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Declarations under Rule 4.17:
— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

(54) Title: STAPLE CARTRIDGE INCLUDING PROJECTIONS

(57) Abstract: A staple cartridge (1000) comprising a cartridge body (1010) comprising a longitudinal slot, a deck surface (1030), and a plurality of staple cavities (1012) defined in the cartridge body is disclosed. The cartridge body further comprises a plurality of projections (1040) extending from the deck surface. A surface of each projection is flush with one of a proximal end wall and a distal end wall of each staple cavity. The staple cartridge further comprises staples removably stored in the staple cavities.

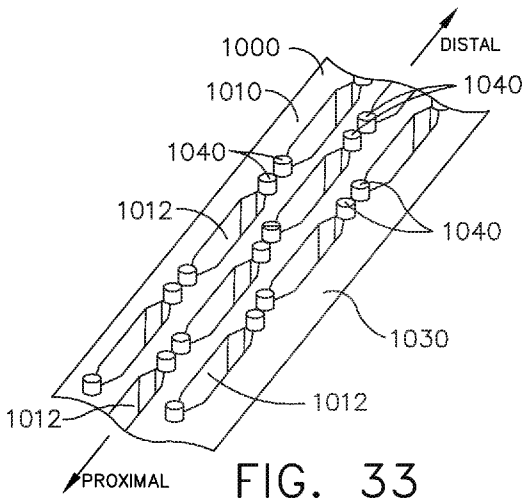


FIG. 33

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TITLE
STAPLE CARTRIDGE INCLUDING PROJECTIONS

BACKGROUND

[0001] The present invention relates to surgical instruments and, in various arrangements, to surgical stapling and cutting instruments and staple cartridges for use therewith that are designed to staple and cut tissue.

BRIEF DESCRIPTION OF THE DRAWINGS

[0002] The features and advantages of this invention, and the manner of attaining them, will become more apparent and the invention itself will be better understood by reference to the following description of exemplary embodiments of the invention taken in conjunction with the accompanying drawings, wherein:

[0003] FIG. 1 is a perspective view of a surgical instrument that has an interchangeable shaft assembly operably coupled thereto;

[0004] FIG. 2 is an exploded assembly view of the interchangeable shaft assembly and surgical instrument of FIG. 1;

[0005] FIG. 3 is an exploded assembly view of a portion of the surgical instrument of FIGS. 1 and 2;

[0006] FIG. 4 is another exploded assembly view showing portions of the interchangeable shaft assembly and surgical instrument of FIGS. 1-3;

[0007] FIG. 5 is a perspective view of a staple cartridge positioned in an end effector of a surgical instrument in accordance with at least one embodiment, wherein the staple cartridge comprises a plurality of ridges extending from a cartridge body of the staple cartridge;

[0008] FIG. 6 is an exploded view of a battery pack assembly in accordance with at least one embodiment;

[0009] FIG. 7 is a perspective view of the battery pack assembly of FIG. 6, a second battery pack assembly, and a battery dock of a surgical instrument;

[0010] FIG. 8 is a perspective view of a battery assembly in accordance with at least one embodiment comprising electrical contacts;

[0011] FIG. 9 is a perspective view of a battery pack assembly including the battery assembly of FIG. 8;

[0012] FIG. 10 is a perspective view of the battery pack assembly of FIG. 9 positioned in a battery dock of a surgical instrument;

[0013] FIG. 11 is a partial perspective view of a surgical instrument in accordance with at least one embodiment comprising an end effector including a firing member lockout illustrated with components removed;

[0014] FIG. 12 is a partial cross-sectional view of the end effector and surgical instrument of FIG. 11 with the firing member lockout in a locked configuration;

[0015] FIG. 13 is a partial cross-sectional view of the end effector and surgical instrument of FIG. 11 with the firing member lockout in an unlocked configuration;

[0016] FIG. 14 is a partial cross-sectional perspective view of a staple cartridge and a cartridge pan attached to the staple cartridge;

[0017] FIG. 15 is a partial cross-sectional perspective view of a sled including a lockout key of the staple cartridge of FIG. 14;

[0018] FIG. 16 is a partial side cross-sectional view of the staple cartridge of FIG. 14 positioned in an end effector of a surgical instrument including a firing member in a locked out configuration;

[0019] FIG. 17 is a partial side cross-sectional view of the end effector of FIG. 16 depicting the firing member in an unlocked configuration;

[0020] FIG. 18 is a perspective view of a manual bailout assembly for use with a drive system of a surgical instrument in accordance with at least one embodiment;

[0021] FIG. 19 is a perspective view of a surgical instrument in accordance with at least one embodiment comprising an articulation assembly and an articulation lock assembly illustrated with components removed;

[0022] FIG. 20 is a bottom view of the surgical instrument of FIG. 19 illustrating the articulation lock assembly in a locked configuration;

[0023] FIG. 21 is a bottom view of the surgical instrument of FIG. 19 illustrating the articulation lock assembly in an unlocked configuration;

[0024] FIG. 22 is a perspective view of a control circuit including a conformal coating in accordance with at least one embodiment;

[0025] FIG. 23 is a partial side cross-sectional view of a switch and a seal of the control circuit of FIG. 22;

[0026] FIG. 24 is a perspective view of seals for use with a gear box and motor of a surgical instrument in accordance with at least one embodiment;

[0027] FIG. 25 is a cross sectional view of the seals, gear box, and motor of FIG. 24;

[0028] FIG. 26 is an exploded view of a packaging assembly for a surgical instrument illustrating particulate traps positioned in the packaging assembly in accordance with at least one embodiment;

[0029] FIG. 27 is a perspective view of a particulate trap;

[0030] FIG. 28 is a cross-sectional view of the particulate trap of FIG. 27;

[0031] FIG. 29 is a perspective view of a particulate trap;

[0032] FIG. 30 is a cross-sectional view of the particulate trap of FIG. 29;

[0033] FIG. 31 is a partial perspective view of a staple cartridge including a honeycomb extension in accordance with at least one embodiment;

[0034] FIG. 32 is a partial cross-sectional view of the staple cartridge of FIG. 31 taken along line 32-32 in FIG. 31;

[0035] FIG. 33 is a partial perspective view of a staple cartridge in accordance with at least one embodiment comprising a plurality of staple cavities defined in a cartridge body and a plurality of posts extending from the cartridge body;

[0036] FIG. 34 is an enlarged view of one of the staple cavities and one of the posts of the staple cartridge of FIG. 33;

[0037] FIG. 35 is a plan view of one of the staple cavities and a pair of posts of the staple cartridge of FIG. 33;

[0038] FIG. 36 is a side cross-sectional view of the staple cavity and posts of FIG. 35 taken along line 36-36 in FIG. 35;

[0039] FIG. 37 is a partial perspective view of a staple cartridge in accordance with at least one embodiment comprising a plurality of staple cavities defined in a cartridge body and a plurality of quarter-sphere projections extending from the cartridge body;

[0040] FIG. 38 is an enlarged perspective view of one of the staple cavities and one of the quarter-sphere projections of the staple cartridge of FIG. 37;

[0041] FIG. 39 is a plan view of one of the staple cavities and a quarter-sphere projection of the staple cartridge of FIG. 37;

[0042] FIG. 40 is a side cross-sectional view of the staple cavity and quarter-sphere projection of FIG. 39 taken along line 40-40 in FIG. 39;

[0043] FIG. 41 is a partial perspective view of a staple cartridge in accordance with at least one embodiment comprising a plurality of staple cavities defined in a cartridge body and a plurality of cuboids extending from the cartridge body;

[0044] FIG. 42 is an enlarged perspective view of one of the staple cavities and one of the cuboids of the staple cartridge of FIG. 41;

[0045] FIG. 43 is a plan view of one of the staple cavities of the staple cartridge of FIG. 41 with a pair of cuboids positioned at the proximal and distal ends of the staple cavity;

[0046] FIG. 44 is a side cross-sectional view of the staple cavity and cuboids of FIG. 43 taken along line 44-44 in FIG. 43;

[0047] FIG. 45 is a partial perspective view of a staple cartridge in accordance with at least one embodiment comprising a plurality of staple cavities defined in a cartridge body and a plurality of posts extending from the cartridge body;

[0048] FIG. 46 is an enlarged perspective view of one of the staple cavities and a pair of posts of the staple cartridge of FIG. 45;

[0049] FIG. 47 is a plan view of one of the staple cavities and a pair of posts of the staple cartridge of FIG. 45;

[0050] FIG. 48 is a side cross-sectional view of the staple cavity and posts of FIG. 47 taken along line 48-48 in FIG. 47;

[0051] FIG. 49 is a partial perspective view of a staple cartridge in accordance with at least one embodiment comprising a plurality of staple cavities defined in a cartridge body and a plurality of posts and cuboids extending from the cartridge body;

[0052] FIG. 50 is an enlarged perspective view of one of the staple cavities of the staple cartridge of FIG. 49 with a post and a pair of cuboids positioned adjacent to the staple cavity;

[0053] FIG. 51 is a plan view of one of the staple cavities of the staple cartridge of FIG. 49 with a post and a pair of cuboids positioned at the proximal and distal end of the staple cavity;

[0054] FIG. 52 is a side cross-sectional view of the staple cavity, posts, and cuboids of FIG. 51 taken along line 52-52 in FIG. 51;

[0055] FIG. 53 is a partial perspective view of a staple cartridge in accordance with at least one embodiment comprising a plurality of staple cavities defined in a cartridge body and a plurality of circular posts and rectangular posts extending from the cartridge body;

[0056] FIG. 54 is a plan view of one of the staple cavities of the staple cartridge of FIG. 53 with a post positioned at the proximal end of the staple cavity and a pair of cuboids positioned at the distal end of the staple cavity;

[0057] FIG. 55 is a side cross-sectional view of the staple cavity, post, and cuboids of FIG. 54 taken along line 55-55 in FIG. 54;

[0058] FIG. 56 is a partial perspective view of a staple cartridge in accordance with at least one embodiment comprising a plurality of staple cavities defined in a cartridge body and a plurality of arcuate projections extending from the cartridge body;

[0059] FIG. 57 is an enlarged perspective view of one of the staple cavities and one of the partial cylinder projections of the staple cartridge of FIG. 56;

[0060] FIG. 58 is a plan view of one of the staple cavities of the staple cartridge of FIG. 56 with a pair of partial cylinder projections positioned at the proximal and distal ends of the staple cavity;

[0061] FIG. 59 is a side cross-sectional view of the staple cavity and partial cylinder projections of FIG. 58 taken along line 59-59 in FIG. 58;

[0062] FIG. 60 illustrates a schematic of a surgical instrument including a control unit;

[0063] FIG. 61 is a side elevation view of a surgical instrument;

[0064] FIG. 62 is a partial plan view of an end effector of the surgical instrument of FIG. 61 articulated about an articulation axis by an articulation system;

[0065] FIG. 63 is a side elevation view of the surgical instrument of FIG. 61 with portions removed to illustrate the articulation system and a closure system of the surgical instrument; and

[0066] FIG. 64 is a side cross-sectional view of a surgical instrument including a manual rotation system and a rotation lockout.

[0067] Corresponding reference characters indicate corresponding parts throughout the several views. The exemplifications set out herein illustrate various embodiments of the invention, in one form, and such exemplifications are not to be construed as limiting the scope of the invention in any manner.

DETAILED DESCRIPTION

[0068] Applicant of the present application owns the following U.S. Patent Applications that were filed on even date herewith and which are each herein incorporated by reference in their respective entireties:

- Attorney Docket No. END9143USNP1/190219, entitled SURGICAL INSTRUMENT INCLUDING A BATTERY UNIT;
- Attorney Docket No. END9133USNP1/190220, entitled BATTERY PACK INCLUDING A CIRCUIT INTERRUPTER;
- Attorney Docket No. END9134USNP1/190226, entitled SURGICAL INSTRUMENT INCLUDING A FIRING LOCKOUT;
- Attorney Docket No. END9139USNP1/190232, entitled SURGICAL INSTRUMENT INCLUDING A LOCKOUT KEY;
- Attorney Docket No. EN9136USNP1/190229, entitled SURGICAL INSTRUMENT INCLUDING A FIRING SYSTEM BAILOUT;
- Attorney Docket No. END9144USNP1/190227, entitled SURGICAL INSTRUMENT INCLUDING AN ARTICULATION LOCK;
- Attorney Docket No. END9137USNP1/190230, entitled CONTROL CIRCUIT COMPRISING A COATING;
- Attorney Docket No. END9135USNP1/190228, entitled PACKAGING ASSEMBLY INCLUDING A PARTICULATE TRAP;
- Attorney Docket No. END9140USNP1/190233, entitled STAPLE CARTRIDGE INCLUDING A HONEYCOMB EXTENSION; and
- Attorney Docket No. END9138USNP1/190231, entitled SURGICAL INSTRUMENTS INCLUDING MANUAL AND POWERED SYSTEM LOCKOUTS.

[0069] Numerous specific details are set forth to provide a thorough understanding of the overall structure, function, manufacture, and use of the embodiments as described in the specification and illustrated in the accompanying drawings. Well-known operations, components, and elements have not been described in detail so as not to obscure the embodiments described in the specification. The reader will understand that the embodiments described and illustrated herein are non-limiting examples, and thus it can be appreciated that the specific structural and functional details disclosed herein may be representative and illustrative. Variations and changes thereto may be made without departing from the scope of the claims.

[0070] The terms "comprise" (and any form of comprise, such as "comprises" and "comprising"), "have" (and any form of have, such as "has" and "having"), "include" (and any form of include, such as "includes" and "including"), and "contain" (and any form of contain, such as "contains" and "containing") are open-ended linking verbs. As a result, a surgical system, device, or apparatus that "comprises," "has," "includes", or "contains" one or more elements possesses those one or more elements, but is not limited to possessing only those one or more elements. Likewise, an element of a system, device, or apparatus that "comprises," "has," "includes", or "contains" one or more features possesses those one or more features, but is not limited to possessing only those one or more features.

[0071] The terms “proximal” and “distal” are used herein with reference to a clinician manipulating the handle portion of the surgical instrument. The term “proximal” refers to the portion closest to the clinician and the term “distal” refers to the portion located away from the clinician. It will be further appreciated that, for convenience and clarity, spatial terms such as “vertical”, “horizontal”, “up”, and “down” may be used herein with respect to the drawings. However, surgical instruments are used in many orientations and positions, and these terms are not intended to be limiting and/or absolute.

[0072] Various exemplary devices and methods are provided for performing laparoscopic and minimally invasive surgical procedures. However, the reader will readily appreciate that the various methods and devices disclosed herein can be used in numerous surgical procedures and applications including, for example, in connection with open surgical procedures. As the present Detailed Description proceeds, the

reader will further appreciate that the various instruments disclosed herein can be inserted into a body in any way, such as through a natural orifice, through an incision or puncture hole formed in tissue, etc. The working portions or end effector portions of the instruments can be inserted directly into a patient's body or can be inserted through an access device that has a working channel through which the end effector and elongate shaft of a surgical instrument can be advanced.

[0073] A surgical stapling system can comprise a shaft and an end effector extending from the shaft. The end effector comprises a first jaw and a second jaw. The first jaw comprises a staple cartridge. The staple cartridge is insertable into and removable from the first jaw; however, other embodiments are envisioned in which a staple cartridge is not removable from, or at least readily replaceable from, the first jaw. The second jaw comprises an anvil configured to deform staples ejected from the staple cartridge. The second jaw is pivotable relative to the first jaw about a closure axis; however, other embodiments are envisioned in which the first jaw is pivotable relative to the second jaw. The surgical stapling system further comprises an articulation joint configured to permit the end effector to be rotated, or articulated, relative to the shaft. The end effector is rotatable about an articulation axis extending through the articulation joint. Other embodiments are envisioned which do not include an articulation joint.

[0074] The staple cartridge comprises a cartridge body. The cartridge body includes a proximal end, a distal end, and a deck extending between the proximal end and the distal end. In use, the staple cartridge is positioned on a first side of the tissue to be stapled and the anvil is positioned on a second side of the tissue. The anvil is moved toward the staple cartridge to compress and clamp the tissue against the deck. Thereafter, staples removably stored in the cartridge body can be deployed into the tissue. The cartridge body includes staple cavities defined therein wherein staples are removably stored in the staple cavities. The staple cavities are arranged in six longitudinal rows. Three rows of staple cavities are positioned on a first side of a longitudinal slot and three rows of staple cavities are positioned on a second side of the longitudinal slot. Other arrangements of staple cavities and staples may be possible.

[0075] The staples are supported by staple drivers in the cartridge body. The drivers are movable between a first, or unfired position, and a second, or fired, position to eject

the staples from the staple cavities. The drivers are retained in the cartridge body by a retainer which extends around the bottom of the cartridge body and includes resilient members configured to grip the cartridge body and hold the retainer to the cartridge body. The drivers are movable between their unfired positions and their fired positions by a sled. The sled is movable between a proximal position adjacent the proximal end and a distal position adjacent the distal end. The sled comprises a plurality of ramped surfaces configured to slide under the drivers and lift the drivers, and the staples supported thereon, toward the anvil.

[0076] Further to the above, the sled is moved distally by a firing member. The firing member is configured to contact the sled and push the sled toward the distal end. The longitudinal slot defined in the cartridge body is configured to receive the firing member. The anvil also includes a slot configured to receive the firing member. The firing member further comprises a first cam which engages the first jaw and a second cam which engages the second jaw. As the firing member is advanced distally, the first cam and the second cam can control the distance, or tissue gap, between the deck of the staple cartridge and the anvil. The firing member also comprises a knife configured to incise the tissue captured intermediate the staple cartridge and the anvil. It is desirable for the knife to be positioned at least partially proximal to the ramped surfaces such that the staples are ejected ahead of the knife.

[0077] FIGS. 1-4 depict a motor-driven surgical cutting and fastening instrument 1001. The instrument 1001 includes a housing 1002 that comprises a handle 1004 that is configured to be grasped, manipulated, and actuated by a clinician. The housing 1002 is configured to be attached to an interchangeable shaft assembly 1200 including an end effector 1300 that is configured to perform one or more surgical tasks or procedures. That said, embodiments are envisioned in which the shaft assembly 1200 is not interchangeable with another shaft assembly and is, instead, affixed to, but rotatable relative to, the handle 1004. The end effector 1300 comprises a surgical cutting and fastening device that is configured to operably support a surgical staple cartridge 1304 therein, although any suitable arrangement can be used. The housing 1002 may be adapted for use with robotic systems, instruments, components and methods such as those disclosed in U.S. Patent Application Serial No. 13/118,241,

entitled SURGICAL STAPLING INSTRUMENTS WITH ROTATABLE STAPLE DEPLOYMENT ARRANGEMENTS, now U.S. Patent Application Publication No. US 2012/0298719. The disclosure of U.S. Patent Application Serial No. 13/118,241, entitled SURGICAL STAPLING INSTRUMENTS WITH ROTATABLE STAPLE DEPLOYMENT ARRANGEMENTS, now U.S. Patent Application Publication No. US 2012/0298719, is incorporated by reference herein in its entirety.

[0078] As can be seen in FIG. 3, the handle 1004 comprises handle housing segments 1006 and 1008 that are interconnected by screws, snap features, and/or adhesives, for example. The handle housing segments 1006, 1008 cooperate to form a pistol grip portion 1019 that can be gripped and manipulated by the clinician, but can comprise any suitable configuration. As will be discussed in further detail below, the handle 1004 operably supports a plurality of drive systems therein that are configured to generate and apply various control motions to corresponding portions of the interchangeable shaft assembly 1200.

[0079] Referring now to FIG. 3, the handle 1004 includes a frame 1022 that operably supports a plurality of drive systems. The frame 1022 operably supports a closure drive system, generally designated as 1003, which is employed to apply closing and opening motions to the interchangeable shaft assembly 1200. In at least one form, the closure drive system 1003 includes an actuator in the form of a closure trigger 1032 that is pivotally supported by the frame 1022. As illustrated in FIG. 3, the closure trigger 1032 is pivotally coupled to the housing 1002 by a pin 1033. Such an arrangement enables the closure trigger 1032 to be manipulated by a clinician such that, when the clinician grips the pistol grip portion 1019 of the handle 1004, the closure trigger 1032 may be easily pivoted from a starting or unactuated position to an actuated position. The closure trigger 1032 may be biased into the unactuated position by a spring or other biasing arrangement. In various forms, the closure drive system 1003 further includes a closure linkage assembly 1034 that is pivotally coupled to the closure trigger 1032. As can be seen in FIG. 3, the closure linkage assembly 1034 includes a first closure link 1036 and a second closure link 1038 that are pivotally coupled to the closure trigger 1032 by a pin 1035. The second closure link 1038 may also be referred to herein as an attachment member and include a transverse attachment pin 1037.

[0080] Still referring to FIG. 3, the first closure link 1036 comprises a locking wall or end 1039 thereon that is configured to cooperate with a closure release assembly 1007 that is pivotally coupled to the frame 1022. In at least one form, the closure release assembly 1007 comprises a release button assembly 1065 that has a distally protruding locking pawl 1064 formed thereon. The release button assembly 1065 is pivoted in a counter-clockwise direction by a release spring. As the clinician depresses the closure trigger 1032 from its unactuated position toward the pistol grip portion 1019 of the handle 1004, the first closure link 1036 pivots upward to a point wherein the locking pawl 1064 drops into retaining engagement with the locking wall 1039 on the first closure link 1036 thereby preventing the closure trigger 1032 from returning to the unactuated position. Thus, the closure release assembly 1007 serves to lock the closure trigger 1032 in the fully actuated position. When the clinician desires to unlock the closure trigger 1032, the clinician pivots the closure release button assembly 1065 such that the locking pawl 1064 is moved out of engagement with the locking wall 1039 on the first closure link 1036. When the locking pawl 1064 has been moved out of engagement with the first closure link 1036, the closure trigger 1032 may pivot back to the unactuated position. Other closure trigger locking and release arrangements may also be employed.

[0081] Further to the above, an arm 1061 extends from the closure release button 1065. A magnetic element 1063, such as a permanent magnet, for example, is mounted to the arm 1061. When the closure release button 1065 is rotated from its first position to its second position, the magnetic element 1063 moves toward a circuit board 1101. The circuit board 1101 includes at least one sensor that is configured to detect the movement of the magnetic element 1063. In at least one embodiment, a Hall Effect sensor can be mounted to the bottom surface of the circuit board 1101. The Hall Effect sensor is configured to detect changes in a magnetic field surrounding the Hall Effect sensor caused by the movement of the magnetic element 1063. The Hall Effect sensor is in signal communication with a microcontroller, for example, which can determine whether the closure release button 1065 is in its first position, which is associated with the unactuated position of the closure trigger 1032, and the open configuration of the end effector 1300, its second position, which is associated with the actuated position of

the closure trigger 1032 and the closed configuration of the end effector 1300, and/or any position between the first position and the second position.

[0082] In at least one form, the handle 1004 and the frame 1022 operably supports another drive system, *i.e.*, firing drive system 1080, that is configured to apply firing motions to the interchangeable shaft assembly 1200. The firing drive system 1080 comprises an electric motor 1082 that is located in the pistol grip portion 1019 of the handle 1004. In various forms, the motor 1082 is be a DC brushed driving motor having a maximum rotation of, approximately, 25,000 RPM, for example. In other forms, the motor 1082 is a brushless DC motor. In various arrangements, the motor includes a brushless motor, a cordless motor, a synchronous motor, a stepper motor, or any other suitable electric motor. The motor 1082 is powered by a power source 1090 that, in one form, comprises a removable power pack 1092. As can be seen in FIG. 3, the power pack 1092 comprises a proximal housing portion 1094 attached to a distal housing portion 1096. The proximal housing portion 1094 and the distal housing portion 1096 support a plurality of batteries 1098 therein. Batteries 1098 may each comprise, for example, a Lithium Ion ("LI") and/or any other suitable battery. The distal housing portion 1096 is configured to be coupled to the circuit board assembly 1101 which is also operably coupled to the motor 1082. The batteries 1098 may be connected in series and/or parallel and comprise the power source for the surgical instrument 1001. In addition, the power source 1090 may be replaceable and/or rechargeable.

[0083] The electric motor 1082 includes a rotatable shaft that operably interfaces with a gear reducer assembly 1084 that is mounted in meshing engagement with a set, or rack, of drive teeth 1129 on a longitudinally-movable drive member 1121. In use, a voltage polarity provided by the power source 1090 can operate the electric motor 1082 in a clockwise direction. The voltage polarity applied to the electric motor by the battery can be reversed in order to operate the electric motor 1082 in a counter-clockwise direction. When the electric motor 1082 is rotated in one direction, the drive member 1121 will be axially driven in the distal direction DD. When the motor 1082 is driven in the opposite rotary direction, the drive member 1121 will be axially driven in a proximal direction PD. The handle 1004 includes a switch which can be configured to reverse the polarity applied to the electric motor 1082 by the power source 1090. In other

embodiments, the controller of the surgical instrument 1001 can reverse the polarity applied to the electric motor 1082 after the staple firing stroke. The handle 1004 can also include a sensor that is configured to detect the position of the drive member 1121 and/or the direction in which the drive member 1121 is being moved.

[0084] The actuation of the motor 1082 is controlled by a firing trigger 1131 that is pivotally supported on the handle 1004. The firing trigger 1131 may be pivoted between an unactuated position and an actuated position. The firing trigger 1131 is biased into the unactuated position by a spring 1133 or other biasing arrangement such that, when the clinician releases the firing trigger 1131, it is pivoted or otherwise returned to the unactuated position by the spring 1133. In at least one form, the firing trigger 1131 is positioned "outboard" with respect to the closure trigger 1032. A firing trigger safety button 1135 is pivotally mounted to the closure trigger 1032 by the pin 1035. The safety button 1135 is positioned between the firing trigger 1131 and the closure trigger 1032 and comprises a pivot arm 1137 protruding therefrom. See FIG. 3. When the closure trigger 1032 is in the unactuated position, the safety button 1135 is contained in the handle 1004 where the clinician cannot readily access it and move it between a safety position preventing actuation of the firing trigger 1131 and a firing position wherein the firing trigger 1131 may be fired. As the clinician depresses the closure trigger 1032, the safety button 1135 and the firing trigger 1131 pivot down wherein they can then be manipulated by the clinician.

[0085] As indicated above, the longitudinally movable drive member 1121 has a rack of teeth 1129 formed thereon for meshing engagement with a corresponding drive gear 1086 of the gear reducer assembly 1084. The surgical instrument 1001 also includes a manually-actuatable "bailout" assembly 1141 that is configured to enable the clinician to manually retract the longitudinally movable drive member 1121 should the motor 1082 become disabled. The bailout assembly 1141 includes a lever or bailout handle assembly 1143 that is configured to be manually pivoted into ratcheting engagement with teeth 1124 also provided in the drive member 1121. Thus, the clinician can manually retract the drive member 1121 by using the bailout handle assembly 1143 to ratchet the drive member 1121 in the proximal direction PD. U.S. Patent Application Publication No. US 2010/0089970, now U.S. Patent No. 8,608,045, discloses bailout

arrangements and other components, arrangements and systems that may also be employed with the various instruments disclosed herein. U.S. Patent Application Serial No. 12/249,117, entitled POWERED SURGICAL CUTTING AND STAPLING APPARATUS WITH MANUALLY RETRACTABLE FIRING SYSTEM, now U.S. Patent No. 8,608,045, is hereby incorporated by reference herein in its entirety. U.S. Patent Application Serial No. 12/235,972, entitled MOTORIZED SURGICAL INSTRUMENT, now U.S. Patent No. 9,050,083, is hereby incorporated by reference herein in its entirety. U.S. Patent Application Serial No. 11/651,807, entitled SURGICAL INSTRUMENT WITH WIRELESS COMMUNICATION BETWEEN CONTROL UNIT AND REMOTE SENSOR, now U.S. Patent No. 8,459,520, is hereby incorporated by reference herein in its entirety.

[0086] Further to the above, turning now to FIGS. 2 and 4, the end effector 1300 comprises an elongate channel 1302 that is configured to operably support the staple cartridge 1304 therein. The end effector 1300 further includes an anvil 1306 that is pivotally supported relative to the elongate channel 1302. The interchangeable shaft assembly 1200 may further include an articulation joint 1270 and an articulation lock which can be configured to releasably hold the end effector 1300 in a desired position relative to a shaft axis SA (FIG. 4). Details regarding the construction and operation of the end effector 1300, the articulation joint 1270 and the articulation lock are set forth in U.S. Patent Application Serial No. 13/803,086, filed March 14, 2013, entitled ARTICULATABLE SURGICAL INSTRUMENT COMPRISING AN ARTICULATION LOCK. The entire disclosure of U.S. Patent Application Serial No. 13/803,086, filed March 14, 2013, entitled ARTICULATABLE SURGICAL INSTRUMENT COMPRISING AN ARTICULATION LOCK is hereby incorporated by reference herein in its entirety. Other embodiments are envisioned with more than one articulation joint or no articulation joint,

[0087] As can be seen in FIG. 4, the interchangeable shaft assembly 1200 further includes a proximal housing or nozzle 1201 comprised of nozzle portions 1202 and 1203. The interchangeable shaft assembly 1200 can further include a closure tube 1260 which can be utilized to close and/or open the anvil 1306 of the end effector 1300. The shaft assembly 1200 includes a spine 1210 that is configured to, one, slideably

support a firing member therein and, two, slideably support the closure tube 1260 which extends around the spine 1210. The spine 1210 can also be configured to slideably support a proximal articulation driver. The articulation driver has a distal end that is configured to operably engage the articulation lock. The articulation lock interfaces with an articulation frame that is adapted to operably engage a drive pin on the end effector frame. As indicated above, further details regarding the operation of the articulation lock and the articulation frame may be found in U.S. Patent Application Serial No. 13/803,086. In various circumstances, the spine 1210 can comprise a proximal end 1211 which is rotatably supported in a chassis 1240. The proximal end 1211 of the spine 1210 has a thread 1214 formed thereon for threaded attachment to a spine bearing 1216 configured to be supported within the chassis 1240. See FIG. 4. Such an arrangement facilitates the rotatable attachment of the spine 1210 to the chassis 1240 such that the spine 1210 may be selectively rotated about the shaft axis SA relative to the chassis 1240.

[0088] Referring primarily to FIG. 4, the interchangeable shaft assembly 1200 includes a closure shuttle 1250 that is slideably supported within the chassis 1240 such that it may be axially moved relative thereto. The closure shuttle 1250 includes a pair of proximally-protruding hooks 1252 that are configured for attachment to the attachment pin 1037 (FIGS. 2 and 3) that is attached to the second closure link 1038 as will be discussed in further detail below. A proximal end 1261 of the closure tube 1260 is coupled to the closure shuttle 1250. More specifically, a U-shaped connector 1263 is inserted into an annular slot 1262 in the proximal end 1261 of the closure tube 1260 and is retained within vertical slots 1253 in the closure shuttle 1250. Such an arrangement serves to attach the closure tube 1260 to the closure shuttle 1250 for axial travel therewith while enabling the closure tube 1260 to rotate relative to the closure shuttle 1250 about the shaft axis SA. A closure spring 1268 is journaled on the closure tube 1260 and serves to bias the closure tube 1260 in the proximal direction PD which can serve to pivot the closure trigger into the unactuated position when the shaft assembly 1200 is operably coupled to the handle 1004.

[0089] Further to the above, the interchangeable shaft assembly 1200 includes an articulation joint 1270. As can be seen in FIG. 4, the articulation joint 1270 includes a

double pivot closure sleeve assembly 1271. The double pivot closure sleeve assembly 1271 includes an end effector closure sleeve assembly 1272 having upper and lower distally projecting tangs 1273, 1274. An end effector closure sleeve assembly 1272 includes a horseshoe aperture 1275 and a tab 1276 for engaging an opening tab on the anvil 1306 in the various manners described in U.S. Patent Application Serial No. 13/803,086, filed March 14, 2013, entitled, ARTICULATABLE SURGICAL INSTRUMENT COMPRISING AN ARTICULATION LOCK which has been incorporated by reference herein. The horseshoe aperture 1275 and tab 1276 engage a tab on the anvil when the anvil 1306 is opened. An upper double pivot link 1277 includes upwardly projecting distal and proximal pivot pins that engage, respectively, an upper distal pin hole in the upper proximally projecting tang 1273 and an upper proximal pin hole in an upper distally projecting tang 1264 on the closure tube 1260. A lower double pivot link 1278 includes upwardly projecting distal and proximal pivot pins that engage, respectively, a lower distal pin hole in the lower proximally projecting tang 1274 and a lower proximal pin hole in the lower distally projecting tang 1265. See also FIG. 4.

[0090] During an actuation of the closing system, the closure tube 1260 is translated distally (direction DD) to close the anvil 1306 in response to the actuation of the closure trigger 1032. The anvil 1306 is closed by distally translating the closure tube 1260 and thus the closure sleeve assembly 1272, causing it to strike a proximal surface on the anvil 1360 in the manner described in the aforementioned referenced U.S. Patent Application Serial No. 13/803,086. As was also described in detail in that reference, the anvil 1306 is opened by proximally translating the closure tube 1260 and the closure sleeve assembly 1272, causing tab 1276 and the horseshoe aperture 1275 to contact and push against the anvil tab to lift the anvil 1306.

[0091] As discussed above, the interchangeable shaft assembly 1200 further includes a firing member that is supported for axial travel within the shaft spine 1210. The firing member includes an intermediate firing shaft portion 1222 attached to a distal cutting portion or knife bar. The intermediate firing shaft portion 1222 includes a longitudinal slot in the distal end thereof which receives a tab on the proximal end of the distal knife bar. The longitudinal slot and the proximal end are sized and configured to permit relative movement therebetween and can comprise a slip joint. The slip joint can permit

the intermediate firing shaft portion 1222 of the firing drive to be moved to articulate the end effector 1300 without moving, or at least substantially moving, the knife bar. Once the end effector 1300 has been suitably oriented, the intermediate firing shaft portion 1222 can be advanced distally until a proximal sidewall of the longitudinal slot comes into contact with the tab in order to advance the knife bar and fire the staple cartridge positioned within the channel 1302. Further description of the operation of the firing member may be found in U.S. Patent Application Serial No. 13/803,086.

[0092] As can be seen in FIG. 4, the shaft assembly 1200 further includes a switch drum 1500 that is rotatably received on the closure tube 1260. The switch drum 1500 comprises a hollow shaft segment 1502 that has a shaft boss formed thereon to receive an outwardly protruding actuation pin therein. In various circumstances, the actuation pin extends through a longitudinal slot provided in a lock sleeve to facilitate axial movement of the lock sleeve when it is engaged with the articulation driver. A rotary torsion spring 1420 is configured to engage the boss on the switch drum 1500 and a portion of the nozzle 1201 to apply a biasing force to the switch drum 1500. The switch drum 1500 further comprises circumferential openings or slots 1506 defined therein which can be configured to receive circumferential mounts extending from the nozzle halves 1202, 1203 and permit relative rotation, but not translation, between the switch drum 1500 and the proximal nozzle 1201. The mounts also extend through openings 1266 in the closure tube 1260 to be seated in recesses in the shaft spine 1210. U.S. Patent Application Serial No. 13/803,086 and U.S. Patent Application Serial No. 14/226,142, entitled SURGICAL INSTRUMENT COMPRISING A SENSOR SYSTEM, filed March 26, 2014, is incorporated by reference herein in its entirety.

[0093] As also illustrated in FIG. 4, the shaft assembly 1200 comprises a slip ring assembly 1600 which is configured to conduct electrical power to and/or from the end effector 1300 and/or communicate signals to and/or from the end effector 1300, for example. The slip ring assembly 1600 comprises a proximal connector flange 1604 that is mounted to a chassis flange 1242 that extends from the chassis 1240 and a distal connector flange that is positioned within a slot defined in the shaft housings. The proximal connector flange 1604 comprises a first face and the distal connector flange comprises a second face which is positioned adjacent to and movable relative to the

first face. The distal connector flange can rotate relative to the proximal connector flange 1604 about the shaft axis SA. The proximal connector flange 1604 comprises a plurality of concentric, or at least substantially concentric, conductors defined in the first face thereof. A connector is mounted on the proximal side of the connector flange and has a plurality of contacts, wherein each contact corresponds to and is in electrical contact with one of the conductors. Such an arrangement permits relative rotation between the proximal connector flange 1604 and the distal connector flange while maintaining electrical contact therebetween. The proximal connector flange 1604 includes an electrical connector 1606 which places the conductors in signal communication with a shaft circuit board 1610 mounted to the shaft chassis 1240. In at least one instance, a wiring harness comprising a plurality of conductors extends between the electrical connector 1606 and the shaft circuit board 1610. The electrical connector 1606 extends proximally through a connector opening 1243 defined in the chassis mounting flange 1242. See FIG. 4. U.S. Patent Application Serial No. 13/800,067, entitled STAPLE CARTRIDGE TISSUE THICKNESS SENSOR SYSTEM, filed on March 13, 2013, is incorporated by reference herein in its entirety. U.S. Patent Application Serial No. 13/800,025, entitled STAPLE CARTRIDGE TISSUE THICKNESS SENSOR SYSTEM, filed on March 13, 2013, is incorporated by reference herein in its entirety. Further details regarding slip ring assembly 1600 may be found in U.S. Patent Application Serial No. 13/803,086.

[0094] As discussed above, the shaft assembly 1200 can include a proximal portion which is fixably mounted to the handle 1004 and a distal portion which is rotatable about a longitudinal axis. The rotatable distal shaft portion can be rotated relative to the proximal portion about the slip ring assembly 1600, as discussed above. The distal connector flange of the slip ring assembly 1600 is positioned within the rotatable distal shaft portion. Moreover, further to the above, the switch drum 1500 is also positioned within the rotatable distal shaft portion. When the rotatable distal shaft portion is rotated, the distal connector flange and the switch drum 1500 can be rotated synchronously with one another. In addition, the switch drum 1500 is rotatable between a first position and a second position relative to the distal connector flange. When the switch drum 1500 is in its first position, the articulation drive system is operably disengaged from the firing

drive system 1080 and, thus, the operation of the firing drive system 1080 does not articulate the end effector 1300 of the shaft assembly 1200. When the switch drum 1500 is in its second position, the articulation drive system is operably engaged with the firing drive system 1080 and, thus, the operation of the firing drive system 1080 articulates the end effector 1300 of the shaft assembly 1200. When the switch drum 1500 is moved between its first position and its second position, the switch drum 1500 is moved relative to distal connector flange. In various instances, the shaft assembly 1200 can comprise at least one sensor configured to detect the position of the switch drum 1500.

[0095] Referring again to FIG. 4, the chassis 1240 includes two tapered attachment portions 1244 formed thereon that are adapted to be received within corresponding dovetail slots 1702 formed within a distal attachment flange portion 1700 of the frame 1022. See FIG. 3. Each dovetail slot 1702 is tapered or, stated another way, somewhat V-shaped to seatingly receive the attachment portions 1244 therein. As can be further seen in FIG. 4, a shaft attachment lug 1226 is formed on the proximal end of the intermediate firing shaft 1222. When the interchangeable shaft assembly 1200 is coupled to the handle 1004, the shaft attachment lug 1226 is received in a firing shaft attachment cradle 1126 formed in the distal end 1125 of the longitudinal drive member 1121. See FIG. 3.

[0096] The surgical instrument 1001 comprises a latch system 1710 for removably coupling the shaft assembly 1200 to the housing 1002 and, more specifically, to the frame 1022. As can be seen in FIG. 4, the latch system 1710 includes a lock member or lock yoke 1712 that is movably coupled to the chassis 1240. The lock yoke 1712 has a U-shape with two spaced downwardly extending legs 1714. The legs 1714 each have a pivot lug 1715 formed thereon that are adapted to be received in corresponding holes 1245 formed in the chassis 1240. Such an arrangement facilitates the pivotal attachment of the lock yoke 1712 to the chassis 1240. The lock yoke 1712 includes two proximally protruding lock lugs 1716 that are configured for releasable engagement with corresponding lock detents or grooves 1704 in the distal attachment flange 1700 of the frame 1022. See FIG. 3. The lock yoke 1712 is biased in the proximal direction by spring or biasing member. Actuation of the lock yoke 1712 is accomplished by a latch

button 1722 that is slideably mounted on a latch actuator assembly 1720 that is mounted to the chassis 1240. The latch button 1722 is biased in a proximal direction relative to the lock yoke 1712. As will be discussed in further detail below, the lock yoke 1712 is moved to an unlocked position by biasing the latch button 1722 in the distal direction which also causes the lock yoke 1712 to pivot out of retaining engagement with the distal attachment flange 1700 of the frame 1022. When the lock yoke 1712 is in retaining engagement with the distal attachment flange 1700 of the frame 1022, the lock lugs 1716 are retainingly seated within the corresponding lock detents or grooves 1704 in the distal attachment flange 1700.

[0097] In use, in various instances, the clinician may partially actuate the closure trigger 1032 to grasp and manipulate the target tissue into a desired position. Once the target tissue is suitably positioned within the end effector 1300, the clinician may then fully actuate the closure trigger 1032 to close the anvil 1306 and clamp the target tissue in position for cutting and stapling. In that instance, the closure drive system 1003 has been fully actuated. After the target tissue has been clamped in the end effector 1300, it may be desirable to prevent the inadvertent detachment of the shaft assembly 1200 from the housing 1002. The latch system 1710 is configured to prevent such inadvertent detachment. Referring to FIG. 4, the lock yoke 1712 includes two lock hooks 1718 that are adapted to contact corresponding lock lug portions 1256 that are formed on the closure shuttle 1250. When the closure shuttle 1250 is in an unactuated position (i.e., the closure system 1003 is unactuated and the anvil 1306 is open), the lock yoke 1712 may be pivoted in a distal direction to unlock the interchangeable shaft assembly 1200 from the housing 1002. In such instances, the lock hooks 1718 do not contact the lock lug portions 1256 on the closure shuttle 1250. However, when the closure shuttle 1250 is moved to an actuated position (i.e., the closure drive system 1003 is actuated and the anvil 1306 is in the closed position), the lock yoke 1712 is prevented from being pivoted to an unlocked position. Stated another way, if the clinician were to attempt to pivot the lock yoke 1712 to an unlocked position or the lock yoke 1712 was inadvertently bumped or contacted in a manner that might otherwise cause it to pivot distally, the lock hooks 1718 on the lock yoke 1712 will contact the lock

lugs 1256 on the closure shuttle 1250 and prevent movement of the lock yoke 1712 to an unlocked position.

[0098] In order to assemble the interchangeable shaft assembly 1200 to the handle 1004, the clinician may position the chassis 1240 of the interchangeable shaft assembly 1200 above or adjacent to the distal attachment flange 1700 of the frame 1022 such that the tapered attachment portions 1244 formed on the chassis 1240 are aligned with the dovetail slots 1702 in the frame 1022. The clinician may then move the shaft assembly 1200 along an installation axis that is perpendicular to the shaft axis SA to seat the attachment portions 1244 in operable engagement with the corresponding dovetail receiving slots 1702. In doing so, the shaft attachment lug 1226 on the intermediate firing shaft 1222 will also be seated in the cradle 1126 in the longitudinally movable drive member 1121 and the portions of pin 1037 on the second closure link 1038 will be seated in the corresponding hooks 1252 in the closure shuttle 1250. As used herein, the term operable engagement in the context of two components means that the two components are sufficiently engaged with each other so that upon application of an actuation motion thereto, the components may carry out their intended action, function and/or procedure.

[0099] At least five systems of the interchangeable shaft assembly 1200 can be operably coupled with at least five corresponding systems of the handle 1004. A first system can comprise a frame system which couples and/or aligns the frame or spine of the shaft assembly 1200 with the frame 1022 of the handle 1004. Another system can comprise a closure drive system 1003 which operably connect the closure trigger 1032 of the handle 1004 and the closure tube 1260 and the anvil 1306 of the shaft assembly 1200. As outlined above, the closure shuttle 1250 of the shaft assembly 1200 is engaged with the pin 1037 on the second closure link 1038. Another system can comprise the firing drive system 1080 which operably connects the firing trigger 1131 of the handle 1004 with the intermediate firing shaft 1222 of the shaft assembly 1200. As outlined above, the shaft attachment lug 1226 is operably connected with the cradle 1126 of the longitudinal drive member 1121. Another system can comprise an electrical system which can signal to a controller in the handle 1004, such as a microcontroller, for example, that a shaft assembly, such as shaft assembly 1200, for example, has

been operably engaged with the handle 1004 and/or, two, conduct power and/or communicate signals between the shaft assembly 1200 and the handle 1004. Further to the above, the shaft assembly 1200 can include an electrical connector 1810 that is operably mounted to the shaft circuit board 1610. The electrical connector 1810 is configured for mating engagement with a corresponding electrical connector 1800 on the handle control board 1101. Further details regaining the circuitry and control systems may be found in U.S. Patent Application Serial No. 13/803,086, and U.S. Patent Application Serial No. 14/226,142, the entire disclosures of which are hereby incorporated herein by reference in their entirety. The fifth system may comprise the latching system for releasably locking the shaft assembly 1200 to the handle 1004.

[0100] An end effector of a surgical stapling instrument is illustrated in FIG. 5. The end effector includes an anvil, such as an anvil 2001, for example, and a jaw, or staple cartridge channel, 2002 configured to removably support a staple cartridge therein. A staple cartridge 2000, for example, is positioned in the cartridge channel 2002. The staple cartridge 2000 comprises a cartridge body 2010 including a plurality of staple cavities 2050 defined therein. A staple is removably stored in each staple cavity 2050. The cartridge body 2010 includes a deck surface 2011 and a longitudinal slot 2015 defined in the deck surface 2011 configured to receive a firing member and/or cutting edge therein. The cartridge body 2010 further comprises a distal end 2013, a proximal end 2016, and opposing longitudinal sides 2012 extending between the distal end 2013 and the proximal end 2016. The entire disclosure of U.S. Patent Application Serial No. 14/319,004, entitled SURGICAL END EFFECTORS WITH FIRING ELEMENT MONITORING ARRANGEMENTS, now U.S. Patent No. 9,844,369, is hereby incorporated by reference herein in its entirety.

[0101] FIGS. 6 and 7 illustrate an embodiment of a battery unit 110 for use with a surgical instrument 100. A handle 102 of the surgical instrument 100 houses at least one battery unit 110. The battery unit 110 comprise one or more batteries 112 arranged in a series and/or parallel configuration. At least one of the batteries 112 may be rechargeable. The batteries may be CR-123A batteries and/or CR-2 batteries and/or any other suitable battery, for example. The handle 102 of the surgical instrument 100 comprises a battery dock 104 to which the battery unit 110 is attached. The battery

dock 104 comprises any suitable structure for coupling the battery unit 110 to the instrument 100. For example, the battery dock 104 comprises a cavity in the handle 102 configured to receive at least a portion of the battery unit 110, as illustrated in FIG. 7. In other embodiments, the battery dock 104 may be implemented using any suitable structures. In one embodiment, the battery dock 104 includes a post 106 that is received by the battery unit 110. In one embodiment, a pistol grip portion of the handle 102 comprises the battery dock 104.

[0102] As discussed in greater detail below, the battery dock 104 comprise a protruding portion which interacts with the battery unit 110 when the battery unit 110 is attached to the handle 102. Once attached, the battery unit 110 is electrically connected to and may provide power to a circuit of the surgical instrument 100. The circuit may be located in the handle 102, in an end effector of the surgical instrument 100, and/or in any combination of locations within the instrument 100. In use, the circuit may power the operation of at least one surgical implement at the end effector. For example, the circuit comprises an electric motor for operating an electrically-powered cutter, clasper, and/or other mechanical device. In addition to, or instead of, a motor, the circuit may comprise suitable circuit components for implementing an RF, ultrasonic, and/or other type of non-motor-powered surgical implement, for example.

[0103] Referring again to FIGS. 6 and 7, the battery unit 110 comprises a battery housing 114, batteries 112 positioned in the battery housing 114, and an outer housing 120 configured to receive the battery housing 114. In the illustrated embodiment, the battery housing 114 is configured to store four batteries 112; however, other embodiments are envisioned where the battery housing 114 stores any suitable number and/or type of batteries 112. For example, CR123 and/or CR2 battery cells may be used. The outer housing 120 comprises a top cover or lid 122 movable between an open position (FIG. 6) and a closed position. The lid 122 is secured in the closed position by a retention member 123 that engages a recess 129 in the outer housing 120. Other embodiments are envisioned with different securement methods such as latches, detents, etc. to secure the lid 122 to the outer housing 120. The outer housing 120 further includes a post 124 including electrical contacts 126 positioned thereon. The battery housing 114 comprises a cavity 118 and electrical contacts 116. The

electrical contacts 116 and electrical contacts 126 provide a portion of an electrical pathway from the batteries 112 to the surgical instrument 100 as will be discussed in greater detail below.

[0104] When the battery housing 114 is positioned in the outer housing 120, the post 124 of the outer housing 120 is received in the cavity 118 of the battery housing 114 and the electrical contacts 116 of the battery housing 114 are in contact with the electrical contacts 126 of the outer housing 120. The lid 122 is then closed to enclose the battery housing 114 within the outer housing 120. In at least one embodiment, the outer housing 120 may be a sterile outer housing 120 that has gone through a sterilization procedure such as autoclaving, for example. That said, the battery housing 114 and batteries 112 received therein may be sterile, but do not have to be. Thus, when the non-sterile battery assembly is received in the sterile outer housing 120 the entire battery unit 110 becomes a sterile assembly. In other words, the outer housing 120 acts as a sterile barrier between the non-sterile battery housing 114 and batteries 112 and the surrounding environment. Such an arrangement allows battery assemblies such as the battery housing 114 to be re-used without having to be sterilized. In at least one embodiment, a seal is positioned between the lid 122 and the outer housing 120 to seal the battery housing 114 and batteries 112 from the surrounding environment. The seal may be rubber, plastic, and/or any suitable material.

[0105] After the batteries 112 are assembled to the battery housing 114 and the battery housing 114 is assembled to the outer housing 120, the battery unit 110 is attached to the surgical instrument 100. The battery unit 110 comprises a cavity defined inside the post 124 of the outer housing 120. This cavity defined within the post 124 is configured to receive the post 106 of the battery dock 104 of the surgical instrument 100. The electrical contacts 126 positioned on the post 124 of the outer housing 120 are aligned with and in electrical contact with electrical contacts 108 positioned in the battery dock 104 when the battery unit 110 is seated in the battery dock 104. The electrical contacts 126 are sealed such that the sterile barrier discussed above remains intact. When the battery unit 110 is assembled within the battery dock 104, the electrical contacts 116, 126, and 108 form an electrical pathway from the batteries 112 to the surgical instrument 100.

[0106] Referring to FIG. 7, the battery unit 110 comprises exterior dimensions similar to that of a battery unit 130 and/or those described in U.S. Patent No. 8,632,525, entitled POWER CONTROL ARRANGEMENTS FOR SURGICAL INSTRUMENTS AND BATTERIES, the entire disclosure of which is hereby incorporated herein by reference in its entirety. The battery dock 104 of the surgical instrument 100 can receive either the battery unit 110 or the battery unit 130.

[0107] Further to the above, the battery housing 114 further comprises a control circuit or circuit board 113 and battery status indicators 119 in communication with the circuit board 113 and the batteries 112 when the batteries 112 are positioned in the battery housing 114. The battery status indicators 119 comprise lights; however, other embodiments with different types of indicators 119 are envisioned. In at least one embodiment the status indicators 119 comprise a linear LED display and/or a rotary dial LED indicator, for example. The lid 122 of the outer housing 120 comprises a clear window 128 aligned with the battery status indicators 119 when the lid 122 is closed. The clear window 128 allows a clinician to see the status indicators 119 after the battery housing 114 is assembled within the outer housing 120. In alternative embodiments, the lid 122 comprises the status indicators 119.

[0108] Further to the above, the battery status indicators 119 are configured to indicate the charging status of the battery unit 110, for example. In at least one embodiment, the battery status indicators 119 indicate the remaining electrical capacity of the battery unit 110 as a number of remaining actuations of the surgical instrument 100. The actuations could be the number of staple cartridges that could still be fired before having to replace the battery unit 110, for example. The remaining electrical capacity may be displayed as the amount of time until the battery unit 110 is drained if the battery unit 110 is discharged at a predetermined, or recent, voltage, current, and/or power level, for example. Further still, the control circuit 113 of the battery housing 114 is configured to limit the current draw of the surgical instrument 100 in at least one embodiment in order to extend the life of a battery unit 110 to complete a staple firing, for example. For instance, if the battery unit 110 has enough power to complete two and a half more staple firings based on historical data, the charge management circuit of the battery unit 110 can limit the current draw to expedite life to three firings.

[0109] FIGS. 8-10 illustrate a battery unit 210 for use with a surgical instrument such as the surgical instrument 100, for example. Similar to battery unit 110 discussed above, the battery unit 210 is configured to be received in the battery dock 104 of the surgical instrument 100. The battery unit 201 comprises a battery assembly 214 and an outer housing 220 configured to receive the battery assembly 214. The battery assembly 214 comprises four batteries 112, however other embodiments are envisioned where the battery assembly 214 comprises two batteries, three batteries, or more than four batteries. The battery assembly 214 comprises electrical contacts 216 which electrically connect the batteries 112 into two pairs. The battery assembly 214 further comprises a first electrical connector 218 extending from the first pair of batteries 112 and a second electrical connector 219 extending from the second pair of batteries 112. The first and second electrical connectors 218, 219 are configured to electrically connect the two pairs of batteries 112. A dielectric interruption member or pull tab 230 is positioned between the first and second electrical connectors 218, 219 such that the two pairs of batteries 112 are not electrically connected when the pull tab 230 is present. As a result, the battery circuit is open when the pull tab 230 is present.

[0110] The electrical contacts 216, the first electrical connector 218, and the second electrical connector 219 are soldered, for example, to the batteries 112. The first and second electrical connectors 218, 219 are biased toward one another by a biasing member, such as a leaf spring for example, and/or by their own compliant structure. Other embodiments are envisioned where the electrical contacts 216, the first electrical connector 218, and the second electrical connector 219 are part of an outer housing or casing that houses the batteries 112. When the batteries are positioned in the outer housing or casing they are brought into contact with, or cammed into, the electrical contacts 216, the first electrical connector 218, and the second electrical connector 219. In other embodiments, one or more of the contacts 216 are cammed into a closed position to close at least portions of the battery circuit. That said, the battery circuit is not completely closed until the battery unit 210 is seated in the battery dock 104. In at least one embodiment, the outer housing 220 comprises the electrical contacts 216, the first electrical connector 218, and the second electrical connector 219, for example.

[0111] As discussed above, the outer housing 220 is configured to receive the battery assembly 214. Once the battery assembly 214 is received in the outer housing 220, a covering or lid 222 may be closed to enclose the battery assembly 214 within the outer housing 220. The outer housing 220 and lid 222 form a sterile barrier between the battery assembly 214 and the surrounding environment as was discussed above with regard to the embodiment of FIGS. 6 and 7. The outer housing 220 further comprises a retention member 223 similar to retention member 123. The retention member 223 secures the lid 222 to the outer housing 220, for example.

[0112] Further to the above, the pull tab 230 is accessible to a user of the battery unit 210 when the battery assembly 214 is positioned in the outer housing 220 and when the battery unit 210 is attached to the surgical instrument 100. The pull tab 230 can be displaced to electrically connect all four batteries 112 within the battery assembly 214. The pull tab 230 can be displaced before or after the battery unit 210 is assembled to the surgical instrument 100. In at least one embodiment, the battery unit 110 comprises packaging that at least partially surrounds the battery unit 210. The packaging may be attached to the pull tab 230 such that, when the battery unit 210 is at least partially removed from the packaging, the pull tab 230 is pulled out of the battery unit 210 allowing the four batteries 112 to be electrically connected. In at least one embodiment, the electrical connection between the two pairs of batteries 212 via the first and second electrical connectors 218, 219 is interrupted again when the battery unit 210 is detached from the surgical instrument 100, for example. More specifically, the battery unit 210 comprises a resettable pull tab that is biased toward or spring loaded toward the battery assembly 214 such that when the battery unit 210 is detached from the battery dock 104, the resettable tab interrupts the electrical connection between the two pairs of batteries 212.

[0113] An end effector 320 of a surgical instrument, such as a surgical instrument 300, is illustrated in FIGS. 11-13. The surgical instrument 300 may be similar to the surgical instruments described herein. The end effector 320 comprises a first jaw, or elongate channel 330, and a second jaw, or anvil 340. The anvil 340 is pivotally coupled to the elongate channel 330 and movable relative to the elongate channel 330 between an open position and a closed position. However, other embodiments are

envisioned wherein the elongate channel 330 is movable relative to the anvil 340 between an open position and a closed position. In any event, the elongate channel 330 is configured to receive a staple cartridge 350. The staple cartridge 350 is replaceable with another staple cartridge; however, other embodiments are envisioned in which the staple cartridge is not replaceable. The staple cartridge 350 comprises a plurality of staples removably stored therein. The staples are prevented from falling out of the staple cartridge 350 by a cartridge pan 352 that is attached to the staple cartridge 350. Further, the staple cartridge 350 comprises a sled 354 configured to move from a proximal unfired position to a distal fired position to eject the staples from the staple cartridge 350 during a staple firing stroke.

[0114] Further to the above, the elongate channel 330 comprises a longitudinal cavity 332 and a channel opening 334 defined in the bottom of the elongate channel 330. The surgical instrument 300 further comprises a firing member 310 configured to travel through the end effector 320 during a staple firing stroke to eject the staples from the staple cartridge 350. More specifically, the firing member 310 is configured to move the sled 354 from the proximal unfired position toward the distal fired position during the staple firing stroke to eject the staples from the staple cartridge 350. The firing member 310 comprises a lower lateral flange, or first camming member, 312 and an upper lateral flange, or second camming member, 314. During the staple firing stroke, the first camming member 312 is configured to slide within the longitudinal cavity 332 defined in the elongate channel 330 and the second camming member 314 is configured to slideably engage an anvil slot 342 defined in the anvil 340 to position the anvil 340 at a desired spacing relative to the elongate channel 330 and the staple cartridge 350. The firing member 310 further comprises a distal portion, or distal protrusion, 316 which, in conjunction with the sled 354, overcomes a firing member lockout as described in greater detail below.

[0115] When a staple cartridge 350 is not positioned in the elongate channel 330 or when the staple cartridge 350 is positioned in the elongate channel 330 and the sled 354 is not in the proximal unfired position at the beginning of the staple firing stroke, the firing member 310 is locked out (i.e., prevented from performing the staple firing stroke). More specifically, if the staple cartridge 350 is not positioned in the elongate channel

330 and the firing member 310 is actuated (i.e., advanced distally), the first camming member 312 of the firing member 310 will be biased into the channel opening 334 in the elongate channel 330 at the beginning of the staple firing stroke. The firing member 310 is biased toward the channel opening 334 by a biasing member such as a spring, for example, in the shaft of the surgical instrument 300. When the first camming member 312 is positioned in the channel opening 334, the first camming member 312 engages a sidewall or lock shoulder 336 of the channel opening 334 at the beginning of the staple firing stroke thereby preventing further distal advancement of the firing member 310. If the staple cartridge 350 is positioned in the elongate channel 330 and the sled 354 is not in the proximal unfired position as shown in FIG. 12, the same result happens as if the staple cartridge 350 is missing altogether.

[0116] In order to defeat the firing member lockout describe above, referring primarily to FIG. 13, the sled 354 must be in the proximal unfired position when the staple cartridge 350 is positioned in the elongate channel 330. The sled 354 comprises a proximal camming surface 356 that cammingly engages the distal protrusion 316 upwardly when the firing member 310 is advanced distally and lifts the firing member 310 over the lock shoulder 336 to permit the firing member 310 to perform the staple firing stroke. Further, the interaction between the distal protrusion 316 and the proximal camming surface 356 aligns the first camming member 312 with the longitudinal cavity 332 of the elongate channel 330 and aligns the second camming member 314 with the anvil slot 342 of the anvil 340. When the distal protrusion 316 engages the proximal camming surface 356 to lift the firing member 310 over the lock shoulder 336, the biasing force on the firing member 310 is overcome and the firing member lockout is defeated. The proximal camming surface 356 does more than just support the firing member 310, it cams the firing member 310 upwardly away from the lock shoulder 336. Once the firing member 310 is supported on the sled 354, the firing member 310 can be advanced distally to perform the staple firing stroke. Also notably, the firing member 310 further comprises a cutting edge or knife 318 configured to incise patient tissue that has been captured between the anvil 340 and the staple cartridge 350 during the staple firing stroke.

[0117] The entire disclosures of U.S. Patent No. 7,143,923, entitled SURGICAL STAPLING INSTRUMENT HAVING A FIRING LOCKOUT FOR AN UNCLOSED ANVIL, which issued on December 5, 2006; U.S. Patent No. 7,044,352, SURGICAL STAPLING INSTRUMENT HAVING A SINGLE LOCKOUT MECHANISM FOR PREVENTION OF FIRING, which issued on May 16, 2006; U.S. Patent No. 7,000,818, SURGICAL STAPLING INSTRUMENT HAVING SEPARATE DISTINCT CLOSING AND FIRING SYSTEMS, which issued on February 21, 2006; U.S. Patent No. 6,988,649, SURGICAL STAPLING INSTRUMENT HAVING A SPENT CARTRIDGE LOCKOUT, which issued on January 24, 2006; and U.S. Patent No. 6,978,921, SURGICAL STAPLING INSTRUMENT INCORPORATING AN E-BEAM FIRING MECHANISM, which issued on December 27, 2005, are incorporated by reference herein.

[0118] Other embodiments are envisioned where a longitudinal cavity is defined between the cartridge pan 352 and the elongate channel 330 when the staple cartridge 350 and cartridge pan 352 are positioned in the elongate channel 330, for example. The first camming member 312 is configured to slide within the longitudinal cavity defined between the cartridge pan 352 and the elongate channel 330 during the staple firing stroke.

[0119] FIGS. 14-17 illustrate an end effector 420 of a surgical instrument 400. The surgical instrument 400 may be similar to the surgical instrument 100, the surgical instrument 300, and/or or the surgical instruments described herein. The end effector 420 comprises a first jaw or elongate channel 430 and a second jaw or anvil. In at least one embodiment, the elongate channel 430 is movable relative to the anvil between an open position and a closed position. In the illustrated embodiment, the anvil is pivotally coupled to the elongate channel 430 and movable relative to the elongate channel 430 between an open position and a closed position. In either event, the elongate channel 430 is configured to receive a staple cartridge 450. The staple cartridge 450 is replaceable with another staple cartridge, but may not be replaceable in other embodiments. The staple cartridge 450 comprises a plurality of staples removably stored therein. The staples are prevented from falling out of the staple cartridge 450 by a cartridge pan 452 that is removably attached to the staple cartridge 450. The staple cartridge 450 comprises a sled 454 configured to move from a proximal unfired position

P_0 (FIG. 16) to an intermediate unfired position P_1 (FIG. 17) and then to a distal fired position to eject the staples from the staple cartridge 450.

[0120] The elongate channel 430 comprises a channel opening 434 defined in the bottom of the elongate channel 430. The surgical instrument 400 further comprises a firing member 410 configured to travel through the end effector 420 during a staple firing stroke to eject the staples from the staple cartridge 450 when the staple cartridge 450 is positioned in the elongate channel 430 and the sled 454 is in its proximal unfired position P_0 or its intermediate unfired position P_1. The firing member 410 comprises a lower lateral flange or first camming member 412, an upper lateral flange or second camming member 414, a distally-protruding nose portion 416, and laterally-extending lock members 419. The laterally-extending lock members 419 are positioned intermediate the first camming member 412 and the second camming member 414 and extend in opposite directions. During the staple firing stroke, the first camming member 412 is configured to slideably engage the bottom of the elongate channel 430 and the second camming member 414 is configured to slideably engage an anvil slot defined in the anvil to position the anvil at a desired spacing relative to the elongate channel 430 and staple cartridge 450. Further, the laterally-extending lock members 419 are configured to travel within a longitudinal cavity 455 defined between the staple cartridge 450 and the cartridge pan 452 during the staple firing stroke. The distally-protruding nose portion 416 - in conjunction with a rotating member of the sled 454 serve to overcome a firing member lockout as described in greater detail below.

[0121] When a staple cartridge 450 is not positioned in the elongate channel 430, the firing member 410 is locked out (i.e., prevented from performing the firing stroke). More specifically, if the staple cartridge 450 is not positioned in the elongate channel 430 and the firing member 410 is actuated (i.e., advanced distally), the firing member 410 is biased downwardly by a biasing member and the laterally-extending lock members 419 of the firing member 410 are biased into a channel opening 434 in the elongate channel 430. The firing member 410 is biased toward the channel opening 434 by a biasing member such as a spring, for example, in the shaft. When the laterally-extending lock members 419 are biased into the channel opening 434 and the firing member 410 is advanced distally, the laterally-extending lock members 419 engage a distal wall or lock

shoulder 436 of the channel opening 434 which prevents further distal advancement of the firing member 410. Further, if the staple cartridge 450 is positioned in the elongate channel 430 and the sled 454 is positioned distal to the intermediate unfired position P_1, the firing member 410 will be prevented from distally advancing in a similar manner. In order to defeat the firing member lockout describe above, the sled 454 must be positioned at the intermediate unfired position P_1, or proximal to the intermediate unfired position P_1 when the staple firing stroke is initiated as described in greater detail below.

[0122] Referring primarily to FIGS. 16 and 17, the sled 454 comprises a proximal camming surface 456 and a lockout key or rotary member 458. The rotary member 458 is rotatable relative to the sled 454 between an unactuated position (FIG. 16) and an actuated position (FIG. 17). The staple cartridge 450 comprises a protrusion 451 that rotates the rotary member 458 to rotate the rotary member 458 from the unactuated position to the actuated position when the sled 454 is moved from the proximal unfired position P_0 to the intermediate unfired position P_1. In use, when the sled 454 is in the proximal unfired position P_0 and the firing member 410 is advanced distally, the distally-protruding nose portion 416 will slideably engage the proximal camming surface 456 of the sled 454 and the firing member 410 will advance the sled 454 distally from the proximal unfired position P_0 toward the intermediate unfired position P_1 contacting the proximal camming surface 456, however, this is not enough to lift the laterally-extending lock members 419 over the lock shoulder 436. As the sled 454 is advanced distally by the firing member 410, the rotary member 458 engages the protrusion 451 of the staple cartridge 450 and rotates the rotary member 458 from the unactuated position (FIG. 16) toward the actuated position (FIG. 17). As the rotary member 458 rotates from the unactuated position toward the actuated position, the rotary member 458 engages the distally-protruding nose portion 416 of the firing member 410 and lifts the firing member 410 over the lock shoulder 436 of the elongate channel 430. In other words, the laterally-extending lock members 419 are lifted over the lock shoulder 436 and are prevented from entering the channel opening and engaging the lock shoulder 436 owing to the lifting action of the rotary member 458. Thus, an initial distal advancement of the sled 454 from the proximal unfired position P_0 toward the intermediate unfired position P_1 defeats the firing member lockout. Further, the initial distal advancement of the sled

454 from the proximal unfired position P_0 toward the intermediate unfired position P_1 aligns the laterally-extending lock members 419 with the longitudinal cavity 455 and aligns the second camming member 414 with the anvil slot during the staple firing stroke to eject the staples. In the illustrated embodiment, the firing member 410 further comprises a cutting edge or knife 418 configured to incise patient tissue that has been captured between the anvil and the staple cartridge 450 during the staple firing stroke.

[0123] FIG. 18 illustrates a bailout assembly 500 of a surgical instrument such as surgical instruments 100, 200, and/or 300 and/or the surgical instruments described in U.S. Patent Application No. 12/249,117, entitled POWERED SURGICAL CUTTING AND STAPLING APPARATUS WITH MANUALLY RETRACTABLE FIRING SYSTEM, which is hereby incorporated herein by reference in its entirety. The bailout assembly 500 may be used, for example, in the event the energy level of the surgical instrument's power source falls below sufficient operational levels and the motor can't be used to retract the firing system. The surgical instrument comprises a drive system 530 for driving a firing member 538 through a staple firing stroke. The drive system 530 comprises a motor 510, a gear box 520 operably coupled the motor 510, a drive shaft 522 extending from the gear box 520, a drive gear 524 fixed to the drive shaft 522, a driven gear 535 operably engaged with the drive gear 524, and a drive rack 532 operably engaged with the driven gear 535. The drive gear 524 is configured to rotate in response to rotary motions generated by the motor 510. In at least one embodiment, the drive system 530 may be housed within a handle and/or housing of the surgical instrument.

[0124] Further to the above, the drive rack 532 comprises a first rack of teeth 534 operably engaged with the driven gear 535 and a second rack of teeth 536 operably engaged with the bailout assembly 500. In use, when a rotary motion of a first direction is transmitted from the motor 510 to the drive gear 524, the drive gear 524 is rotated in a counter-clockwise direction and the driven gear 535 rotates in a clockwise direction. When the driven gear 535 is rotated in a clockwise direction the drive rack 532 and firing member 538 are translated distally to perform the staple firing stroke. When a rotary motion of a second direction opposite the first direction is transmitted from the motor 510 to the drive gear 524, the drive gear 524 is rotated in a clockwise direction

and the driven gear 535 rotates in a counter-clockwise direction. When the driven gear 535 is rotated in a counter-clockwise direction the drive rack 532 is translated proximally to retract the firing member 538.

[0125] Further to the above, the bailout assembly 500 comprises a lever 502 and a pawl 504 extending from the lever 502. The lever 502 is mounted to the handle or housing of the surgical instrument such that the lever 502 is rotatable relative to the handle or housing. In at least one embodiment, the lever 502 is generally concealed from the user by an access door or panel covering an opening in the handle or housing. The access door is removable by the user to allow the user access to the lever 502 through the opening in the handle or housing of the instrument. In at least one embodiment, the access door is coupled to an electronic switch and a control circuit such that when the clinician removes the access door, electric power to the motor 510 is cut, as described in greater detail below.

[0126] When the user actuates the bailout assembly 500, the pawl 504 of the bailout assembly 500 is configured to engage the second rack of teeth 536. The pawl 504 is biased toward the second rack of teeth 536 by a biasing member such as a spring, for example. When the lever 502 is rotated clockwise, for example, the pawl 504 engages the second rack of teeth 536 and drives the drive rack 532 and firing member 538 proximally. When the drive rack 532 is driven proximally by the bailout assembly 500, the motor 510 is back-driven. More specifically, the driven gear 535 rotates counter-clockwise, the drive gear 524 rotates clockwise, and the motor 510 is back-driven when the drive rack 532 is driven proximally by the bailout assembly 500 as illustrated in FIG. 18.

[0127] In at least one embodiment, the motor 510 is an electro-magnetic brushless DC motor. The surgical instrument further comprises a power source such as a battery or battery pack for example, and a control circuit including a microprocessor. The power source is configured to supply power to the motor 510 and the control circuit is configured to control the supply of power from the power source to the motor 510. In at least one embodiment, the control circuit may be similar to the control circuit 1200 comprising an emergency access door bailout switch 1218 as described in U.S. Patent No. 8,695,866, entitled SURGICAL INSTRUMENT HAVING A POWER CONTROL

CIRCUIT, which is hereby incorporated herein by reference in its entirety. The emergency access door bailout switch cuts the flow of power from the power source to the motor 510 when the access door is detached from the surgical instrument such that when the motor is not accidently operated when manually driving the bailout assembly 500.

[0128] In at least one embodiment, the motor 510 is an electro-magnetic brushless DC motor comprising a capacitive timing element configured to control the motor 510. In any event, utilizing a brushless DC motor and a motor control circuit eliminates the need to mechanically decouple the motor 510 from the drive system 530 when the bailout assembly 500 is actuated to retract the firing member 538. In at least one embodiment, the bailout assembly 500 is in electrical communication with the control circuit of instrument such that, when the lever 502 is actuated, electrical power is prevented from flowing from the power source to the motor 510 to allow the motor 510 to be back-driven as described above.

[0129] Further to the above, the control circuit is configured to adjust the speed of the motor 510 during the firing stroke. More specifically, the control circuit utilizes pulse width modulation to control the speed of the motor 510 and thus the speed of the firing stroke at certain predefined locations with respect to the overall firing stroke (i.e. at the end of stoke and/or at the beginning during a lockout portion of the firing stroke), for example. In at least one embodiment, the control circuit could be located in a battery pack which acts as the power source for the motor 510 as described in in U.S. Patent Application No. 12/031,573, entitled SURGICAL CUTTING AND FASTENING INSTRUMENT HAVING RF ELECTRODES, which is hereby incorporated herein by reference in its entirety.

[0130] FIGS. 19-21 illustrates a surgical instrument 600 comprising a housing 610, an elongate shaft 620 extending from the housing 610, an end effector 630 extending from the elongate shaft 620, and an articulation joint 640. The end effector 630 is rotatably coupled to the elongate shaft 620 by the articulation joint 640 and the elongate shaft 620 and the end effector 630 are rotatable together about a longitudinal shaft axis SA. The end effector 630 is rotatable about an articulation axis AA relative to the elongate shaft 620 by an articulation assembly 650 comprising a first rod or articulation member

652, a second rod or articulation member 654, and a manually-rotatable articulation knob 656. The articulation knob 656 extends away from the housing 610 of the surgical instrument 600 so that it can be manually rotated by a clinician. The articulation assembly 650 comprises a shaft 657 extending from the articulation knob 656 into the housing 610 and a yoke 658 which connects the articulation knob 656 to the first and second articulation members 652, 654. The first articulation member 652 is attached to a first side of the yoke 658 and a first side of the end effector 630. The second articulation member 654 is attached to a second side of the yoke 658 opposite the first side of the yoke 658 and a second side of the end effector 630 opposite the first side of the end effector 630. The first and second articulation members 652, 654 are attached to the yoke 658 via pins 659; however, any suitable attachment mechanism for attaching the articulation members 652, 654 to the yoke 658 may be utilized.

[0131] In use, the articulation knob 656 is rotatable between an unarticulated position (shown in FIG. 19) and a plurality of articulated positions to articulate the end effector 630 about the articulation axis AA. The unarticulated position aligns the articulation knob 656 with the elongate shaft 620. When the articulation knob 656 is rotated clockwise, the yoke 658 rotates clockwise, the first articulation member 652 is moved distally, the second articulation member is moved proximally 654, and the end effector 630 is rotated in clockwise about the articulation axis AA. When the articulation knob 656 is rotated counter-clockwise, the yoke 658 rotates counter-clockwise, the first articulation member 652 is moved proximally, the second articulation member is moved distally 654, and the end effector 630 is rotated in counter-clockwise about the articulation axis AA.

[0132] Further to the above, the surgical instrument 600 further comprises an articulation lock assembly 660 configured to lock the end effector 630 relative to the elongate shaft 620. The articulation lock assembly 660 comprises proximal lock member 664, a shaft 663 extending distally from the proximal lock member 664, and a distal lock member 662 extending from the shaft 663. The distal lock member 662 comprises a protrusion 665 configured to selectively engage a plurality of detents or teeth 632 defined in the proximal end of the end effector 630. The articulation lock assembly 660 is biased toward the end effector 630 by a biasing member or spring 670

positioned in the elongate shaft 620. The articulation lock assembly 660 is movable between a distal locked position (FIG. 20) where the protrusion 665 of the distal lock member 662 is engaged with one of the teeth 632 of the end effector 630 and a proximal unlocked position (FIG. 21) where the protrusion 665 of the distal lock member 662 is not engaged with any of the teeth 632 of the end effector 630. The articulation lock assembly 660 is moved between the distal locked position and the proximal locked position when the articulation knob 656 is rotated in either direction as described in greater detail below.

[0133] The proximal lock member 664 comprises a carriage or collar 667 positioned around the shaft 657 of the articulation assembly 650. The collar 667 comprises a protrusion 669 extending toward the shaft 657 of the articulation assembly 650. The articulation assembly 650 further comprises a plurality of detents or teeth 655 radially positioned around the shaft 657. In the illustrated embodiment, a disc extending from the shaft 657 has the teeth 655 defined thereon. When the articulation knob 656 is rotated counter-clockwise, for example, one of the teeth 655 cammingly engages the protrusion 669 of the articulation lock assembly 660 to drive the articulation lock assembly 660 proximally from the distal locked position (FIG. 20) to the proximal unlocked position (FIG. 21). When the articulation knob 656 is rotated in this manner, the articulation lock assembly 660 is automatically unlocked and the first and second articulation members 652, 654 are simultaneously rotating the end effector 630 about the articulation axis AA a predetermined amount. The predetermined amount is dependent upon the size, shape, and/or spacing of the teeth 655 of the articulation assembly 650 and the size and/or shape of the protrusion 669 of the articulation lock assembly 660, among other things.

[0134] As discussed above, the articulation lock assembly 660 is biased distally by the spring 670. When the articulation knob 656 is rotated, the biasing force of the spring 670 is overcome and the articulation lock assembly 660 is driven proximally to the proximal unlocked position. When the articulation knob 656 is rotated further, the protrusion 669 of the articulation lock assembly 660 is aligned in a recess defined between adjacent teeth 655 and the articulation lock assembly 660 is once again biased distally by the spring 670 such that the distal lock member 662 is once again engaged

with the end effector 630 to lock the end effector 630 in position. This arrangement allows the end effector 630 to be rotated about the articulation axis AA and locked into place in a plurality of rotated positions about the articulation axis AA.

[0135] In at least one embodiment, an elongate staple cartridge channel of the end effector 630 comprises a plastic coating to minimize damage and binding as a result of cleaning with caustic solutions. The plastic coating is applied to the elongate channel by way of an injection molded polymer that is not highly hydrophilic, but could be applied in any suitable manner. The molding material can comprise polyethylene, polycarbonate, nylon 6/12 with a glass or mineral fill, ABS, and/or combinations thereof, for example. In at least one embodiment, the elongate channel comprises discrete features or cutouts arrayed around the perimeter of the elongate channel which are contacted by the closure tube of the surgical instrument when the closure tube is advanced distally. The cutouts limit the contact of the elongate channel with the closure tube to small interfaces which minimize the damage to both the elongate channel and closure tube during repeated use. In at least one embodiment, portions of the end effector 630, elongate shaft 620, and elongate channel are lubricated to prevent wear. In various embodiments, dried sodium stearate is applied to the internal structures of these components in such a manner as if they were wet-dipped and then dried. In certain embodiments, the elongate shaft 620 and/or any of the other elements of the surgical instrument 600 may be dipped in the lubricant and baked to fixate the lubricants to the parts.

[0136] FIG. 22 illustrates a control circuit 700 for use with a surgical instrument such as the surgical instruments 100, 300, 400, 600, and/or the surgical instruments described herein. The control circuit 700 is configured to control the supply of power from a power source to a motor such as the motor 510, for example. The power source may be a battery, a battery pack, a rechargeable battery pack or any combination thereof, for example. The control circuit 700 comprises a printed circuit board 704, electrical components 706, a switch or rocker switch 710, and an electrical port 720 configured to receive an electrical harness 730. The electrical components 706 comprise any combination of printed circuit board components such as a processor, microprocessor, resistors, LEDs, transistors, capacitors, inductors, diodes, and

switches, for example. A conformal coating 702 is applied to the control circuit 700 to seal the control circuit 700 from the surrounding environment. In at least one embodiment, the conformal coating 702 comprises TECHNOMELT®; however, the conformal coating may comprise any suitable sealant flowed onto the control circuit 700 to protect the control circuit 700 from the surrounding environment. In at least one embodiment, the conformal coating 702 is configured to protect the integrity of the control circuit 700 during one or more sterilization autoclave cycles. The sterilization autoclave cycles may include temperatures ranging from 140 degrees Celsius to 170 degrees Celsius, for example.

[0137] Referring now to FIG. 23, a seal such as gasket seal 740 is positioned between the conformal coating 702 and the rocker switch 710 to protect the control circuit 700 from the surrounding environment. Further, the rocker switch 710 comprises a flexible elastomer diaphragm 712 covering the switch 710 to maintain functionality of the switch 710 while still protecting the control circuit 700 from the surrounding environment. In various embodiments, electrical contacts on the rocker switch 710 are soldered to electrical contacts on the circuit board 704. Surface mount technology and/or through-hole technology may be employed for the electrical components of the circuit board 704. In at least one embodiment, an adhesive is applied between the elastomer diaphragm 712 and the rocker switch 710 to further seal the rocker switch 710 from the surrounding environment. In at least one embodiment, the circuit board 704 comprises a snap fit and/or press fit connection between the rocker switch 710 and the circuit board 704.

[0138] Referring again to FIG. 22, a gasket seal 750 is positioned between the conformal coating 702 and the electrical harness 730 that is electrically connected to the electrical port 720. The gasket seal 750 protects the control circuit 700 from the surrounding environment and allows an exterior electrical input (the electrical harness 730) to be connected to the control circuit 700. The electrical harness 730 may be connected to the power source and/or the motor of a surgical instrument, for example.

[0139] Referring now to FIGS. 24 and 25 which illustrate seals for use between a gear box and motor of a surgical instrument such as the surgical instruments disclosed herein. In at least one embodiment, the gear box may be the gear box 520 and the

motor may be the motor 510, for example (see FIG. 18). A double-lipped seal 760 is positioned around the drive shaft 522 extending from the gear box 520. The double-lipped seal 760 protects the gear box 520 from the surrounding environment. Further, a dual o-ring 770 is positioned between the gear box 520 and motor 510 to seal the connection between the gear box 520 and motor 510 from the surrounding environment. Further still, double-lipped seals 780 are positioned around the electrical contacts extending from the bottom of the motor 510. The double-lipped seals 780 protect the motor 510 from the surrounding environment.

[0140] FIG. 26 illustrates a sterile packaging assembly 800 for a surgical instrument 850. The surgical instrument 850 may be similar to the surgical instruments 100, 300, 400, 600, and/or the surgical instruments described herein. The sterile packaging assembly 800 comprises a tray 810 and a cover 820 secured to the tray 810. The tray 810 comprises a plurality of cavities 812 defined therein that are configured to receive the surgical instrument 850. In at least one embodiment, the tray 810 is a vacuum-molded tray, but can be formed in any suitable manner. The cavities 812 substantially mimic the outer profile of the surgical instrument 850 to properly and securely seat the surgical instrument 850 in the tray 810 such that little, if any, relative shifting between the surgical instrument 850 and the tray 810 can occur. The tray 810 comprises additional cavities 816 defined in the tray 810 that are configured to receive supplemental components typically packaged with the surgical instrument 850. In the illustrated embodiment, the additional cavities 816 are configured to receive a battery pack 852, for example. However, other embodiments are envisioned with more or less cavities 816 than the illustrated embodiment depending on the number of supplemental components packaged with a specific surgical instrument.

[0141] Further to the above, the tray 810 further comprises a plurality of trap cavities 814 defined in the tray 810. The trap cavities 814 are configured to receive particulate traps 830 and particulate traps 840. The particulate traps 830, 840 are configured to collect particulates within the packaging assembly 800 and trap the particulates within the particulate traps 830, 840. The trap cavities 814 substantially mimic the profiles of the particulate traps 830, 840 to properly and securely seat the particulate traps 830, 840 in the tray 810 such that little, if any, relative shifting between the particulate traps

830, 840 and the tray 810 can occur. After the particulate traps 830, 840 are assembled into their respective trap cavities 814 in the tray 810, and the surgical instrument 850 is seated in the tray 810, the cover 820 is secured to the tray 810 forming a sterile barrier. In at least one embodiment, an additional film wrapping or sealant may be applied to at least a portion of the packaging assembly 800 to further seal the packaging assembly 800 from the surrounding environment.

[0142] Referring now to FIGS. 27-30, each of the particulate traps 830, 840 comprise at least one concave surface or funnel shaped surface terminating in an opening. Referring to FIGS. 27 and 28, the particulate trap 840 comprises an outer profile that is substantially cubic with four side walls 842, a top wall 844, and a bottom wall 846. That said, the particulate trap 840 can comprise any suitable shape. The particulate trap 840 is hollow, i.e., it comprises a chamber or inner cavity 841. In the illustrated embodiment, each of the four side walls 842 comprise inwardly tapered surfaces 843 terminating in an opening 845 that is in communication with the inner cavity 841. The tapered surfaces 843 funnel particulates toward the openings 845 to aid in the collection of the particulates within the particulate trap 840. Moreover, the inner geometry of the particulate trap 840 is arranged to inhibit the particulates from falling out of the particulate trap 840. Among other things, the tapered surfaces 843 are defined on angled walls which create partially-closed and tapered pockets with the particulate trap 840. Stated another way, the tapered surfaces 843 are angled away from the opening 845 within the cavity 841 such that, once the particulates enter the cavity 841, they are not easily expelled from the particulate trap 840. The particulate trap 840 further comprises an adhesive material 847 positioned inside the cavity 841. One or more pieces of two-sided adhesive material are attached to the inner walls of the particulate trap 840. The adhesive materials 847 help prevent the particulates from exiting the particulate trap 840 and/or from rattling around inside the particulate trap 840.

[0143] Referring now to FIGS. 29 and 30, the particulate trap 830 comprises an outer profile that is a rectangular prism with four side walls 832, a top wall 834, and a bottom wall 836. The particulate trap 830 is hollow, i.e., it comprises a chamber or inner cavity 831. In the illustrated embodiment, the top wall 834 comprises an inwardly tapered surface 833 terminating in an opening 835. The tapered surface 833 funnels

particulates positioned on the outer profile of the particulate trap 830 toward the opening 835 to aid in the collection of the particulates within the particulate trap 830. Further, the tapered surface 833 is angled away from the opening 835 within the cavity 831 such that once the particulates enter the cavity 831 they are not easily expelled from the particulate trap 830. The particulate trap 830 further comprises an adhesive material 837 positioned inside the cavity 831. The adhesive materials 837 help prevent the particulates from exiting the particulate trap 830 and/or from rattling around inside the particulate trap 830.

[0144] Further to the above, the particulate traps 830, 840 are positionable in the tray 810 in a plurality of different configurations. The openings 835, 845 are faced toward areas that are most likely to produce particulates, for example. For instance, the openings 835, 845 can be faced toward the cavities 812, 816. In such instances, the openings 835, 845 of the particulate traps 830, 840 are in communication with the cavities 812, 816. Other embodiments are envisioned with differently sized and shaped particulate traps as the particulate traps 830, 840 are not intended to be all encompassing but rather exemplary embodiments of particulate traps. The particulate traps may be opaque or the same color as the tray 810, for example. In at least one embodiment, the particulate traps comprise soundproofing material configured to reduce the noise generated by loose particulates rattling inside the particulate traps. Such sound proofing material can comprise foam, for example.

[0145] FIGS. 31 and 32 illustrate a surgical staple cartridge 900 for use with a surgical instrument, the surgical instrument comprises a jaw configured to receive the staple cartridge 900 and a jaw including an anvil. The staple cartridge 900 and the anvil jaw are configured to capture tissue therebetween which is then stapled and cut by the surgical instrument. The staple cartridge 900 comprises a cartridge body 910, a longitudinal slot 920 defined in the cartridge body 910, and a deck surface 930 positioned on either side of the longitudinal slot 920. The longitudinal slot 920 is configured to receive a cutting member of the surgical instrument. The cartridge body 910 comprises a plurality of staple cavities 932 defined therein. Each staple cavity 932 defines a staple cavity opening in the deck surface 930. The staple cavities 932 are positioned in a plurality of longitudinal rows extending along the length of the cartridge

body 910. The longitudinal rows of staple cavities 932 are staggered relative to one another. Stated another way, each side of the deck surface 930 comprises an inner row of staple cavities 932 adjacent the longitudinal slot 920, an outer row of staple cavities 932, and an intermediate row of staple cavities 932 between the outer row of staple cavities 932 and the inner row of staple cavities 932, wherein the staple cavities 932 of the intermediate row are shifted longitudinally with respect to the staple cavities 932 of the inner row and outer rows. However, other embodiments are envisioned where the rows of staple cavities 932 are not staggered relative to one another. In any event, each staple cavity 932 comprises a staple positioned therein which is ejected out of the staple cavity opening of the staple cavity 932 by a staple driver movably positioned within the staple cavity 932 during a staple firing stroke.

[0146] Further to the above, the staple cartridge 900 further comprises a lattice extension or honeycomb extension 940 extending above the deck surface 930. The honeycomb extension 940 comprises a plurality of through holes 942 defined in the honeycomb extension 940. Each through hole 942 extends through the honeycomb extension 940 and terminates at the deck surface 930. Each through hole 942 is aligned with and in communication with one of the staple cavity openings of the staple cavities 932 defined in the deck surface 930. Further, each through hole 942 in the honeycomb extension 940 is larger than the corresponding staple cavity opening that it is aligned with. Each through hole 942 comprises an outer perimeter which at least partially aligns with an outer perimeter of a corresponding staple cavity opening of a staple cavity 932 in the deck surface 930. In the illustrated embodiment, the distal end 946 of each through hole 942 is aligned with the distal end of a corresponding staple cavity opening and the proximal end 947 of each through hole 942 is aligned with a proximal end 937 of a corresponding staple cavity opening. The through holes 942 defined in the honeycomb extension 940 are configured to prevent the flow of tissue relative to the cartridge body 910 when the staples are ejected from the staple cavities 932 during the staple firing stroke.

[0147] Further to the above, the honeycomb extension 940 comprises cutouts 944 and cutouts 948 that are not in registration with and/or alignment with any of the staple cavities 932 defined in the deck surface 930. Each cutout 948 extends through the

honeycomb extension 940 and terminates in an outer deck surface 950 of a lug 952. Each lug 952 extends laterally from the cartridge body 910 and is positioned below the deck surface 930 of the cartridge body 910, as illustrated in FIG. 32. The cutouts 948 and outer deck surfaces 950 provide additional surface area for the clamping and spreading of the tissue during the staple firing stroke. The cutouts 944 extend through the honeycomb extension 940 and terminate on the deck surface 930 but are not aligned with any of the staple cavity openings of the staple cavities 932. A portion of the honeycomb extension 940 extends longitudinally beyond the deck surface 930 adjacent the cutouts 944 as illustrated in FIG. 31.

[0148] Referring again to FIG. 31, the through holes 942 defined in the honeycomb extension 940 vary in size and shape between each longitudinal row of through holes 942. More specifically, the through holes 942 positioned closest to the longitudinal slot 920 are smaller than the through holes 942 in the intermediate row of through holes 942. In any event, the size and shape of the through holes 942 as well as the size and shape of the cutouts 944 and 948 may vary relative to one another. The size, shape, and pattern of the through holes 942, the cutouts 944, and the cutouts 948 can be varied depending on the desired amount of tissue compression desired in a specific area of the staple cartridge 900. Other embodiments are envisioned with differently sized and shaped through holes that the through holes 942 as the through holes 942 are not intended to be all encompassing but rather exemplary embodiments of a pattern of through holes. In any event, the through holes 942 allow the tissue to flow toward the staple cavities 932 instead of away from the staple cavities 932. In at least one embodiment, a portion of the staple cavity openings of the staple cavities 932 and the through holes 942 support the legs of the staples as the staples are ejected from the staple cartridge 900.

[0149] Referring now to FIGS. 33-59, a staple cartridge, such as staple cartridge 1000, for example, comprises a cartridge body 1010, a plurality of staple cavities 1012 defined in the cartridge body 1010, and a staple 1020 positioned in each of the staple cavities 1012. The cartridge body 1010 further comprise a cartridge deck surface 1030. The plurality of staple cavities 1012 define a plurality of staple cavity openings in the cartridge deck surface 1030. Each of the staple cavities 1012 comprises a pair of

lateral sidewalls 1013 that oppose one another and converge at the proximal and distal ends of each staple cavity 1012. More specifically, each staple cavity 1012 comprises a pair of proximal tapered sidewalls 1014 and a pair of distal tapered sidewalls 1015. The proximal tapered sidewalls 1014 converge toward one another and terminate in a proximal end wall 1016. The distal tapered sidewalls 1015 converge toward one another and terminate in a distal end wall 1017. The lateral sidewalls 1013, the tapered sidewalls 1014, 1015, the proximal end wall 1016, and the distal end wall 1017 form a perimeter of each staple cavity opening at the cartridge deck surface 1030. The cartridge body 1010 further comprises a plurality of projections extending from the cartridge deck surface 1030. The projections may be sized and shaped differently and/or arranged in different pluralities, arrays, or patterns on the cartridge deck surface 1030 to control the flow of tissue relative to the cartridge deck surface 1030, as described in greater detail below.

[0150] Referring to FIGS. 33-36, a plurality of projections or posts 1040 extend from the cartridge deck surface 1030. In at least one embodiment, the posts 1040 are cylindrical in shape and comprise a chamfered end. Other embodiments are envisioned where each post 1040 comprises a domed end. In any event, a post 1040 is positioned at the proximal and distal ends of each staple cavity 1012. Further, the proximal end wall 1016 of each staple cavity 1012 is flush or aligned with the outer diameter of the post 1040 positioned at its proximal end and the distal end wall 1017 of each staple cavity 1012 is flush or aligned with the outer diameter of the post 1040. In the illustrated embodiment, the posts 1040 are not interconnected with one another above the cartridge deck surface 1030. In other words, the posts 1040 are only interconnected by the cartridge deck surface 1030 which they discretely extend from. Other embodiments are envisioned where the posts 1040 are positioned adjacent to the staple cavities 1012 but are spaced away from the perimeter of the staple cavity openings defined in the cartridge deck surface 1030. Further, other embodiments are envisioned with the posts 1040 positioned at only one of the proximal and distal ends of each staple cavity 1012.

[0151] Referring to FIGS. 37-40, a plurality of projections or quarter-sphere ridges 1050 extend from the cartridge deck surface 1030. Each quarter-sphere ridge 1050 comprises a flat surface or face 1052 and an arcuate sphere portion 1054. A ridge

1050 is positioned at the distal end of each staple cavity 1012. Further, the distal end wall 1017 of each staple cavity 1012 is flush or aligned with the flat face 1052 of the ridge 1050 positioned at its distal end. In the illustrated embodiment, the ridges 1050 are not interconnected with one another above the cartridge deck surface 1030. In other words, the ridges 1050 are only interconnected by the cartridge deck surface 1030 which they discretely extend from. Other embodiments are envisioned where the ridges 1050 are positioned adjacent to the staple cavities 1012 but are spaced away from the perimeter of the staple cavity openings defined in the cartridge deck surface 1030. In addition to or in lieu of the above, other embodiments are envisioned with ridges 1050 positioned at the proximal end of each staple cavity 1012 with the flat face 1052 of each ridge 1050 flush or aligned with the proximal end wall 1016 of each corresponding staple cavity 1012.

[0152] Referring to FIGS. 41-44, a plurality of projections or cuboids 1060 extend from the cartridge deck surface 1030. In at least one embodiment, the cuboids 1060 are substantially cubic in shape. A pair of cuboids 1060 are positioned at the proximal and distal ends of each staple cavity 1012 adjacent to the proximal and distal tapered sidewalls 1014, 1015. A face 1062 of each of the cuboids 1060 positioned at the proximal end of each staple cavity 1012 is flush or aligned with the proximal tapered sidewall 1014. Further, a face of each of the cuboids 1060 positioned at the distal end of each staple cavity 1012 is flush or aligned with the distal tapered sidewall 1015. The cuboids 1060 are not interconnected with one another above the cartridge deck surface 1030. In other words, the cuboids 1060 are only interconnected by the cartridge deck surface 1030 which they discretely extend from. Other embodiments are envisioned where the cuboids 1060 are positioned adjacent to the staple cavities 1012 but are spaced away from the perimeter of the staple cavity openings defined in the cartridge deck surface 1030. Further, other embodiments are envisioned with a pair of cuboids 1060 positioned at only the proximal or distal end of each staple cavity 1012.

[0153] Referring to FIGS. 45-48, a pair of posts 1040 are positioned at the distal end of each staple cavity 1012 adjacent to the distal tapered sidewalls 1015. The outer diameter of each of the posts 1040 positioned at the distal end is flush or aligned with a distal tapered sidewall 1015 of the staple cavity 1012. In addition to or in lieu of the

above, a pair of posts 1040 are positioned at the proximal end of each staple cavity 1012 adjacent to the proximal tapered sidewalls 1014. In such instances, the outer diameter of each of the posts 1040 is positioned at the proximal end of each staple cavity 1012 and is flush or aligned with a proximal tapered sidewall 1014 of the staple cavity 1012. The posts 1040 are not interconnected with one another above the cartridge deck surface 1030. In other words, the posts 1040 are only interconnected by the cartridge deck surface 1030 which they discretely extend from. Other embodiments are envisioned where the posts 1040 are positioned adjacent to the staple cavities 1012 but are spaced away from the perimeter of the staple cavity openings defined in the cartridge deck surface 1030.

[0154] FIGS. 49-52 illustrate a combination of the embodiments illustrated in FIG. 33 and FIG. 41. More specifically, the staple cartridge 1000 includes the cuboids 1060 arranged as they are in FIG. 41 and the posts 1040 are arranged as they are in FIG. 33, for example. Other embodiments are envisioned with a pair of cuboids 1060 and a post 1040 positioned at only the proximal end or distal end of each staple cavity 1012.

[0155] FIGS. 53-55 illustrate another combination of the embodiments illustrated in FIG. 33 and FIG. 41. More specifically, the staple cartridge 1000 includes a pair of cuboids 1060 positioned at the distal end of each staple cavity 1012 and a post 1040 positioned at the proximal end of each staple cavity 1012. As discussed above, a face 1062 of each of the pair of cuboids 1060 is flush or aligned with the distal tapered sidewall 1015 on each side of the staple cavity 1012. See FIGS. 41-44. The outer diameter of each post 1040 is flush or aligned with the proximal end wall 1016 of each staple cavity 1012. See FIGS. 33-36. Other embodiments are envisioned where the cuboids 1060 and posts 1040 are positioned adjacent to the staple cavities 1012 but are spaced away from the outer perimeter of the staple cavity openings of the staple cavities 1012.

[0156] Referring primarily to FIGS. 56-59, a plurality of arcuate projections 1070 extend from the cartridge deck surface 1030. A pair of arcuate projections 1070 are positioned at the proximal and distal end of each staple cavity 1012 adjacent to the proximal and distal tapered sidewalls 1014, 1015. A face 1072 of each of the arcuate projections 1070 is positioned at the proximal end of a staple cavity 1012 that is flush or

aligned with the proximal tapered sidewall 1014. Further, a face 1072 of the arcuate projections 1070 positioned at the distal end of a staple cavity 1012 is flush or aligned with the distal tapered sidewall 1015. The arcuate projections 1070 are not interconnected with one another above the cartridge deck surface 1030. In other words, the arcuate projections 1070 are only interconnected by the cartridge deck surface 1030 which they discretely extend from. Other embodiments are envisioned where the arcuate projections 1070 are positioned adjacent to the staple cavities 1012 but are spaced away from the perimeter of the staple cavity openings defined in the cartridge deck surface 1030. Further, other embodiments are envisioned in which a pair of arcuate projections 1070 are positioned at only the proximal end or the distal end of each staple cavity 1012.

[0157] Various surgical instruments comprise powered and/or mechanical systems for performing surgical functions such as shaft rotation, end effector articulation, end effector jaw closure, and firing of the end effector to staple and cut tissue positioned between the end effector jaws, for example. In at least one embodiment, the mechanical and powered systems interact with one another to mechanically and/or electrically lock out one system based on the operation of another system, or systems, of the surgical instrument, as described in greater detail below.

[0158] FIG. 60 illustrates a schematic of a surgical instrument 1100 comprising a mechanical closure system 1110, a powered firing system 1120, a powered articulation system 1130, a powered shaft rotation system 1140, a control unit 1150, and a power source 1160. The control unit 1150 is configured to control the supply of power from the power source 1160 to the powered firing system 1120, the powered articulation system 1130, and the powered shaft rotation system 1140.

[0159] The mechanical closure system 1110 may be similar to the mechanical closure systems described in U.S. Patent No. 7,845,537, entitled SURGICAL INSTRUMENT HAVING RECORDING CAPABILITIES, which is hereby incorporated herein by reference in its entirety. The mechanical closure system 1110 is configured to move a jaw of an end effector 1102 between an open position and a closed position when a closure trigger 1112 is moved between an unclamped position and a clamped position. See FIG. 61. In at least one embodiment, the mechanical closure system 1110

comprises a latch or lock that locks the closure trigger 1112 in the clamped position. Further, a closure trigger release is utilized to unlock the closure trigger 1112 from the clamped position. In various embodiments, the end effector closure system can comprise a motor-powered closure system.

[0160] The powered firing system 1120 may be similar to the powered firing systems described in U.S. Patent No. 7,845,537, entitled SURGICAL INSTRUMENT HAVING RECORDING CAPABILITIES, which is hereby incorporated herein by reference in its entirety. The powered firing system 1120 comprises a firing motor 1122 of the surgical instrument 1100 such that, when power is supplied from the power source 1160 to the firing motor 1122, the powered firing system 1120 moves a firing member of the surgical instrument 1100 through a firing stroke and a retraction stroke within the end effector 1102 of the surgical instrument 1100 to staple and cut patient tissue.

[0161] The powered articulation system 1130 may be similar to the powered articulation systems described in U.S. Patent No. 8,517,239, entitled SURGICAL STAPLING INSTRUMENT COMPRISING A MAGNETIC ELEMENT DRIVER, and U.S. Patent No. 9,629,629, entitled CONTROL SYSTEMS FOR SURGICAL INSTRUMENTS which are hereby incorporated herein by reference in their entirety. The powered articulation system 1130 is operably engaged with an articulation motor 1132 of the surgical instrument 1100 such that when power is supplied from the power source 1160 to the articulation motor 1132 the end effector 1102 is articulated about an articulation axis AA (see FIG. 62) relative to an elongate shaft 1118 of the surgical instrument 1100.

[0162] The powered shaft rotation system 1140 comprises a shaft rotation motor 1142 in communication with the control unit 1150. The control unit 1150 is configured such that, when power is supplied from the power source 1160 to the shaft rotation motor 1142, the elongate shaft 1118 and end effector 1102 are rotated about a longitudinal shaft axis SA defined by the elongate shaft 1118. In various alternative embodiments, the elongate shaft 1118 and the end effector 1102 can be manually rotated about the longitudinal shaft axis SA.

[0163] When the surgical instrument 1100 is inserted into a patient cavity, the jaws of the end effector 1102 are in the closed position so that they fit through a trocar or cannula inserted into the patient. After being inserted into the patient cavity, the jaws of

the end effector 1102 are moved from the closed position to the open position by the mechanical closure system 1110. The end effector 1102 can then be articulated about the articulation axis AA by the powered articulation system 1130 to position the jaws of the end effector 1102 relative to patient tissue. An articulation sensor 1134 of the surgical instrument 1100 is in signal communication with the powered articulation system 1130 and the control unit 1150. In the illustrated embodiment, the articulation sensor 1134 is positioned on an articulation rod 1136 of the articulation system 1130 and detects movement of the articulation rod 1136, see FIG. 62. The articulation sensor 1134 is configured to detect when the end effector 1102 is being articulated about the articulation axis AA. In various embodiments, the control unit 1150 is also configured to detect when the end effector 1102 is being articulated as the control unit 1150 controls the articulation motor 1132 driving the articulation system 1130.

[0164] When the end effector 1102 is being articulated, the control unit 1150 prevents power from being supplied to the firing motor 1122. Also, the control unit 1150 actuates a lock solenoid 1170 (see FIG. 63) of the surgical instrument 1100 when the articulation system 1130 is being actuated. The lock solenoid 1170 is in signal communication with the control unit 1150 and comprises a mechanical member or pin 1172 which extends into a portion of the mechanical closure system 1110 to prevent the closure system 1110 form being actuated when the lock solenoid 1170 is actuated. The pin 1172 is retracted to permit the mechanical closure system 1110 to be actuated when the articulation sensor 1134 no longer detects that the end effector 1102 is being articulated.

[0165] In at least one alternative embodiment, when the control unit 1150 supplies power from the power source 1160 to the articulation motor 1132, the control unit 1150 prevents the supply of power to the firing motor 1122 and the lock solenoid 1170 is actuated to engage a carriage 1114 of the mechanical closure system 1110 and prevents the mechanical closure system 1110 from being actuated. In such an arrangement, an articulation sensor may not be necessary.

[0166] After the end effector 1102 has been articulated to the desired orientation, the closure trigger 1112 of the mechanical closure system 1110 can be actuated between the unclamped position and the clamped position to capture tissue between the jaws of

the end effector 1102. The mechanical closure system 1110 comprises a closure sensor 1113 in signal communication with the control unit 1150. The closure sensor 1113 is configured to detect the position of the closure trigger 1112. When the closure sensor 1113 detects that the closure trigger 1113 has been moved from the unclamped position toward the clamped position, the control unit 1150 prevents the supply of power to the firing motor 1122, the articulation motor 1132, and the shaft rotation motor 1142. The control unit 1150 prevents the supply of power to the firing motor 1122 unless the closure sensor 1113 detects that the closure trigger 1113 is in the clamped position (i.e., the jaws of the end effector 1102 are in the closed position). In other words, the control unit 1150 prevents the powered firing system 1120 from firing the end effector 1102 when the jaws of the end effector 1102 are in the open position or when the jaws are partially closed. When the jaws of the end effector 1102 are in the closed position (i.e., the closure trigger 1112 is in the clamped position), the control unit 1150 permits the supply of power to the firing motor 1122 to allow the powered firing system 1120 to perform the firing and retraction strokes within the end effector 1102.

[0167] Further to the above, the control unit 1150 prevents power from being supplied from the power source 1160 to the articulation motor 1132 and the shaft rotation motor 1142 when power is supplied to the firing motor 1122. The control unit 1150 controls the amount and direction of current supplied to the firing motor 1122 to advance the firing member from an unfired position to a fired position during a firing stroke and retract the firing member from the fired position to the unfired position during a retraction stroke after the firing stroke is complete. The firing member is advanced through the end effector 1102 during the firing stroke when the firing motor 1122 is rotated in a first direction when a first voltage polarity is applied to the firing motor 1122 and is retracted through the end effector during the retraction stroke when the firing motor 1122 is rotated in a second direction opposite the first direction when a second voltage polarity opposite the first voltage polarity is applied to the firing motor 1122.

[0168] The surgical instrument 1100 further comprises an encoder, for example, that can track the position of the firing member. The encoder is in communication with the control unit 1150 which can determine whether or not the firing member is in its proximal unfired position. The control unit 1150 prevents the supply of power to the articulation

motor 1132 and the shaft rotation motor 1142 when the firing member is not in its proximal unfired position. Further, the control unit 1150 operates the closure trigger solenoid 1170 to lock the closure system 1110 in its closed configuration when the firing member is distal to its proximal unfired position.

[0169] In at least one embodiment, another solenoid in signal communication with the control unit 1150 and selectively engageable with the closure trigger release prevents the closure trigger release from being actuated to unlock the closure trigger 1112 from its clamped position. More specifically, a solenoid in signal communication with the control unit 1150 may be actuated to mechanically engage the closure trigger release to prevent the closure trigger release from being actuated when the firing member is not in the unfired position.

[0170] In at least one alternative embodiment, the elongate shaft 1118 and end effector 1102 are rotatable about the longitudinal shaft axis SA by a manual rotation system 1140'. To prevent shaft rotation when the jaws of the end effector 1102 are in the process of being closed or when the jaws are closed, referring now to FIG. 64, the carriage 1114 of the mechanical closure system 1110 operably engages the manual rotation system 1140' of the surgical instrument. More specifically, a rotation nozzle 1144 is configured to be manually rotated to rotate the elongate shaft 1118 and the end effector 1102 about the longitudinal shaft axis SA. The rotation nozzle 1144 is journaled on the elongate shaft 1118 such that the elongate shaft 1118 is translatable relative to the rotation nozzle 1144. The carriage 1114 comprises a pin 1119 extending therefrom that is configured to engage the rotation nozzle 1144. The carriage 1114 is moved from a proximal position to a distal position to advance the elongate shaft 1118 and move the jaws of end effector 1102 between the open position and the closed position. When the carriage 1114 is moved from the proximal position toward the distal position, the pin 1119 engages one of a plurality of holes defined in a rotary indexing member 1146 of the rotation nozzle 1144 preventing the elongate shaft 1118 and end effector 1102 from being rotated about the longitudinal shaft axis SA. When the carriage 1114 is retracted from its distal position toward its proximal position, the pin 1119 is disengaged from the nozzle 1144 such that the elongate shaft 1118 and end effector 1102 can be rotated when the rotation nozzle 1144 is rotated.

[0171] As discussed above, the shaft rotation system is a manual shaft rotation system 1140'. See FIG. 64. In such an arrangement, the elongate shaft 1118 and the end effector 1102 are not rotatable about the shaft axis SA unless the jaws of the end effector 1102 are in the open position owing to the lockout that is engaged when the closure system is closed. Further, the powered firing system 1120 cannot perform the firing stroke unless the jaws of the end effector 1102 are in the closed position (i.e., the closure trigger 1112 is in the clamped position) as discussed above. Therefore, when the firing motor 1122 is actuated to move the firing member through the firing stroke and retraction stroke, the manual shaft rotation system 1140' is locked out preventing the elongate shaft 1118 and end effector 1102 from being rotated about the shaft axis SA.

[0172] As described above, the surgical instrument 1100 can comprise a powered shaft rotation system 1140. The powered shaft rotation system 1140 comprises the shaft rotation motor 1142 in communication with the control unit 1150. The control unit 1150 is configured such that, when the end effector 1102 and elongate shaft 1118 are being rotated about the shaft axis SA the mechanical closure system 1110, the powered firing system 1120, and the powered articulation system 1130 are locked out. More specifically, the control unit 1150 actuates the lock solenoid 1170 to prevent the mechanical closure system 1110 from being actuated when the end effector 1102 and elongate shaft 1118 are being rotated. Further, the control unit 1150 prevents power form being supplied to the firing motor 1122 and the articulation motor 1132 when the end effector 1102 and the elongate shaft 1118 are being rotated, for example. In at least one alternative embodiment, the powered shaft rotation system 1140 may be employed in conjunction with a powered closure system, the powered firing system 1120, and the powered articulation system 1130, for example. In such instances, when the powered shaft rotation system 1140 is being actuated (i.e., the end effector 1102 and elongate shaft 1118 are being rotated about the shaft axis) the control unit 1150 prevents power from being supplied to the powered closure system and the powered firing system 1120.

[0173] Various aspects of the subject matter described herein are set out in the following examples.

Example Set 1

[0174] Example 1 - A surgical instrument comprising an end effector and a handle. The handle comprises a drive system configured to actuate the end effector and a battery dock comprising first electrical contacts. The surgical instrument further comprises a battery unit releasably attachable to the battery dock. The battery unit comprises rechargeable battery cells, a non-sterile housing, and a sterile housing. The battery cells are positioned in the non-sterile housing. The sterile housing is configured to receive the non-sterile housing. The sterile housing comprises second electrical contacts configured to electrically couple the battery cells of the non-sterile housing to the first electrical contacts of the battery dock when the battery unit is attached to the battery dock. The sterile housing further comprises a retention member configured to secure the battery unit to the battery dock.

[0175] Example 2 - The surgical instrument of Example 1, wherein the battery cells are positioned in the non-sterile housing such that all of the battery cells are electrically connected at the same time.

[0176] Example 3 - The surgical instrument of Examples 1 or 2, wherein at least one battery cell of the battery cells is selected from the group consisting of a CR123 cell and a CR2 cell.

[0177] Example 4 - The surgical instrument of Examples 1, 2, or 3, wherein the non-sterile housing comprises means for indicating a charging status of the battery unit to a user of the surgical instrument.

[0178] Example 5 - The surgical instrument of Examples 1, 2, 3, or 4, wherein the non-sterile housing comprises a display configured to indicate to a user of the surgical instrument the remaining electrical capacity of the battery cells, and wherein the remaining electrical capacity is displayed as a number of remaining actuations of the drive system.

[0179] Example 6 - The surgical instrument of Examples 1, 2, 3, 4, or 5, wherein the non-sterile housing comprises a display configured to indicate to a user of the surgical instrument the remaining electrical capacity of the battery cells, and wherein the remaining electrical capacity is displayed as the time until the battery cells are drained when the battery cells are discharged at a predetermined voltage, current, or power level.

[0180] Example 7 - The surgical instrument of Examples 1, 2, 3, 4, 5, or 6, wherein the non-sterile housing comprises a control circuit which limits the current draw of the surgical instrument to a predefined threshold.

[0181] Example 8 - A surgical instrument comprising an end effector and a handle. The handle comprises a drive system configured to actuate the end effector and a battery dock comprising first electrical contacts. The surgical instrument further comprises a battery unit releasably attachable to the battery dock. The battery unit comprises rechargeable battery cells, a first housing, and a second housing. The battery cells are positioned in the first housing. The second housing is configured to receive the first housing. The second housing is configured to encapsulate the first housing to create a sterile barrier between the first housing and the second housing. The second housing comprises second electrical contacts and a retention member. The second electrical contacts are configured to electrically couple the battery cells of the first housing to the first electrical contacts of the battery dock when the battery unit is attached to the battery dock. The retention member is configured to secure the battery unit to the battery dock.

[0182] Example 9 - The surgical instrument of Example 8, wherein the battery cells are positioned in the first housing such that all of the battery cells are electrically connected at the same time.

[0183] Example 10 - The surgical instrument of Examples 8 or 9, wherein at least one battery cell of the battery cells is selected from the group consisting of a CR123 cell and a CR2 cell.

[0184] Example 11 - The surgical instrument of Examples 8, 9, or 10, wherein the first housing comprises means for indicating a charging status of the battery unit to a user of the surgical instrument.

[0185] Example 12 - The surgical instrument of Examples 8, 9, 10, or 11, wherein the first housing comprises a display configured to indicate to a user of the surgical instrument the remaining electrical capacity of the battery cells, and wherein the remaining electrical capacity is displayed as a number of remaining actuations of the drive system.

[0186] Example 13 - The surgical instrument of Examples 8, 9, 10, 11, or 12, wherein the first housing comprises a display configured to indicate to a user of the surgical instrument the remaining electrical capacity of the battery cells, and wherein the remaining electrical capacity is displayed as an amount of time until the battery cells are drained if the battery cells are discharged at a predetermined voltage, current, or power level.

[0187] Example 14 - The surgical instrument of Examples 8, 9, 10, 11, 12, or 13, wherein the first housing comprises a control circuit which limits the current draw of the surgical instrument to a predefined threshold.

[0188] Example 15 - A surgical instrument comprising an instrument housing and a power unit releasably attachable to the instrument housing. The instrument housing comprises a battery dock including a first electrical contact. The power unit comprises rechargeable battery cells, a first housing, and a second housing. The battery cells are positioned in the first housing. The first housing is enclosed within the second housing to create a sterile barrier around the first housing. The second housing comprises a second electrical contact and retention means for securing the power unit to the instrument housing. The second electrical contact is configured to electrically couple the battery cells of the first housing to the first electrical contact of the battery dock when the power unit is attached to the instrument housing.

[0189] Example 16 - The surgical instrument of Example 15, wherein at least one battery cell of the battery cells is selected from the group consisting of a CR123 cell and a CR2 cell.

[0190] Example 17 - The surgical instrument of Examples 15 or 16, wherein the first housing comprises means for indicating a charging status of the power unit to a user of the surgical instrument.

[0191] Example 18 - The surgical instrument of Examples 15, 16, or 17, wherein the first housing comprises a display configured to indicate to a user of the surgical instrument the remaining electrical capacity of the battery cells, and wherein the remaining electrical capacity is displayed as a number of remaining uses of the surgical instrument.

[0192] Example 19 - The surgical instrument of Examples 15, 16, 17, or 18, wherein the first housing comprises a display configured to indicate to a user of the surgical instrument the remaining electrical capacity of the battery cells, and wherein the remaining electrical capacity is displayed as an amount of time until the battery cells are drained if the battery cells are discharged at a predetermined voltage, current, or power level.

[0193] Example 20 - The surgical instrument of Examples 15, 16, 17, 18, or 19, wherein the first housing comprises a control circuit which limits the current draw of the surgical instrument to a predefined threshold.

Example Set 2

[0194] Example 1 - A battery pack for use with a surgical instrument. The battery pack comprises an outer housing, electrical contacts configured to electrically couple the battery pack to the surgical instrument when the battery pack is attached to the surgical instrument, a first pair of batteries, a second pair of batteries, an electrical connector configured to electrically connect the first pair of batteries and the second pair of batteries, and an interruption member that prevents the electrical connector from electrically connecting the first pair of batteries and the second pair of batteries until the interruption member is displaced. The electrical connector electrically connects the first pair of batteries and the second pair of batteries when the interruption member is displaced. The first pair of batteries and the second pair of batteries are electrically connected to the surgical instrument when the interruption member is displaced and the battery pack is attached to the surgical instrument.

[0195] Example 2 - The battery pack of Examples 1, wherein the battery pack is packaged in packaging, and wherein the interruption member is displaced when the battery pack is at least partially removed from the packaging.

[0196] Example 3 - The battery pack of Examples 1 or 2, wherein the interruption member comprises a gripable tab extending from the battery pack.

[0197] Example 4 - The battery pack of Examples 1, 2, or 3, wherein the first pair of batteries and the second pair of batteries comprise CR123a batteries.

[0198] Example 5 - The battery pack of Examples 1, 2, 3, or 4, wherein at least one of the batteries is rechargeable.

[0199] Example 6 - The battery pack of Examples 1, 2, 3, 4, or 5, wherein the first pair of batteries and the second pair of batteries are electrically interrupted when the battery pack is detached from the surgical instrument.

[0200] Example 7 - A battery pack for use with a surgical instrument. The battery pack comprises a battery housing, batteries positioned in the battery housing, and an interruption member. The battery housing includes electrical contacts configured to electrically couple the battery pack to the surgical instrument when the battery pack is attached to the surgical instrument. The interruption member is movable from a first position where the interruption member electrically disconnects at least one battery from another battery and a second position. The batteries are electrically connected to the surgical instrument when the interruption member is moved from the first position to the second position and the battery pack is attached to the surgical instrument.

[0201] Example 8 - The battery pack of Example 7, wherein the battery pack is packaged in packaging, and wherein the interruption member is moved from the first position to the second position when the battery pack is at least partially removed from the packaging.

[0202] Example 9 - The battery pack of Examples 7 or 8, wherein the interruption member comprises a gripable tab extending from the battery pack.

[0203] Example 10 - The battery pack of Examples 7, 8, or 9, wherein the batteries comprise CR123a batteries.

[0204] Example 11 - The battery pack of Examples 7, 8, 9, or 10, wherein at least one of the batteries is rechargeable.

[0205] Example 12 - The battery pack of Examples 7, 8, 9, 10, or 11, wherein the batteries are electrically interrupted when the battery pack is detached from the surgical instrument.

[0206] Example 13 - A battery pack for use with a surgical instrument. The battery pack comprises a battery housing, batteries position in the battery housing, an electrical circuit, and a circuit interrupter. The battery housing includes electrical contacts configured to electrically couple the battery pack to the surgical instrument when the battery pack is attached to the surgical instrument. The circuit interrupter is movable from a first position where the circuit interrupter electrically disconnects at least one

battery from the electrical circuit and a second position where all of the batteries are electrically connected to the electrical circuit. The batteries are electrically connected to the surgical instrument when the circuit interrupter is moved from the first position to the second position and the battery pack is attached to the surgical instrument.

[0207] Example 14 - The battery pack of Example 13, wherein the battery pack is packaged in packaging, and wherein the circuit interrupter is moved from the first position to the second position when the battery pack is at least partially removed from the packaging.

[0208] Example 15 - The battery pack of Examples 13 or 14, wherein the circuit interrupter comprises a gripable tab extending from the battery pack.

[0209] Example 16 - The battery pack of Examples 13, 14, or 15, wherein the batteries comprise CR123a batteries.

[0210] Example 17 - The battery pack of Examples 13, 14, 15, or 16, wherein at least one of the batteries is rechargeable.

[0211] Example 18 - The battery pack of Examples 13, 14, 15, 16, or 17, wherein the batteries are electrically interrupted when the battery pack is detached from the surgical instrument.

Example Set 3

[0212] Example 1 - A surgical instrument comprising a staple cartridge, an anvil, a firing member, an elongate channel, and a firing lockout. The staple cartridge comprises a cartridge body, staples, a cartridge pan releasably attached to the staple cartridge, and a sled configured to eject the staples from the staple cartridge. The sled is movable from a proximal position to a distal position. One of the anvil and the staple cartridge is movable relative to the other of the anvil and the staple cartridge. The anvil comprises an anvil slot. The firing member is configured to move the sled from the proximal position to the distal position to eject the staples from the staple cartridge during a firing stroke. The firing member comprises a cutting edge, a first camming member, a second camming member configured to engage the anvil slot during the firing stroke, and a distal protrusion. The elongate channel is configured to receive the staple cartridge. A longitudinal cavity is defined between the cartridge pan and the elongate channel when the staple cartridge is received in the elongate channel. The

longitudinal cavity is configured to receive the first camming member during the firing stroke. The elongate channel comprises a channel opening. The lockout is enabled when the staple cartridge is not positioned in the elongate channel or when the staple cartridge is positioned in the elongate channel and the sled is not in the proximal position. The firing member engages a distal end of the channel opening to prevent the firing member from performing the firing stroke when the lockout is enabled. The lockout is defeated when the sled is in the proximal position and the distal protrusion of the firing member engages the sled and prevents the firing member from engaging the channel opening.

[0213] Example 2 - The surgical instrument of Example 1, wherein the sled is configured to align the first camming member with the longitudinal cavity and the second camming member with the anvil slot when the lockout is defeated.

[0214] Example 3 - The surgical instrument of Examples 1 or 2, wherein the staple cartridge is replaceable.

[0215] Example 4 - The surgical instrument of Examples 1, 2, or 3, wherein the firing member is biased into the channel opening by a biasing member when the lockout is enabled.

[0216] Example 5 - The surgical instrument of Example 4, wherein the sled comprises a proximal camming portion configured to cammingly engage the distal protrusion of the firing member to overcome the force of the biasing member and defeat the lockout.

[0217] Example 6 - The surgical instrument of Examples 1, 2, 3, 4, or 5, wherein the firing member is lifted out of the channel opening by the sled when the lockout is defeated.

[0218] Example 7 - A surgical instrument comprising a staple cartridge, an anvil, a firing member, an elongate channel, and a biasing member. The staple cartridge comprises a cartridge body, staples, a cartridge pan releasably attached to the staple cartridge, and a sled configured to eject the staples from the staple cartridge. The sled is movable from a proximal position to a distal position. One of the anvil and the staple cartridge is movable relative to the other of the anvil and the staple cartridge. The anvil comprises an anvil slot. The firing member is configured to move the sled from the proximal position to the distal position to eject the staples from the staple cartridge

during a firing stroke. The firing member comprises a cutting edge, a first camming member, a second camming member configured to engage the anvil slot during the firing stroke, and a distal protrusion. The elongate channel is configured to receive the staple cartridge. A longitudinal cavity is defined between the cartridge pan and the elongate channel when the staple cartridge is received in the elongate channel. The longitudinal cavity is configured to receive the first camming member during the firing stroke. The elongate channel comprises a channel opening. The biasing member is configured to apply a biasing force to the firing member and move the firing member into the channel opening when the sled is not in the proximal position. The firing member is prevented from performing the firing stroke when the firing member is positioned in the channel opening. The biasing force of the biasing member is overcome when the sled is in the proximal position and engages the distal protrusion of the firing member. The firing member is removed from the channel opening when the sled engages the distal protrusion.

[0219] Example 8 - The surgical instrument of Example 7, wherein the sled is configured to align the first camming member with the longitudinal cavity and the second camming member with the anvil slot when the sled is in the proximal position.

[0220] Example 9 - The surgical instrument of Examples 7 or 8, wherein the staple cartridge is replaceable.

[0221] Example 10 - The surgical instrument of Examples 7, 8, or 9, wherein the sled comprises a proximal camming portion configured to cammingly engage the distal protrusion of the firing member to overcome the biasing force of the biasing member.

[0222] Example 11 - The surgical instrument of Examples 7, 8, 9, or 10, wherein the firing member is lifted out of the channel opening by the sled when the sled is in the proximal position.

[0223] Example 12 - A surgical instrument comprising a staple cartridge, an anvil, a firing member, an elongate channel, and a lockout. The staple cartridge comprises a cartridge body, staples, a cartridge pan releasably attached to the staple cartridge, and a sled configured to eject the staples from the staple cartridge. The sled is movable from a proximal position to a distal position. The sled comprises a proximal camming portion. One of the anvil and the staple cartridge is movable relative to the other of the

anvil and the staple cartridge. The anvil comprises an anvil slot. The firing member is configured to move the sled from the proximal position to the distal position to eject the staples from the staple cartridge during a firing stroke. The firing member comprises, a cutting edge, a first camming member, a second camming member configured to engage the anvil slot during the firing stroke, and a distal protrusion. The elongate channel is configured to receive the staple cartridge. A longitudinal cavity is defined between the cartridge pan and the elongate channel when the staple cartridge is received in the elongate channel. The longitudinal cavity is configured to receive the first camming member during the firing stroke. The elongate channel comprises a channel opening. The lockout is configured to prevent the firing member from performing the firing stroke when the sled is not in the proximal position. The firing member is configured to engage the channel opening when the sled is not in the proximal position. The lockout is further configured to permit the firing member to perform the firing stroke when the staple cartridge is positioned in the elongate channel, the sled is in the proximal position, and the proximal camming portion of the sled engages the distal protrusion of the firing member and moves the firing member out of engagement with the channel opening.

[0224] Example 13 - The surgical instrument of Example 12, wherein the sled is configured to align the first camming member with the longitudinal cavity and the second camming member with the anvil slot when the proximal camming portion engages the distal protrusion of the firing member.

[0225] Example 14 - The surgical instrument of Examples 12 or 13, wherein the staple cartridge is replaceable.

[0226] Example 15 - The surgical instrument of Examples 12, 13, or 14, wherein the firing member is biased into the channel opening by a biasing member when the sled is not in the proximal position.

[0227] Example 16 - The surgical instrument of Example 15, wherein the proximal camming portion of the sled is configured to cammingly engage the distal protrusion of the firing member to overcome the force of the biasing member to permit the firing member to perform the firing stroke.

[0228] Example 17 - The surgical instrument of Examples 12, 13, 14, 15, or 16, wherein the firing member is lifted toward the anvil when the proximal camming portion engages the distal protrusion of the firing member.

Example Set 4

[0229] Example 1 - A surgical instrument comprising an elongate channel, an anvil, a staple cartridge, a firing member, and a lockout key. The elongate channel comprises a lock shoulder. The staple cartridge comprises staples and a sled movable from a proximal end position to an intermediate position and then to a distal position during a staple firing stroke. The firing member is movable distally to advance the sled through the staple cartridge during the staple firing stroke to eject the staples from the staple cartridge. The firing member comprises a cutting edge, a first camming member configured to engage the elongate channel during the staple firing stroke, and a second camming member configured to engage the anvil during the staple firing stroke, and a lockout key movably mounted to the sled. The lockout key is movable between an unactuated position and an actuated position during the staple firing stroke. The key lifts the firing member over the lock shoulder when the lockout key is moved from the unactuated position toward the actuated position.

[0230] Example 2 - The surgical instrument of Example 1, wherein the lockout key comprises a rotary member configured to rotate relative to the sled, and wherein the rotary member is movable between a starting position and a rotated position when the sled is moved from the proximal end position to the intermediate position.

[0231] Example 3 - The surgical instrument of Example 2, wherein the rotary member lifts the firing member over the lock shoulder when the sled is moved from the proximal end position to the intermediate position.

[0232] Example 4 - The surgical instrument of Examples 2 or 3, wherein the staple cartridge further comprises a protrusion configured to engage the rotary member to move the rotary member from the starting position to the rotated position when the sled is moved from the proximal end position to the intermediate position.

[0233] Example 5 - The surgical instrument of Examples 1, 2, 3, or 4, wherein the firing member comprises a laterally extending member intermediate the first camming member and the second camming member, and wherein the lockout key lifts the

laterally extending member over the lock shoulder when the lockout key is moved from the unactuated position toward the actuated position.

[0234] Example 6 - The surgical instrument of Examples 1, 2, 3, 4, or 5, wherein the staple cartridge is replaceable.

[0235] Example 7 - A surgical instrument comprising an elongate channel, an anvil, a staple cartridge, a firing member, and a lockout key. The elongate channel comprises a blocking member. The staple cartridge comprises staples and a sled movable from a proximal end position to an intermediate position and then to a distal position during a staple firing stroke. The firing member is movable distally to advance the sled through the staple cartridge during the staple firing stroke to eject the staples from the staple cartridge. The firing member comprises a cutting edge. The lockout key is movably mounted to the sled. The lockout key is movable between an unactuated position and an actuated position during the staple firing stroke. The lockout key lifts the firing member over the blocking member when the lockout key is moved from the unactuated position toward the actuated position.

[0236] Example 8 - The surgical instrument of Example 7, wherein the lockout key comprises a rotary member configured to rotate relative to the sled, and wherein the rotary member is movable from a starting position and a rotated position when the sled is moved from the proximal end position to the intermediate position.

[0237] Example 9 - The surgical instrument of Example 8, wherein the rotary member lifts the firing member over the blocking member when the sled is moved from the proximal end position toward the intermediate position.

[0238] Example 10 - The surgical instrument of Examples 8 or 9, wherein the staple cartridge further comprises a protrusion configured to engage the rotary member and move the rotary member from the starting position to the rotated position when the sled is moved from the proximal end position to the intermediate position.

[0239] Example 11 - The surgical instrument of Examples 7, 8, 9, or 10, wherein the staple cartridge is replaceable.

[0240] Example 12 - A surgical instrument comprising an anvil, a staple cartridge, an elongate channel, and a firing member. The staple cartridge comprises staples and a sled movable from a proximal end position to an intermediate position and then to a

distal end position during a staple firing stroke. The elongate channel is configured to receive the staple cartridge. The elongate channel comprises a lock shoulder. The firing member is movable distally to advance the sled through the staple cartridge during the staple firing stroke to eject the staples from the staple cartridge. The sled is configured to transition the firing member from a locked configuration where the firing member is prevented from distally advancing by the lock shoulder and an unlocked configuration where the firing member is permitted to distally advance. The firing member is transitioned from the locked configuration to the unlocked configuration when the sled is moved from the proximal end position to the intermediate position.

[0241] Example 13 - The surgical instrument of Example 12, wherein the firing member is in the locked configuration when the staple cartridge is not present in the elongate channel.

[0242] Example 14 - The surgical instrument of Examples 12 or 13, wherein the lock shoulder comprises a distal end of an opening in the elongate channel.

[0243] Example 15 - The surgical instrument of Examples 12, 13, or 14, wherein the firing member further comprises a cutting edge, a first camming member configured to engage the anvil during the staple firing stroke, and a second camming member configured to engage the elongate channel during the staple firing stroke.

[0244] Example 16 - The surgical instrument of Example 12, wherein the firing member is biased into the locked configuration by a biasing member, and wherein the biasing member imparts a biasing force on the firing member.

[0245] Example 17 - The surgical instrument of Example 16, wherein the sled is configured to lift the firing member over the lock shoulder and overcome the biasing force of the biasing member when the sled moves from the proximal end position to the intermediate position.

[0246] Example 18 - The surgical instrument of Examples 12, 13, 14, 15, 16, or 17, wherein the sled comprises a lockout key movable from an unactuated position to an actuated position when the sled is moved from the proximal end position to the intermediate position, and wherein the lockout key lifts the firing member over the lock shoulder when the lockout key is moved toward the actuated position.

[0247] Example 19 - The surgical instrument of Example 18, wherein the lockout key is configured to engage a protrusion in the staple cartridge to move the lockout key from the unactuated position to the actuated position.

[0248] Example 20 - The surgical instrument of Examples 12, 13, 14, 15, 16, 17, 18, or 19, wherein the staple cartridge is replaceable.

Example Set 5

[0249] Example 1 - A surgical instrument for fastening and stapling tissue. The surgical instrument comprises an end effector, a firing member, and a housing. The firing member is configured to move relative to the end effector during a firing stroke. The housing comprises a drive rack operably engaged with the firing member, a drive gear operably engaged with the drive rack, and a brushless motor operably engaged with the drive gear. The brushless motor is configured to transmit rotary motions to the drive gear. The housing further comprises a power source configured to supply power to the brushless motor, an access opening, an access door covering the access opening, a control circuit configured to control the supply of power from the power source to the brushless motor, and a bailout lever accessible by a user of the surgical instrument through the access opening. The bailout lever is configured to be manually actuated by the user of the surgical instrument between an unactuated position and an actuated position to retract the drive rack and the firing member. The brushless motor is back-driven when the bailout lever is moved from the unactuated position toward the actuated position.

[0250] Example 2 - The surgical instrument of Example 1, wherein the control circuit comprises a bailout switch, wherein the bailout switch is in a closed state when the access door is closed, and wherein the bailout switch is in an open state when the access door is open.

[0251] Example 3 - The surgical instrument of Example 2, wherein the control circuit is configured to permit power to flow from the power source to the brushless motor when the bailout switch is in the closed state, and wherein the control circuit is configured to prevent power from flowing to the brushless motor from the power source when the bailout switch is in the open state.

[0252] Example 4 - The surgical instrument of Examples 1, 2, or 3, wherein the control circuit comprises a pulse width modulation control circuit configured to control the speed of the brushless motor during the firing stroke.

[0253] Example 5 - The surgical instrument of Examples 1, 2, 3, or 4, wherein the power source comprises a replaceable battery pack.

[0254] Example 6 - The surgical instrument of Examples 1, 2, 3, 4, or 5, wherein the brushless motor comprises a brushless DC motor.

[0255] Example 7 - The surgical instrument of Examples 1, 2, 3, 4, 5, or 6, wherein the firing member is configured to perform multiple the firing strokes.

[0256] Example 8 - A surgical instrument for fastening and cutting tissue. The surgical instrument comprises a firing member, a drive assembly, a control circuit, and a bailout lever. The firing member is movable distally during a firing stroke. The drive assembly comprises a drive rack operably engaged with the firing member, a drive gear operably engaged with the drive rack, and a brushless motor operably engaged with the drive gear. The brushless motor is configured to transmit rotary motions to the drive gear. The control circuit is configured to control the supply of power from a power source to the brushless motor. The bailout lever is configured to be manually actuated by a user of the surgical instrument between an unactuated position and an actuated position to retract the firing member. The brushless motor is back-driven when the bailout lever is moved from the unactuated position to the actuated position.

[0257] Example 9 - The surgical instrument of Example 8, further comprising a housing configured to receive the drive assembly. The housing comprises an access opening and an access door covering the access opening.

[0258] Example 10 - The surgical instrument of Example 9, wherein the bailout lever is accessible by the user of the surgical instrument through the access opening when the access door is removed.

[0259] Example 11 - The surgical instrument of Example 10, wherein the control circuit comprises a bailout switch, wherein the bailout switch is in a closed state when the access door is covering the access opening, and wherein the bailout switch is in an open state when the access door is removed.

[0260] Example 12 - The surgical instrument of Example 11, wherein the control circuit is configured to permit power to flow from the power source to the brushless motor when the bailout switch is in the closed state, and wherein the control circuit is further configured to prevent power from flowing to the brushless motor from the power source when the bailout switch is in the open state.

[0261] Example 13 - The surgical instrument of Examples 8, 9, 10, 11, or 12, wherein the control circuit comprises a pulse width modulation control circuit configured to control the speed of the brushless motor at various times during the firing stroke.

[0262] Example 14 - The surgical instrument of Examples 8, 9, 10, 11, 12, or 13, wherein the power source comprises a replaceable battery pack.

[0263] Example 15 - The surgical instrument of Examples 8, 9, 10, 11, 12, 13, or 14, wherein the power source comprises a battery.

[0264] Example 16 - The surgical instrument of Examples 8, 9, 10, 11, 12, 13, 14, or 15, further comprising an end effector comprising a staple cartridge including a plurality of staples configured to be ejected from the staple cartridge during the firing stroke.

[0265] Example 17 - A surgical instrument for fastening and cutting tissue. The surgical instrument comprises a firing member, a housing, a bailout lever, and a control circuit. The firing member is movable through a firing stroke. The housing comprises a drive rack operably engaged with the firing member, a drive gear operable engaged with the drive rack, and a brushless motor operably engaged with the drive gear. The brushless motor is configured to transmit rotary motions to the drive gear. The housing further comprises an access opening and a cover releasably attached to the housing to cover the access opening. The bailout lever is accessible by a user of the surgical instrument through the access opening when the cover is detached from the housing. The bailout lever is configured to be manually actuated by the user of the surgical instrument between an unactuated position and an actuated position to retract the firing member. The brushless motor is back-driven when the bailout lever is moved from the unactuated position to the actuated position. A control circuit configured to control the supply of power from a power source to the brushless motor. The control circuit is configured to prevent the power source from supplying power to the brushless motor when the cover is detached from the housing.

[0266] Example 18 - The surgical instrument of Example 17, wherein the control circuit comprises a pulse width modulation control circuit configured to control the speed of the brushless motor at various times during the firing stroke.

[0267] Example 19 - The surgical instrument of Examples 17 or 18, wherein the power source comprises a replaceable battery pack.

[0268] Example 20 - The surgical instrument of Examples 17, 18, or 19, wherein the power source comprises a battery.

Example Set 6

[0269] Example 1 - A surgical instrument comprising a handle, an elongate shaft, an end effector, an articulation joint, an articulation knob, a first articulation member, a second articulation member, and an articulation lock. The elongate shaft extends from the handle and defines a shaft axis. The end effector comprising a plurality of detents. The end effector is rotatably coupled to the elongate shaft by the articulation joint about an articulation axis. The articulation knob is rotatable between an unarticulated position and articulation positions. The first articulation member is attached to a first side of the end effector and to the articulation knob. The second articulation member is attached to a second side of the end effector and to the articulation knob. The articulation lock comprises a lock member configured to move between a locked position where the lock member is engaged with a detent of the end effector and an unlocked position where the lock member is disengaged from the end effector. The lock member is movable between the locked position and the unlocked position by the articulation knob. The first articulation member and the second articulation member are moved in opposite directions to articulate the end effector about the articulation axis when the articulation knob is moved from the unarticulated position toward an articulated position.

[0270] Example 2 - The surgical instrument of Example 1, wherein the lock member is moved proximally when the lock member moves from the locked position to the unlocked position.

[0271] Example 3 - The surgical instrument of Examples 1 or 2, wherein the lock member is biased into the locked position by a biasing member.

[0272] Example 4 - The surgical instrument of Examples 1, 2, or 3, wherein the lock member comprises a carriage including a protrusion configured to engage the articulation knob, and wherein the carriage surrounds a portion of the articulation knob.

[0273] Example 5 - The surgical instrument of Example 4, wherein the articulation knob comprises a plurality of knob detents, and wherein a knob detent engages the protrusion and moves the carriage and the lock member proximally when the articulation knob is moved from the unarticulated position toward an articulated position.

[0274] Example 6 - The surgical instrument of Examples 1, 2, 3, 4, or 5, wherein the end effector comprises a staple cartridge.

[0275] Example 7 - A surgical instrument comprising a handle, an elongate shaft, an end effector, an articulation joint, an articulation knob, a first articulation member, a second articulation member, and an articulation lock. The elongate shaft extends from the handle and defines a shaft axis. The end effector comprising a plurality of detents. The end effector is rotatably coupled to the elongate shaft by the articulation joint about an articulation axis. The articulation knob is rotatable between an unarticulated position and articulation positions. The first articulation member is attached to a first side of the end effector and to the articulation knob. The second articulation member is attached to a second side of the end effector and to the articulation knob. Rotation of the articulation knob moves the first articulation member and the second articulation member in opposite directions to articulate the end effector about the articulation axis. The articulation lock comprises a distal lock member and a proximal lock member. The distal lock member is selectively engageable with the end effector. The end effector is prevented from rotating when the distal lock member is engaged with the end effector. The proximal lock member is operably engaged with the articulation knob. The articulation lock is configured to be transitioned between a locked state where the distal lock member is engaged with the end effector and an unlocked state where the distal lock member is disengaged with the end effector. Rotation of the articulation knob between the unarticulated position and an articulated position transitions the articulation lock from the locked state to the unlocked state and then into the locked state again.

[0276] Example 8 - The surgical instrument of Example 7, wherein the proximal lock member is moved proximally when the articulation lock transitions from the locked state to the unlocked state.

[0277] Example 9 - The surgical instrument of Examples 7 or 8, wherein the articulation lock is biased into the locked state by a biasing member.

[0278] Example 10 - The surgical instrument of Examples 7, 8, or 9, wherein the proximal lock member comprises a carriage including a protrusion configured to engage the articulation knob, and wherein the carriage surrounds a portion of the articulation knob.

[0279] Example 11 - The surgical instrument of Example 10, wherein the articulation knob comprises a plurality of knob detents, and wherein a knob detent engages the protrusion and moves the carriage and the proximal lock member proximally when the articulation knob is moved from the unarticulated position toward an articulated position.

[0280] Example 12 - The surgical instrument of Examples 7, 8, 9, 10, or 11, wherein the end effector comprises a staple cartridge.

[0281] Example 13 - A surgical instrument comprising a handle, an elongate shaft, an end effector, an articulation joint, an articulation knob, an articulation member, and an articulation lock. The elongate shaft extends from the handle and defines a shaft axis. The end effector comprises a plurality of detents. The end effector is rotatably coupled to the elongate shaft by the articulation joint about an articulation axis. The articulation knob is rotatable between an un-rotated position and rotated positions. The articulation member is attached to the end effector and to the articulation knob. The articulation member is movable between a proximal position and a distal position. The articulation lock comprises a lock member configured to move between a locked position where the lock member is engaged with a detent of the end effector and an unlocked position where the lock member is disengaged from the end effector. The lock member is movable between the locked position and the unlocked position by the articulation knob. The articulation member is moved between the proximal position and the distal position to articulate the end effector about the articulation axis when the articulation knob is moved from the un-rotated position toward a rotated position.

[0282] Example 14 - The surgical instrument of Example 13, wherein the lock member comprises a carriage including a protrusion configured to engage the articulation knob, and wherein the carriage surrounds a portion of the articulation knob.

[0283] Example 15 - The surgical instrument of Example 14, wherein the articulation knob comprises a plurality of knob detents, and wherein a knob detent engages the protrusion and moves the carriage and the lock member proximally when the articulation knob is moved from the un-rotated position toward a rotated position.

[0284] Example 16 - The surgical instrument of Examples 13, 14, or 15, wherein the end effector comprises a staple cartridge.

[0285] Example 17 - A surgical instrument comprising a handle, an elongate shaft, an end effector, an articulation joint, an articulation knob, an articulation member, and an articulation lock. The elongate shaft extends from the handle and defines a shaft axis. The end effector comprises a plurality of detents. The end effector is rotatably coupled to the elongate shaft by the articulation joint about an articulation axis. The articulation knob is rotatable between an un-rotated position and rotated positions. The articulation member is attached to the end effector and to the articulation knob. The articulation member is movable between a proximal position and a distal position. The articulation lock comprises a distal lock member and a proximal lock member. The distal lock member is selectively engageable with the end effector. The end effector is prevented from rotating when the distal lock member is engaged with the end effector. The proximal lock member is operably engaged with the articulation knob. The articulation lock is configured to be transitioned between a locked state where the distal lock member is engaged with the end effector and an unlocked state where the distal lock member is disengaged with the end effector. Rotation of the articulation knob between the un-rotated position and a rotated position transitions the articulation lock from the locked state to the unlocked state and then into the locked state again.

[0286] Example 18 - The surgical instrument of Example 17, wherein the proximal lock member comprises a carriage including a protrusion configured to engage the articulation knob, and wherein the carriage surrounds a portion of the articulation knob.

[0287] Example 19 - The surgical instrument of Example 18, wherein the articulation knob comprises a plurality of knob detents, and wherein a knob detent engages the

protrusion and moves the carriage and the proximal lock member proximally when the articulation knob is moved from the un-rotated position toward a rotated position.

[0288] Example 20 - The surgical instrument of Examples 17, 18, or 19, wherein the end effector comprises a staple cartridge.

Example Set 7

[0289] Example 1 - A powered surgical stapler for stapling and cutting tissue comprising a handle, an elongate shaft extending from the handle, an end effector extending from the elongate shaft, a firing member, and an articulation joint. The a handle comprises a motor configured to generate a rotary motion, a battery pack configured to supply power to the motor, and a control circuit configured to control the supply of power from the battery pack to the motor. The control circuit comprises conformal coating which seals the control circuit from the environment. The handle further comprises a firing trigger and a closure trigger. The firing trigger is movable between an unactuated position and an actuated position. The closure trigger is movable between an unclamped position and a clamped position. The end effector comprises an elongate channel and an anvil. The elongate channel is configured to receive a staple cartridge. The staple cartridge comprises a plurality of staples removably stored in the staple cartridge. The anvil is movable relative to the elongate channel between an open position and a closed position. The end effector is configured to capture patient tissue between the anvil and the staple cartridge when the anvil is moved toward the closed position. The anvil is moved from the open position toward the closed position when the closure trigger is moved from the unclamped position toward the clamped position. The firing member is movable from an unfired position to a fired position to eject the staples from the staple cartridge and cut the patient tissue during a firing stroke. The firing member is configured to perform the firing stroke when the firing trigger is moved from the unactuated position toward the actuated position. The firing member can only perform the firing stroke when the closure trigger is in the clamped position. The end effector is configured to rotate relative to the elongate shaft about the articulation joint.

[0290] Example 2 - The powered surgical stapler of Example 1, wherein the conformal coating is configured to survive a sterilization autoclave cycle.

[0291] Example 3 - The powered surgical stapler of Example 2, wherein the sterilization autoclave cycle includes a temperature range of 140 degrees Celsius to 170 degrees Celsius.

[0292] Example 4 - The powered surgical stapler of Examples 1, 2, or 3, wherein the conformal coating comprises a sealant flowed onto the control circuit.

[0293] Example 5 - The powered surgical stapler of Examples 1, 2, 3, or 4, wherein the control circuit comprises a switch and an elastomer diaphragm covering the switch, wherein the elastomer diaphragm is configured to seal the switch from the environment.

[0294] Example 6 - The powered surgical stapler of Example 5, wherein the switch comprises a manually actuatable rocker switch.

[0295] Example 7 - The powered surgical stapler of Examples 5 or 6, further comprising a gasket seal positioned between the switch and the conformal coating, wherein the gasket seal is configured to seal the control circuit from the environment.

[0296] Example 8 - The powered surgical stapler of Examples 1, 2, 3, 4, 5, 6, or 7, wherein the control circuit comprises an electrical port, wherein the powered surgical stapler further comprises an electrical harness electrically connected to the electrical port and a gasket seal positioned between the electrical port and the electrical harness, and wherein the gasket seal is configured to seal the control circuit from the environment.

[0297] Example 9 - A powered surgical stapler for stapling and cutting tissue. The powered surgical stapler comprises a handle. The handle comprises a motor, a control circuit, a firing trigger, and a closure trigger. The motor is configured to generate a rotary motion. The control circuit is configured to control the supply of power from a power source to the motor. The control circuit comprises a printed circuit board, electrical components mounted to the printed circuit board, and a coating over the printed circuit board and the electrical components which seals the control circuit from the environment. The firing trigger is movable between an unactuated position and an actuated position. The closure trigger is movable between an unclamped position and a clamped position.

[0298] Example 10 - The powered surgical stapler of Example 9, wherein the coating is configured to survive a sterilization autoclave cycle.

[0299] Example 11 - The powered surgical stapler of Example 10, wherein the sterilization autoclave cycle includes a temperature range of 140 degrees Celsius to 170 degrees Celsius.

[0300] Example 12 - The powered surgical stapler of Examples 9, 10, or 11, wherein the coating comprises a sealant flowable onto the control circuit.

[0301] Example 13 - The powered surgical stapler of Examples 9, 10, 11, or 12, wherein the control circuit comprises a switch and an elastomer diaphragm covering the switch, wherein the elastomer diaphragm is configured to seal the switch from the environment.

[0302] Example 14 - The powered surgical stapler of Example 13, wherein the switch comprises a manually actuatable rocker switch.

[0303] Example 15 - The powered surgical stapler of Examples 13 or 14, further comprising a gasket seal positioned between the switch and the coating, wherein the gasket seal is configured to seal the control circuit from the environment.

[0304] Example 16 - The powered surgical stapler of Examples 9, 10, 11, 12, 13, 14, or 15, wherein the control circuit comprises an electrical port, wherein the powered surgical stapler further comprises an electrical harness electrically connected to the electrical port and a gasket seal positioned between the electrical port and the electrical harness, and wherein the gasket seal is configured to seal the control circuit from the environment.

[0305] Example 17 - A powered surgical stapler for stapling and cutting tissue. The powered surgical staple comprises a handle, an elongate shaft extending from the handle, an end effector extending from the elongate shaft, and a firing member. The handle comprises a motor, a power pack, a control circuit, a firing trigger, and a closure trigger. The motor is configured to generate a rotary motion. The power pack is configured to supply power to the motor. The power pack is releasably attachable to the handle. The control circuit is configured to control the supply of power from the power pack to the motor. The control circuit comprises conformal coating which prevents the control circuit from being exposed to the surrounding environment. The firing trigger is movable between an unactuated position and an actuated position. The closure trigger is movable between an unclamped position and a clamped position. The

end effector comprises a first jaw, a second jaw, and an elongate channel. The second jaw is movable relative to the first jaw between an open position and a closed position to clamp patient tissue between the first jaw and the second jaw. The second jaw is moved from the open position toward the closed position when the closure trigger is moved from the unclamped position toward the clamped position. The elongate channel is configured to receive a staple cartridge. The staple cartridge comprises a plurality of staples removably stored in the staple cartridge. The firing member is movable from an unfired position to a fired position to eject the staples from the staple cartridge and cut the patient tissue during a firing stroke. The firing member is configured to perform the firing stroke when the firing trigger is moved from the unactuated position toward the actuated position. The firing member can only perform the firing stroke when the closure trigger is in the clamped position.

[0306] Example 18 - The powered surgical stapler of Example 17, wherein the conformal coating is configured to survive a sterilization autoclave cycle.

[0307] Example 19 - The powered surgical stapler of Example 18, wherein the sterilization autoclave cycle includes a temperature range of 140 degrees Celsius to 170 degrees Celsius.

[0308] Example 20 - The powered surgical stapler of Examples 17, 18, or 19, wherein the conformal coating comprises a sealant flowed onto the control circuit.

Example Set 8

[0309] Example 1 - A sterile packaging assembly configured to receive a surgical instrument. The sterile packaging assembly comprises a vacuum-molded tray and a particulate trap. The vacuum-molded tray comprises an instrument cavity configured to receive the surgical instrument, and a trap cavity. The particulate trap is positioned in the trap cavity. The particulate trap comprises a housing including a funnel shaped side terminating in an opening. The opening is in communication with a chamber defined in the particulate trap.

[0310] Example 2 - The sterile packaging assembly of Example 1, wherein the particulate trap further comprises an adhesive positioned in the chamber.

[0311] Example 3 - The sterile packaging assembly of Examples 1 or 2, wherein the particulate trap is opaque.

[0312] Example 4 - The sterile packaging assembly of Examples 1, 2, or 3, wherein the particulate trap is the same color as the vacuum-molded tray.

[0313] Example 5 - The sterile packaging assembly of Examples 1, 2, 3, or 4, wherein the particulate trap further comprises a soundproofing material.

[0314] Example 6 - The sterile packaging assembly of Examples 1, 2, 3, 4, or 5, wherein the housing comprises another funnel shaped side terminating in another opening in communication with the chamber.

[0315] Example 7 - The sterile packaging assembly of Examples 1, 2, 3, 4, 5, or 6, wherein the particulate trap is not visible when the surgical instrument is positioned in the sterile packaging assembly.

[0316] Example 8 - The sterile packaging assembly of Examples 1, 2, 3, 4, 5, 6, or 7, wherein the vacuum-molded tray comprises another trap cavity, wherein the sterile packing assembly comprises another particulate trap positioned in the another trap cavity.

[0317] Example 9 - A sterile packaging assembly configured to receive a surgical instrument. The sterile packaging assembly comprises a tray and a hollow particulate trap. The tray comprises an instrument cavity configured to receive the surgical instrument, and a trap cavity. The hollow particulate trap is positioned in the trap cavity. The hollow particulate trap comprises a funnel shaped surface terminating in an opening.

[0318] Example 10 - The sterile packaging assembly of Example 9, further comprising an adhesive positioned inside the hollow particulate trap.

[0319] Example 11 - The sterile packaging assembly of Examples 9 or 10, wherein the hollow particulate trap is opaque.

[0320] Example 12 - The sterile packaging assembly of Examples 9, 10, or 11, wherein the hollow particulate trap is the same color as the tray.

[0321] Example 13 - The sterile packaging assembly of Examples 9, 10, 11, or 12, wherein the hollow particulate trap further comprises a soundproofing material.

[0322] Example 14 - The sterile packaging assembly of Examples 9, 10, 11, 12, or 13, wherein the hollow particulate trap further comprises another funnel shape surface terminating in another opening.

[0323] Example 15 - The sterile packaging assembly of Examples 9, 10, 11, 12, 13, or 14, wherein the hollow particulate trap is not visible when the surgical instrument is positioned in the tray.

[0324] Example 16 - The sterile packaging assembly of Examples 9, 10, 11, 12, 13, 14, or 15, wherein the tray further comprises another trap cavity, wherein the sterile packing assembly further comprises another hollow particulate trap positionable in the another trap cavity.

[0325] Example 17 - A sterile packaging assembly comprising a surgical instrument, a tray, and a particulate trap. The tray comprises an instrument cavity configured to receive the surgical instrument, and a trap cavity. The particulate trap is positioned in the trap cavity. The particulate trap comprises a funnel shaped surface terminating in an opening. The opening is in communication with a chamber defined in the particulate trap.

[0326] Example 18 - The particulate trap of Example 17, further comprising an adhesive positioned in the chamber, wherein the adhesive is configured to trap particulates thereto.

[0327] Example 19 - The particulate trap of Examples 17 or 18, wherein the particulate trap is opaque.

[0328] Example 20 - The particulate trap of Examples 17, 18, or 19, wherein the particulate trap further comprises a soundproofing material.

Example Set 9

[0329] Example 1 - A staple cartridge comprising a cartridge body, a longitudinal slot defined in the cartridge body, and a deck surface positioned on a first side of the longitudinal slot. The deck surface comprises a plurality of staple cavity openings. The staple cartridge further comprises staples removable stored in the staple cavity openings, a honeycomb extension extending above the deck surface, and a plurality of through holes defined in the honeycomb extension. Each through hole is aligned with a corresponding staple cavity opening. Each through hole is larger than the corresponding staple cavity opening. The through holes are configured to prevent the flow of tissue when the staples are ejected from the staple cavity openings during a staple firing stroke.

[0330] Example 2 - The staple cartridge of Example 1, wherein each staple cavity opening defines a first perimeter, wherein each through hole defines a second perimeter, and wherein the second perimeter is partially aligned with the first perimeter.

[0331] Example 3 - The staple cartridge of Examples 1 or 2, wherein the deck surface comprises a first deck surface, and wherein the staple cartridge further comprises a second deck surface positioned below the first deck surface.

[0332] Example 4 - The staple cartridge of Example 3, wherein the second deck surface comprises a second overall surface area which is smaller than a first overall surface area of the first deck surface.

[0333] Example 5 - The staple cartridge of Examples 3 or 4, wherein the second deck surface does not surround any of the staple cavity openings.

[0334] Example 6 - A staple cartridge comprising a cartridge body, a longitudinal slot defined in the cartridge body, and a deck surface positioned on a first side of the longitudinal slot. The deck surface comprises a plurality of staple cavity openings. The staple cartridge further comprises staples removably stored in the staple cavity openings. The staple cartridge further comprises a lattice extension extending above the deck surface. The lattice extension comprises a plurality of through holes defined in the lattice extension. Each through hole is aligned with a corresponding staple cavity opening. Each through hole is larger than the corresponding staple cavity opening. The through holes are configured to prevent the flow of tissue when the staples are fired.

[0335] Example 7 - The staple cartridge of Example 6, wherein each staple cavity opening defines a first perimeter, wherein each through hole defines a second perimeter, and wherein the second perimeter is partially aligned with the first perimeter.

[0336] Example 8 - The staple cartridge of Examples 6 or 7, wherein the deck surface comprises a first deck surface, and wherein the staple cartridge further comprises a second deck surface positioned below the first deck surface.

[0337] Example 9 - The staple cartridge of Example 8, wherein the second deck surface comprises a second overall surface area which is smaller than a first overall surface area of the first deck surface.

[0338] Example 10 - The staple cartridge of Examples 8 or 9, wherein the second deck surface does not surround any of the staple cavity openings.

[0339] Example 11 - A staple cartridge for use with a surgical instrument including an anvil. One of the staple cartridge and the anvil is movable relative to the other of the staple cartridge and the anvil between an open position and a closed position. The staple cartridge comprises a cartridge body, a longitudinal slot defined in the cartridge body, and a staple cartridge deck defined in the cartridge body. The staple cartridge deck comprises a first deck surface and a second deck surface. The first deck surface comprises a plurality of openings. The first surface is positioned a first distance from the anvil when the staple cartridge and the anvil are in the closed position. The second deck surface comprises a plurality of staple cavity openings. The second surface is positioned a second distance from the anvil when the staple cartridge and the anvil are in the closed position. The second distance is greater than the first distance. Each opening of the first surface is aligned with a corresponding staple cavity opening of the second surface. The openings of the first surface are larger than the staple cavity openings of the second surface. The openings of the first surface are configure to prevent the flow of tissue when the staple cartridge is fired.

[0340] Example 12 - The staple cartridge of Example 11, wherein the openings of the first surface are arranged in a honeycomb pattern.

[0341] Example 13 - The staple cartridge of Examples 11 or 12, wherein the openings of the first surface are a different shape than the staple cavity openings of the second surface.

[0342] Example 14 - The staple cartridge of Examples 11, 12, or 13, wherein the staple cavity openings of the second surface are the same shape, and wherein the openings of the first surface are a different shape than the same shape.

[0343] Example 15 - The staple cartridge of Examples 11, 12, 13, or 14, wherein an opening of the first surface is a different size than another opening of the first surface.

[0344] Example 16 - The staple cartridge of Examples 11, 12, 13, 14, or 15, wherein an opening of the first surface defines a first shape, wherein another opening of the first surface defines a second shape, and wherein the first shape and the second shape are different.

[0345] Example 17 - The staple cartridge of Examples 11, 12, 13, 14, 15, or 16, further comprising a third deck surface positioned below the first deck surface and the second deck surface.

[0346] Example 18 - The staple cartridge of Example 17, wherein the third deck surface comprises a second overall surface area which is smaller than an overall surface area of the second deck surface.

[0347] Example 19 - The staple cartridge of Examples 17 or 18, wherein the third deck surface does not surround any of the openings of the first deck surface or the staple cavity openings of the second deck surface.

[0348] Example 20 - The staple cartridge of Examples 17, 18, or 19, wherein the first deck surface, the second deck surface, and the third deck surface are positioned on one side of the longitudinal slot.

Example Set 10

[0349] Example 1 - A staple cartridge comprising a cartridge body. The cartridge body comprises a longitudinal slot, a deck surface, and a plurality of staple cavities defined in the cartridge body. The cartridge body further comprises a plurality of cylindrical projections extending from the deck surface. The outer diameter of each cylindrical projection is flush with one of a proximal end wall and a distal end wall of each staple cavity. The staple cartridge further comprises staples removably stored in the staple cavities.

[0350] Example 2 - The staple cartridge of Example 1, wherein the cylindrical projections are not interconnected above the deck surface.

[0351] Example 3 - The staple cartridge of Examples 1 or 2, wherein each cylindrical projection comprises an end chamfer.

[0352] Example 4 - The staple cartridge of Examples 1, 2, or 3, wherein each cylindrical projection comprises a domed end.

[0353] Example 5 - A staple cartridge comprising a cartridge body. The cartridge body comprises a longitudinal slot, a deck surface, and a plurality of staple cavities defined in the cartridge body. Each staple cavity comprises a proximal end wall and a distal end wall. The cartridge body further comprises a plurality of quarter-sphere projections extending from the deck surface. A face of each quarter-sphere projection

is flush with one of a proximal end wall and a distal end wall of each staple cavity. The staple cartridge further comprises a plurality of staples stored in the staple cavities.

[0354] Example 6 - The staple cartridge of Example 5, wherein the plurality of quarter-sphere projections are not interconnected above the deck surface.

[0355] Example 7 - The staple cartridge of Examples 5 or 6, wherein the plurality of quarter-sphere projections extend laterally beyond the staple cavities.

[0356] Example 8 - A staple cartridge comprising a cartridge body. The cartridge body comprises a longitudinal slot, a deck surface, and a plurality of staple cavities defined in the cartridge body. Each staple cavity comprises a proximal end wall, a distal end wall, a first lateral side extending between the proximal end wall and the distal end wall, and a second lateral side extending between the proximal end wall and the distal end wall. The second lateral side opposes the first lateral side. The cartridge body further comprises a cylindrical projection extending from the deck surface. The outer diameter of the cylindrical projection is flush with one of the proximal end wall and the distal end wall. The cartridge body further comprises a plurality of substantially cubic projections extending from the deck surface. The plurality of cubic projections are positioned along the first lateral side and the second lateral side. Each cubic projection comprises a side that is flush with the first lateral side or the second lateral side. The staple cartridge further comprises a plurality of staples removably stored in the staple cavities.

[0357] Example 9 - The staple cartridge of Example 8, further comprising gaps between the cylindrical projection and the cubic projections.

[0358] Example 10 - The staple Cartridge of Examples 8 or 9, wherein the cylindrical projection and the cubic projections are not interconnected above the deck surface.

[0359] Example 11 - A staple cartridge comprising a cartridge body. The cartridge body comprises a longitudinal slot, a deck surface, and a plurality of staple cavities defined in the cartridge body. Each staple cavity comprises a proximal end, a distal end a first lateral side extending between the proximal end and the distal end, and a second lateral side extending between the proximal end and the distal end. The second lateral side opposes the first lateral side. The cartridge body further comprises a plurality of cylindrical projections extending from the deck surface. The plurality of cylindrical

projections are positioned on either side of each staple cavity at one of the proximal end and the distal end of each staple cavity. The outer diameter of each cylindrical projection is flush with either the first lateral side or the second lateral side of each staple cavity. The staple cartridge further comprises staples removably stored in the staple cavities.

[0360] Example 12 - The staple cartridge of Example 11, wherein the cylindrical projections are not interconnected above the deck surface.

[0361] Example 13 - The staple cartridge of Examples 11 or 12, further comprising gaps between the cylindrical projections.

[0362] Example 14 - A staple cartridge comprising a cartridge body. The cartridge body comprises a longitudinal slot, a deck surface, and a plurality of staple cavities defined in the cartridge body. Each staple cavity comprises a proximal end, a distal end, a first lateral side extending between the proximal end and the distal end, and a second lateral side extending between the proximal end and the distal end. The second lateral side opposes the first lateral side. The cartridge body further comprises a plurality of substantially cubic projections extending from the deck surface. The plurality of cubic projections are positioned on either side of each staple cavity at one of the proximal end and the distal end of each staple cavity. A face of each cubic projection is flush with either the first lateral side or the second lateral side of each staple cavity. The staple cartridge further comprises staples removably stored in the staple cavities.

[0363] Example 15 - The staple cartridge of Example 14, wherein the cubic projections are not interconnected above the deck surface.

[0364] Example 16 - A staple cartridge comprising a cartridge body. The cartridge body comprises a longitudinal slot, a deck surface, and a plurality of staple cavities defined in the cartridge body. Each staple cavity comprises a proximal end including a proximal end wall, a distal end including a distal end wall, a first lateral side extending between the proximal end and the distal end, and a second lateral side extending between the proximal end and the distal end. The second lateral side opposes the first lateral side. The cartridge body further comprises a plurality of substantially cubic projections extending from the deck surface. The plurality of cubic projections are positioned on either side of each staple cavity at one of the proximal end and the distal

end of each staple cavity. A face of each cubic projection is flush with either the first lateral side or the second lateral side of each staple cavity. The cubic projections are not interconnected above the deck surface. The cartridge body further comprises a plurality of cylindrical projections extending from the deck surface. Each cylindrical projection is positioned at the other of the proximal end and the distal end of each staple cavity. The outer diameter of each cylindrical projection is flush with one of the proximal end wall and the distal end wall of each staple cavity of the plurality of staple cavities. The cylindrical projections are not interconnected above the deck surface. The staple cartridge further comprises staples removably stored in the plurality of staple cavities.

[0365] Example 17 - The staple cartridge of Example 16, wherein the cubic projections and the cylindrical projections are not interconnected above the deck surface.

[0366] Example 18 - A staple cartridge comprising a cartridge body. The cartridge body comprises a longitudinal slot, a deck surface, and a plurality of staple cavities defined in the cartridge body. Each staple cavity comprises a proximal end, a distal end, a first lateral side extending between the proximal end and the distal end, and a second lateral side extending between the proximal end and the distal end. The second lateral side opposes the first lateral side. The cartridge body further comprises a plurality of radial fillet projections extending from the deck surface. The plurality of radial fillet projections are positioned along the first lateral side and the second lateral side. The radial fillet projections are not interconnected above the deck surface. The staple cartridge further comprises a plurality of staples stored in the staple cavities.

[0367] Example 19 - The staple cartridge of Example 18, wherein a portion of each radial fillet projection is flush with one of the first lateral side and the second lateral side of each staple cavity.

[0368] Example 20 - The staple cartridge of Examples 18 or 19, wherein the radial fillet projections are positioned at one of the proximal end and the distal end of each staple cavity.

Example Set 11

[0369] Example 1 - A surgical instrument comprising a handle, an elongate shaft extending from the handle, and an end effector extending from the elongate shaft. The

elongate shaft defines a longitudinal shaft axis. The end effector comprises a first jaw and a second jaw movable relative to the first jaw between an open position and a closed position. The surgical instrument further comprises an articulation joint, a motor-powered articulation system, a motor-powered firing system, a closure system, a lock solenoid, a power source, and a control unit. The end effector is rotatably coupled to the elongate shaft about the articulation joint. The end effector is rotatable about an articulation axis that is transverse to the longitudinal shaft axis. The motor-powered articulation system is configured to rotate the end effector about the articulation axis. The articulation system is operated in a plurality of states. The plurality of states comprises an active state where the end effector is being articulated and an inactive state where the end effector is not being articulated. The motor-powered firing system comprises a firing member movable from an unfired position to a fired position during a firing stroke. The closure system comprises a closure trigger operably engaged with the end effector. The closure trigger is actuatable relative to the handle between an unclamped position where the second jaw is in the open position and a clamped position where the second jaw is in the closed position. The lock solenoid is movable between an actuated position where the lock solenoid is engaged with a portion of the closure system and an unactuated position where the lock solenoid is not engaged with the closure system. The closure system is prevented from being actuated when the lock solenoid is in the actuated position. The power source is configured to supply power to the articulation system, the firing system, and the lock solenoid. The control unit is configured to control the supply of power from the power source to the articulation system, the firing system, and the lock solenoid. The control unit moves the lock solenoid to the actuated position and prevents the supply of power from the power source to the firing system when the articulation system is in the active state.

[0370] Example 2 - The surgical instrument of Example 1, further comprising a closure sensor in signal communication with the control unit, wherein the closure sensor is configured to detect when the closure trigger is in the clamped position.

[0371] Example 3 - The surgical instrument of Examples 1 or 2, wherein the control unit is configured to prevent the supply of power from the power source to the firing system when the closure trigger is not in the clamped position.

[0372] Example 4 - The surgical instrument of Examples 1, 2, or 3, wherein one of the first jaw and the second jaw is configured to receive a staple cartridge, and wherein the other of the first jaw and the second jaw comprises an anvil.

[0373] Example 5 - The surgical instrument of Example 4, further comprising the staple cartridge.

[0374] Example 6 - A surgical instrument comprising a handle, an elongate shaft extending from the handle and defining a longitudinal shaft axis, an end effector extending from the elongate shaft, an articulation joint, a powered articulation system, a powered firing system, a closure system, a lock system, a power source, and a control unit. The end effector comprises a pair of jaws movable between an open position and a closed position. The end effector is rotatably coupled to the elongate shaft about the articulation joint. The end effector is rotatable about an articulation axis that is transverse to the longitudinal shaft axis. The powered articulation system is configured to rotate the end effector about the articulation axis. The articulation system is operable in a plurality of states. The plurality of states comprises an active state where the end effector is being articulated and an inactive state where the end effector is not being articulated. The powered firing system comprises a firing member movable from an unfired position to a fired position during a firing stroke. The closure system comprises a closure trigger operably engaged with the end effector. The closure trigger is actuatable relative to the handle between an unclamped position where the end effector is in the open position and a clamped position where the end effector is in the closed position. The lock system is operable in a plurality of states. The plurality of states comprises a locked state where the lock system locks the closure system and an unlocked state where the lock system unlocks the closure system. The closure system is prevented from being actuated when the lock system is in the locked state. The power source is configured to supply power to the articulation system, the firing system, and the lock system. The control unit is configured to control the supply of power from the power source to the articulation system, the firing system, and the lock system. The control unit transitions the lock system to the locked state and prevents the supply of power from the power source to the firing system when the articulation system is in the active state.

[0375] Example 7 - The surgical instrument of Example 6, further comprising a closure sensor in signal communication with the control unit, wherein the closure sensor is configured to detect when the closure trigger is in the clamped position.

[0376] Example 8 - The surgical instrument of Examples 6 or 7, wherein the control unit is configured to prevent the supply of power from the power source to the firing system when the closure trigger is not in the clamped position.

[0377] Example 9 - The surgical instrument of Examples 6, 7, or 8, wherein the end effector is configured to receive a staple cartridge.

[0378] Example 10 - The surgical instrument of Example 9, further comprising the staple cartridge.

[0379] Example 11 - A surgical instrument comprising a handle, an elongate shaft extending from the handle and defining a longitudinal shaft axis, an end effector extending from the elongate shaft, an articulation joint, a power source, a powered articulation system, a closure system, and a control unit. The end effector comprises a first jaw and a second jaw movable relative to the first jaw between an open position and a closed position. The end effector is rotatably coupled to the elongate shaft about the articulation joint. The end effector is rotatable about an articulation axis that is transverse to the longitudinal shaft axis. The powered articulation system is configured to rotate the end effector about the articulation axis when power is supplied from the power source. The closure system comprises a closure trigger and a closure sensor. The closure trigger is operably engaged with the end effector. The closure trigger is actuatable relative to the handle between an unclamped position where the second jaw is in the open position and a clamped position where the second jaw is in the closed position. The closure sensor is configured to detect the position of the closure trigger. The control unit is configured to control the supply of power from the power source to the articulation system. The closure sensor is in signal communication with the control unit. The control unit prevents the supply of power from the power source to the articulation system when the closure sensor detects the closure trigger is not in the unclamped position.

[0380] Example 12 - The surgical instrument of Example 11, further comprising a powered firing system comprises a firing member movable from an unfired position to a

fired position during a firing stroke, wherein the power source is configured to supply power to the firing system, and wherein the control unit is configured to control the supply of power to the firing system.

[0381] Example 13 - The surgical instrument of Example 12, wherein the control unit is configured to prevent the power source from supplying power to the firing system when the closure trigger is not in the clamped position.

[0382] Example 14 - The surgical instrument of Examples 11, 12, or 13, wherein one of the first jaw and the second jaw is configured to receive a staple cartridge, and wherein the other of the first jaw and the second jaw comprises an anvil.

[0383] Example 15 - The surgical instrument of Example 14, further comprising the staple cartridge.

[0384] Example 16 - A surgical instrument comprising a handle, an elongate shaft extending from the handle and defining a longitudinal shaft axis, an end effector extending from the elongate shaft, an articulation joint, a power source, a powered articulation system, a motor-powered closure system, a closure sensor, and a control unit. The end effector comprises a first jaw and a second jaw movable relative to the first jaw between an open position and a closed position. The end effector is rotatably coupled to the elongate shaft about the articulation joint. The end effector is rotatable about an articulation axis that is transverse to the longitudinal shaft axis. The powered articulation system is configured to rotate the end effector about the articulation axis when power is supplied from the power source. The motor-powered closure system is operably engaged with the end effector. The closure system is transitionable between an unactuated state where the second jaw is in the open position and an actuated state where the second jaw is in the closed position. The closure sensor is configured to detect when the closure system is being actuated. The control unit is configured to control the supply of power from the power source to the articulation system. The closure sensor is in signal communication with the control unit. The control unit prevents the supply of power from the power source to the articulation system when the closure sensor detects the closure system is being actuated.

[0385] Example 17 - The surgical instrument of Example 16, further comprising a powered firing system comprising a firing member movable from an unfired position to a

fired position during a firing stroke, wherein the power source is configured to supply power to the firing system, and wherein the control unit is configured to control the supply of power to the firing system.

[0386] Example 18 - The surgical instrument of Example 17, wherein the control unit is configured to prevent the power source from supplying power to the firing system when the closure system is being actuated.

[0387] Example 19 - The surgical instrument of Examples 16, 17, or 18, wherein one of the first jaw and the second jaw is configured to receive a staple cartridge, and wherein the other of the first jaw and the second jaw comprises an anvil.

[0388] Example 20 - The surgical instrument of Example 19, further comprising the staple cartridge.

[0389] Example 21 - A surgical instrument comprising a handle, an elongate shaft extending from the handle and defining a longitudinal shaft axis, an end effector extending from the elongate shaft, a shaft rotation system, and a closure system. The end effector comprises a first jaw and a second jaw movable relative to the first jaw between an open position and a closed position. The shaft rotation system is operably engaged with the end effector and the elongate shaft. The shaft rotation system is transitionable between a locked state where the end effector and the elongate shaft are prevented from rotating about the shaft axis and an unlocked state where the end effector and the elongate shaft are rotatable about the shaft axis. The closure system is operably engaged with the end effector and is transitionable between an unactuated state where the second jaw is in the open position and an actuated state where the second jaw is in the closed position. The closure system transitions the shaft rotation system from the unlocked state to the locked state when the closure system is actuated.

[0390] Example 22 - The surgical instrument of Example 21, wherein the shaft rotation system comprises a motor-powered shaft rotation system configured to rotate the end effector and the elongate shaft about the shaft axis when power is supplied from a power source to the motor-powered shaft rotation system.

[0391] Example 23 - The surgical instrument of Example 22, further comprising a control unit and a closure sensor in signal communication with the control unit, wherein the closure sensor is configured to detect when the closure system is being actuated,

and wherein the control unit prevents the supply of power from the power source to the motor-powered shaft rotation system when the closure sensor detects the closure system is being actuated.

[0392] Many of the surgical instrument systems described herein are motivated by an electric motor; however, the surgical instrument systems described herein can be motivated in any suitable manner. In various instances, the surgical instrument systems described herein can be motivated by a manually-operated trigger, for example. In certain instances, the motors disclosed herein may comprise a portion or portions of a robotically controlled system. Moreover, any of the end effectors and/or tool assemblies disclosed herein can be utilized with a robotic surgical instrument system. U.S. Patent Application Serial No. 13/118,241, entitled SURGICAL STAPLING INSTRUMENTS WITH ROTATABLE STAPLE DEPLOYMENT ARRANGEMENTS, now U.S. Patent No. 9,072,535, for example, discloses several examples of a robotic surgical instrument system in greater detail and is incorporated by reference herein in its entirety.

[0393] The surgical instrument systems described herein have been described in connection with the deployment and deformation of staples; however, the embodiments described herein are not so limited. Various embodiments are envisioned which deploy fasteners other than staples, such as clamps or tacks, for example. Moreover, various embodiments are envisioned which utilize any suitable means for sealing tissue. For instance, an end effector in accordance with various embodiments can comprise electrodes configured to heat and seal the tissue. Also, for instance, an end effector in accordance with certain embodiments can apply vibrational energy to seal the tissue.

[0394] The entire disclosures of:

- U.S. Patent No. 5,403,312, entitled ELECTROSURGICAL HEMOSTATIC DEVICE, which issued on April 4, 1995;
- U.S. Patent No. 7,000,818, entitled SURGICAL STAPLING INSTRUMENT HAVING SEPARATE DISTINCT CLOSING AND FIRING SYSTEMS, which issued on February 21, 2006;
- U.S. Patent No. 7,422,139, entitled MOTOR-DRIVEN SURGICAL CUTTING AND FASTENING INSTRUMENT WITH TACTILE POSITION FEEDBACK, which issued on September 9, 2008;

- U.S. Patent No. 7,464,849, entitled ELECTRO-MECHANICAL SURGICAL INSTRUMENT WITH CLOSURE SYSTEM AND ANVIL ALIGNMENT COMPONENTS, which issued on December 16, 2008;
- U.S. Patent No. 7,670,334, entitled SURGICAL INSTRUMENT HAVING AN ARTICULATING END EFFECTOR, which issued on March 2, 2010;
- U.S. Patent No. 7,753,245, entitled SURGICAL STAPLING INSTRUMENTS, which issued on July 13, 2010;
- U.S. Patent No. 8,393,514, entitled SELECTIVELY ORIENTABLE IMPLANTABLE FASTENER CARTRIDGE, which issued on March 12, 2013;
- U.S. Patent Application Serial No. 11/343,803, entitled SURGICAL INSTRUMENT HAVING RECORDING CAPABILITIES, now U.S. Patent No. 7,845,537;
- U.S. Patent Application Serial No. 12/031,573, entitled SURGICAL CUTTING AND FASTENING INSTRUMENT HAVING RF ELECTRODES, filed February 14, 2008;
- U.S. Patent Application Serial No. 12/031,873, entitled END EFFECTORS FOR A SURGICAL CUTTING AND STAPLING INSTRUMENT, filed February 15, 2008, now U.S. Patent No. 7,980,443;
- U.S. Patent Application Serial No. 12/235,782, entitled MOTOR-DRIVEN SURGICAL CUTTING INSTRUMENT, now U.S. Patent No. 8,210,411;
- U.S. Patent Application Serial No. 12/235,972, entitled MOTORIZED SURGICAL INSTRUMENT, now U.S. Patent No. 9,050,083.
- U.S. Patent Application Serial No. 12/249,117, entitled POWERED SURGICAL CUTTING AND STAPLING APPARATUS WITH MANUALLY RETRACTABLE FIRING SYSTEM, now U.S. Patent No. 8,608,045;
- U.S. Patent Application Serial No. 12/647,100, entitled MOTOR-DRIVEN SURGICAL CUTTING INSTRUMENT WITH ELECTRIC ACTUATOR DIRECTIONAL CONTROL ASSEMBLY, filed December 24, 2009, now U.S. Patent No. 8,220,688;
- U.S. Patent Application Serial No. 12/893,461, entitled STAPLE CARTRIDGE, filed September 29, 2012, now U.S. Patent No. 8,733,613;
- U.S. Patent Application Serial No. 13/036,647, entitled SURGICAL STAPLING INSTRUMENT, filed February 28, 2011, now U.S. Patent No. 8,561,870;

- U.S. Patent Application Serial No. 13/118,241, entitled SURGICAL STAPLING INSTRUMENTS WITH ROTATABLE STAPLE DEPLOYMENT ARRANGEMENTS, now U.S. Patent No. 9,072,535;
- U.S. Patent Application Serial No. 13/524,049, entitled ARTICULATABLE SURGICAL INSTRUMENT COMPRISING A FIRING DRIVE, filed on June 15, 2012, now U.S. Patent No. 9,101,358;
- U.S. Patent Application Serial No. 13/800,025, entitled STAPLE CARTRIDGE TISSUE THICKNESS SENSOR SYSTEM, filed on March 13, 2013, now U.S. Patent No. 9,345,481;

U.S. Patent Application Serial No. 13/800,067, entitled STAPLE CARTRIDGE TISSUE THICKNESS SENSOR SYSTEM, filed on March 13, 2013, now U.S. Patent Application Publication No. 2014/0263552;

- U.S. Patent Application Publication No. 2007/0175955, entitled SURGICAL CUTTING AND FASTENING INSTRUMENT WITH CLOSURE TRIGGER LOCKING MECHANISM, filed January 31, 2006; and
- U.S. Patent Application Publication No. 2010/0264194, entitled SURGICAL STAPLING INSTRUMENT WITH AN ARTICULATABLE END EFFECTOR, filed April 22, 2010, now U.S. Patent No. 8,308,040, are hereby incorporated by reference herein.

[0395] Although various devices have been described herein in connection with certain embodiments, modifications and variations to those embodiments may be implemented. Particular features, structures, or characteristics may be combined in any suitable manner in one or more embodiments. Thus, the particular features, structures, or characteristics illustrated or described in connection with one embodiment may be combined in whole or in part, with the features, structures or characteristics of one ore more other embodiments without limitation. Also, where materials are disclosed for certain components, other materials may be used. Furthermore, according to various embodiments, a single component may be replaced by multiple components, and multiple components may be replaced by a single component, to perform a given function or functions. The foregoing description and following claims are intended to cover all such modification and variations.

[0396] The devices disclosed herein can be designed to be disposed of after a single use, or they can be designed to be used multiple times. In either case, however, a device can be reconditioned for reuse after at least one use. Reconditioning can include any combination of the steps including, but not limited to, the disassembly of the device, followed by cleaning or replacement of particular pieces of the device, and subsequent reassembly of the device. In particular, a reconditioning facility and/or surgical team can disassemble a device and, after cleaning and/or replacing particular parts of the device, the device can be reassembled for subsequent use. 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.

[0397] The devices disclosed herein may be processed before surgery. First, a new or used instrument may be obtained and, when necessary, cleaned. The instrument may then be sterilized. In one sterilization technique, the instrument is placed in a closed and sealed container, such as a plastic or TYVEK bag. The container and instrument may then be placed in a field of radiation that can penetrate the container, such as gamma radiation, x-rays, and/or high-energy electrons. The radiation may kill bacteria on the instrument and in the container. The sterilized instrument may then be stored in the sterile container. The sealed container may keep the instrument sterile until it is opened in a medical facility. A device may also be sterilized using any other technique known in the art, including but not limited to beta radiation, gamma radiation, ethylene oxide, plasma peroxide, and/or steam.

[0398] While this invention has been described as having exemplary designs, the present invention may be further modified within the spirit and scope of the disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the invention using its general principles.

WHAT IS CLAIMED IS:

1. A staple cartridge, comprising:

a cartridge body, comprising:

a longitudinal slot;

a deck surface;

a plurality of staple cavities defined in said cartridge body, wherein each said staple cavity comprises a proximal end wall and a distal end wall; and

a plurality of cylindrical projections extending from said deck surface, wherein the outer diameter of each said cylindrical projection is flush with one of a said proximal end wall and a said distal end wall; and

staples removably stored in said staple cavities.

2. The staple cartridge of Claim 1, wherein said cylindrical projections are not interconnected above said deck surface.

3. The staple cartridge of Claim 1, wherein each said cylindrical projection comprises an end chamfer.

4. The staple cartridge of Claim 1, wherein each said cylindrical projection comprises a domed end.

5. A staple cartridge, comprising:

a cartridge body, comprising:

a longitudinal slot;

a deck surface;

a plurality of staple cavities defined in said cartridge body, wherein each said staple cavity comprises a proximal end wall and a distal end wall; and

a plurality of quarter-sphere projections extending from said deck surface, wherein a face of each said quarter-sphere projection is flush with one of a said proximal end wall and a said distal end wall; and

a plurality of staples stored in said staple cavities.

6. The staple cartridge of Claim 5, wherein said plurality of quarter-sphere projections are not interconnected above said deck surface.

7. The staple cartridge of Claim 5, wherein said plurality of quarter-sphere projections extend laterally beyond said staple cavities.

8. A staple cartridge, comprising:

a cartridge body, comprising:

a longitudinal slot;

a deck surface;

a plurality of staple cavities defined in said cartridge body, wherein each said staple cavity comprises:

a proximal end wall;

a distal end wall;

a first lateral side extending between said proximal end wall and said distal end wall; and

a second lateral side extending between said proximal end wall and said distal end wall, wherein said second lateral side opposes said first lateral side;

a cylindrical projection extending from said deck surface, wherein the outer diameter of said cylindrical projection is flush with one of said proximal end wall and said distal end wall; and

a plurality of substantially cubic projections extending from said deck surface, wherein said plurality of cubic projections are positioned along said first lateral side and said second lateral side, and wherein each said cubic projection comprises a side that is flush with said first lateral side or said second lateral side; and

a plurality of staples removably stored in said staple cavities.

9. The staple cartridge of Claim 8, further comprising gaps between said cylindrical projection and said cubic projections.

10. The staple Cartridge of Claim 8, wherein said cylindrical projection and said cubic projections are not interconnected above said deck surface.

11. A staple cartridge, comprising:
a cartridge body, comprising:
a longitudinal slot;
a deck surface;
a plurality of staple cavities defined in said cartridge body, wherein each said staple cavity comprises:
a proximal end;
a distal end;
a first lateral side extending between said proximal end and said distal end; and
a second lateral side extending between said proximal end and said distal end, wherein said second lateral side opposes said first lateral side; and
a plurality of cylindrical projections extending from said deck surface, wherein said plurality of cylindrical projections are positioned on either side of each said staple cavity at one of said proximal end and said distal end of each said staple cavity, and wherein the outer diameter of each said cylindrical projection is flush with either said first lateral side or said second lateral side of each said staple cavity; and
staples removably stored in said staple cavities.

12. The staple cartridge of Claim 11, wherein said cylindrical projections are not interconnected above said deck surface.

13. The staple cartridge of Claim 11, further comprising gaps between said cylindrical projections.

14. A staple cartridge, comprising:
a cartridge body, comprising:
a longitudinal slot;

a deck surface;

a plurality of staple cavities defined in said cartridge body, wherein each said staple cavity comprises:

a proximal end;

a distal end;

a first lateral side extending between said proximal end and said distal end; and

a second lateral side extending between said proximal end and said distal end, wherein said second lateral side opposes said first lateral side; and

a plurality of substantially cubic projections extending from said deck surface, wherein said plurality of cubic projections are positioned on either side of each said staple cavity at one of said proximal end and said distal end of each said staple cavity, and wherein a face of each said cubic projection is flush with either said first lateral side or said second lateral side of each said staple cavity; and

staples removably stored in said staple cavities.

15. The staple cartridge of Claim 14, wherein said cubic projections are not interconnected above said deck surface.

16. A staple cartridge, comprising:

a cartridge body, comprising:

a longitudinal slot;

a deck surface;

a plurality of staple cavities defined in said cartridge body, wherein each said staple cavity comprises:

a proximal end including a proximal end wall;

a distal end including a distal end wall;

a first lateral side extending between said proximal end and said distal end; and

a second lateral side extending between said proximal end and said distal end, wherein said second lateral side opposes said first lateral side;

a plurality of substantially cubic projections extending from said deck surface, wherein said plurality of cubic projections are positioned on either side of each said staple cavity at one of said proximal end and said distal end of each said staple cavity, wherein a face of each said cubic projection is flush with either said first lateral side or said second lateral side of each said staple cavity, and wherein said cubic projections are not interconnected above said deck surface; and

a plurality of cylindrical projections extending from said deck surface, wherein each cylindrical projection is positioned at the other of said proximal end and said distal end of each said staple cavity, wherein the outer diameter of each said cylindrical projection is flush with one of said proximal end wall and said distal end wall of each said staple cavity of said plurality of staple cavities, and wherein said cylindrical projections are not interconnected above said deck surface; and

staples removably stored in said plurality of staple cavities.

17. The staple cartridge of Claim 16, wherein said cubic projections and said cylindrical projections are not interconnected above said deck surface.

18. A staple cartridge, comprising:

a cartridge body, comprising:

a longitudinal slot;

a deck surface;

a plurality of staple cavities defined in said cartridge body, wherein each said staple cavity comprises:

a proximal end;

a distal end;

a first lateral side extending between said proximal end and said distal end; and

a second lateral side extending between said proximal end and said distal end, wherein said second lateral side opposes said first lateral side; and

a plurality of radial fillet projections extending from said deck surface, wherein said plurality of radial fillet projections are positioned along said first lateral side

and said second lateral side, and wherein said radial fillet projections are not interconnected above said deck surface; and

a plurality of staples stored in said staple cavities.

19. The staple cartridge of Claim 18, wherein a portion of each said radial fillet projection is flush with one of said first lateral side and said second lateral side of each said staple cavity.

20. The staple cartridge of Claim 18, wherein said radial fillet projections are positioned at one of said proximal end and said distal end of each said staple cavity.

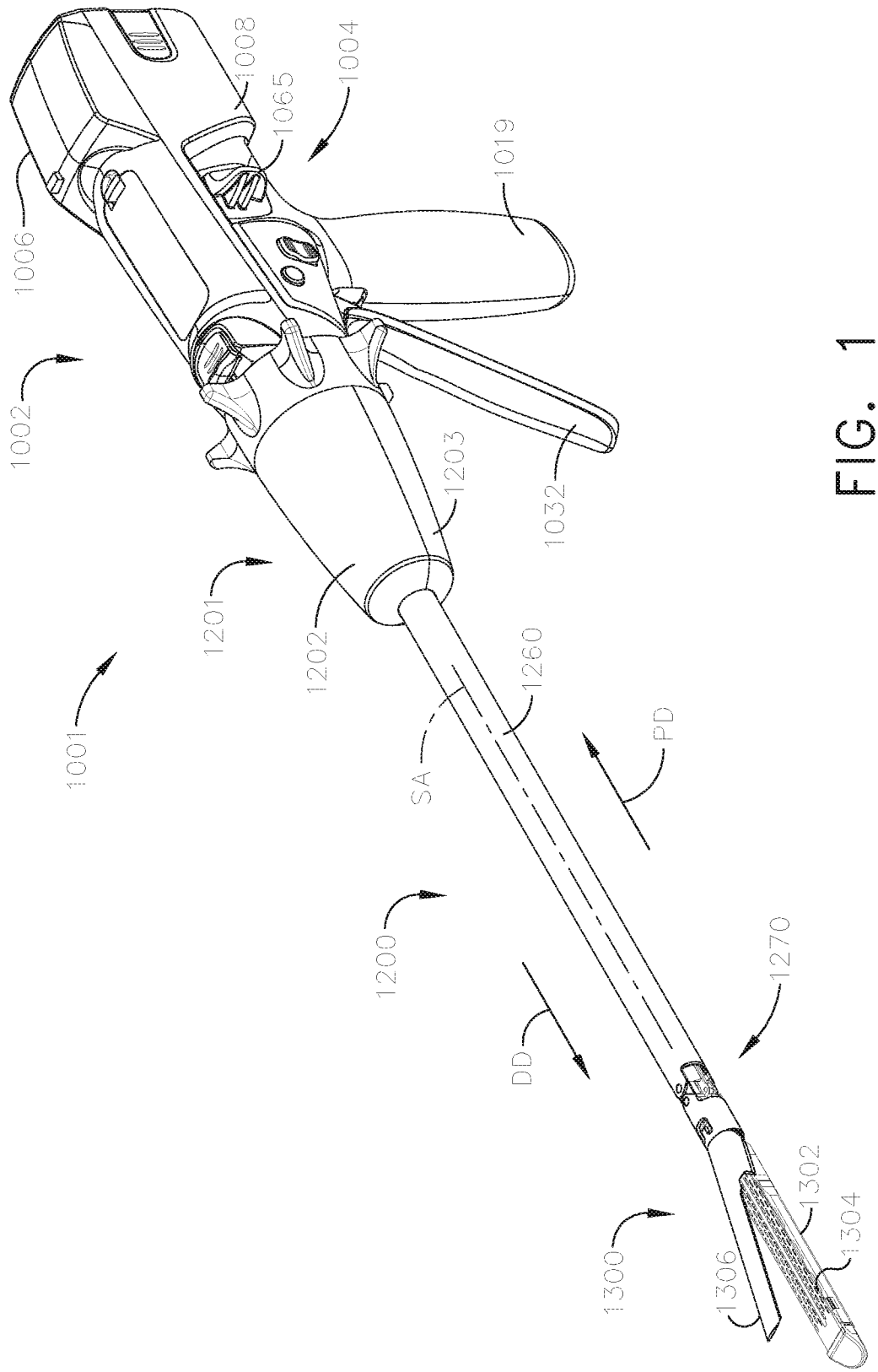

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FIG. 1

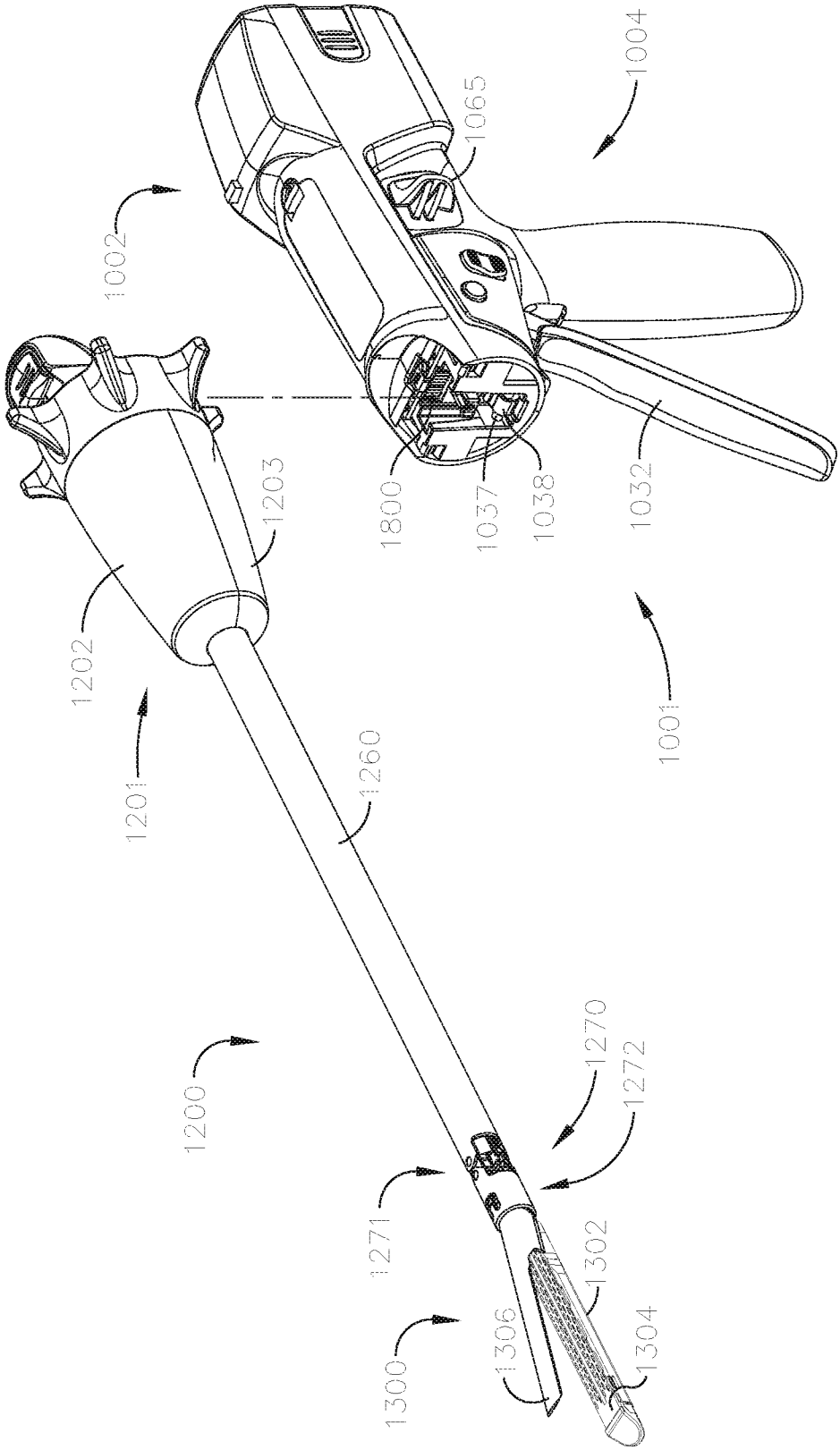

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FIG. 2

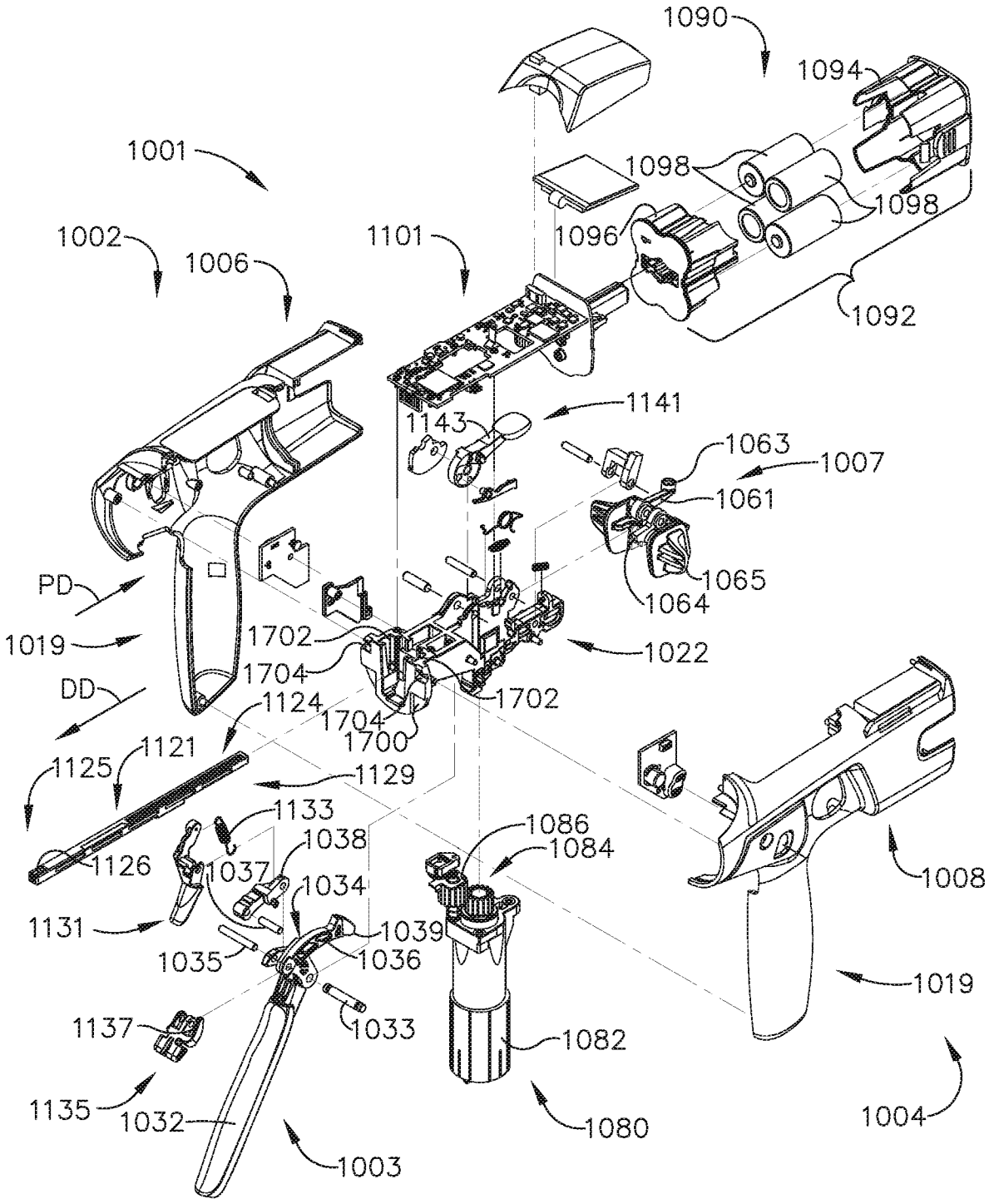

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FIG. 3

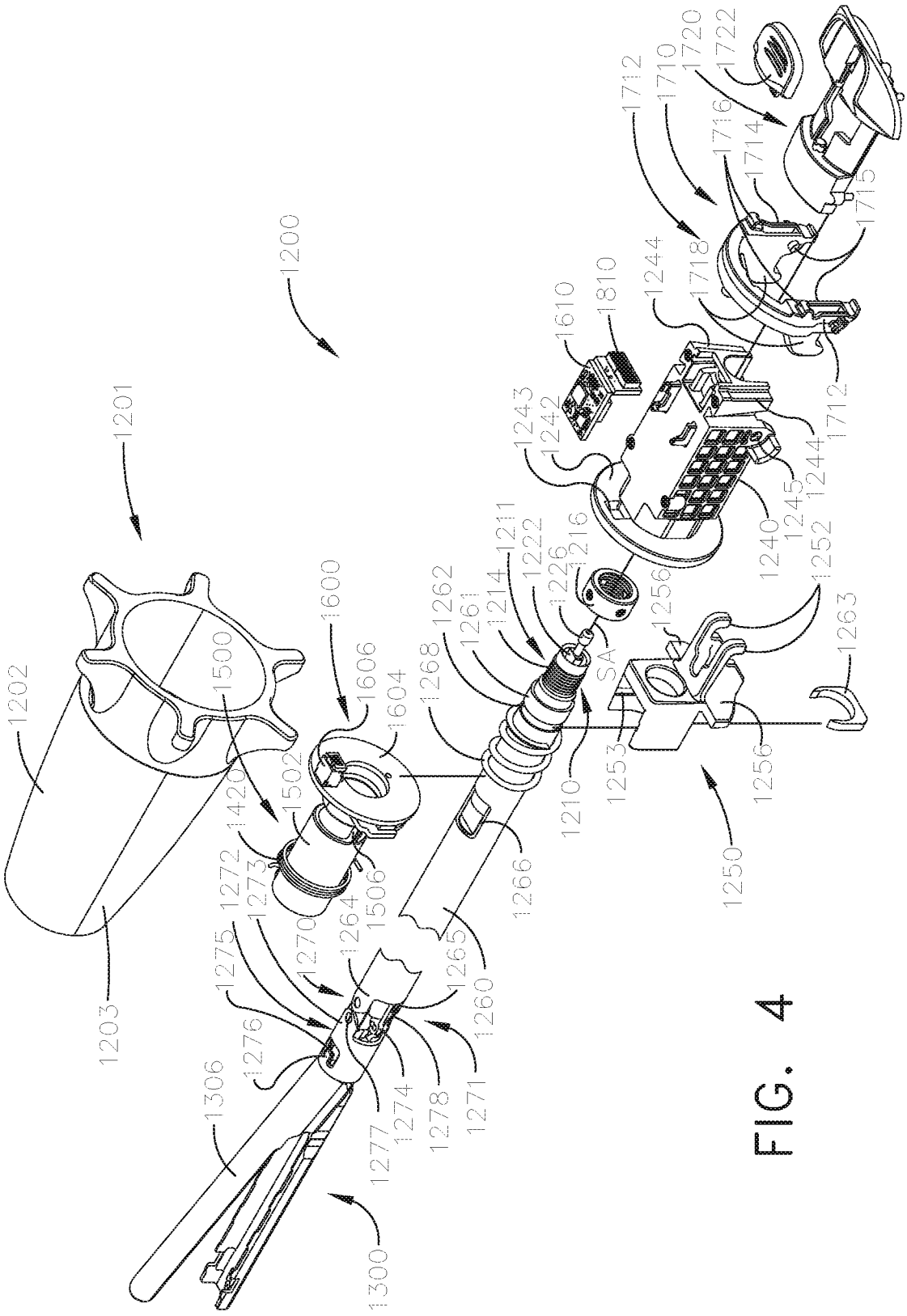

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FIG. 4

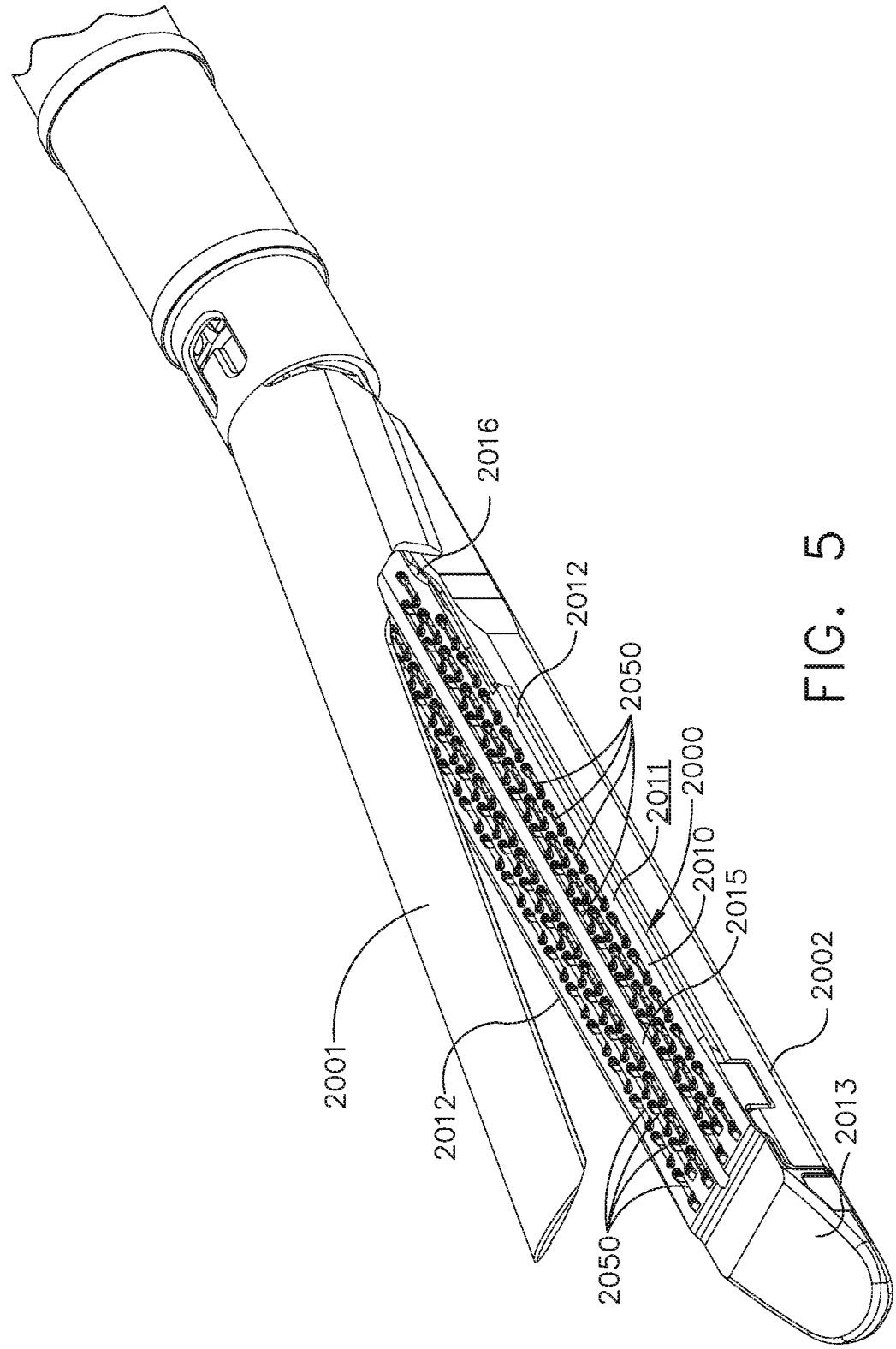


FIG. 5

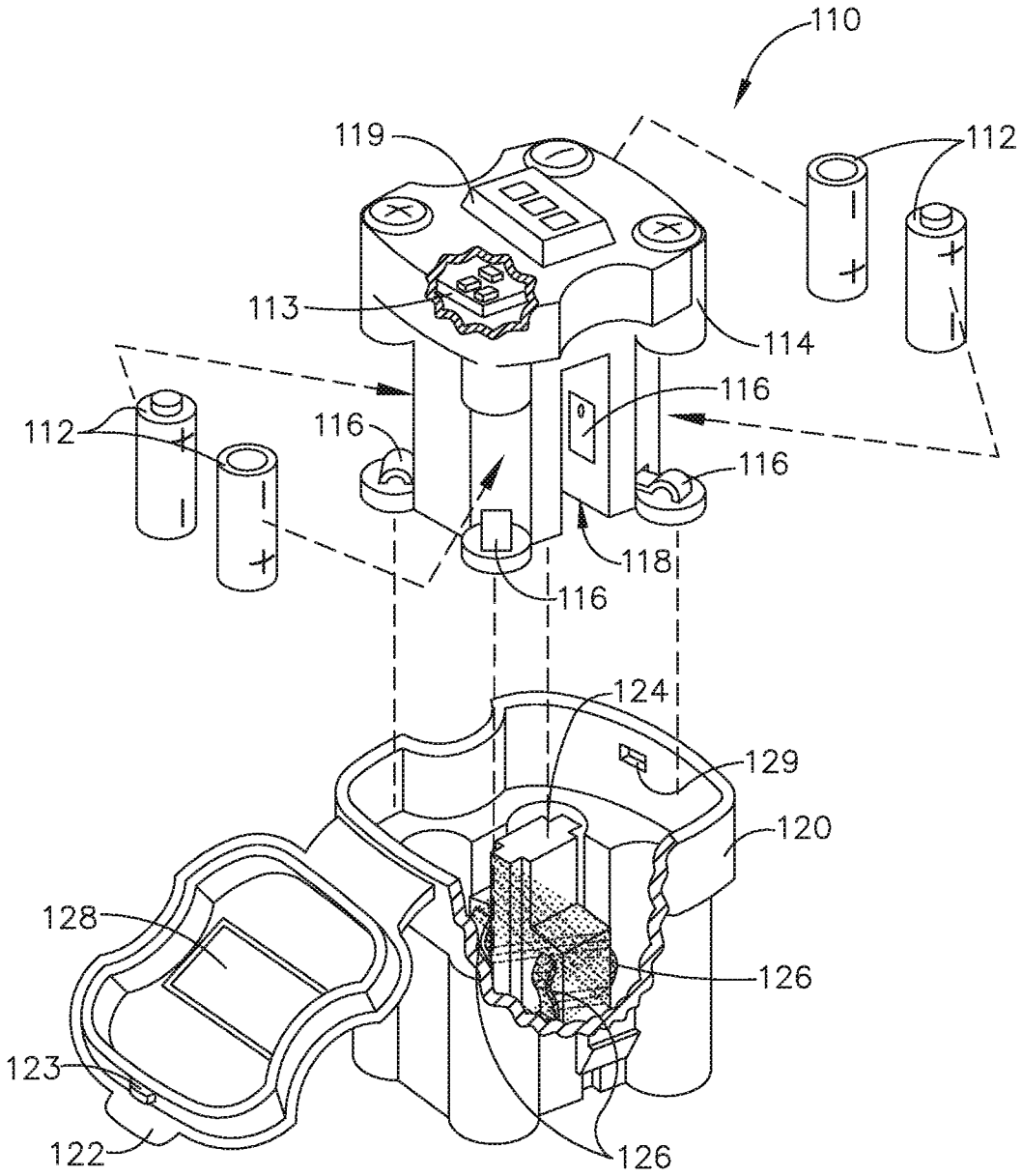

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FIG. 6

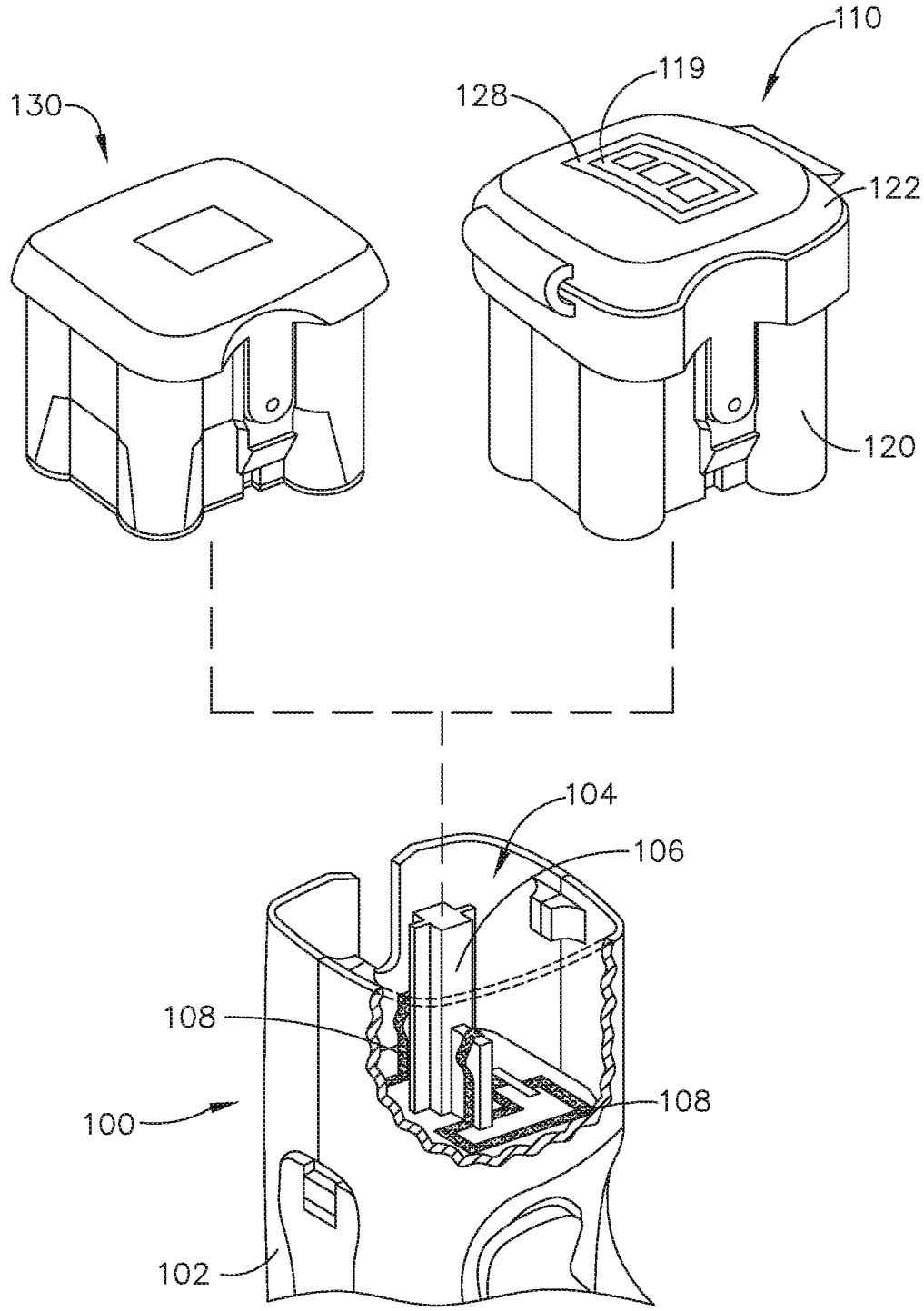


FIG. 7

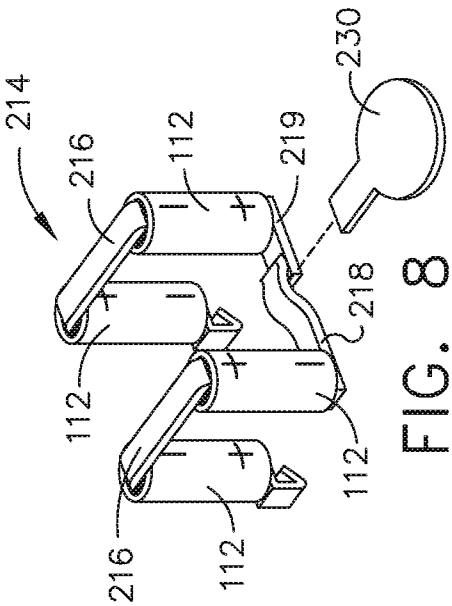


FIG. 8

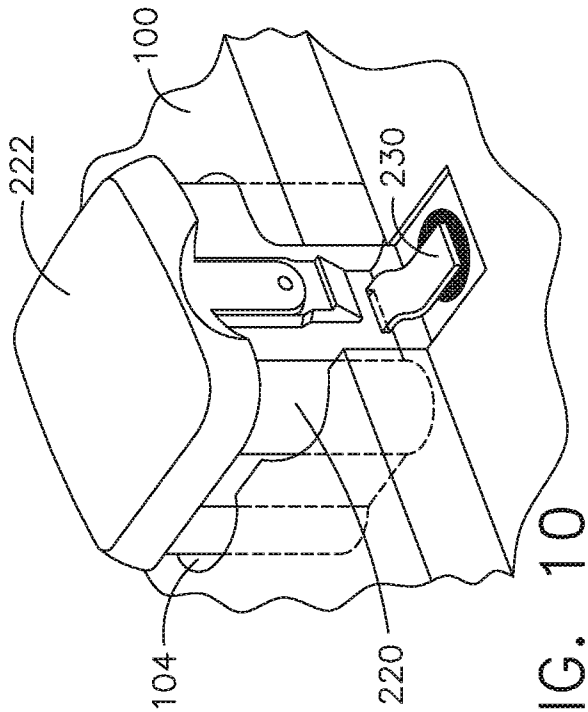


FIG. 10

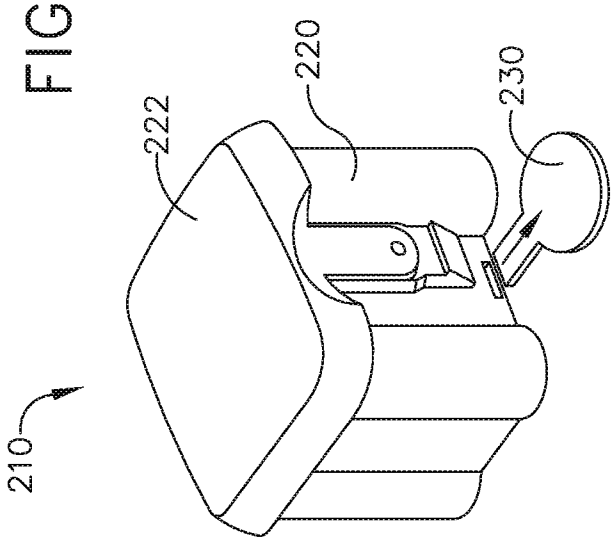


FIG. 9

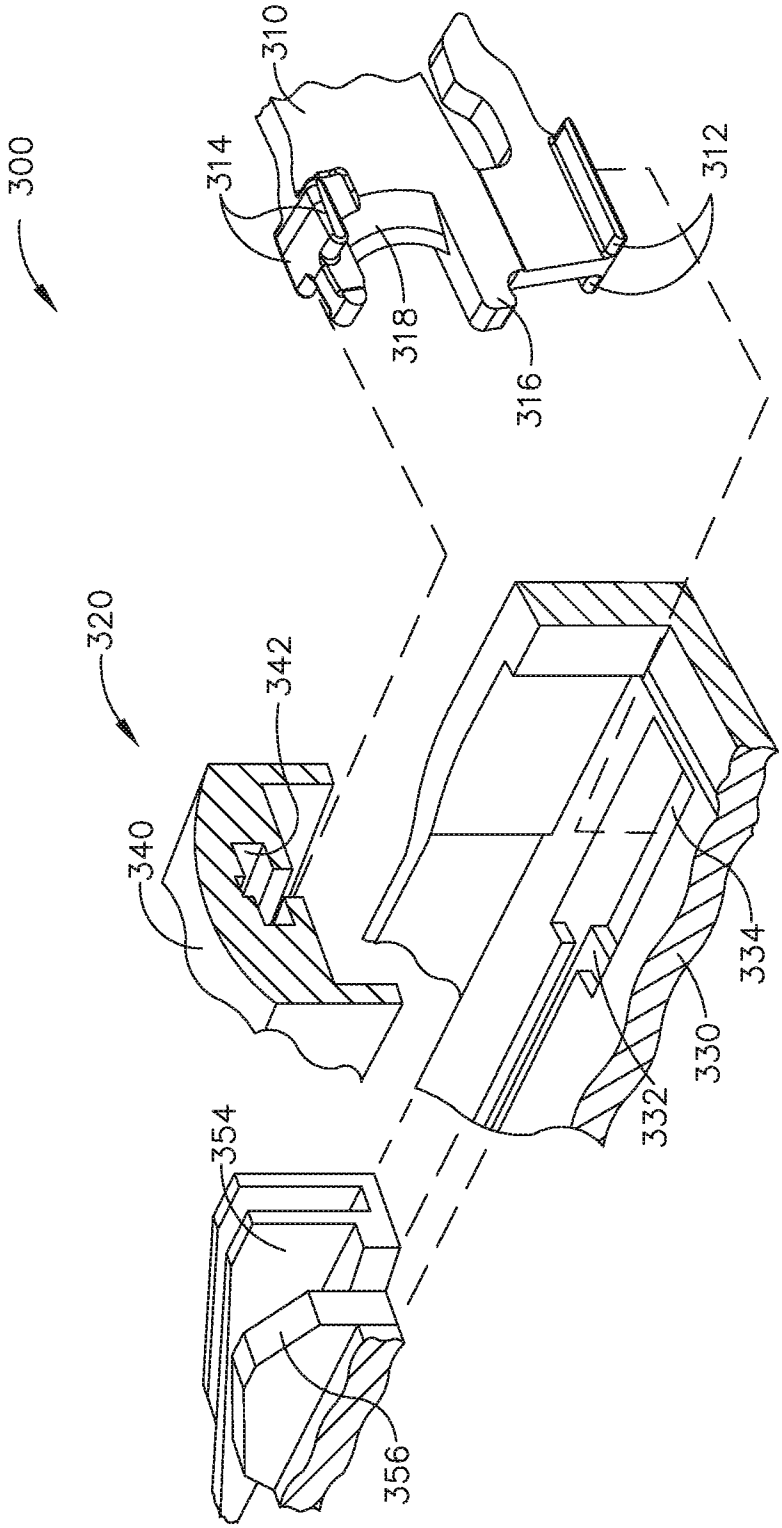


FIG. 11

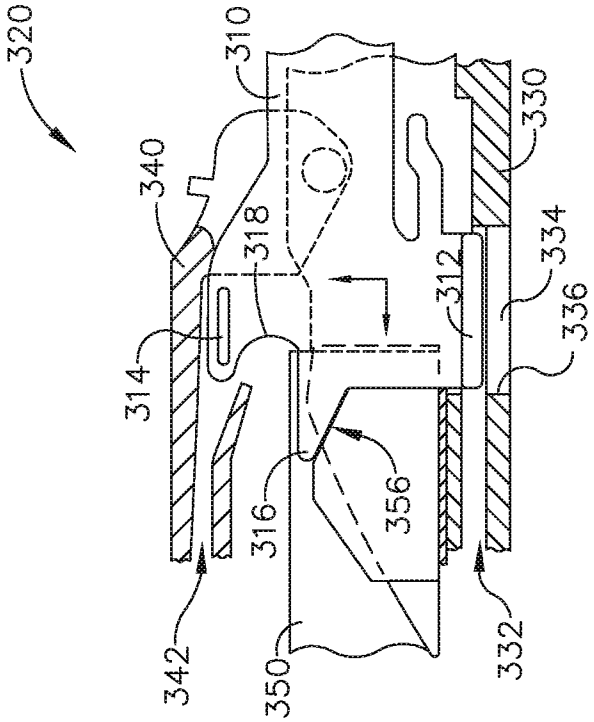

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FIG. 13

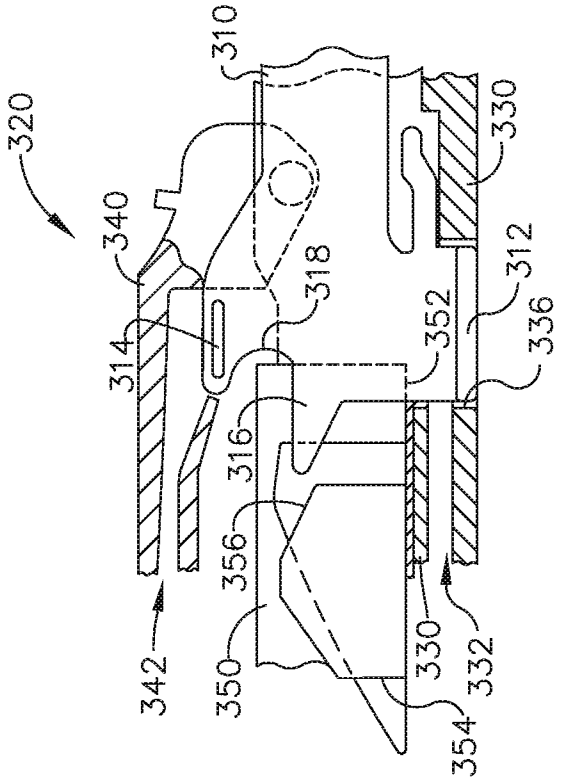

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FIG. 12

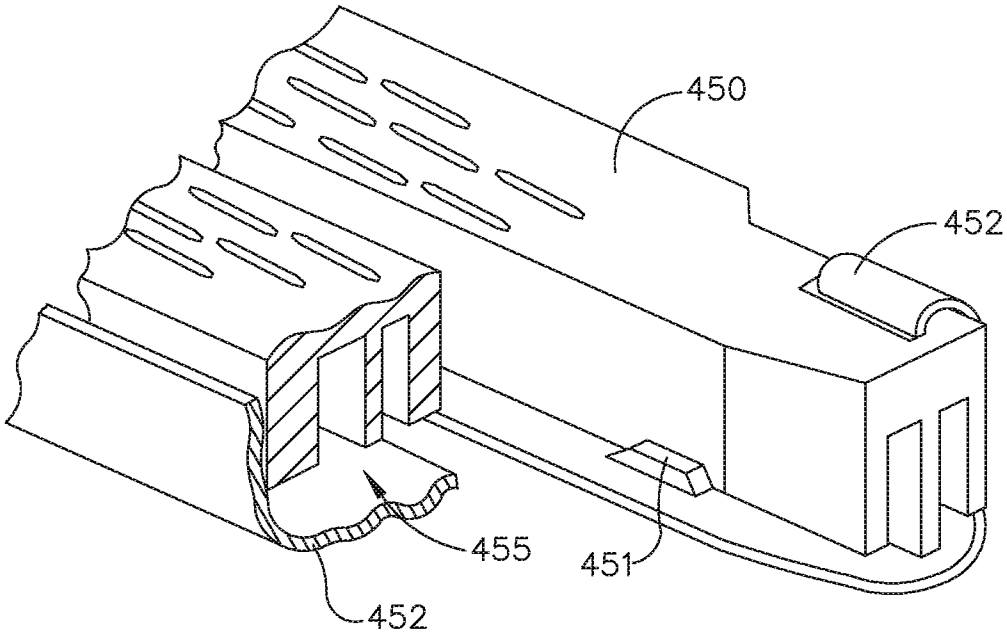


FIG. 14

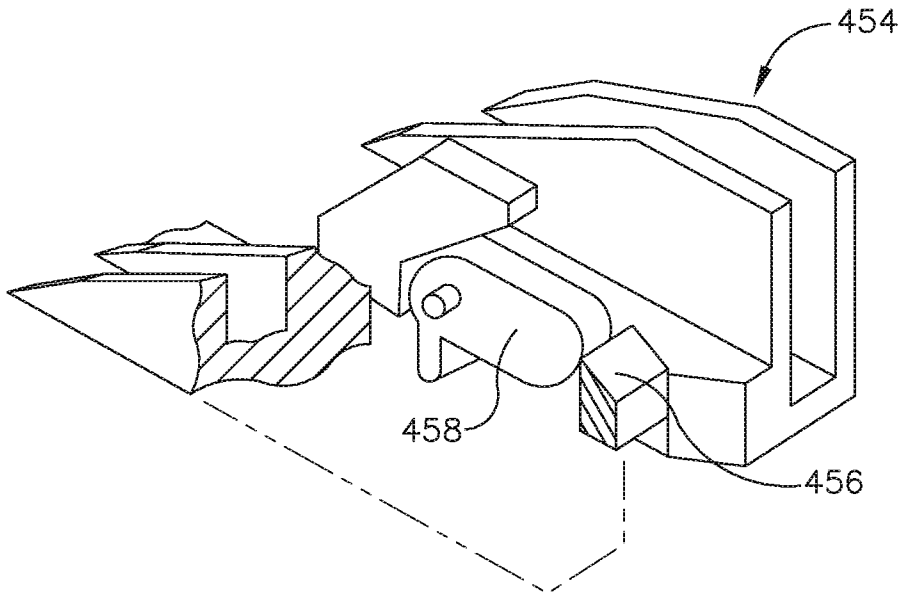


FIG. 15

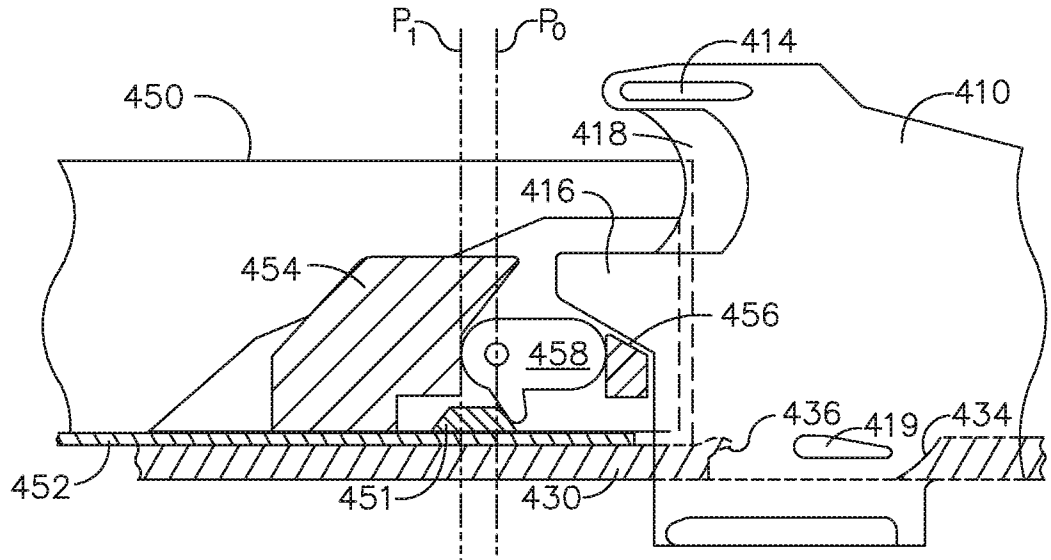

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FIG. 16

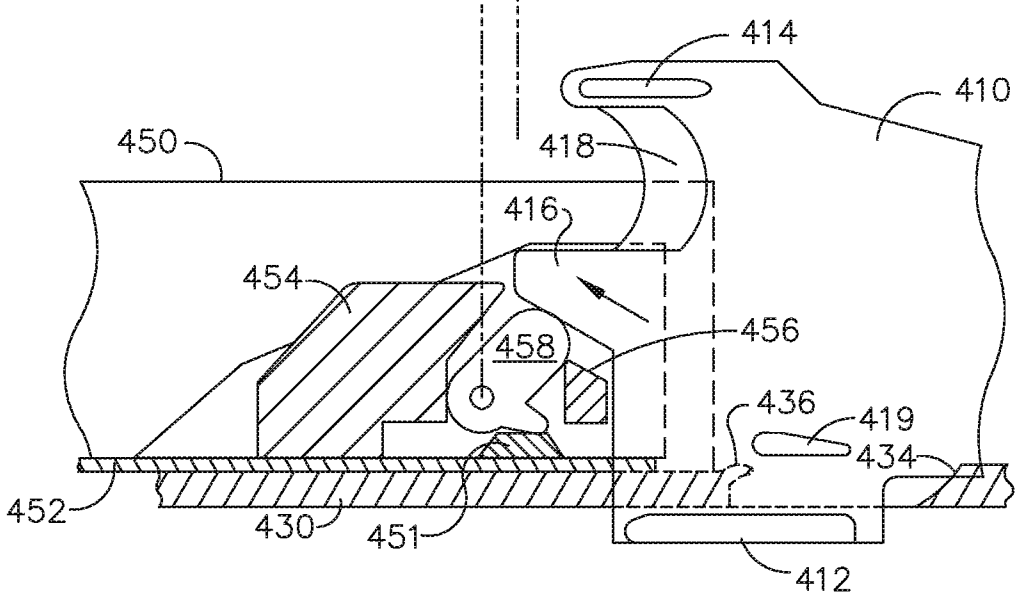

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FIG. 17

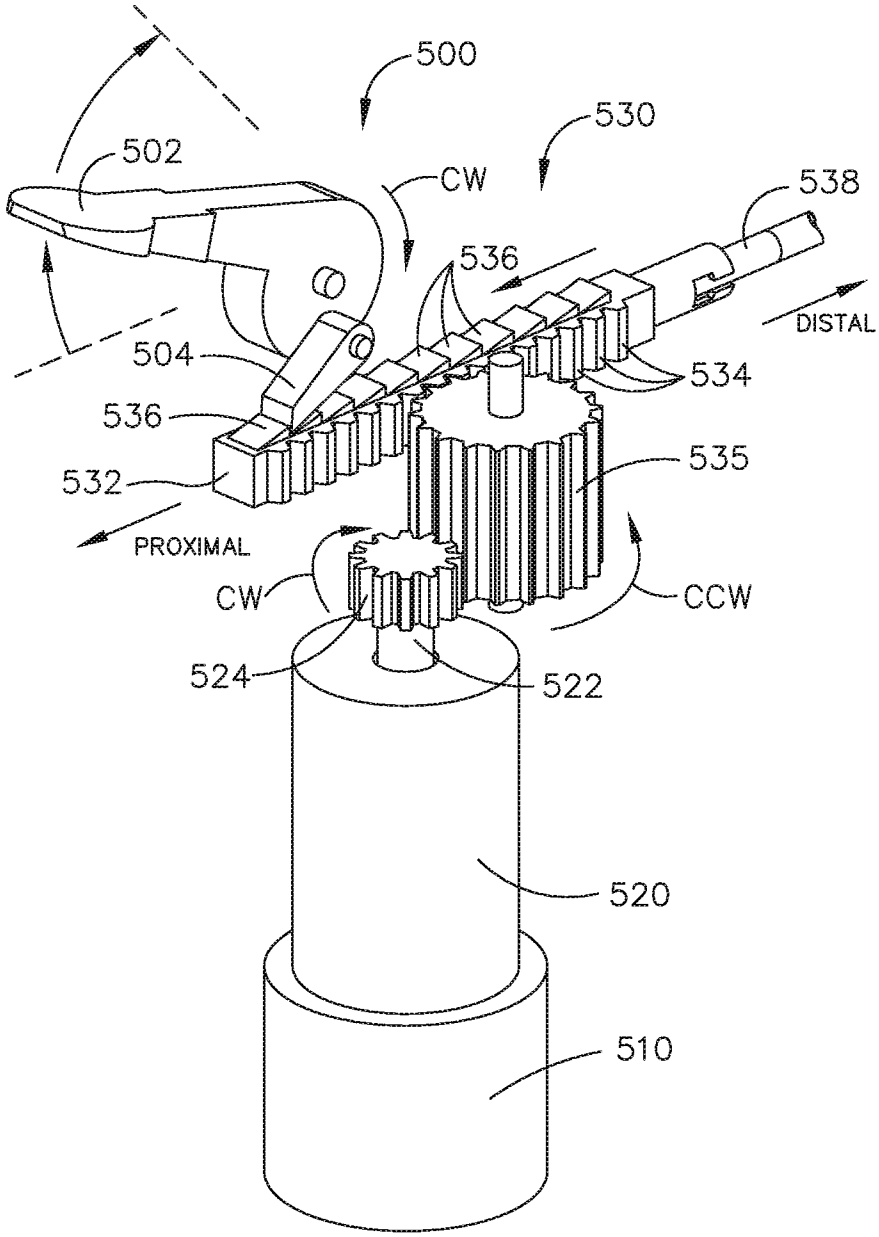

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FIG. 18

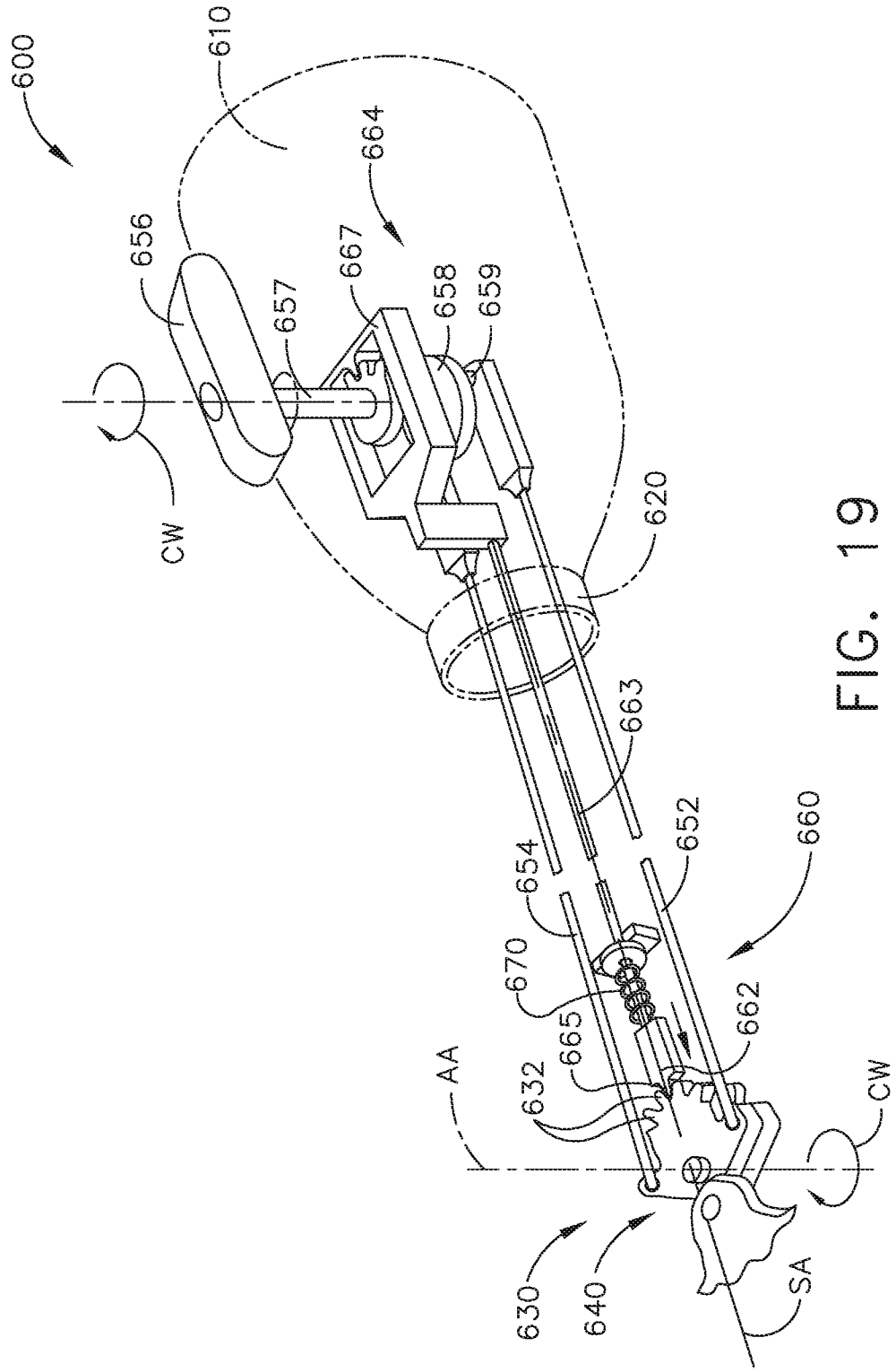

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FIG. 19

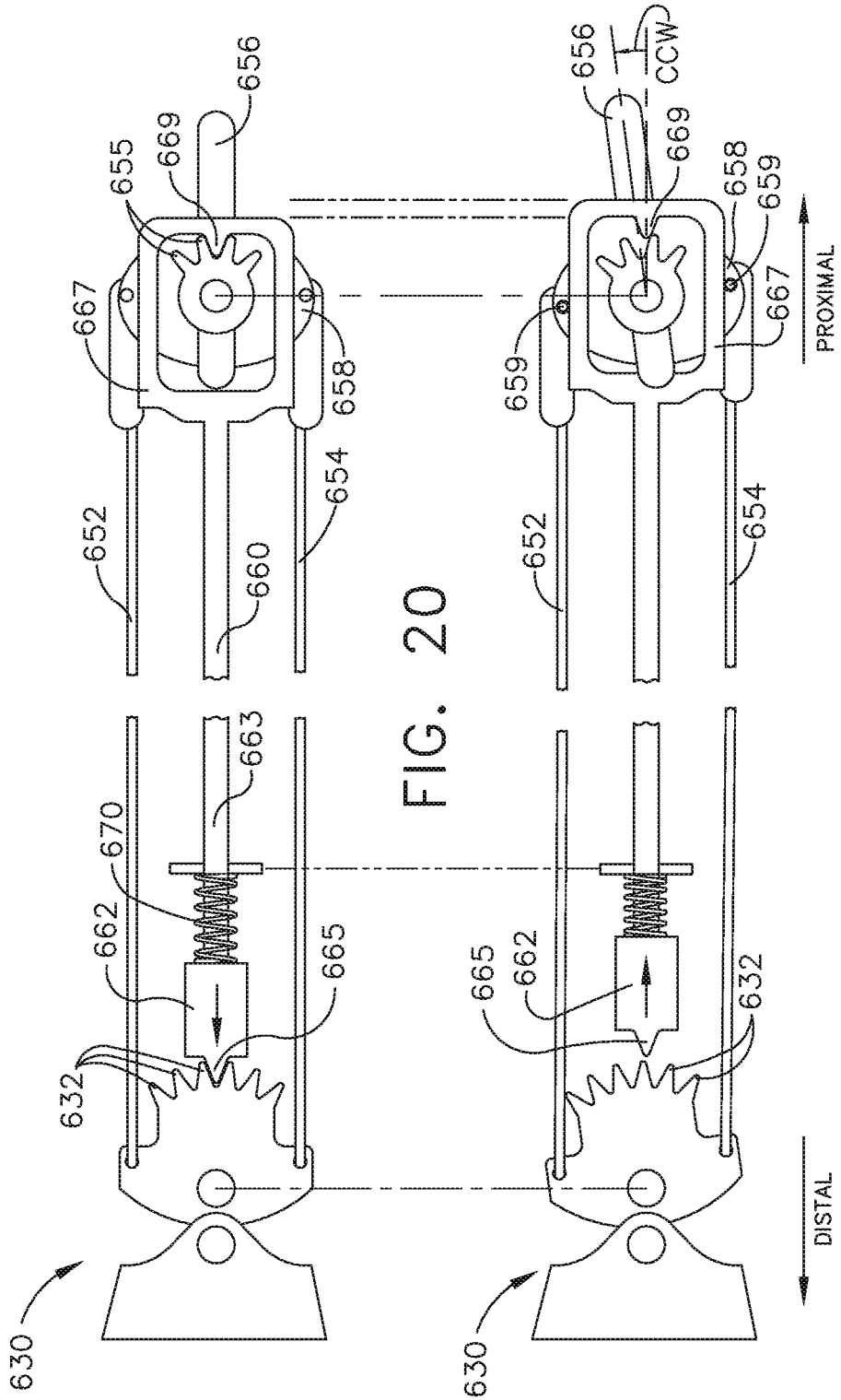

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FIG. 20

FIG. 21

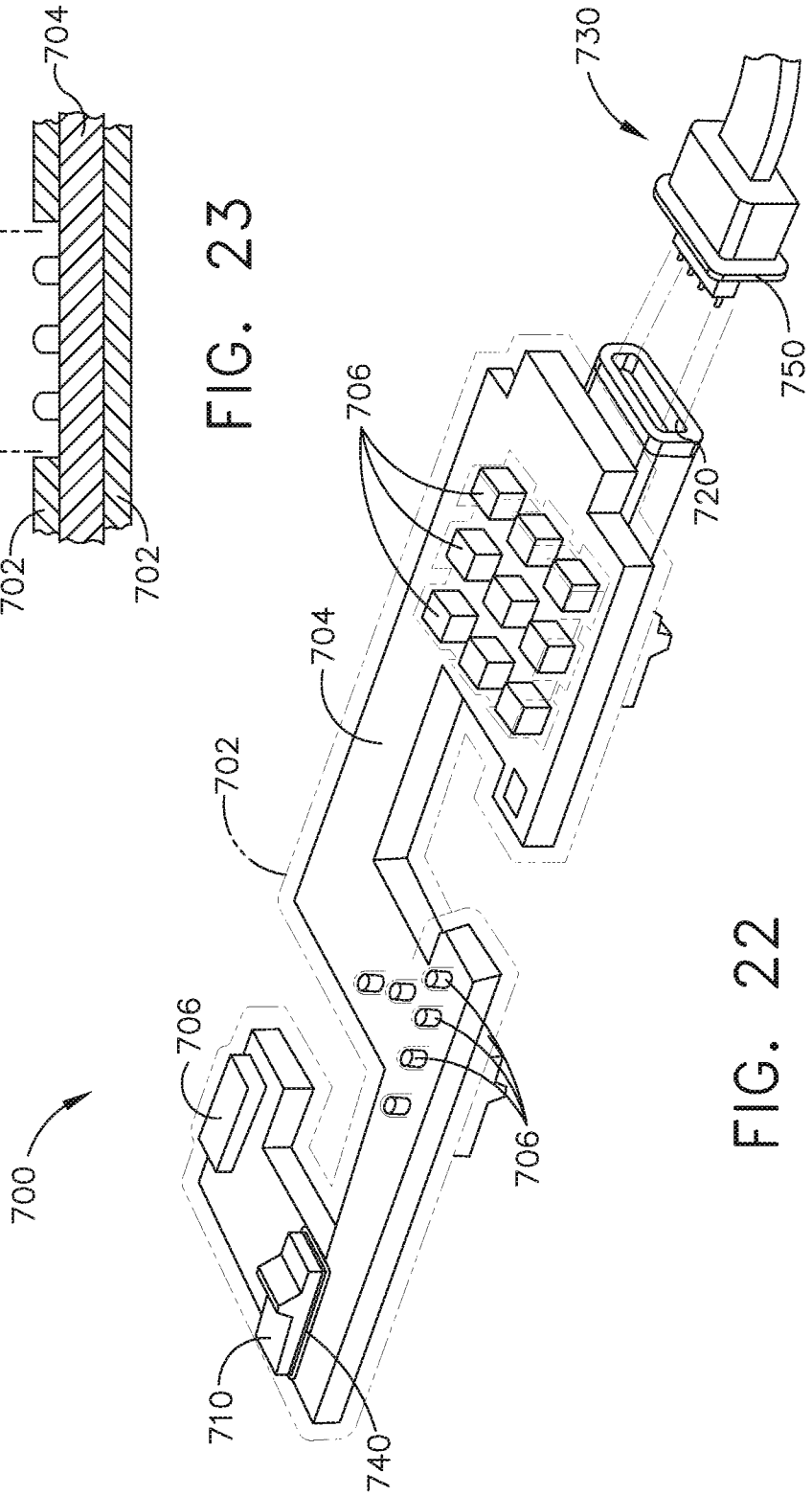


FIG. 22

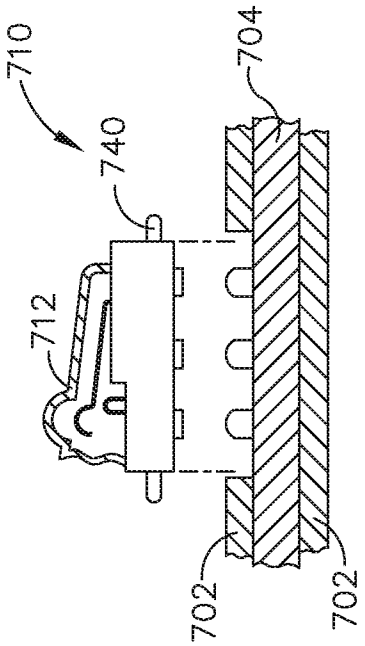


FIG. 23

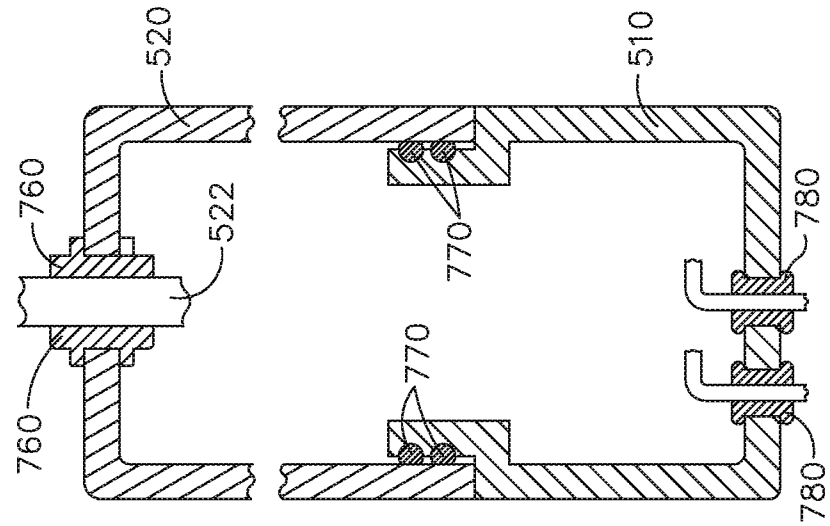


FIG. 25

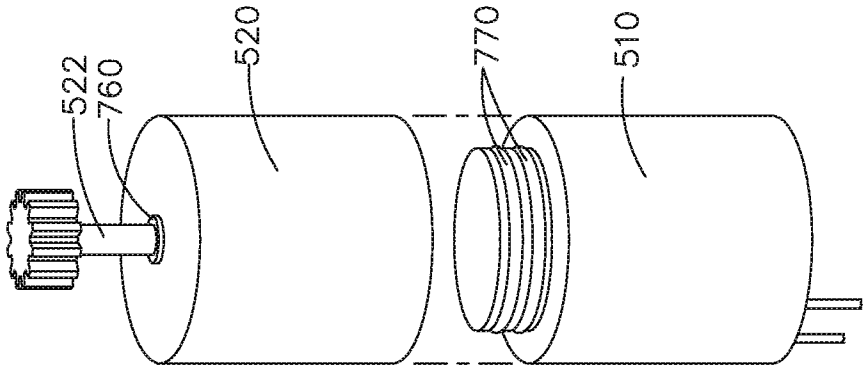


FIG. 24

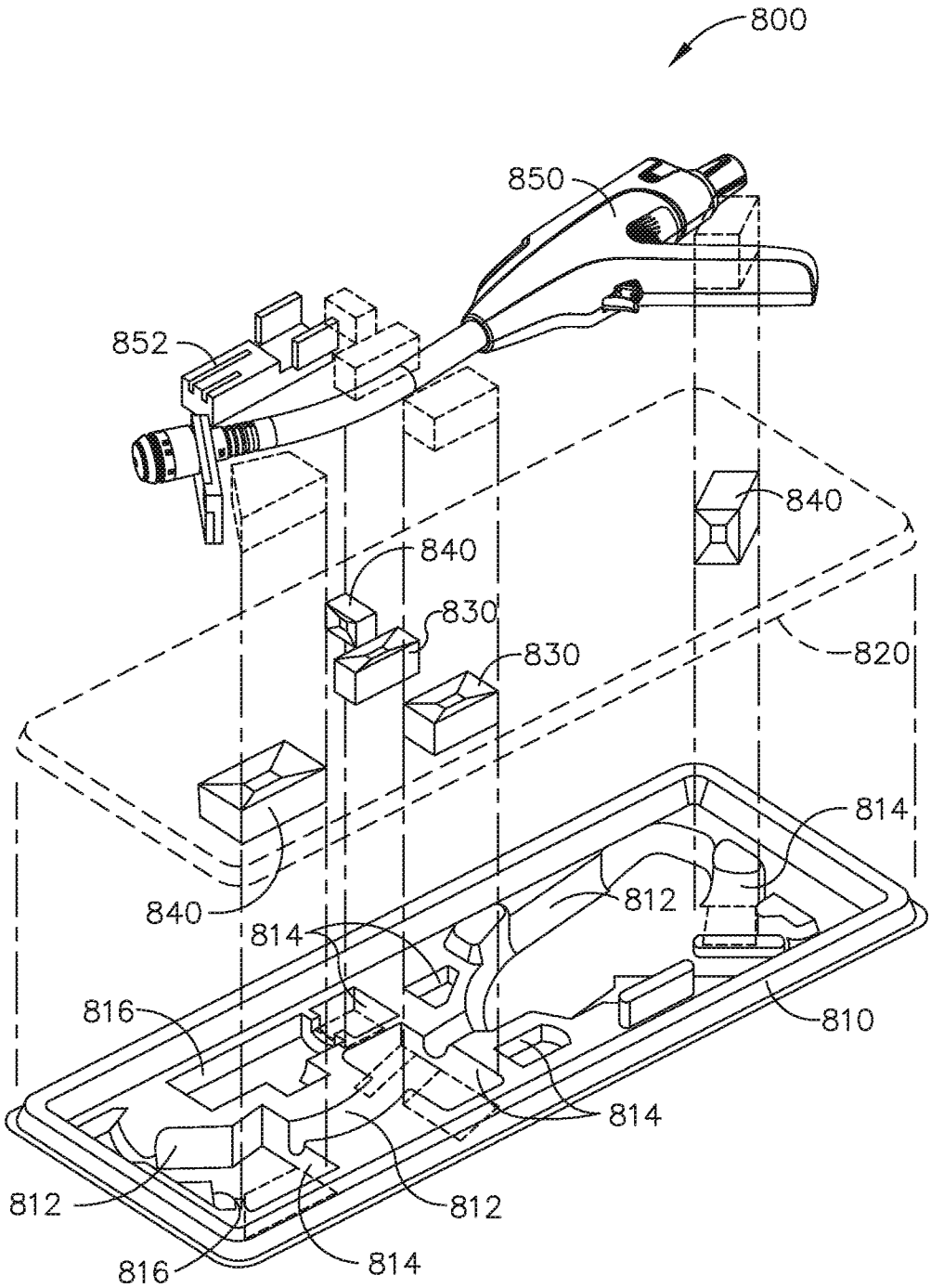

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FIG. 26

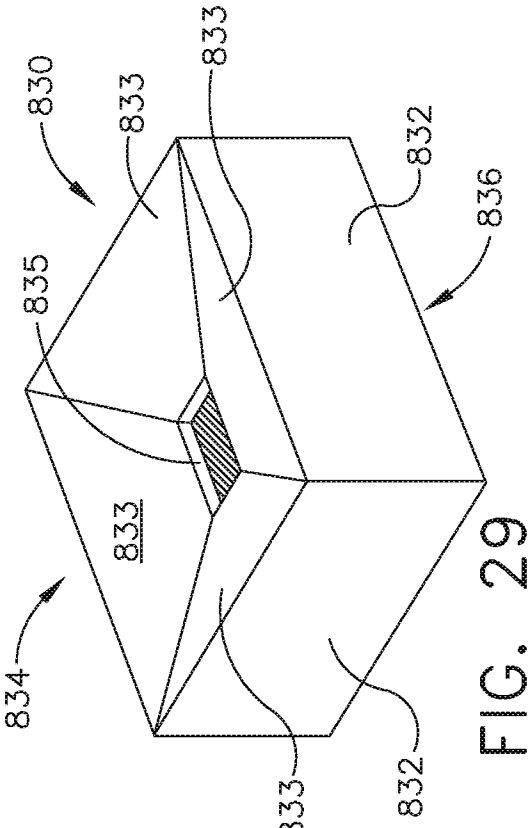


FIG. 29

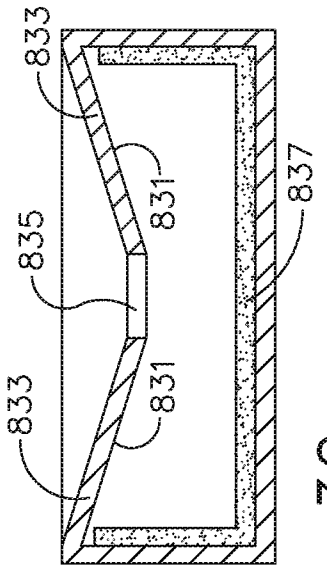


FIG. 30

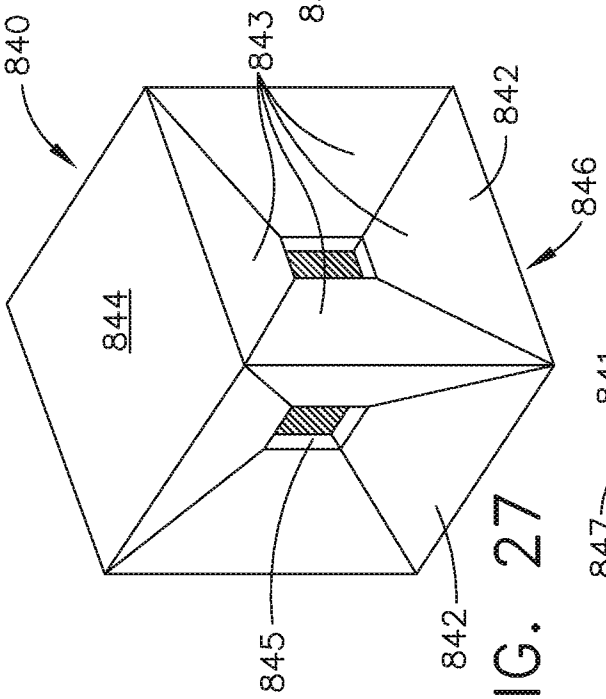


FIG. 27

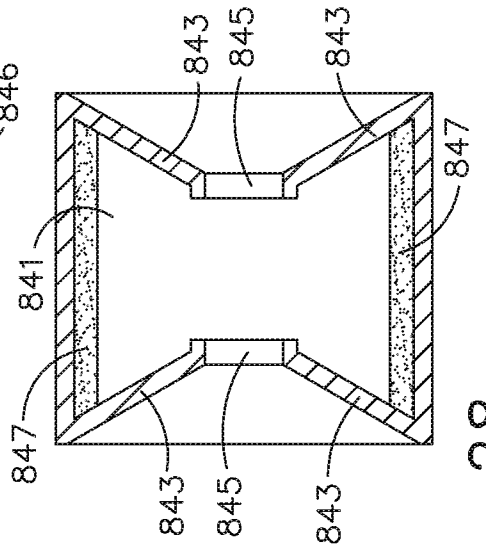


FIG. 28

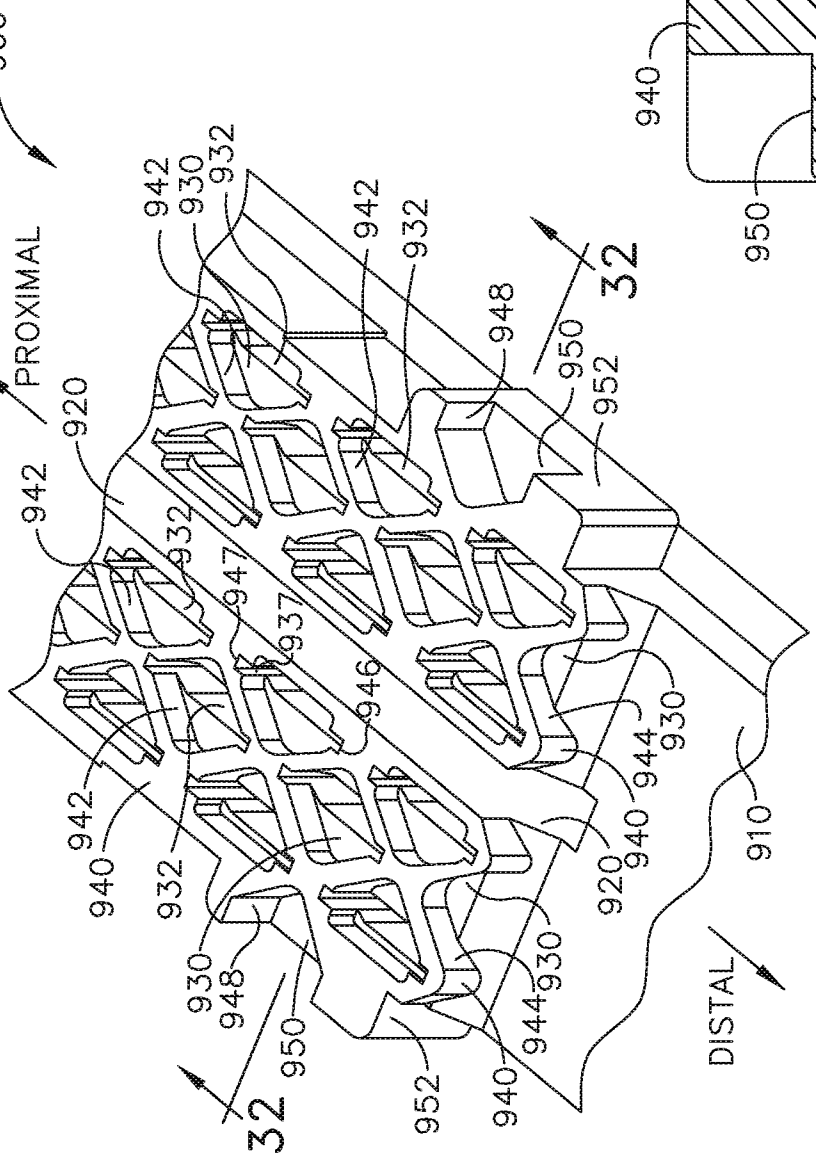

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FIG. 31

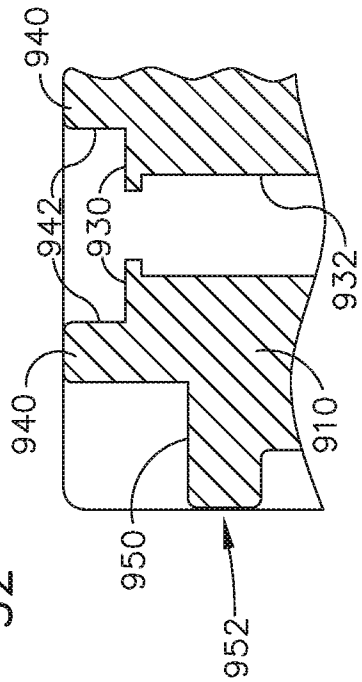

940
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FIG. 32

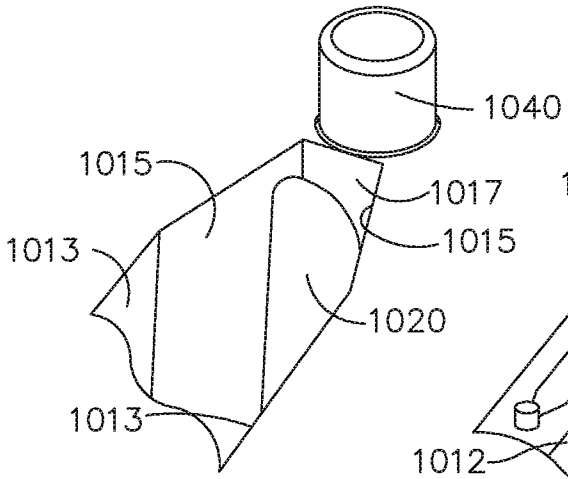


FIG. 34

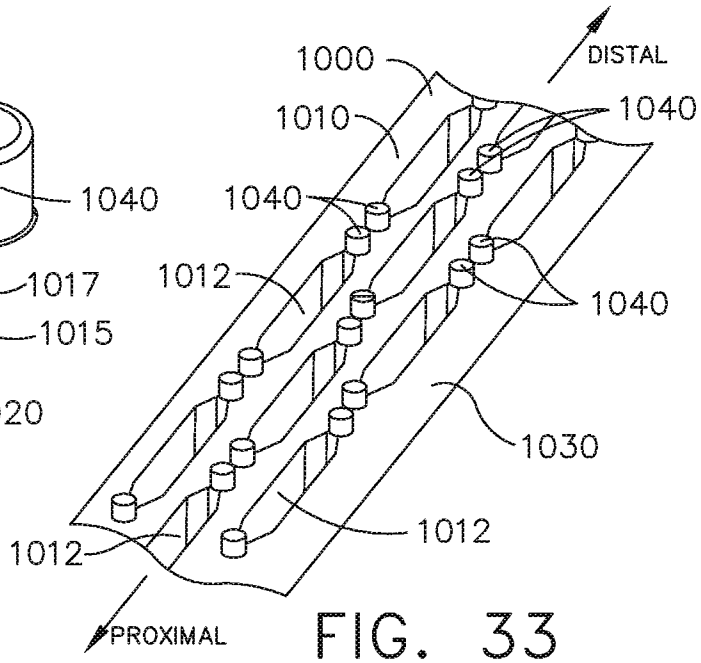


FIG. 33

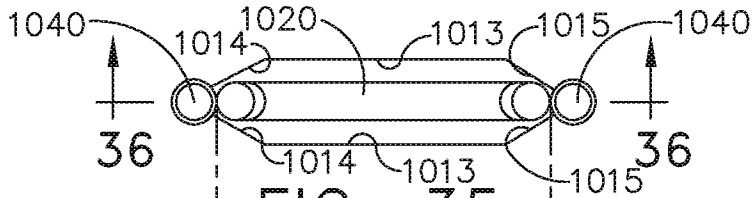


FIG. 35

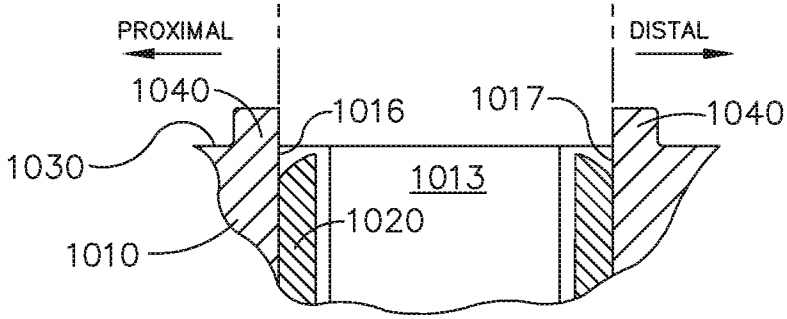


FIG. 36

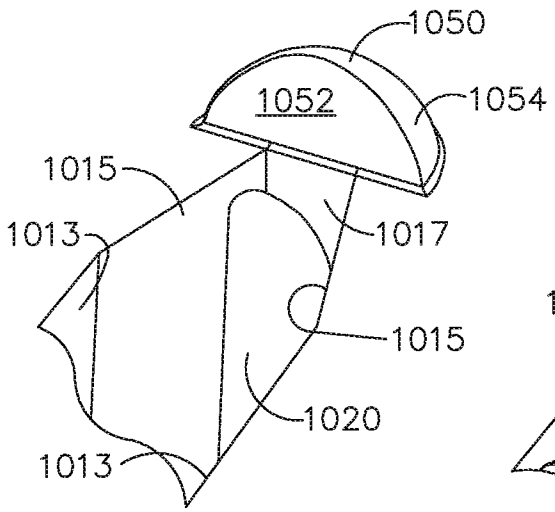


FIG. 38

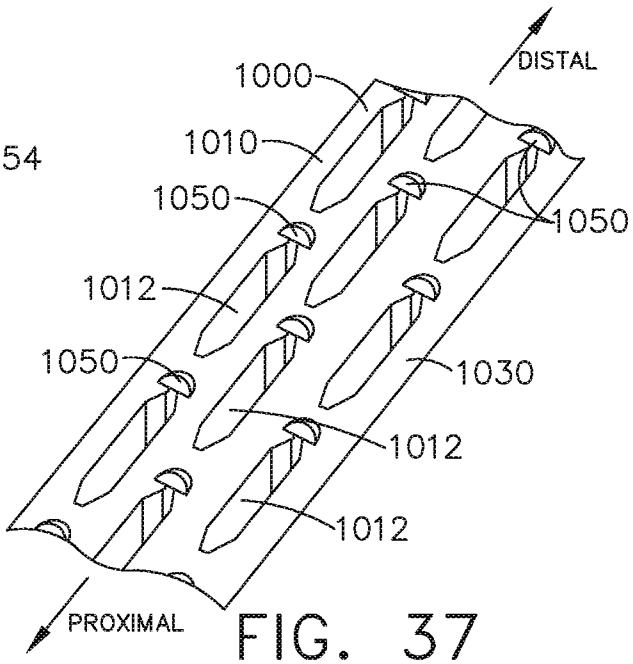


FIG. 37

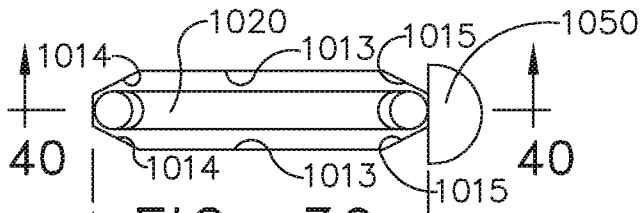


FIG. 39

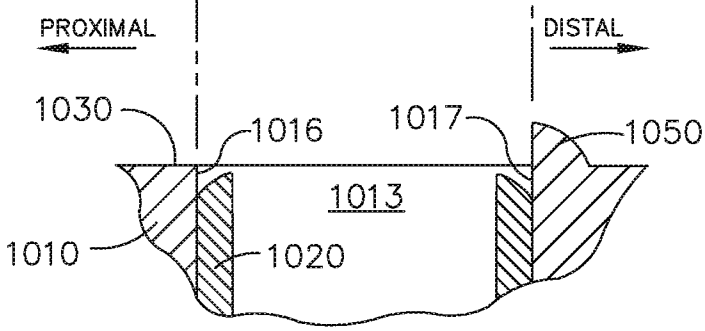


FIG. 40

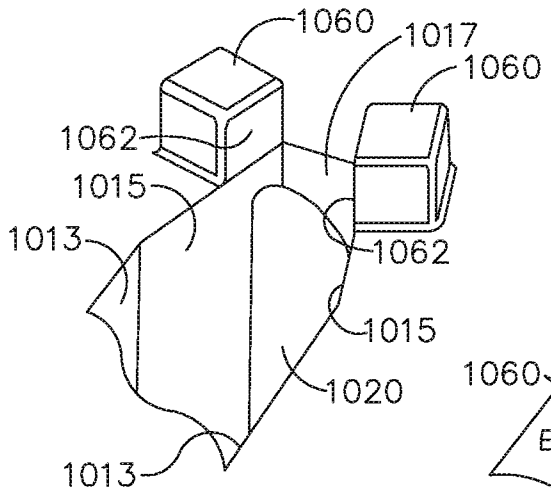


FIG. 42

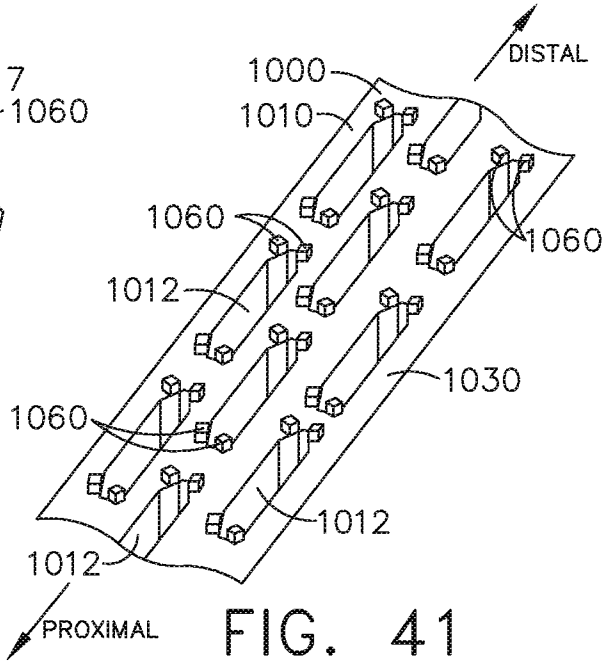


FIG. 41

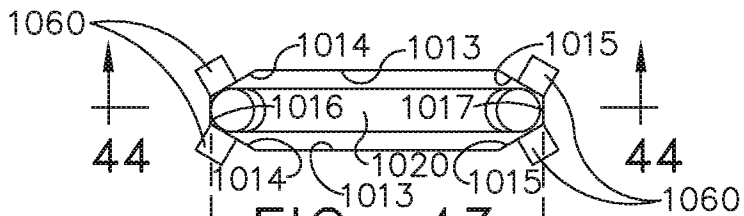


FIG. 43

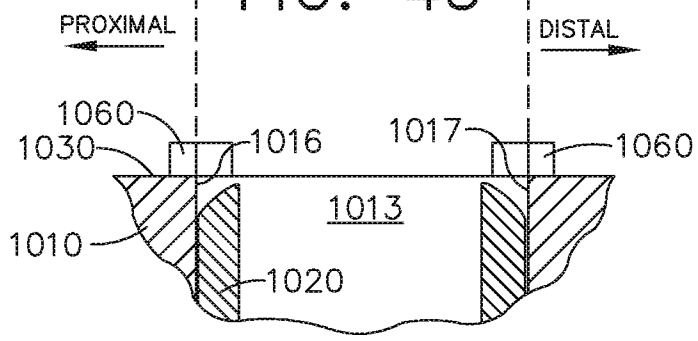


FIG. 44

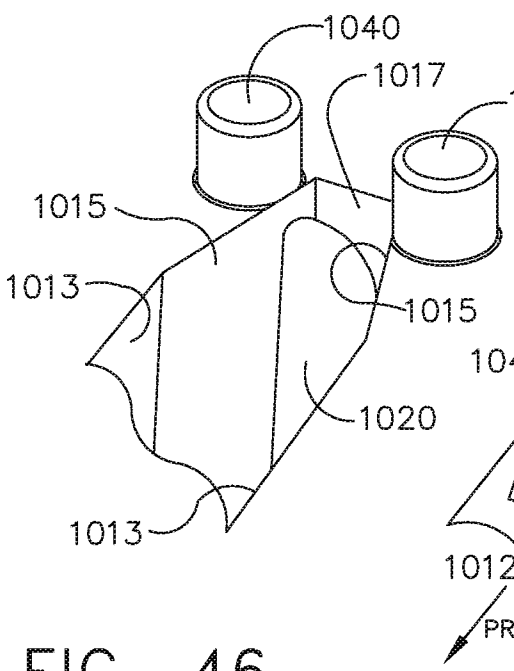


FIG. 46

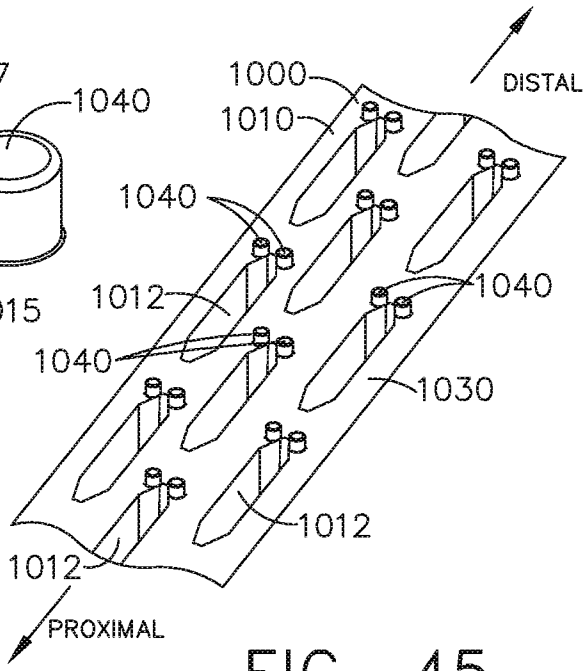


FIG. 45

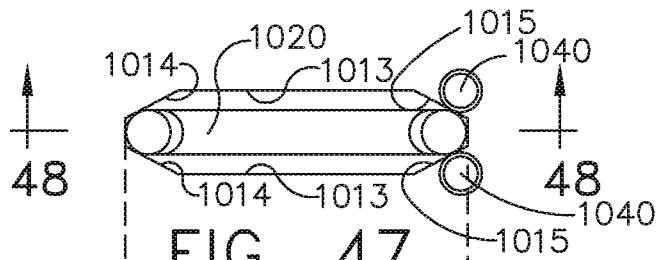


FIG. 47

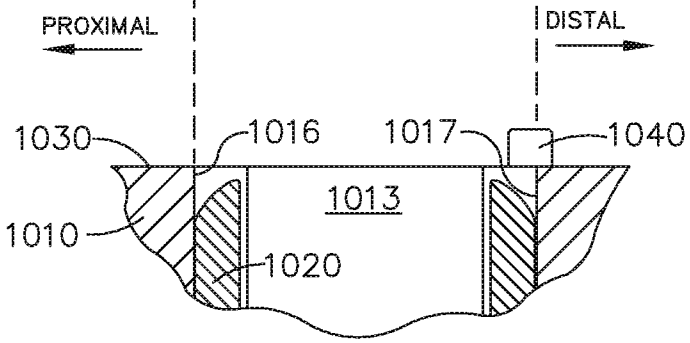


FIG. 48

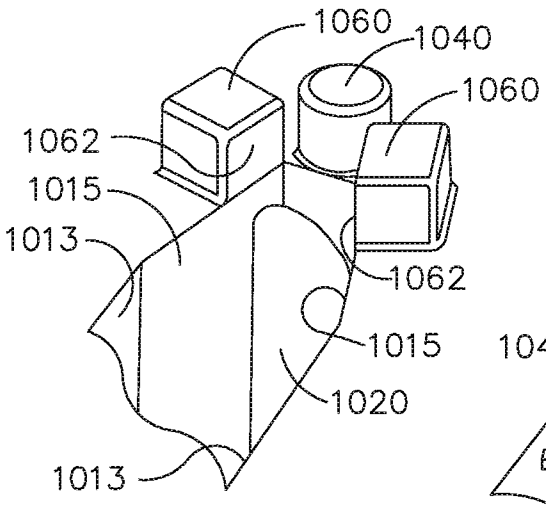


FIG. 50

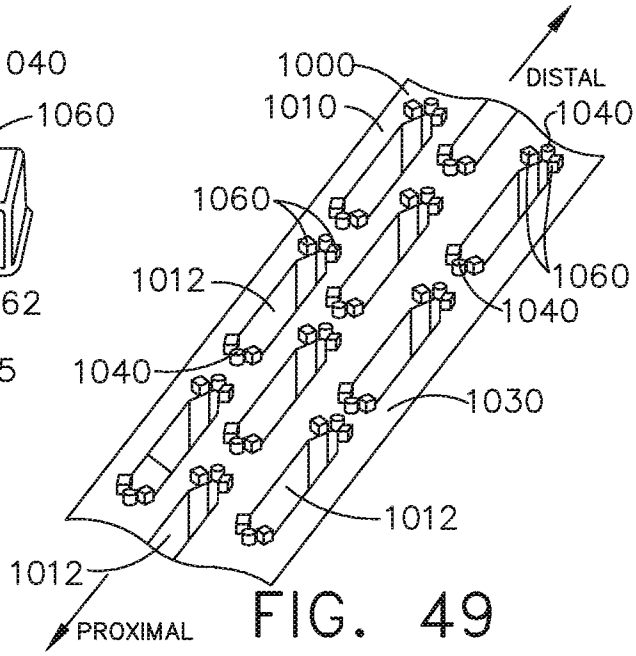


FIG. 49

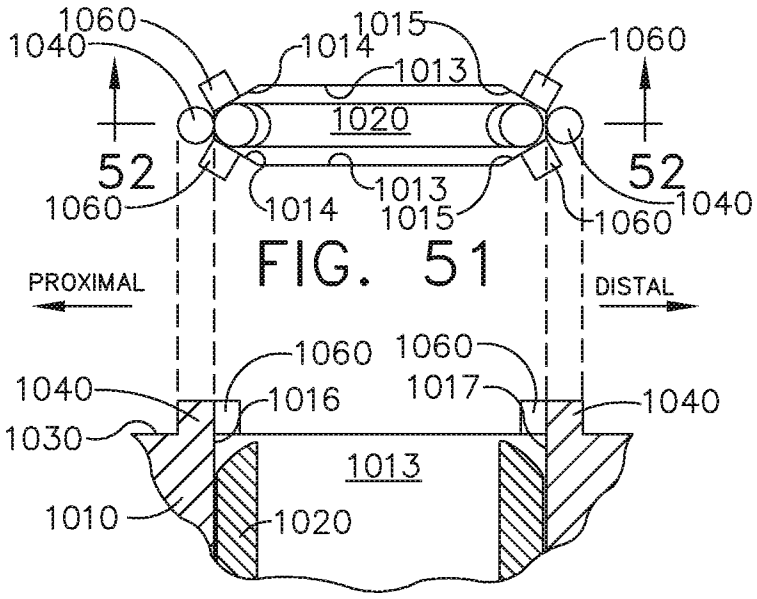


FIG. 51

FIG. 52

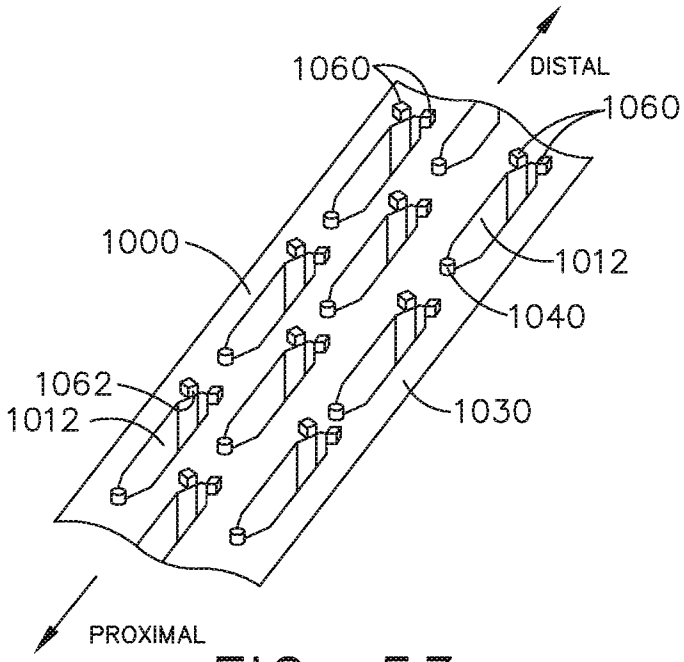


FIG. 53

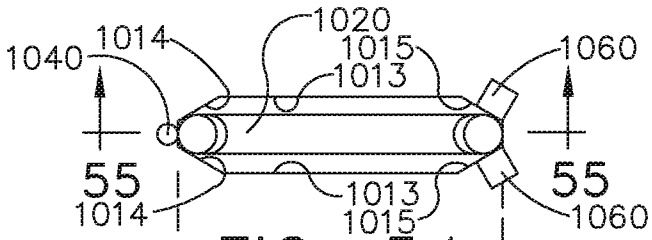


FIG. 54

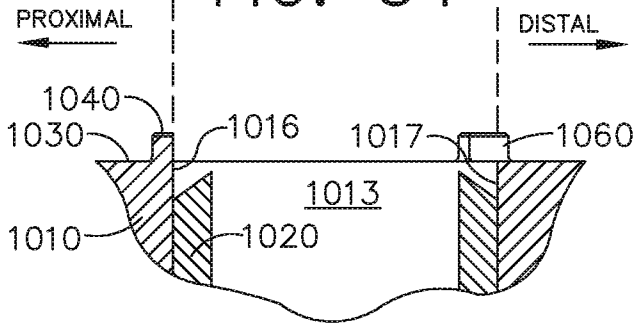


FIG. 55

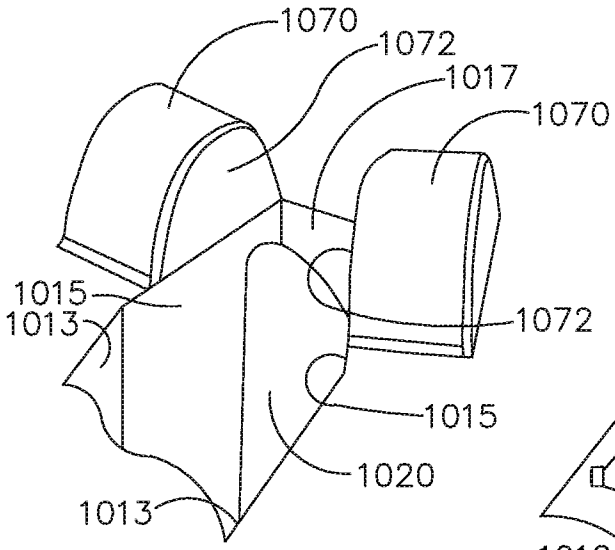


FIG. 57

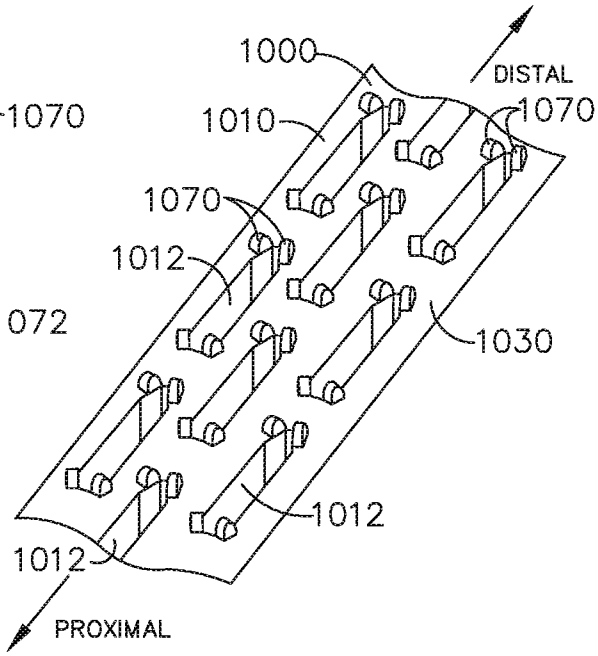


FIG. 56

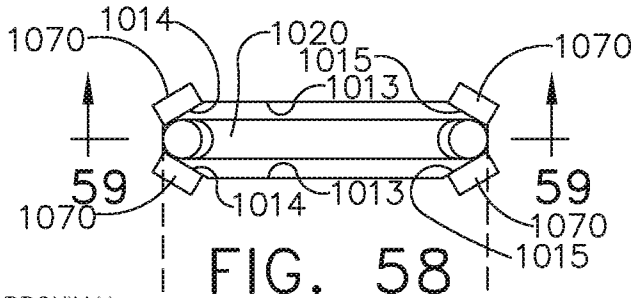


FIG. 58

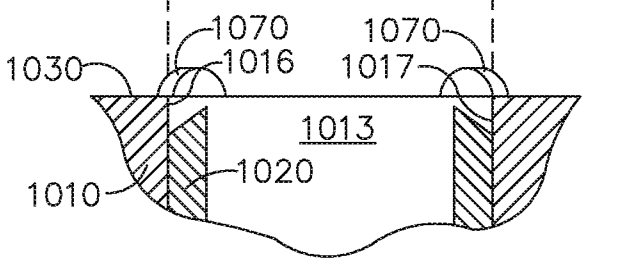


FIG. 59

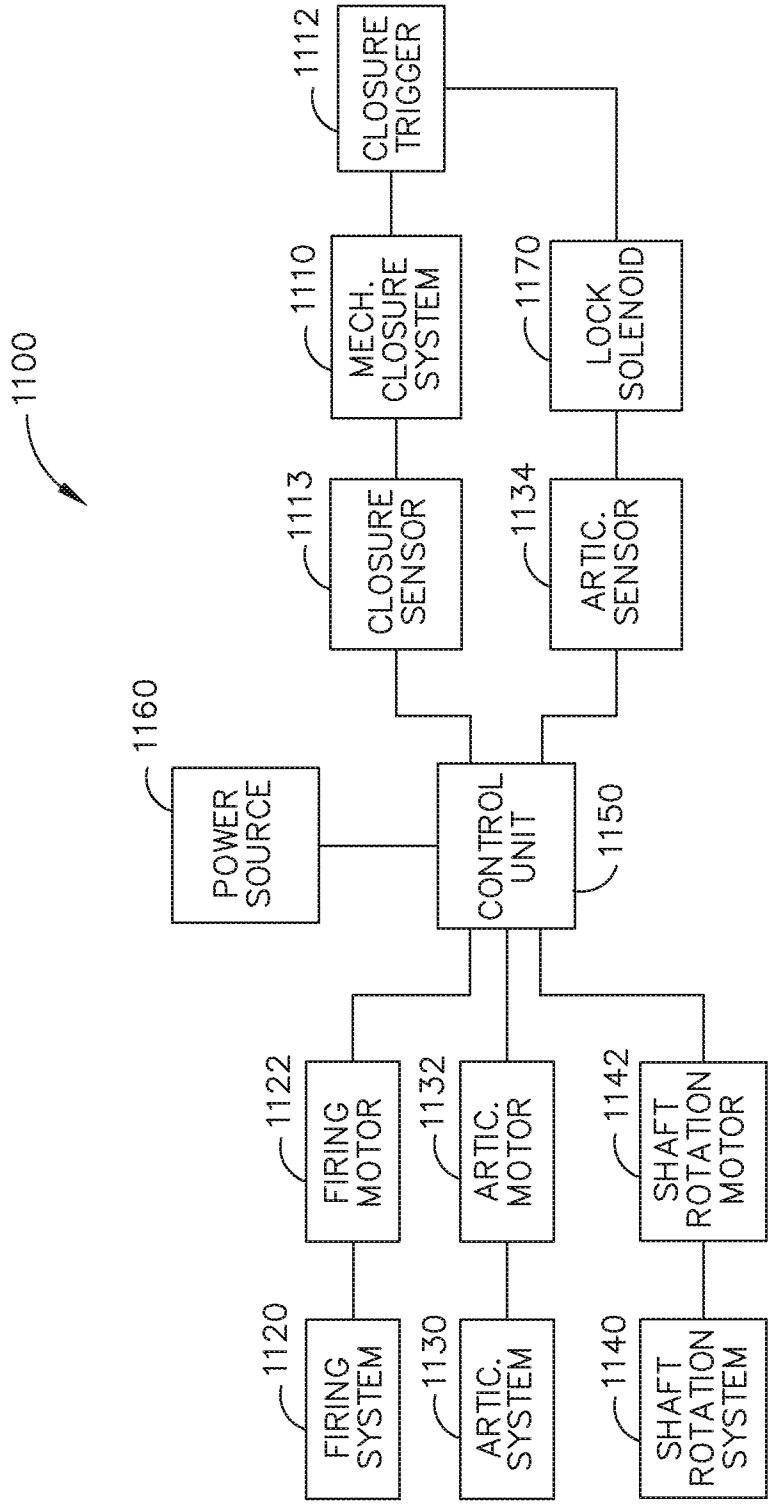

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CLOSURE TRIGGER
1110
MECH. CLOSURE SYSTEM
1170
LOCK SOLENOID
1113
CLOSURE SENSOR
1134
ARTIC. SENSOR
1160
POWER SOURCE
CONTROL UNIT
1150
1122
FIRING MOTOR
1132
ARTIC. MOTOR
1142
SHAFT ROTATION MOTOR
1120
FIRING SYSTEM
1130
ARTIC. SYSTEM
1140
SHAFT ROTATION SYSTEM

FIG. 60

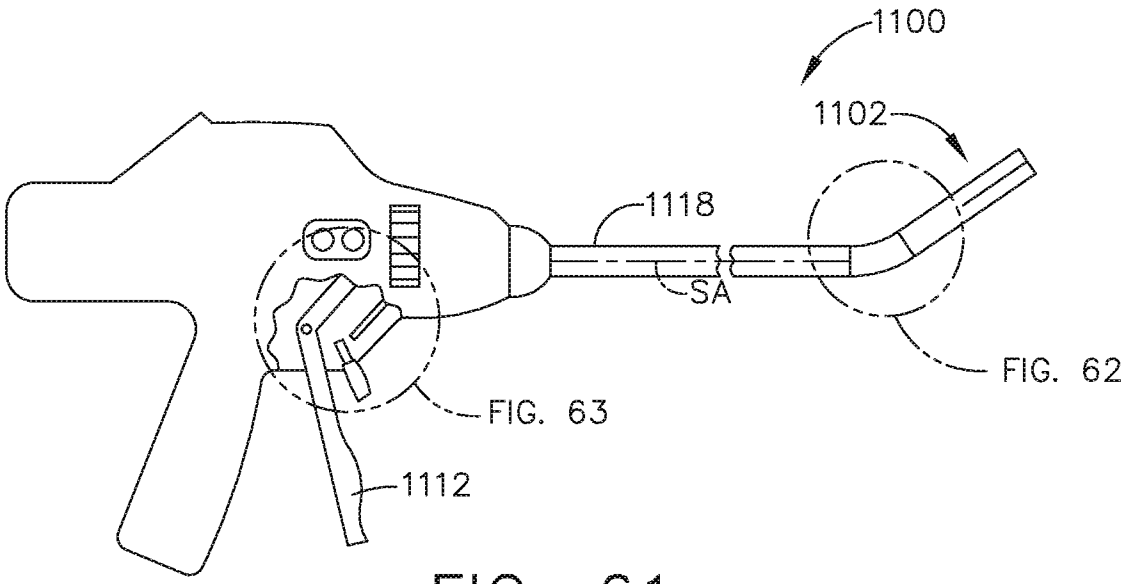


FIG. 61

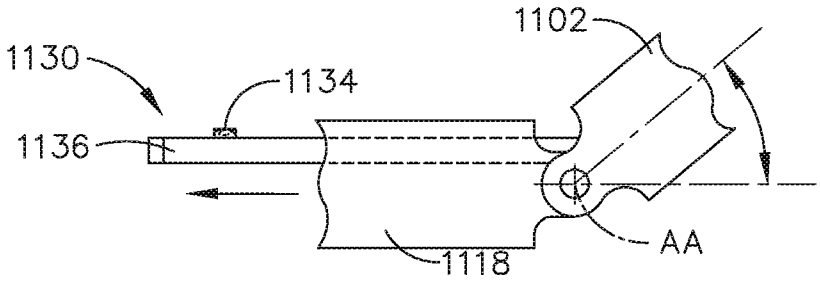


FIG. 62

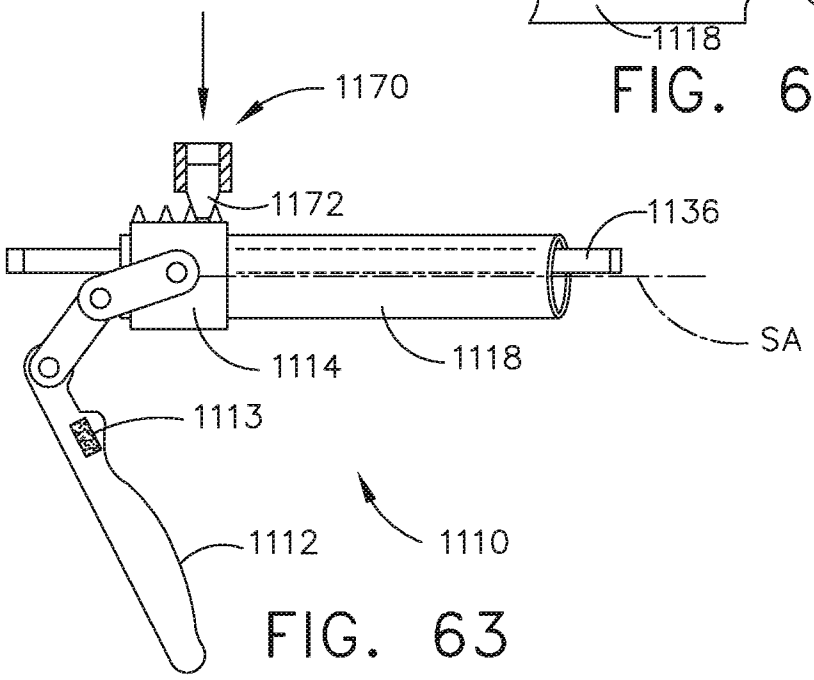


FIG. 63

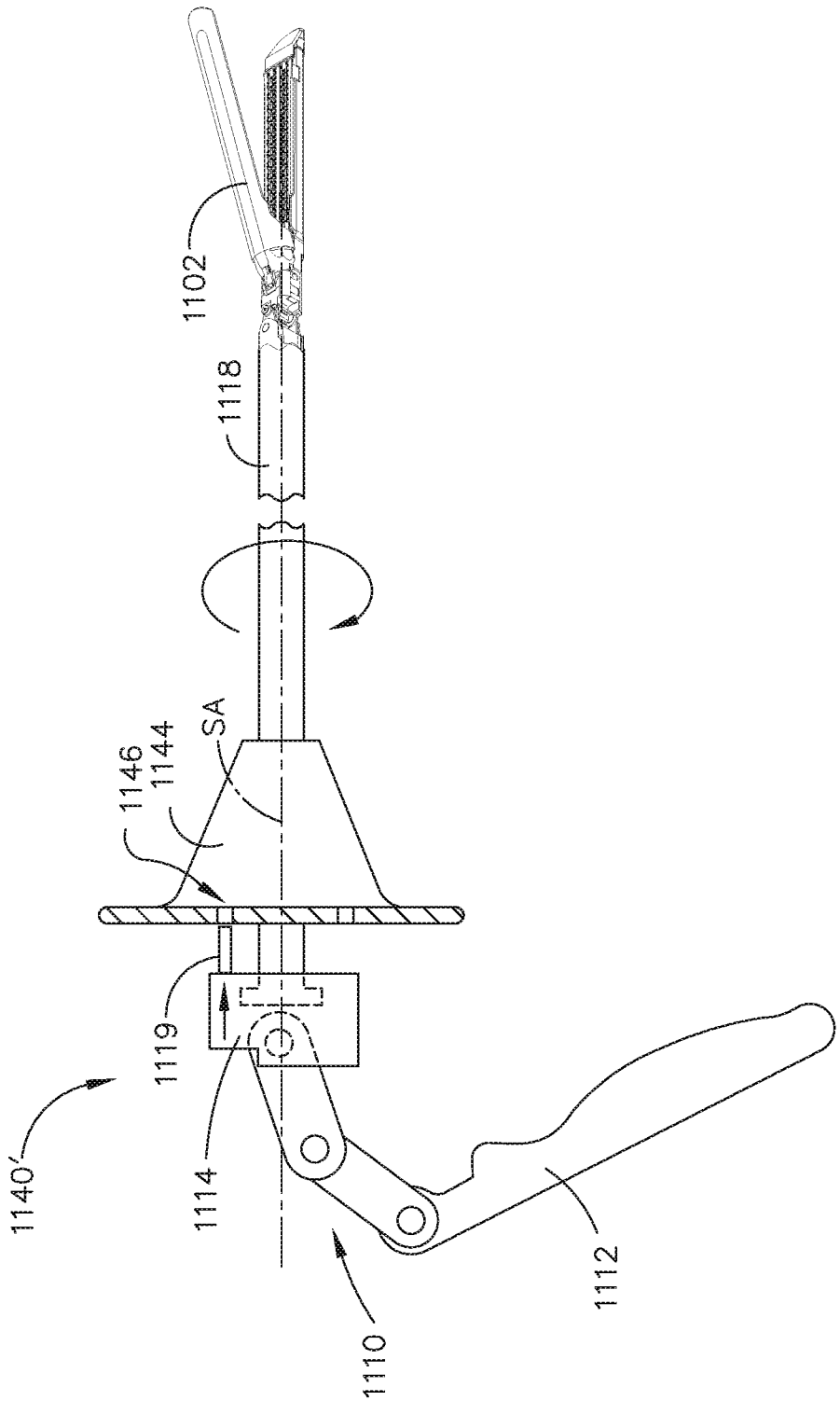


FIG. 64

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2020/055664

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B17/072 A61B50/00
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)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2012/241497 A1 (MANDAKOLATHUR VASUDEVAN VENKATARAMANAN [IN] ET AL) 27 September 2012 (2012-09-27)	1-4, 11-13
A	paragraphs [0818], [0824], [0847]; figures 235, 283, 311, 312, 326	8-10,16, 17

X	US 2013/214030 A1 (ARONHALT TAYLOR W [US] ET AL) 22 August 2013 (2013-08-22)	1-4
A	paragraph [0526] - paragraph [0530]; figures 117-118	8-13,16, 17

X	EP 2 932 918 A1 (ETHICON ENDO SURGERY INC [US]) 21 October 2015 (2015-10-21)	1-4, 11-13
A	paragraph [0023]; figures 7-18, 55-63, 70-83	8-10,16, 17

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
31 August 2020	13/11/2020

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Enborg, Andreas

1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2020/055664

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

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

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

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

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-4, 8-13, 16, 17

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

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

1. claims: 1-4, 8-13, 16, 17

A staple cartridge, comprising a cartridge body and staples, the cartridge body comprising a longitudinal slot, a deck surface, a plurality of staple cavities and a plurality of projections extending from the deck surface, further directed at the projections including at least one projection being cylindrical and positioned such that an outer diameter is flush with either a proximal or a distal side of the staple cavities.

---

2. claims: 5-7

A staple cartridge, comprising a cartridge body and staples, the cartridge body comprising a longitudinal slot, a deck surface, a plurality of staple cavities and a plurality of projections extending from the deck surface, further directed at the projections being quarter-shpere shaped and positioned such that one face of the quarter-spheres is flush with either a proximal or a distal end of the staple cavities.

---

3. claims: 14, 15

A staple cartridge, comprising a cartridge body and staples, the cartridge body comprising a longitudinal slot, a deck surface, a plurality of staple cavities and a plurality of projections extending from the deck surface, further directed at the projections being substantially cubic and positioned such that a face of the cubic projections is flush with a lateral side of the staple cavities.

---

4. claims: 18-20

A staple cartridge, comprising a cartridge body and staples, the cartridge body comprising a longitudinal slot, a deck surface, a plurality of staple cavities and a plurality of projections extending from the deck surface, further directed at the projections being radial fillet shaped and positioned along the lateral sides of the staple cavities.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2020/055664

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		PL 2932917 T3	30-03-2018
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		US 2015297227 A1	22-10-2015

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2020/055664

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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