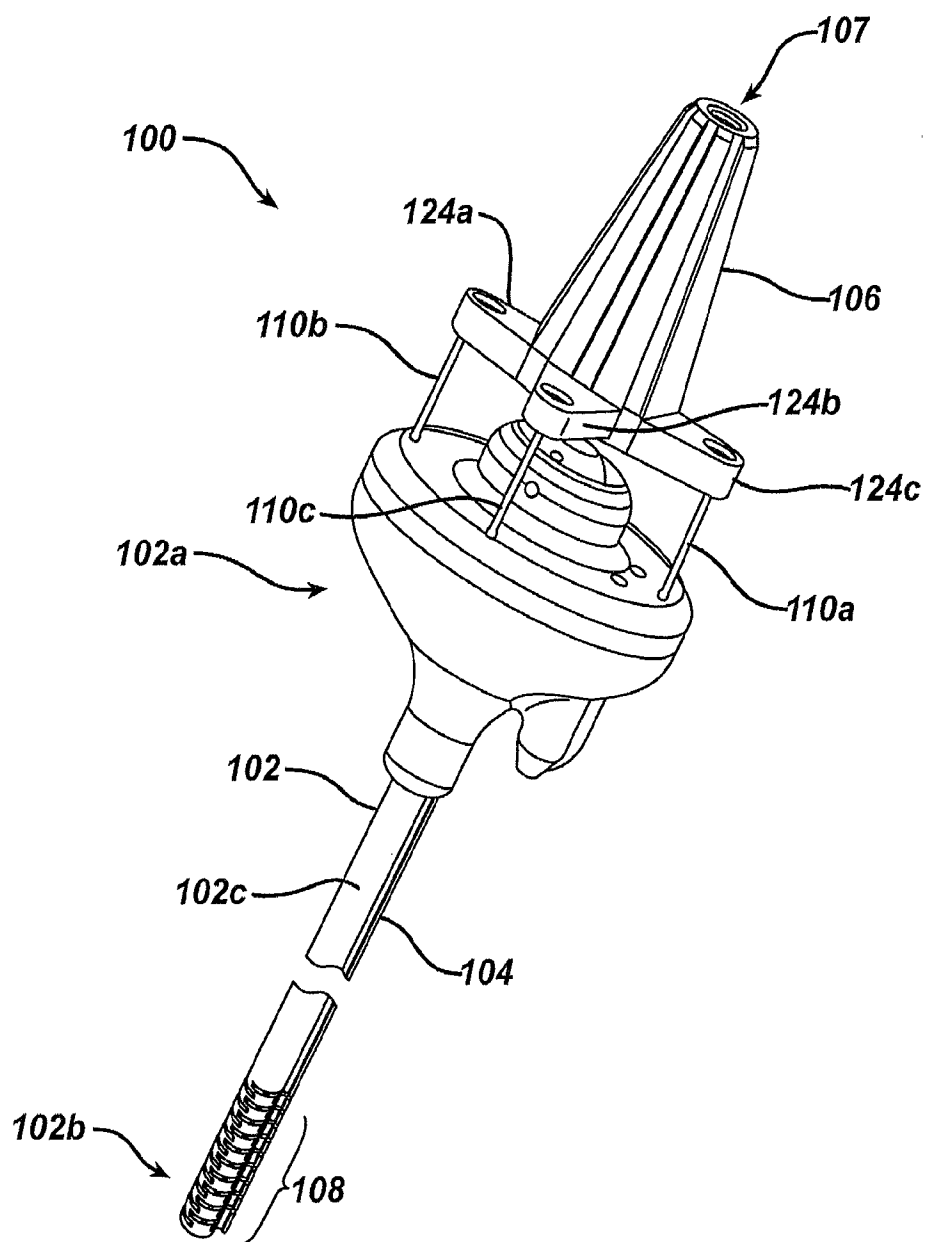


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**FIG. 6**

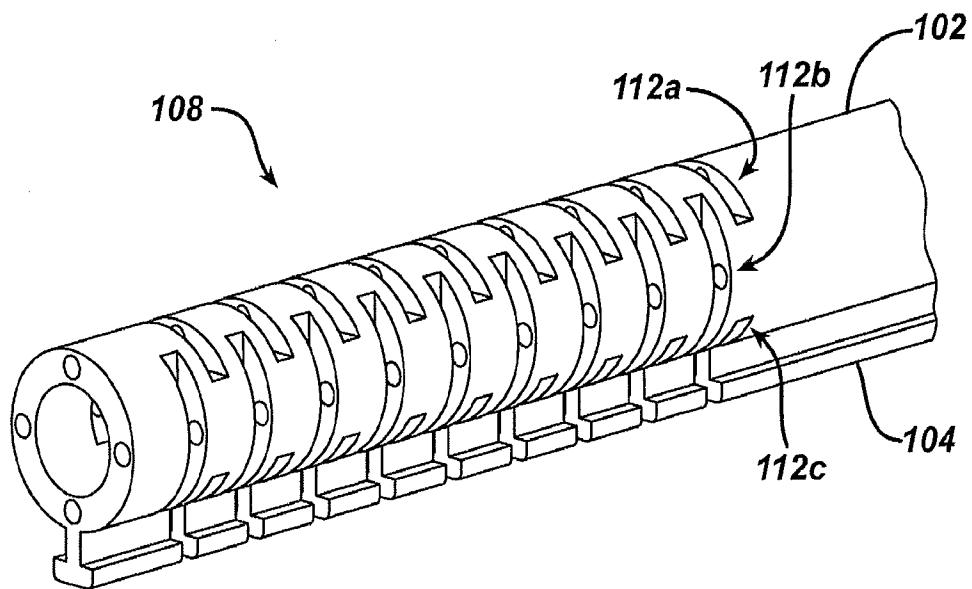


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**FIG. 7**

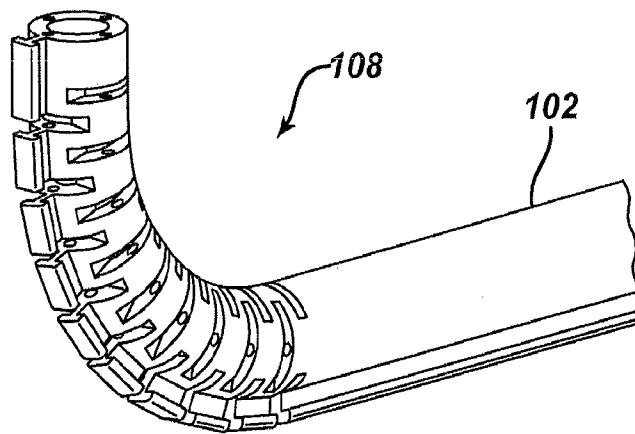
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**FIG. 8A**

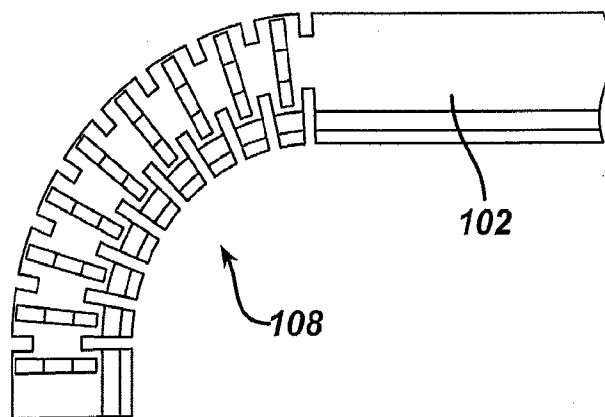


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**FIG. 8B**

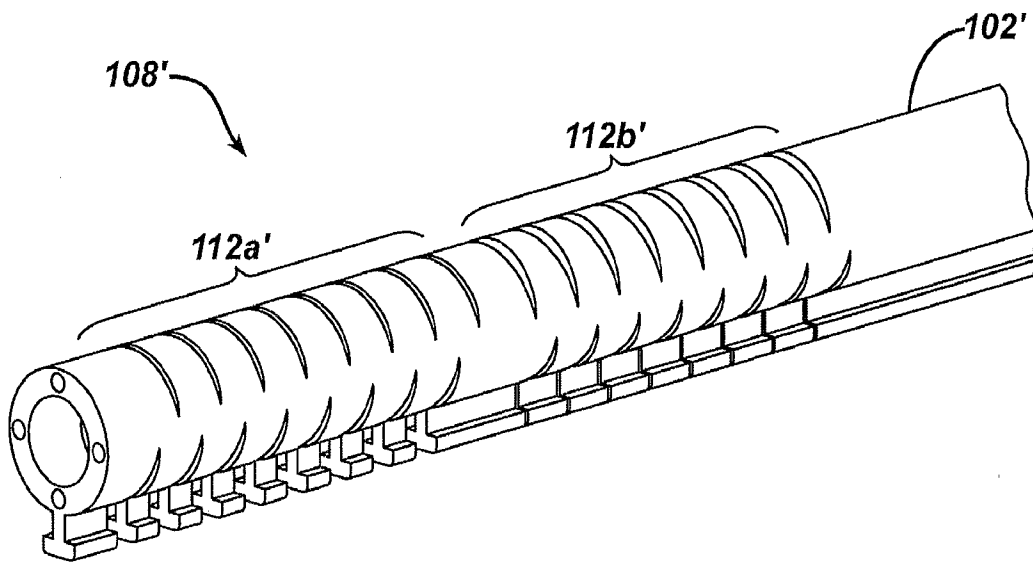


**FIG. 8C**



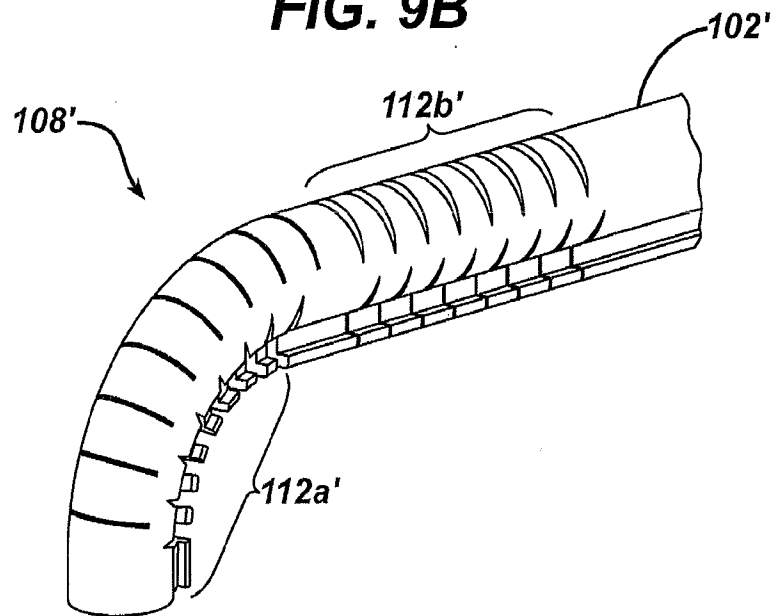
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**FIG. 9A**

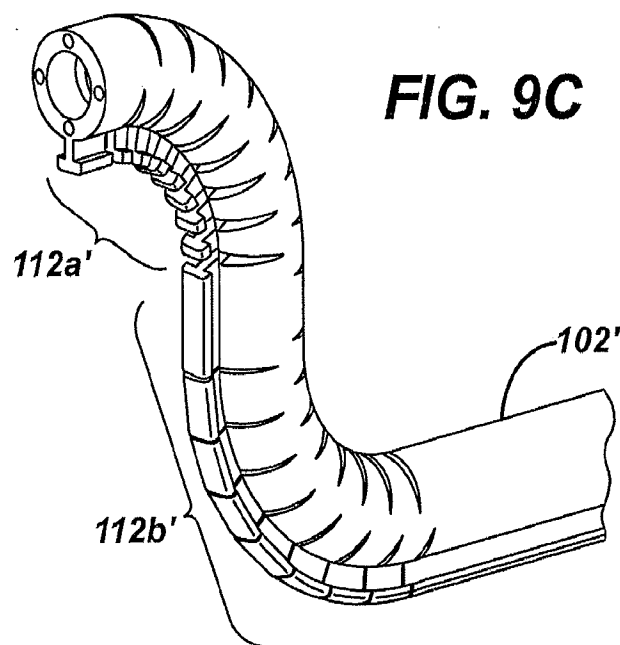


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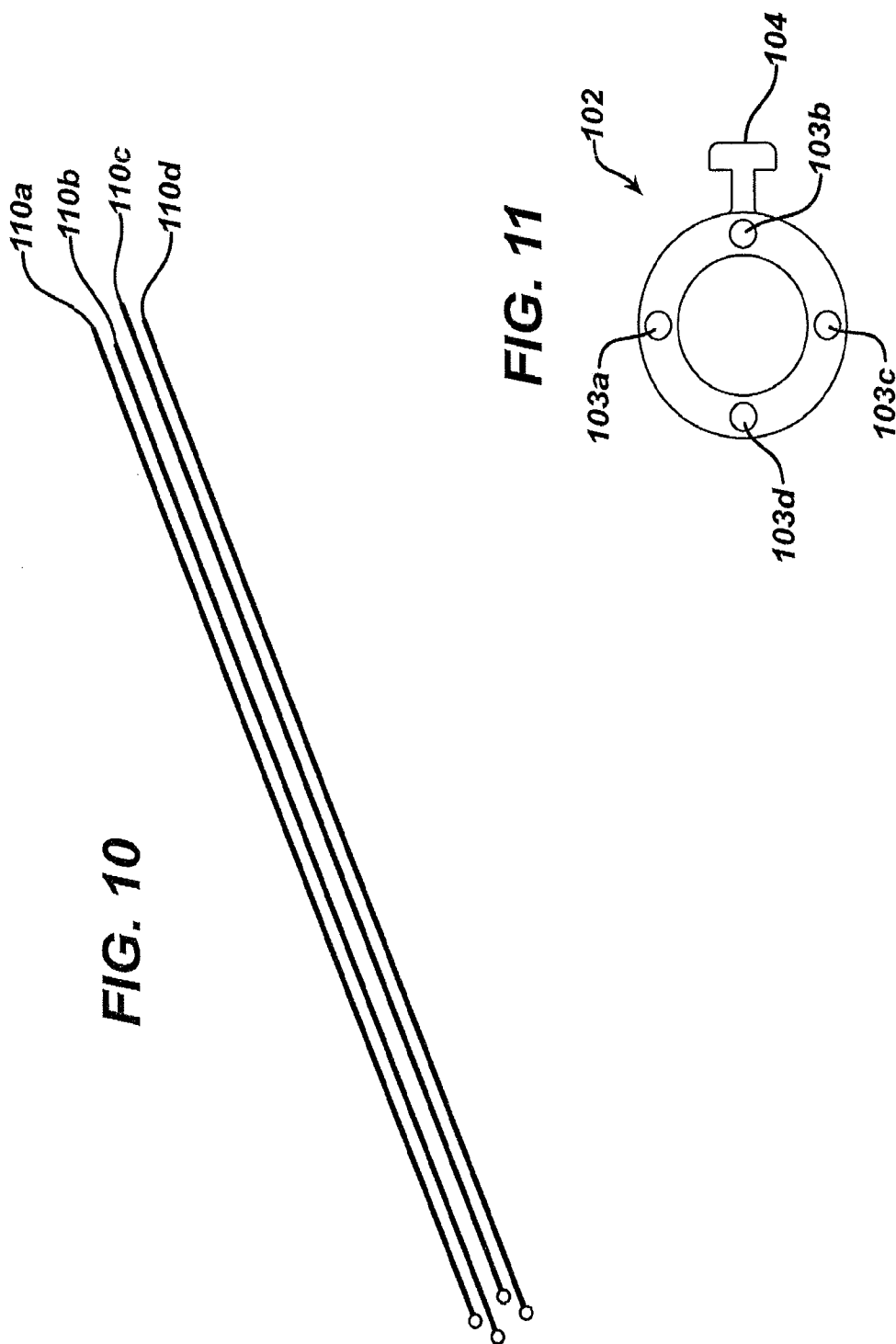
**FIG. 9B**



**FIG. 9C**

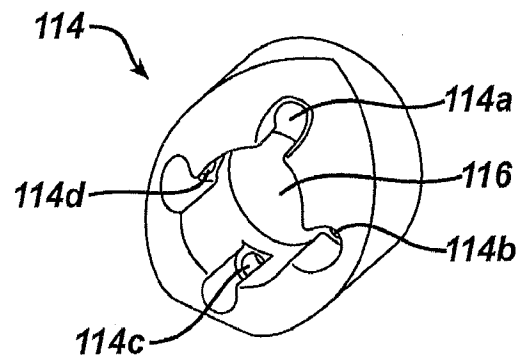


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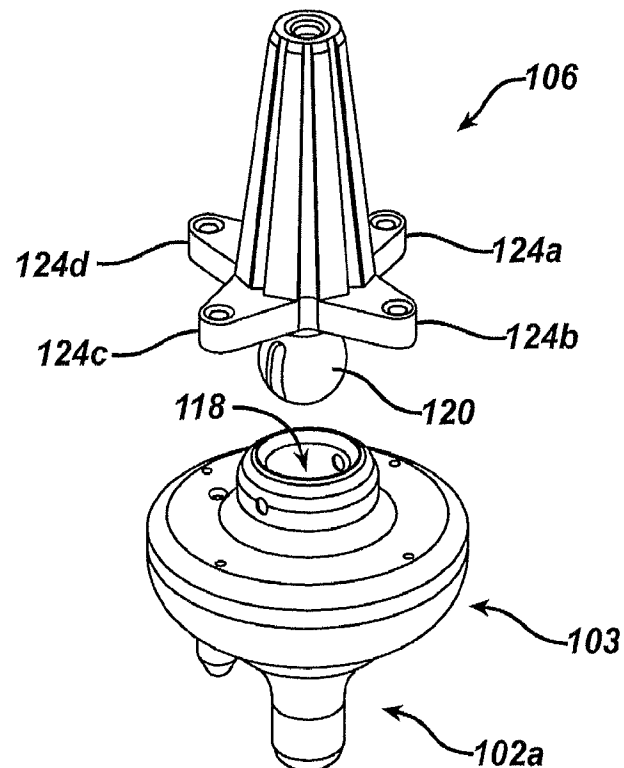


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**FIG. 12**



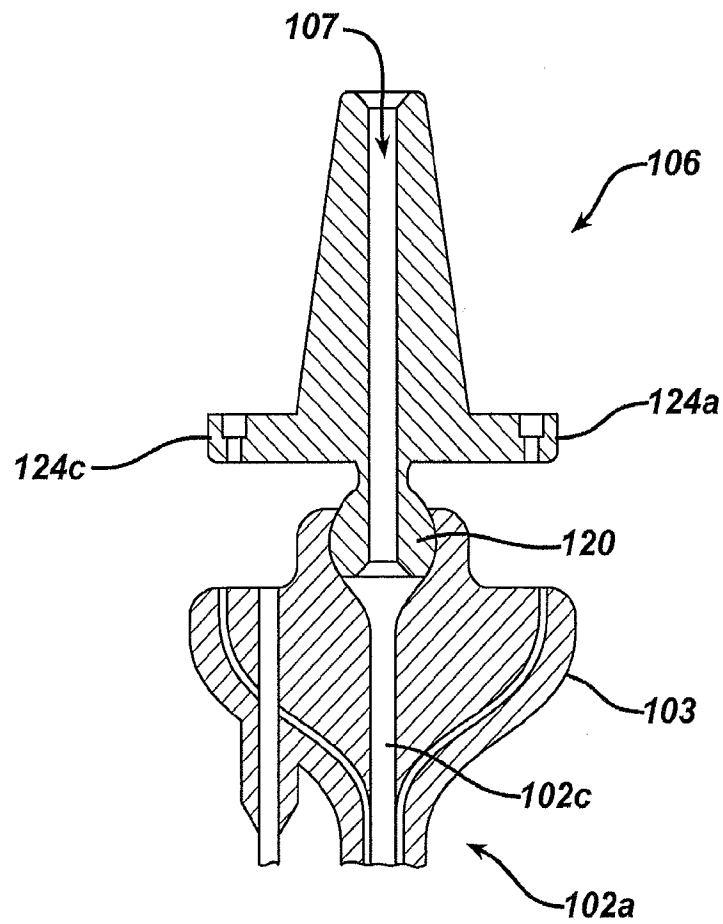
**FIG. 13A**





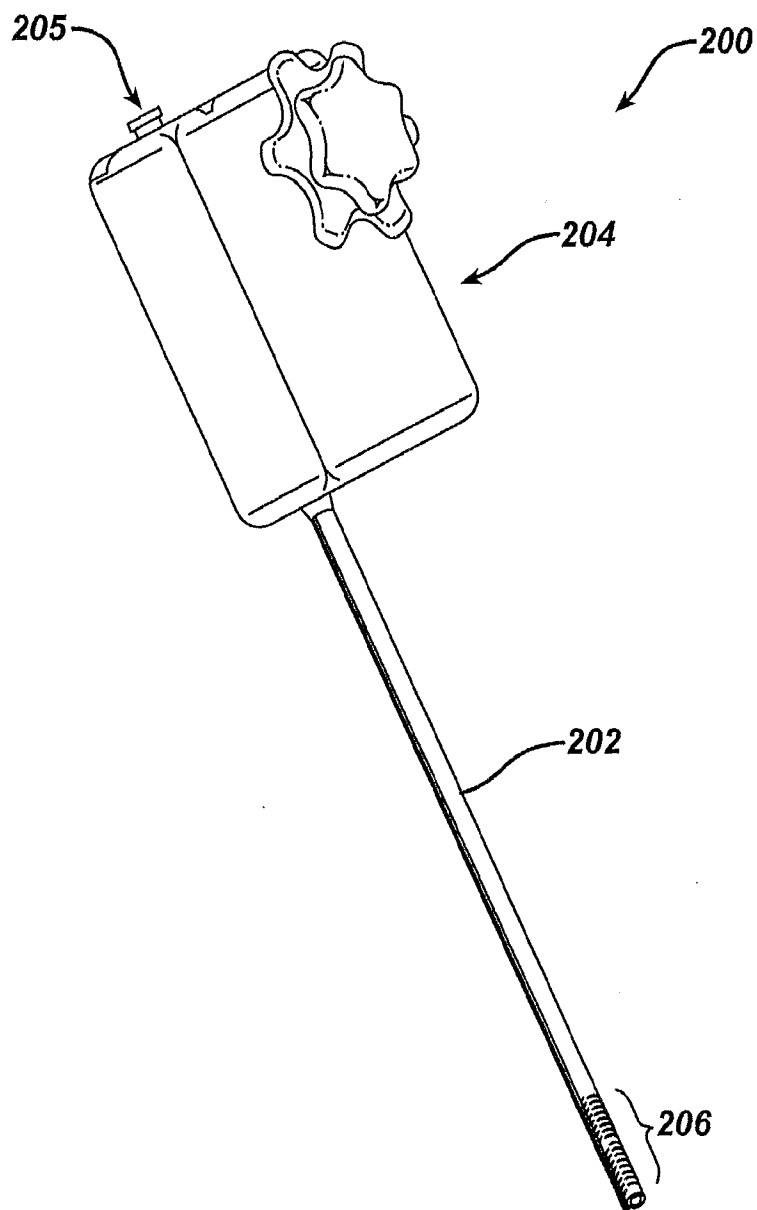
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**FIG. 13B**



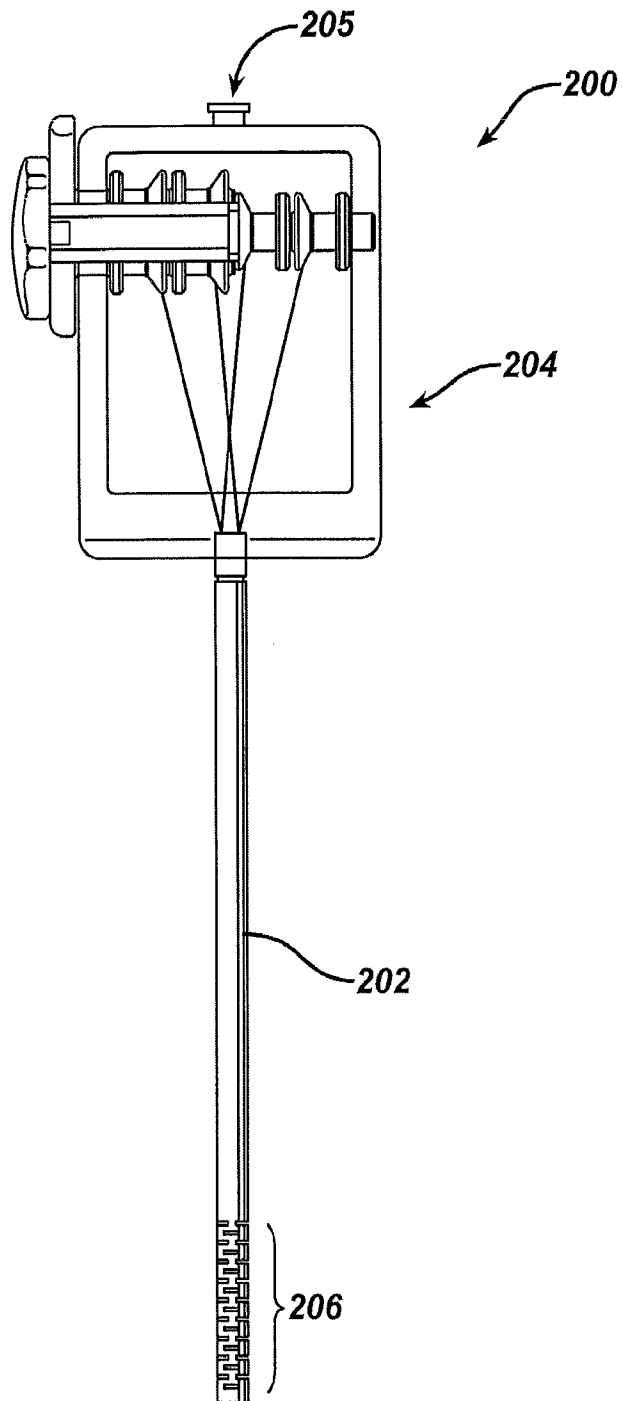
17/21

**FIG. 14A**



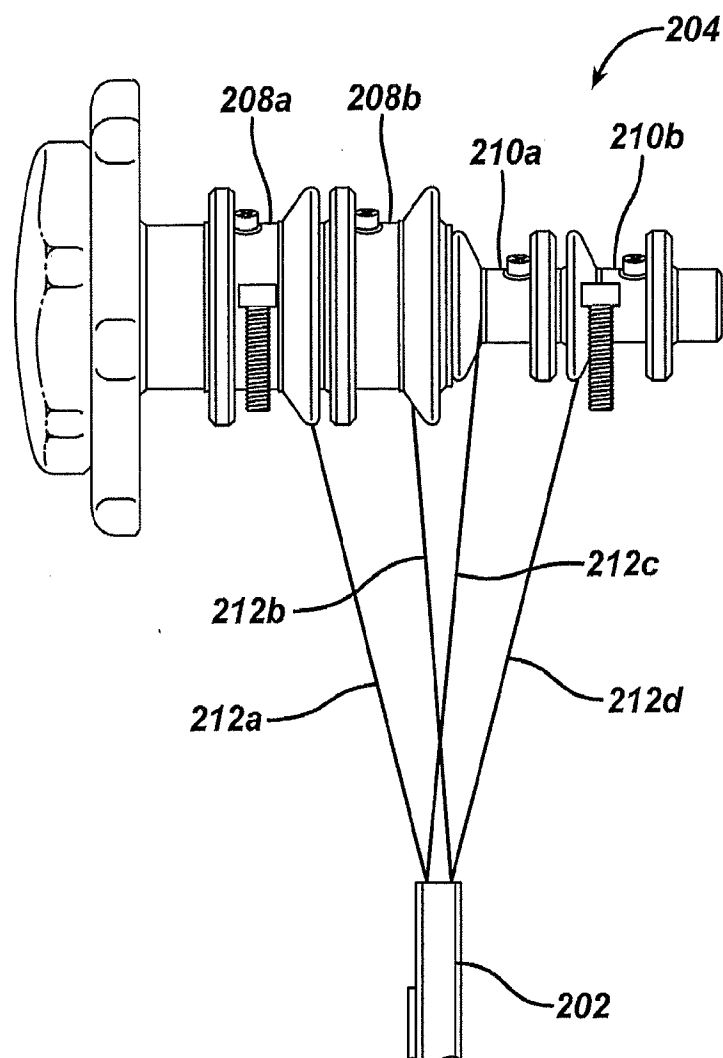
18/21

**FIG. 14B**



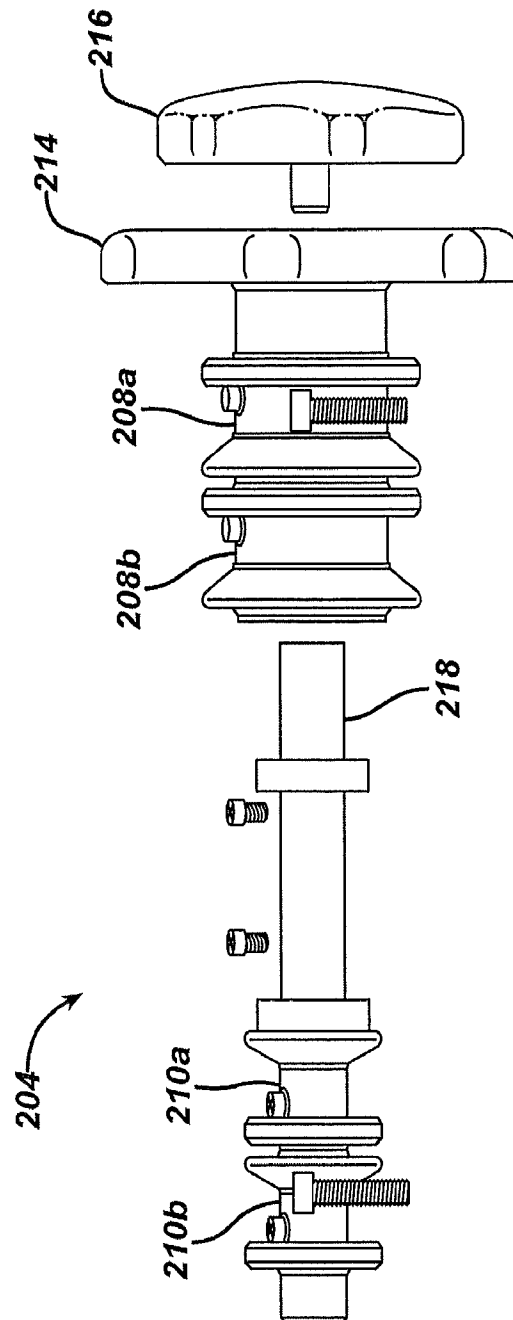
19/21

**FIG. 15A**



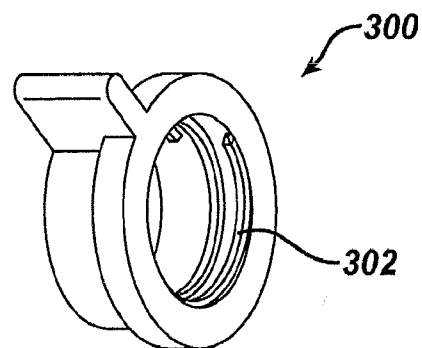
20/21

**FIG. 15B**

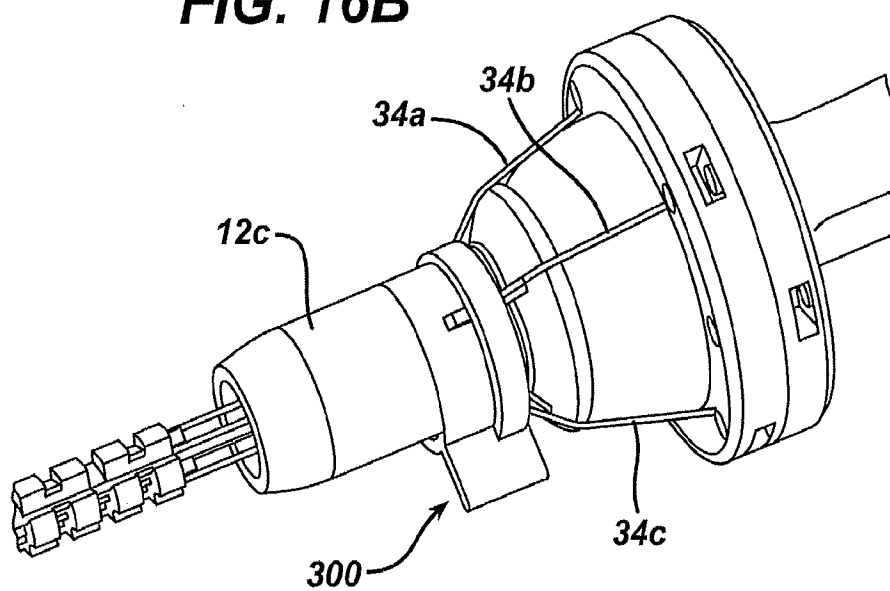


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**FIG. 16A**



**FIG. 16B**



# INTERNATIONAL SEARCH REPORT

International application No  
PCT/US2012/026985

A. CLASSIFICATION OF SUBJECT MATTER  
INV. A61B17/072 A61B19/00  
ADD.

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

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
A61B

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

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

EP0-Internal, WPI Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	WO 2010/050771 A2 (JEONG CHANG WOOK [KR]) 6 May 2010 (2010-05-06) paragraph [0164] - paragraph [0174]; figures ----- -/--	1-3



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

25 May 2012

Date of mailing of the international search report

05/06/2012

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# INTERNATIONAL SEARCH REPORT

International application No  
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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