



(51) International Patent Classification:
A61B 17/072 (2006.01)

(21) International Application Number:
PCT/IB2022/052470

(22) International Filing Date:
18 March 2022 (18.03.2022)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
17/208,347 22 March 2021 (22.03.2021) US

(71) Applicant: CILAG GMBH INTERNATIONAL
[CH/CH]; Gubelstrasse 34, 6300 Zug (CH).

(72) Inventors: ADAMS, Shane R.; 4545 Creek Road, Cincinnati, Ohio 45242 (US). SHELTON, IV, Frederick E.; 4545

Creek Road, Cincinnati, Ohio 45242 (US). HARRIS, Jason L.; 4545 Creek Road, Cincinnati, Ohio 45242 (US).

(74) Agent: TUNSTALL, Christopher Stephen et al.; Carpmaels & Ransford LLP, One Southampton Row, London Greater London WC1B 5HA (GB).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM,

(54) Title: STAPLING INSTRUMENT COMPRISING A PULSED MOTOR-DRIVEN FIRING RACK

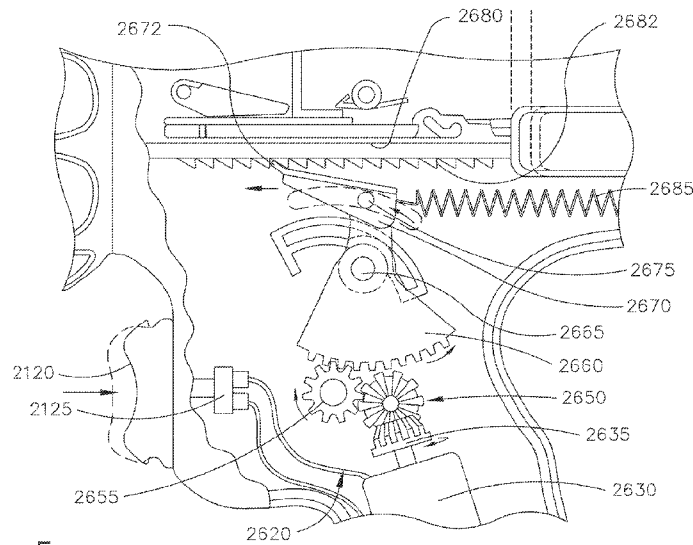


FIG. 5

(57) Abstract: A stapling instrument comprising a firing drive including a motor-driven reciprocable pawl (2670) and a longitudinal rack (2680) is disclosed. The reciprocable pawl is operably coupled with an electric motor (2630). The reciprocable pawl is driven distally a stroke length by the electric motor when the electric motor is operated in a first direction. The reciprocable pawl drives the longitudinal rack and a firing member distally a first stroke length when the reciprocable pawl is driven distally. The reciprocable pawl is retracted proximally relative to the longitudinal rack when the reciprocable electric motor is operated in an opposite direction. The reciprocable pawl is driven distally said stroke length by the electric motor a second time when the electric motor is operated in the first direction once again. The reciprocable pawl drives the longitudinal rack and the firing member distally a second stroke length when the reciprocable pawl is driven distally a second time.



TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

- (84) Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

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))*

Published:

- *with international search report (Art. 21(3))*
 - *in black and white; the international application as filed contained color or greyscale and is available for download from PATENTSCOPE*
-

TITLE

STAPLING INSTRUMENT COMPRISING A PULSED MOTOR-DRIVEN FIRING RACK

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] Various features of the embodiments described herein, together with advantages thereof, may be understood in accordance with the following description taken in conjunction with the accompanying drawings as follows:

[0003] FIG. 1 is an elevational view of a surgical stapling instrument in accordance with at least one embodiment;

[0004] FIG. 2 is an elevational view of a handle of the surgical stapling instrument of FIG. 1;

[0005] FIG. 3 is an elevational view of a surgical stapling instrument in accordance with at least one embodiment illustrated with some components removed;

[0006] FIG. 4 is a detail view of a staple firing system of the surgical stapling instrument of FIG. 3;

[0007] FIG. 5 is a detail view of the staple firing system of FIG. 4 illustrating a first actuation of the staple firing system;

[0008] FIG. 6 is a detail view of the staple firing system of FIG. 4 illustrating a pawl of the staple firing system being retracted after the first actuation;

[0009] FIG. 7 is a detail view of the staple firing system of FIG. 4 illustrating a second actuation of the staple firing system;

[0010] FIG. 8 is a perspective view of an end-of-stroke sensor in accordance with at least one embodiment;

- [0011]** FIG. 9 is a schematic of a control circuit in accordance with at least one embodiment;
- [0012]** FIG. 10 is a schematic of a control circuit in accordance with at least one embodiment;
- [0013]** FIG. 11 is a schematic of a control circuit in accordance with at least one embodiment;
- [0014]** FIG. 12 illustrates a motor-driven firing drive in accordance with at least one embodiment;
- [0015]** FIG. 12A is a schematic of a control circuit in accordance with at least one embodiment;
- [0016]** FIG. 12B illustrates the control circuit of FIG. 12A in a different switch state;
- [0017]** FIG. 13 illustrates a solenoid-driven firing drive in accordance with at least one embodiment;
- [0018]** FIG. 13A is a control circuit of the firing drive of FIG. 13;
- [0019]** FIG. 14 is an elevational view of a surgical stapling instrument in accordance with at least one embodiment illustrated with some components removed;
- [0020]** FIG. 15 is an elevational view of the stapling instrument of FIG. 14 illustrating a firing drive in a closed configuration;
- [0021]** FIG. 16 is an elevational view of the stapling instrument of FIG. 14 illustrating the firing drive in a staple firing mode;
- [0022]** FIG. 17 is an elevational view of the stapling instrument of FIG. 14 illustrating the firing drive being retracted before performing a staple firing actuation;
- [0023]** FIG. 18 is an elevational view of the stapling instrument of FIG. 14 illustrating the firing drive during the staple firing actuation;
- [0024]** FIG. 19 is a graph depicting the operation of a stapling instrument comprising a firing drive including a shiftable transmission in accordance with at least one embodiment;
- [0025]** FIG. 20 is a partial cross-sectional view of a stapling instrument comprising a firing drive including a slip clutch in accordance with at least one embodiment;
- [0026]** FIG. 20A is a cross-sectional view of the slip clutch of FIG. 20;

- [0027]** FIG. 21 is a partial perspective view of a stapling instrument comprising a bailout drive in accordance with at least one embodiment;
- [0028]** FIG. 22 is a partial elevational view of a stapling instrument in accordance with at least one embodiment illustrated with some components removed;
- [0029]** FIG. 22A is a schematic of an indicator system of the stapling instrument of FIG. 22;
- [0030]** FIG. 23 is a partial elevational view of a stapling instrument comprising a loading unit release actuator in accordance with at least one embodiment;
- [0031]** FIG. 24 is an elevational view of a stapling instrument comprising a detachable shaft in accordance with at least one embodiment;
- [0032]** FIG. 25 illustrates a proximal end of a detachable shaft in an open configuration in accordance with at least one embodiment;
- [0033]** FIG. 25A is a top view of the proximal shaft end of FIG. 25;
- [0034]** FIG. 26 is a partial exploded view of a staple cartridge in accordance with at least one embodiment;
- [0035]** FIG. 26A is a partial perspective view of a firing member in a locked condition;
- [0036]** FIG. 26B is a partial exploded view of a staple cartridge in accordance with at least one embodiment;
- [0037]** FIG. 26C is a partial perspective view of a firing member in a locked condition by two sets of lockouts;
- [0038]** FIG. 27 is a partial cross-sectional view of the staple cartridge of FIG. 26 and the firing member of FIG. 26A in an unlocked condition;
- [0039]** FIG. 28 is a partial cross-sectional view of the staple cartridge of FIG. 26 and the firing member of FIG. 26A in the locked condition of FIG. 26A;
- [0040]** FIG. 29 is a partial cross-sectional view of a staple cartridge and a firing member in an unlocked condition in accordance with at least one embodiment;
- [0041]** FIG. 30 is a partial cross-sectional view of the staple cartridge and firing member of FIG. 29 illustrating the firing member in a locked condition;
- [0042]** FIG. 31 illustrates a spent cartridge/missing cartridge lockout in accordance with at least one embodiment;

- [0043]** FIG. 31A illustrates a staple cartridge including a sled holding the lockout of FIG. 31 in an unlocked condition;
- [0044]** FIG. 31B illustrates the sled of FIG. 31A being advanced distally through a staple firing stroke by a firing member;
- [0045]** FIG. 31C illustrates the firing member of FIG. 31B being retracted after the staple firing stroke;
- [0046]** FIG. 31D illustrates the lockout of FIG. 31 in a locked condition preventing the firing member from being moved through another firing stroke;
- [0047]** FIG. 32 illustrates a spent cartridge/missing cartridge lockout in accordance with at least one embodiment;
- [0048]** FIG. 33 illustrates the lockout of FIG. 32 in a locked condition;
- [0049]** FIG. 34 is a partial perspective view of a stapling instrument including a cartridge lock configured to lock a staple cartridge into a cartridge jaw in accordance with at least one embodiment;
- [0050]** FIG. 35 is a partial cross-sectional view of a staple cartridge seated in the cartridge jaw of FIG. 34 illustrating the cartridge lock of FIG. 34 in an unlocked state;
- [0051]** FIG. 36 is a partial cross-sectional view illustrating the cartridge lock of FIG. 34 in a locked state;
- [0052]** FIG. 37 is a cross-sectional end view of the cartridge jaw of FIG. 34;
- [0053]** FIG. 38 is a cross-sectional end view of the staple cartridge of FIG. 35 locked in the cartridge jaw of FIG. 34;
- [0054]** FIG. 39 is a partial cross-sectional view of a surgical stapling instrument comprising a firing member that has been moved distally to close an anvil jaw in accordance with at least one embodiment;
- [0055]** FIG. 40 is a partial cross-sectional view of the stapling instrument of FIG. 39 illustrating the firing member advanced distally to drive the anvil jaw downwardly;
- [0056]** FIG. 41 is a partial cross-sectional view of the anvil jaw of FIG. 39 in an open position after the firing member has been retracted following a staple firing stroke;
- [0057]** FIG. 42 is a partial cross-sectional view of an end effector of a surgical stapling instrument in accordance with at least one embodiment illustrated in an open configuration;

- [0058]** FIG. 43 is a partial cross-sectional view of the end effector of FIG. 42 illustrated in a closed configuration;
- [0059]** FIG. 44 is a partial cross-sectional view of an end effector in accordance with at least one embodiment;
- [0060]** FIG. 44A is a cross-sectional view of the end effector of FIG. 44 taken along line 44A-44A in FIG. 44;
- [0061]** FIG. 44B is a cross-sectional view of the end effector of FIG. 44 taken along line 44B-44B in FIG. 44;
- [0062]** FIG. 45 is a perspective view of a sled in accordance with at least one embodiment;
- [0063]** FIG. 45A is an elevational view of the sled of FIG. 45;
- [0064]** FIG. 45B is a cross-sectional view of the sled of FIG. 45;
- [0065]** FIG. 46 is a partial perspective view of a staple cartridge in accordance with at least one embodiment;
- [0066]** FIG. 46A is a diagram depicting the staples of the staple cartridge of FIG. 46 as they are deformed and after they are deformed;
- [0067]** FIG. 46B is a diagram depicting staples as they are deformed and after they are deformed in accordance with at least one embodiment;
- [0068]** FIG. 47 is a partial cross-sectional perspective view of an anvil jaw and a staple cartridge in accordance with at least one embodiment illustrated with some components removed;
- [0069]** FIG. 48 is a partial cross-sectional view of an anvil jaw and a staple cartridge in accordance with at least one embodiment;
- [0070]** FIG. 49 is a diagram illustrating the staples of the staple cartridge of FIG. 48;
- [0071]** FIG. 50 is a cross-sectional view of an anvil jaw in accordance with at least one embodiment;
- [0072]** FIG. 51 is a cross-sectional view of an anvil jaw in accordance with at least one embodiment;
- [0073]** FIG. 52 is a cross-sectional view of an anvil jaw in accordance with at least one embodiment;

- [0074]** FIG. 52A is a cross-sectional view of the anvil jaw of FIG. 52 after the components of the anvil jaw have been welded;
- [0075]** FIG. 53 is a cross-sectional view of an anvil jaw in accordance with at least one embodiment;
- [0076]** FIG. 54 is a partial cross-sectional view of a staple cartridge and an anvil in accordance with at least one embodiment;
- [0077]** FIG. 55 is a partial cross-sectional view of an anvil jaw and a staple cartridge in accordance with at least one embodiment;
- [0078]** FIG. 55A is a detail view of the anvil jaw and staple cartridge of FIG. 55;
- [0079]** FIG. 55B is a detail view of an alternative embodiment to FIG. 55;
- [0080]** FIG. 56 is a partial cross-sectional view of an anvil jaw and a staple cartridge in accordance with at least one embodiment;
- [0081]** FIG. 56A is a detail view of the anvil jaw and staple cartridge of FIG. 56;
- [0082]** FIG. 56B is a detail view of an alternative embodiment to FIG. 56;
- [0083]** FIG. 57 is a partial cross-sectional view of a staple cartridge in accordance with at least one embodiment;
- [0084]** FIG. 58 is a partial elevational view of an end effector including an anvil jaw and a staple cartridge in accordance with at least one embodiment;
- [0085]** FIG. 59 is a partial perspective view of the anvil jaw of FIG. 58 including a detachable adjunct in accordance with at least one embodiment;
- [0086]** FIG. 60 is a partial perspective view of the staple cartridge of FIG. 58 comprising a detachable adjunct seated in a cartridge jaw in accordance with at least one embodiment;
- [0087]** FIG. 61 is a cross-sectional view of the end effector of FIG. 58;
- [0088]** FIG. 61A is cross-sectional view of an end effector in accordance with at least one embodiment;
- [0089]** FIG. 61B is a partial cross-sectional view of a staple cartridge in accordance with at least one embodiment;
- [0090]** FIG. 62 is an elevational view of a loading unit comprising an articulation joint in accordance with at least one embodiment;

[0091] FIG. 63 is a detail view of the articulation joint of FIG. 62 illustrated in an unarticulated condition;

[0092] FIG. 64 is a detail view of the articulation joint of FIG. 62 illustrated in an articulated condition;

[0093] FIG. 65 is a control schematic of a stapling instrument in accordance with at least one embodiment; and

[0094] FIG. 66 is a schematic of a stapling instrument comprising an articulation joint and an articulation drive including a load limiting interface.

[0095] 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

[0096] Applicant of the present application also 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:

- U.S. Patent Application, entitled METHOD OF SHIFTING A SURGICAL STAPLING INSTRUMENT; Attorney Docket No. END9246USNP1/200061-1M;
- U.S. Patent Application, entitled SURGICAL STAPLING INSTRUMENT COMPRISING A RETRACTION SYSTEM; Attorney Docket No. END9246USNP3/200061-3;
- U.S. Patent Application, entitled SURGICAL INSTRUMENT COMPRISING A FIRING DRIVE INCLUDING A SELECTABLE LEVERAGE MECHANISM; Attorney Docket No. END9246USNP4/200061-4;
- U.S. Patent Application, entitled STAPLE CARTRIDGE COMPRISING STAPLES CONFIGURED TO APPLY DIFFERENT TISSUE COMPRESSION; Attorney Docket No. END9246USNP5/200061-5;
- U.S. Patent Application, entitled STAPLE CARTRIDGE COMPRISING A FIRING LOCKOUT; Attorney Docket No. END9246USNP6/200061-6;

- U.S. Patent Application, entitled STAPLE CARTRIDGE COMPRISING AN IMPLANTABLE LAYER; Attorney Docket No. END9246USNP7/200061-7; and
- U.S. Patent Application, entitled STAPLING INSTRUMENT COMPRISING TISSUE COMPRESSION SYSTEMS; Attorney Docket No. END9246USNP8/200061-8.

[0097] Applicant of the present application also owns the following U.S. Patent Applications that were filed on February 26, 2021 and which are each herein incorporated by reference in their respective entireties:

- U.S. Patent Application Serial No. 17/186,269, entitled METHOD OF POWERING AND COMMUNICATING WITH A STAPLE CARTRIDGE;
- U.S. Patent Application Serial No. 17/186,273, entitled METHOD OF POWERING AND COMMUNICATING WITH A STAPLE CARTRIDGE;
- U.S. Patent Application Serial No. 17/186,276, entitled ADJUSTABLE COMMUNICATION BASED ON AVAILABLE BANDWIDTH AND POWER CAPACITY;
- U.S. Patent Application Serial No. 17/186,283, entitled ADJUSTMENT TO TRANSFER PARAMETERS TO IMPROVE AVAILABLE POWER;
- U.S. Patent Application Serial No. 17/186,345, entitled MONITORING OF MANUFACTURING LIFE-CYCLE;
- U.S. Patent Application Serial No. 17/186,350, entitled MONITORING OF MULTIPLE SENSORS OVER TIME TO DETECT MOVING CHARACTERISTICS OF TISSUE;
- U.S. Patent Application Serial No. 17/186,353, entitled MONITORING OF INTERNAL SYSTEMS TO DETECT AND TRACK CARTRIDGE MOTION STATUS;
- U.S. Patent Application Serial No. 17/186,357, entitled DISTAL COMMUNICATION ARRAY TO TUNE FREQUENCY OF RF SYSTEMS;
- U.S. Patent Application Serial No. 17/186,364, entitled STAPLE CARTRIDGE COMPRISING A SENSOR ARRAY;
- U.S. Patent Application Serial No. 17/186,373, entitled STAPLE CARTRIDGE COMPRISING A SENSING ARRAY AND A TEMPERATURE CONTROL SYSTEM;
- U.S. Patent Application Serial No. 17/186,378, entitled STAPLE CARTRIDGE COMPRISING AN INFORMATION ACCESS CONTROL SYSTEM;

- U.S. Patent Application Serial No. 17/186,407, entitled STAPLE CARTRIDGE COMPRISING A POWER MANAGEMENT CIRCUIT;
- U.S. Patent Application Serial No. 17/186,421, entitled STAPLING INSTRUMENT COMPRISING A SEPARATE POWER ANTENNA AND A DATA TRANSFER ANTENNA;
- U.S. Patent Application Serial No. 17/186,438, entitled SURGICAL INSTRUMENT SYSTEM COMPRISING A POWER TRANSFER COIL; and
- U.S. Patent Application Serial No. 17/186,451, entitled STAPLING INSTRUMENT COMPRISING A SIGNAL ANTENNA.

[0098] Applicant of the present application also owns the following U.S. Patent Applications that were filed on October 29, 2020 and which are each herein incorporated by reference in their respective entireties:

- U.S. Patent Application Serial No. 17/084,179, entitled SURGICAL INSTRUMENT COMPRISING A RELEASABLE CLOSURE DRIVE LOCK;
- U.S. Patent Application Serial No. 17/084,190, entitled SURGICAL INSTRUMENT COMPRISING A STOWED CLOSURE ACTUATOR STOP;
- U.S. Patent Application Serial No. 17/084,198, entitled SURGICAL INSTRUMENT COMPRISING AN INDICATOR WHICH INDICATES THAT AN ARTICULATION DRIVE IS ACTUATABLE;
- U.S. Patent Application Serial No. 17/084,205, entitled SURGICAL INSTRUMENT COMPRISING AN ARTICULATION INDICATOR;
- U.S. Patent Application Serial No. 17/084,258, entitled METHOD FOR OPERATING A SURGICAL INSTRUMENT;
- U.S. Patent Application Serial No. 17/084,206, entitled SURGICAL INSTRUMENT COMPRISING AN ARTICULATION LOCK;
- U.S. Patent Application Serial No. 17/084,215, entitled SURGICAL INSTRUMENT COMPRISING A JAW ALIGNMENT SYSTEM;
- U.S. Patent Application Serial No. 17/084,229, entitled SURGICAL INSTRUMENT COMPRISING SEALABLE INTERFACE;
- U.S. Patent Application Serial No. 17/084,180, entitled SURGICAL INSTRUMENT COMPRISING A LIMITED TRAVEL SWITCH;

- U.S. Design Patent Application Serial No. 29/756,615, Application entitled SURGICAL STAPLING ASSEMBLY;
- U.S. Design Patent Application Serial No. 29/756,620, entitled SURGICAL STAPLING ASSEMBLY;
- U.S. Patent Application Serial No. 17/084,188, entitled SURGICAL INSTRUMENT COMPRISING A STAGED VOLTAGE REGULATION START-UP SYSTEM; and
- U.S. Patent Application Serial No. 17/084,193, entitled SURGICAL INSTRUMENT COMPRISING A SENSOR CONFIGURED TO SENSE WHETHER AN ARTICULATION DRIVE OF THE SURGICAL INSTRUMENT IS ACTUATABLE.

[0099] Applicant of the present application also owns the following U.S. Patent Applications that were filed on April 11, 2020 and which are each herein incorporated by reference in their respective entireties:

- U.S. Patent Application Serial No. 16/846,303, entitled METHODS FOR STAPLING TISSUE USING A SURGICAL INSTRUMENT, now U.S. Patent Application Publication No. 2020/0345353;
- U.S. Patent Application Serial No. 16/846,304, entitled ARTICULATION ACTUATORS FOR A SURGICAL INSTRUMENT, now U.S. Patent Application Publication No. 2020/0345354;
- U.S. Patent Application Serial No. 16/846,305, entitled ARTICULATION DIRECTIONAL LIGHTS ON A SURGICAL INSTRUMENT, now U.S. Patent Application Publication No. 2020/0345446;
- U.S. Patent Application Serial No. 16/846,307, entitled SHAFT ROTATION ACTUATOR ON A SURGICAL INSTRUMENT, now U.S. Patent Application Publication No. 2020/0345349;
- U.S. Patent Application Serial No. 16/846,308, entitled ARTICULATION CONTROL MAPPING FOR A SURGICAL INSTRUMENT, now U.S. Patent Application Publication No. 2020/0345355;
- U.S. Patent Application Serial No. 16/846,309, entitled INTELLIGENT FIRING ASSOCIATED WITH A SURGICAL INSTRUMENT, now U.S. Patent Application Publication No. 2020/0345356;

- U.S. Patent Application Serial No. 16/846,310, entitled INTELLIGENT FIRING ASSOCIATED WITH A SURGICAL INSTRUMENT, now U.S. Patent Application Publication No. 2020/0345357;
- U.S. Patent Application Serial No. 16/846,311, entitled ROTATABLE JAW TIP FOR A SURGICAL INSTRUMENT, now U.S. Patent Application Publication No. 2020/0345358;
- U.S. Patent Application Serial No. 16/846,312, entitled TISSUE STOP FOR A SURGICAL INSTRUMENT, now U.S. Patent Application Publication No. 2020/0345359; and
- U.S. Patent Application Serial No. 16/846,313, entitled ARTICULATION PIN FOR A SURGICAL INSTRUMENT, now U.S. Patent Application Publication No. 2020/0345360.

[0100] Applicant of the present application owns the following U.S. Patent Applications that were filed on June 26, 2019 and which are each herein incorporated by reference in their respective entireties:

- U.S. Patent Application Serial No. 16/453,273, entitled METHOD FOR PROVIDING AN AUTHENTICATION LOCKOUT IN A SURGICAL STAPLER WITH A REPLACEABLE CARTRIDGE, now U.S. Patent Application Publication No. 2020/0261080;
- U.S. Patent Application Serial No. 16/453,283, entitled SURGICAL STAPLING ASSEMBLY WITH CARTRIDGE BASED RETAINER CONFIGURED TO UNLOCK A FIRING LOCKOUT, now U.S. Patent Application Publication No. 2020/0261081;
- U.S. Patent Application Serial No. 16/453,289, entitled SURGICAL STAPLING ASSEMBLY WITH CARTRIDGE BASED RETAINER CONFIGURED TO UNLOCK A CLOSURE LOCKOUT, now U.S. Patent Application Publication No. 2020/0261082;
- U.S. Patent Application Serial No. 16/453,302, entitled UNIVERSAL CARTRIDGE BASED KEY FEATURE THAT UNLOCKS MULTIPLE LOCKOUT ARRANGEMENTS IN DIFFERENT SURGICAL STAPLERS, now U.S. Patent Application Publication No. 2020/0261075;

- U.S. Patent Application Serial No. 16/453,310, entitled STAPLE CARTRIDGE RETAINERS WITH FRANGIBLE RETENTION FEATURES AND METHODS OF USING SAME, now U.S. Patent Application Publication No. 2020/0261083;
- U.S. Patent Application Serial No. 16/453,330, entitled STAPLE CARTRIDGE RETAINER WITH FRANGIBLE AUTHENTICATION KEY, now U.S. Patent Application Publication No. 2020/0261084;
- U.S. Patent Application Serial No. 16/453,335, entitled STAPLE CARTRIDGE RETAINER WITH RETRACTABLE AUTHENTICATION KEY, now U.S. Patent Application Publication No. 2020/0261078;
- U.S. Patent Application Serial No. 16/453,343, entitled STAPLE CARTRIDGE RETAINER SYSTEM WITH AUTHENTICATION KEYS, now U.S. Patent Application Publication No. 2020/0261085;
- U.S. Patent Application Serial No. 16/453,355, entitled INSERTABLE DEACTIVATOR ELEMENT FOR SURGICAL STAPLER LOCKOUTS, now U.S. Patent Application Publication No. 2020/0261086;
- U.S. Patent Application Serial No. 16/453,369, entitled DUAL CAM CARTRIDGE BASED FEATURE FOR UNLOCKING A SURGICAL STAPLER LOCKOUT, now U.S. Patent Application Publication No. 2020/0261076;
- U.S. Patent Application Serial No. 16/453,391, entitled STAPLE CARTRIDGES WITH CAM SURFACES CONFIGURED TO ENGAGE PRIMARY AND SECONDARY PORTIONS OF A LOCKOUT OF A SURGICAL STAPLING DEVICE, now U.S. Patent Application Publication No. 2020/0261077;
- U.S. Patent Application Serial No. 16/453,413, entitled SURGICAL STAPLE CARTRIDGES WITH MOVABLE AUTHENTICATION KEY ARRANGEMENTS, now U.S. Patent Application Publication No. 2020/0261087;
- U.S. Patent Application Serial No. 16/453,423, entitled DEACTIVATOR ELEMENT FOR DEFEATING SURGICAL STAPLING DEVICE LOCKOUTS, now U.S. Patent Application Publication No. 2020/0261088; and
- U.S. Patent Application Serial No. 16/453,429, entitled SURGICAL STAPLE CARTRIDGES WITH INTEGRAL AUTHENTICATION KEYS, now U.S. Patent Application Publication No. 2020/0261089.

[0101] Applicant of the present application owns the following U.S. Design Patent Applications that were filed on June 25, 2019, each of which is herein incorporated by reference in its entirety:

- U.S. Design Patent Application Serial No. 29/696,066, entitled SURGICAL STAPLE CARTRIDGE RETAINER WITH FIRING SYSTEM AUTHENTICATION KEY;
- U.S. Design Patent Application Serial No. 29/696,067, entitled SURGICAL STAPLE CARTRIDGE RETAINER WITH CLOSURE SYSTEM AUTHENTICATION KEY; and
- U.S. Design Patent Application Serial No. 29/696,072, entitled SURGICAL STAPLE CARTRIDGE.

[0102] The entire disclosure of U.S. Provisional Patent Application Serial No. 62/866,208, entitled STAPLE CARTRIDGES WITH FEATURES FOR DEFEATING LOCKOUTS IN SURGICAL STAPLING DEVICES, filed June 25, 2019, is hereby incorporated by reference herein.

[0103] The entire disclosure of U.S. Provisional Patent Application Serial No. 62/840,715, entitled SURGICAL INSTRUMENT COMPRISING AN ADAPTIVE CONTROL SYSTEM, filed April 30, 2019, is hereby incorporated by reference herein.

[0104] Applicant of the present application owns the following U.S. Patent Applications that were filed on February 21, 2019 and which are each herein incorporated by reference in their respective entireties:

- U.S. Patent Application Serial No. 16/281,658, entitled METHODS FOR CONTROLLING A POWERED SURGICAL STAPLER THAT HAS SEPARATE ROTARY CLOSURE AND FIRING SYSTEMS, now U.S. Patent Application Publication No. 2019/0298350;
- U.S. Patent Application Serial No. 16/281,670, entitled STAPLE CARTRIDGE COMPRISING A LOCKOUT KEY CONFIGURED TO LIFT A FIRING MEMBER, now U.S. Patent Application Publication No. 2019/0298340;
- U.S. Patent Application Serial No. 16/281,675, entitled SURGICAL STAPLERS WITH ARRANGEMENTS FOR MAINTAINING A FIRING MEMBER THEREOF IN A LOCKED CONFIGURATION UNLESS A COMPATIBLE CARTRIDGE HAS BEEN INSTALLED THEREIN, now U.S. Patent Application Publication No. 2019/0298354;

- U.S. Patent Application Serial No. 16/281,685, entitled SURGICAL INSTRUMENT COMPRISING CO-OPERATING LOCKOUT FEATURES, now U.S. Patent Application Publication No. 2019/0298341;
- U.S. Patent Application Serial No. 16/281,693, entitled SURGICAL STAPLING ASSEMBLY COMPRISING A LOCKOUT AND AN EXTERIOR ACCESS ORIFICE TO PERMIT ARTIFICIAL UNLOCKING OF THE LOCKOUT, now U.S. Patent Application Publication No. 2019/0298342;
- U.S. Patent Application Serial No. 16/281,704, entitled SURGICAL STAPLING DEVICES WITH FEATURES FOR BLOCKING ADVANCEMENT OF A CAMMING ASSEMBLY OF AN INCOMPATIBLE CARTRIDGE INSTALLED THEREIN, now U.S. Patent Application Publication No. 2019/0298356;
- U.S. Patent Application Serial No. 16/281,707, entitled STAPLING INSTRUMENT COMPRISING A DEACTIVATABLE LOCKOUT, now U.S. Patent Application Publication No. 2019/0298347;
- U.S. Patent Application Serial No. 16/281,741, entitled SURGICAL INSTRUMENT COMPRISING A JAW CLOSURE LOCKOUT, now U.S. Patent Application Publication No. 2019/0298357;
- U.S. Patent Application Serial No. 16/281,762, entitled SURGICAL STAPLING DEVICES WITH CARTRIDGE COMPATIBLE CLOSURE AND FIRING LOCKOUT ARRANGEMENTS, now U.S. Patent Application Publication No. 2019/0298343;
- U.S. Patent Application Serial No. 16/281,666, entitled SURGICAL STAPLING DEVICES WITH IMPROVED ROTARY DRIVEN CLOSURE SYSTEMS, now U.S. Patent Application Publication No. 2019/0298352;
- U.S. Patent Application Serial No. 16/281,672, entitled SURGICAL STAPLING DEVICES WITH ASYMMETRIC CLOSURE FEATURES, now U.S. Patent Application Publication No. 2019/0298353;
- U.S. Patent Application Serial No. 16/281,678, entitled ROTARY DRIVEN FIRING MEMBERS WITH DIFFERENT ANVIL AND CHANNEL ENGAGEMENT FEATURES, now U.S. Patent Application Publication No. 2019/0298355; and
- U.S. Patent Application Serial No. 16/281,682, entitled SURGICAL STAPLING DEVICE WITH SEPARATE ROTARY DRIVEN CLOSURE AND FIRING SYSTEMS

AND FIRING MEMBER THAT ENGAGES BOTH JAWS WHILE FIRING, now U.S. Patent Application Publication No. 2019/0298346.

[0105] Applicant of the present application owns the following U.S. Provisional Patent Applications that were filed on February 19, 2019 and which are each herein incorporated by reference in their respective entireties:

- U.S. Provisional Patent Application Serial No. 62/807,310, entitled METHODS FOR CONTROLLING A POWERED SURGICAL STAPLER THAT HAS SEPARATE ROTARY CLOSURE AND FIRING SYSTEMS;
- U.S. Provisional Patent Application Serial No. 62/807,319, entitled SURGICAL STAPLING DEVICES WITH IMPROVED LOCKOUT SYSTEMS; and
- U.S. Provisional Patent Application Serial No. 62/807,309, entitled SURGICAL STAPLING DEVICES WITH IMPROVED ROTARY DRIVEN CLOSURE SYSTEMS.

[0106] Applicant of the present application owns the following U.S. Provisional Patent Applications, filed on March 28, 2018, each of which is herein incorporated by reference in its entirety:

- U.S. Provisional Patent Application Serial No. 62/649,302, entitled INTERACTIVE SURGICAL SYSTEMS WITH ENCRYPTED COMMUNICATION CAPABILITIES;
- U.S. Provisional Patent Application Serial No. 62/649,294, entitled DATA STRIPPING METHOD TO INTERROGATE PATIENT RECORDS AND CREATE ANONYMIZED RECORD;
- U.S. Provisional Patent Application Serial No. 62/649,300, entitled SURGICAL HUB SITUATIONAL AWARENESS;
- U.S. Provisional Patent Application Serial No. 62/649,309, entitled SURGICAL HUB SPATIAL AWARENESS TO DETERMINE DEVICES IN OPERATING THEATER;
- U.S. Provisional Patent Application Serial No. 62/649,310, entitled COMPUTER IMPLEMENTED INTERACTIVE SURGICAL SYSTEMS;
- U.S. Provisional Patent Application Serial No. 62/649,291, entitled USE OF LASER LIGHT AND RED-GREEN-BLUE COLORATION TO DETERMINE PROPERTIES OF BACK SCATTERED LIGHT;

- U.S. Provisional Patent Application Serial No. 62/649,296, entitled ADAPTIVE CONTROL PROGRAM UPDATES FOR SURGICAL DEVICES;
- U.S. Provisional Patent Application Serial No. 62/649,333, entitled CLOUD-BASED MEDICAL ANALYTICS FOR CUSTOMIZATION AND RECOMMENDATIONS TO A USER;
- U.S. Provisional Patent Application Serial No. 62/649,327, entitled CLOUD-BASED MEDICAL ANALYTICS FOR SECURITY AND AUTHENTICATION TRENDS AND REACTIVE MEASURES;
- U.S. Provisional Patent Application Serial No. 62/649,315, entitled DATA HANDLING AND PRIORITIZATION IN A CLOUD ANALYTICS NETWORK;
- U.S. Provisional Patent Application Serial No. 62/649,313, entitled CLOUD INTERFACE FOR COUPLED SURGICAL DEVICES;
- U.S. Provisional Patent Application Serial No. 62/649,320, entitled DRIVE ARRANGEMENTS FOR ROBOT-ASSISTED SURGICAL PLATFORMS;
- U.S. Provisional Patent Application Serial No. 62/649,307, entitled AUTOMATIC TOOL ADJUSTMENTS FOR ROBOT-ASSISTED SURGICAL PLATFORMS; and
- U.S. Provisional Patent Application Serial No. 62/649,323, entitled SENSING ARRANGEMENTS FOR ROBOT-ASSISTED SURGICAL PLATFORMS.

[0107] Applicant of the present application owns the following U.S. Provisional Patent Application, filed on March 30, 2018, which is herein incorporated by reference in its entirety:

- U.S. Provisional Patent Application Serial No. 62/650,887, entitled SURGICAL SYSTEMS WITH OPTIMIZED SENSING CAPABILITIES.

[0108] Applicant of the present application owns the following U.S. Patent Application, filed on December 4, 2018, which is herein incorporated by reference in its entirety:

- U.S. Patent Application Serial No. 16/209,423, entitled METHOD OF COMPRESSING TISSUE WITHIN A STAPLING DEVICE AND SIMULTANEOUSLY DISPLAYING THE LOCATION OF THE TISSUE WITHIN THE JAWS, now U.S. Patent Application Publication No. 2019/0200981.

[0109] Applicant of the present application owns the following U.S. Patent Applications that were filed on August 20, 2018 and which are each herein incorporated by reference in their respective entireties:

- U.S. Patent Application Serial No. 16/105,101, entitled METHOD FOR FABRICATING SURGICAL STAPLER ANVILS, now U.S. Patent Application Publication No. 2020/0054323;
- U.S. Patent Application Serial No. 16/105,183, entitled REINFORCED DEFORMABLE ANVIL TIP FOR SURGICAL STAPLER ANVIL, now U.S. Patent No. 10,912,559;
- U.S. Patent Application Serial No. 16/105,150, entitled SURGICAL STAPLER ANVILS WITH STAPLE DIRECTING PROTRUSIONS AND TISSUE STABILITY FEATURES, now U.S. Patent Application Publication No. 2020/0054326;
- U.S. Patent Application Serial No. 16/105,098, entitled FABRICATING TECHNIQUES FOR SURGICAL STAPLER ANVILS, now U.S. Patent Application Publication No. 2020/0054322;
- U.S. Patent Application Serial No. 16/105,140, entitled SURGICAL STAPLER ANVILS WITH TISSUE STOP FEATURES CONFIGURED TO AVOID TISSUE PINCH, now U.S. Patent No. 10,779,821;
- U.S. Patent Application Serial No. 16/105,081, entitled METHOD FOR OPERATING A POWERED ARTICULATABLE SURGICAL INSTRUMENT, now U.S. Patent Application Publication No. 2020/0054320;
- U.S. Patent Application Serial No. 16/105,094, entitled SURGICAL INSTRUMENTS WITH PROGRESSIVE JAW CLOSURE ARRANGEMENTS, now U.S. Patent Application Publication No. 2020/0054321;
- U.S. Patent Application Serial No. 16/105,097, entitled POWERED SURGICAL INSTRUMENTS WITH CLUTCHING ARRANGEMENTS TO CONVERT LINEAR DRIVE MOTIONS TO ROTARY DRIVE MOTIONS, now U.S. Patent Application Publication No. 2020/0054328;
- U.S. Patent Application Serial No. 16/105,104, entitled POWERED ARTICULATABLE SURGICAL INSTRUMENTS WITH CLUTCHING AND LOCKING

ARRANGEMENTS FOR LINKING AN ARTICULATION DRIVE SYSTEM TO A FIRING DRIVE SYSTEM, now U.S. Patent No. 10,842,492;

- U.S. Patent Application Serial No. 16/105,119, entitled ARTICULATABLE MOTOR POWERED SURGICAL INSTRUMENTS WITH DEDICATED ARTICULATION MOTOR ARRANGEMENTS, now U.S. Patent Application Publication No. 2020/0054330;

- U.S. Patent Application Serial No. 16/105,160, entitled SWITCHING ARRANGEMENTS FOR MOTOR POWERED ARTICULATABLE SURGICAL INSTRUMENTS, now U.S. Patent No. 10,856,870; and

- U.S. Design Patent Application Serial No. 29/660,252, entitled SURGICAL STAPLER ANVILS.

[0110] Applicant of the present application owns the following U.S. Patent Applications and U.S. Patents that are each herein incorporated by reference in their respective entireties:

- U.S. Patent Application Serial No. 15/386,185, entitled SURGICAL STAPLING INSTRUMENTS AND REPLACEABLE TOOL ASSEMBLIES THEREOF, now U.S. Patent No. 10,639,035;

- U.S. Patent Application Serial No. 15/386,230, entitled ARTICULATABLE SURGICAL STAPLING INSTRUMENTS, now U.S. Patent Application Publication No. 2018/0168649;

- U.S. Patent Application Serial No. 15/386,221, entitled LOCKOUT ARRANGEMENTS FOR SURGICAL END EFFECTORS, now U.S. Patent No. 10,835,247;

- U.S. Patent Application Serial No. 15/386,209, entitled SURGICAL END EFFECTORS AND FIRING MEMBERS THEREOF, now U.S. Patent No. 10,588,632;

- U.S. Patent Application Serial No. 15/386,198, entitled LOCKOUT ARRANGEMENTS FOR SURGICAL END EFFECTORS AND REPLACEABLE TOOL ASSEMBLIES, now U.S. Patent No. 10,610,224;

- U.S. Patent Application Serial No. 15/386,240, entitled SURGICAL END EFFECTORS AND ADAPTABLE FIRING MEMBERS THEREFOR, now U.S. Patent Application Publication No. 2018/0168651;

- U.S. Patent Application Serial No. 15/385,939, entitled STAPLE CARTRIDGES AND ARRANGEMENTS OF STAPLES AND STAPLE CAVITIES THEREIN, now U.S. Patent No. 10,835,246;
- U.S. Patent Application Serial No. 15/385,941, entitled SURGICAL TOOL ASSEMBLIES WITH CLUTCHING ARRANGEMENTS FOR SHIFTING BETWEEN CLOSURE SYSTEMS WITH CLOSURE STROKE REDUCTION FEATURES AND ARTICULATION AND FIRING SYSTEMS, now U.S. Patent No. 10,736,629;
- U.S. Patent Application Serial No. 15/385,943, entitled SURGICAL STAPLING INSTRUMENTS AND STAPLE-FORMING ANVILS, now U.S. Patent No. 10,667,811;
- U.S. Patent Application Serial No. 15/385,950, entitled SURGICAL TOOL ASSEMBLIES WITH CLOSURE STROKE REDUCTION FEATURES, now U.S. Patent No. 10,588,630;
- U.S. Patent Application Serial No. 15/385,945, entitled STAPLE CARTRIDGES AND ARRANGEMENTS OF STAPLES AND STAPLE CAVITIES THEREIN, now U.S. Patent No. 10,893,864;
- U.S. Patent Application Serial No. 15/385,946, entitled SURGICAL STAPLING INSTRUMENTS AND STAPLE-FORMING ANVILS, now U.S. Patent Application Publication No. 2018/0168633;
- U.S. Patent Application Serial No. 15/385,951, entitled SURGICAL INSTRUMENTS WITH JAW OPENING FEATURES FOR INCREASING A JAW OPENING DISTANCE, now U.S. Patent No. 10,568,626;
- U.S. Patent Application Serial No. 15/385,953, entitled METHODS OF STAPLING TISSUE, now U.S. Patent No. 10,675,026;
- U.S. Patent Application Serial No. 15/385,954, entitled FIRING MEMBERS WITH NON-PARALLEL JAW ENGAGEMENT FEATURES FOR SURGICAL END EFFECTORS, now U.S. Patent No. 10,624,635;
- U.S. Patent Application Serial No. 15/385,955, entitled SURGICAL END EFFECTORS WITH EXPANDABLE TISSUE STOP ARRANGEMENTS, now U.S. Patent No. 10,813,638;

- U.S. Patent Application Serial No. 15/385,948, entitled SURGICAL STAPLING INSTRUMENTS AND STAPLE-FORMING ANVILS, now U.S. Patent Application Publication No. 2018/0168584;
- U.S. Patent Application Serial No. 15/385,956, entitled SURGICAL INSTRUMENTS WITH POSITIVE JAW OPENING FEATURES, now U.S. Patent No. 10,588,631;
- U.S. Patent Application Serial No. 15/385,958, entitled SURGICAL INSTRUMENTS WITH LOCKOUT ARRANGEMENTS FOR PREVENTING FIRING SYSTEM ACTUATION UNLESS AN UNSPENT STAPLE CARTRIDGE IS PRESENT, now U.S. Patent No. 10,639,034;
- U.S. Patent Application Serial No. 15/385,947, entitled STAPLE CARTRIDGES AND ARRANGEMENTS OF STAPLES AND STAPLE CAVITIES THEREIN, now U.S. Patent No. 10,568,625;
- U.S. Patent Application Serial No. 15/385,896, entitled METHOD FOR RESETTING A FUSE OF A SURGICAL INSTRUMENT SHAFT, now U.S. Patent Application Publication No. 2018/0168597;
- U.S. Patent Application Serial No. 15/385,898, entitled STAPLE-FORMING POCKET ARRANGEMENT TO ACCOMMODATE DIFFERENT TYPES OF STAPLES, now U.S. Patent No. 10,537,325;
- U.S. Patent Application Serial No. 15/385,899, entitled SURGICAL INSTRUMENT COMPRISING IMPROVED JAW CONTROL, now U.S. Patent No. 10,758,229;
- U.S. Patent Application Serial No. 15/385,901, entitled STAPLE CARTRIDGE AND STAPLE CARTRIDGE CHANNEL COMPRISING WINDOWS DEFINED THEREIN, now U.S. Patent No. 10,667,809;
- U.S. Patent Application Serial No. 15/385,902, entitled SURGICAL INSTRUMENT COMPRISING A CUTTING MEMBER, now U.S. Patent No. 10,888,322;
- U.S. Patent Application Serial No. 15/385,904, entitled STAPLE FIRING MEMBER COMPRISING A MISSING CARTRIDGE AND/OR SPENT CARTRIDGE LOCKOUT, now U.S. Patent No. 10,881,401;

- U.S. Patent Application Serial No. 15/385,905, entitled FIRING ASSEMBLY COMPRISING A LOCKOUT, now U.S. Patent No. 10,695,055;
- U.S. Patent Application Serial No. 15/385,907, entitled SURGICAL INSTRUMENT SYSTEM COMPRISING AN END EFFECTOR LOCKOUT AND A FIRING ASSEMBLY LOCKOUT, now U.S. Patent Application Publication No. 2018/0168608;
- U.S. Patent Application Serial No. 15/385,908, entitled FIRING ASSEMBLY COMPRISING A FUSE, now U.S. Patent Application Publication No. 2018/0168609;
- U.S. Patent Application Serial No. 15/385,909, entitled FIRING ASSEMBLY COMPRISING A MULTIPLE FAILED-STATE FUSE, now U.S. Patent Application Publication No. 2018/0168610;
- U.S. Patent Application Serial No. 15/385,920, entitled STAPLE-FORMING POCKET ARRANGEMENTS, now U.S. Patent No. 10,499,914;
- U.S. Patent Application Serial No. 15/385,913, entitled ANVIL ARRANGEMENTS FOR SURGICAL STAPLERS, now U.S. Patent Application Publication No. 2018/0168614;
- U.S. Patent Application Serial No. 15/385,914, entitled METHOD OF DEFORMING STAPLES FROM TWO DIFFERENT TYPES OF STAPLE CARTRIDGES WITH THE SAME SURGICAL STAPLING INSTRUMENT, now U.S. Patent Application Publication No. 2018/0168615;
- U.S. Patent Application Serial No. 15/385,893, entitled BILATERALLY ASYMMETRIC STAPLE-FORMING POCKET PAIRS, now U.S. Patent No. 10,682,138;
- U.S. Patent Application Serial No. 15/385,929, entitled CLOSURE MEMBERS WITH CAM SURFACE ARRANGEMENTS FOR SURGICAL INSTRUMENTS WITH SEPARATE AND DISTINCT CLOSURE AND FIRING SYSTEMS, now U.S. Patent No. 10,667,810;
- U.S. Patent Application Serial No. 15/385,911, entitled SURGICAL STAPLERS WITH INDEPENDENTLY ACTUATABLE CLOSING AND FIRING SYSTEMS, now U.S. Patent No. 10,448,950;

- U.S. Patent Application Serial No. 15/385,927, entitled SURGICAL STAPLING INSTRUMENTS WITH SMART STAPLE CARTRIDGES, now U.S. Patent Application Publication No. 2018/0168625;
- U.S. Patent Application Serial No. 15/385,917, entitled STAPLE CARTRIDGE COMPRISING STAPLES WITH DIFFERENT CLAMPING BREADTHS, now U.S. Patent Application Publication No. 2018/0168617;
- U.S. Patent Application Serial No. 15/385,900, entitled STAPLE-FORMING POCKET ARRANGEMENTS COMPRISING PRIMARY SIDEWALLS AND POCKET SIDEWALLS, now U.S. Patent No. 10,898,186;
- U.S. Patent Application Serial No. 15/385,931, entitled NO-CARTRIDGE AND SPENT CARTRIDGE LOCKOUT ARRANGEMENTS FOR SURGICAL STAPLERS, now U.S. Patent Application Publication No. 2018/0168627;
- U.S. Patent Application Serial No. 15/385,915, entitled FIRING MEMBER PIN ANGLE, now U.S. Patent No. 10,779,823;
- U.S. Patent Application Serial No. 15/385,897, entitled STAPLE-FORMING POCKET ARRANGEMENTS COMPRISING ZONED FORMING SURFACE GROOVES, now U.S. Patent Application Publication No. 2018/0168598;
- U.S. Patent Application Serial No. 15/385,922, entitled SURGICAL INSTRUMENT WITH MULTIPLE FAILURE RESPONSE MODES, now U.S. Patent No. 10,426,471;
- U.S. Patent Application Serial No. 15/385,924, entitled SURGICAL INSTRUMENT WITH PRIMARY AND SAFETY PROCESSORS, now U.S. Patent No. 10,758,230;
- U.S. Patent Application Serial No. 15/385,910, entitled ANVIL HAVING A KNIFE SLOT WIDTH, now U.S. Patent No. 10,485,543;
- U.S. Patent Application Serial No. 15/385,903, entitled CLOSURE MEMBER ARRANGEMENTS FOR SURGICAL INSTRUMENTS, now U.S. Patent No. 10,617,414;
- U.S. Patent Application Serial No. 15/385,906, entitled FIRING MEMBER PIN CONFIGURATIONS, now U.S. Patent No. 10,856,868;
- U.S. Patent Application Serial No. 15/386,188, entitled STEPPED STAPLE CARTRIDGE WITH ASYMMETRICAL STAPLES, now U.S. Patent No. 10,537,324;

- U.S. Patent Application Serial No. 15/386,192, entitled STEPPED STAPLE CARTRIDGE WITH TISSUE RETENTION AND GAP SETTING FEATURES, now U.S. Patent No. 10,687,810;
- U.S. Patent Application Serial No. 15/386,206, entitled STAPLE CARTRIDGE WITH DEFORMABLE DRIVER RETENTION FEATURES, now U.S. Patent Application Publication No. 2018/0168586;
- U.S. Patent Application Serial No. 15/386,226, entitled DURABILITY FEATURES FOR END EFFECTORS AND FIRING ASSEMBLIES OF SURGICAL STAPLING INSTRUMENTS, now U.S. Patent Application Publication No. 2018/0168648;
- U.S. Patent Application Serial No. 15/386,222, entitled SURGICAL STAPLING INSTRUMENTS HAVING END EFFECTORS WITH POSITIVE OPENING FEATURES, now U.S. Patent Application Publication No. 2018/0168647;
- U.S. Patent Application Serial No. 15/386,236, entitled CONNECTION PORTIONS FOR DEPOSABLE LOADING UNITS FOR SURGICAL STAPLING INSTRUMENTS, now U.S. Patent Application Publication No. 2018/0168650;
- U.S. Patent Application Serial No. 15/385,887, entitled METHOD FOR ATTACHING A SHAFT ASSEMBLY TO A SURGICAL INSTRUMENT AND, ALTERNATIVELY, TO A SURGICAL ROBOT, now U.S. Patent No. 10,835,245;
- U.S. Patent Application Serial No. 15/385,889, entitled SHAFT ASSEMBLY COMPRISING A MANUALLY-OPERABLE RETRACTION SYSTEM FOR USE WITH A MOTORIZED SURGICAL INSTRUMENT SYSTEM, now U.S. Patent Application Publication No. 2018/0168590;
- U.S. Patent Application Serial No. 15/385,890, entitled SHAFT ASSEMBLY COMPRISING SEPARATELY ACTUATABLE AND RETRACTABLE SYSTEMS, now U.S. Patent No. 10,675,025;
- U.S. Patent Application Serial No. 15/385,891, entitled SHAFT ASSEMBLY COMPRISING A CLUTCH CONFIGURED TO ADAPT THE OUTPUT OF A ROTARY FIRING MEMBER TO TWO DIFFERENT SYSTEMS, now U.S. Patent Application Publication No. 2018/0168592;
- U.S. Patent Application Serial No. 15/385,892, entitled SURGICAL SYSTEM COMPRISING A FIRING MEMBER ROTATABLE INTO AN ARTICULATION STATE

TO ARTICULATE AN END EFFECTOR OF THE SURGICAL SYSTEM, now U.S. Patent No. 10,918,385;

- U.S. Patent Application Serial No. 15/385,894, entitled SHAFT ASSEMBLY COMPRISING A LOCKOUT, now U.S. Patent No. 10,492,785;
- U.S. Patent Application Serial No. 15/385,895, entitled SHAFT ASSEMBLY COMPRISING FIRST AND SECOND ARTICULATION LOCKOUTS, now U.S. Patent No. 10,542,982;
- U.S. Patent Application Serial No. 15/385,916, entitled SURGICAL STAPLING SYSTEMS, now U.S. Patent Application Publication No. 2018/0168575;
- U.S. Patent Application Serial No. 15/385,918, entitled SURGICAL STAPLING SYSTEMS, now U.S. Patent Application Publication No. 2018/0168618;
- U.S. Patent Application Serial No. 15/385,919, entitled SURGICAL STAPLING SYSTEMS, now U.S. Patent Application Publication No. 2018/0168619;
- U.S. Patent Application Serial No. 15/385,921, entitled SURGICAL STAPLE CARTRIDGE WITH MOVABLE CAMMING MEMBER CONFIGURED TO DISENGAGE FIRING MEMBER LOCKOUT FEATURES, now U.S. Patent No. 10,687,809;
- U.S. Patent Application Serial No. 15/385,923, entitled SURGICAL STAPLING SYSTEMS, now U.S. Patent Application Publication No. 2018/0168623;
- U.S. Patent Application Serial No. 15/385,925, entitled JAW ACTUATED LOCK ARRANGEMENTS FOR PREVENTING ADVANCEMENT OF A FIRING MEMBER IN A SURGICAL END EFFECTOR UNLESS AN UNFIRED CARTRIDGE IS INSTALLED IN THE END EFFECTOR, now U.S. Patent No. 10,517,595;
- U.S. Patent Application Serial No. 15/385,926, entitled AXIALLY MOVABLE CLOSURE SYSTEM ARRANGEMENTS FOR APPLYING CLOSURE MOTIONS TO JAWS OF SURGICAL INSTRUMENTS, now U.S. Patent Application Publication No. 2018/0168577;
- U.S. Patent Application Serial No. 15/385,928, entitled PROTECTIVE COVER ARRANGEMENTS FOR A JOINT INTERFACE BETWEEN A MOVABLE JAW AND ACTUATOR SHAFT OF A SURGICAL INSTRUMENT, now U.S. Patent Application Publication No. 2018/0168578;

- U.S. Patent Application Serial No. 15/385,930, entitled SURGICAL END EFFECTOR WITH TWO SEPARATE COOPERATING OPENING FEATURES FOR OPENING AND CLOSING END EFFECTOR JAWS, now U.S. Patent Application Publication No. 2018/0168579;
- U.S. Patent Application Serial No. 15/385,932, entitled ARTICULABLE SURGICAL END EFFECTOR WITH ASYMMETRIC SHAFT ARRANGEMENT, now U.S. Patent Application Publication No. 2018/0168628;
- U.S. Patent Application Serial No. 15/385,933, entitled ARTICULABLE SURGICAL INSTRUMENT WITH INDEPENDENT PIVOTABLE LINKAGE DISTAL OF AN ARTICULATION LOCK, now U.S. Patent No. 10,603,036;
- U.S. Patent Application Serial No. 15/385,934, entitled ARTICULATION LOCK ARRANGEMENTS FOR LOCKING AN END EFFECTOR IN AN ARTICULATED POSITION IN RESPONSE TO ACTUATION OF A JAW CLOSURE SYSTEM, now U.S. Patent No. 10,582,928;
- U.S. Patent Application Serial No. 15/385,935, entitled LATERALLY ACTUATABLE ARTICULATION LOCK ARRANGEMENTS FOR LOCKING AN END EFFECTOR OF A SURGICAL INSTRUMENT IN AN ARTICULATED CONFIGURATION, now U.S. Patent No. 10,524,789;
- U.S. Patent Application Serial No. 15/385,936, entitled ARTICULABLE SURGICAL INSTRUMENTS WITH ARTICULATION STROKE AMPLIFICATION FEATURES, now U.S. Patent No. 10,517,596;
- U.S. Patent Application Serial No. 14/318,996, entitled FASTENER CARTRIDGES INCLUDING EXTENSIONS HAVING DIFFERENT CONFIGURATIONS, now U.S. Patent Application Publication No. 2015/0297228;
- U.S. Patent Application Serial No. 14/319,006, entitled FASTENER CARTRIDGE COMPRISING FASTENER CAVITIES INCLUDING FASTENER CONTROL FEATURES, now U.S. Patent No. 10,010,324;
- U.S. Patent Application Serial No. 14/318,991, entitled SURGICAL FASTENER CARTRIDGES WITH DRIVER STABILIZING ARRANGEMENTS, now U.S. Patent No. 9,833,241;

- 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;
- U.S. Patent Application Serial No. 14/319,008, entitled FASTENER CARTRIDGE COMPRISING NON-UNIFORM FASTENERS, now U.S. Patent No. 10,299,792;
- U.S. Patent Application Serial No. 14/318,997, entitled FASTENER CARTRIDGE COMPRISING DEPLOYABLE TISSUE ENGAGING MEMBERS, now U.S. Patent No. 10,561,422;
- U.S. Patent Application Serial No. 14/319,002, entitled FASTENER CARTRIDGE COMPRISING TISSUE CONTROL FEATURES, now U.S. Patent No. 9,877,721;
- U.S. Patent Application Serial No. 14/319,013, entitled FASTENER CARTRIDGE ASSEMBLIES AND STAPLE RETAINER COVER ARRANGEMENTS, now U.S. Patent Application Publication No. 2015/0297233; and
- U.S. Patent Application Serial No. 14/319,016, entitled FASTENER CARTRIDGE INCLUDING A LAYER ATTACHED THERETO, now U.S. Patent No. 10,470,768.

[0111] Applicant of the present application owns the following U.S. Patent Applications that were filed on June 24, 2016 and which are each herein incorporated by reference in their respective entireties:

- U.S. Patent Application Serial No. 15/191,775, entitled STAPLE CARTRIDGE COMPRISING WIRE STAPLES AND STAMPED STAPLES, now U.S. Patent Application Publication No. 2017/0367695;
- U.S. Patent Application Serial No. 15/191,807, entitled STAPLING SYSTEM FOR USE WITH WIRE STAPLES AND STAMPED STAPLES, now U.S. Patent No. 10,702,270;
- U.S. Patent Application Serial No. 15/191,834, entitled STAMPED STAPLES AND STAPLE CARTRIDGES USING THE SAME, now U.S. Patent No. 10,542,979;
- U.S. Patent Application Serial No. 15/191,788, entitled STAPLE CARTRIDGE COMPRISING OVERDRIVEN STAPLES, now U.S. Patent No. 10,675,024; and
- U.S. Patent Application Serial No. 15/191,818, entitled STAPLE CARTRIDGE COMPRISING OFFSET LONGITUDINAL STAPLE ROWS, now U.S. Patent No. 10,893,863.

[0112] Applicant of the present application owns the following U.S. Patent Applications that were filed on June 24, 2016 and which are each herein incorporated by reference in their respective entireties:

- U.S. Design Patent Application Serial No. 29/569,218, entitled SURGICAL FASTENER, now U.S. Design Patent No. D826,405;
- U.S. Design Patent Application Serial No. 29/569,227, entitled SURGICAL FASTENER, now U.S. Design Patent No. D822,206;
- U.S. Design Patent Application Serial No. 29/569,259, entitled SURGICAL FASTENER CARTRIDGE, now U.S. Design Patent No. D847,989; and
- U.S. Design Patent Application Serial No. 29/569,264, entitled SURGICAL FASTENER CARTRIDGE, now U.S. Design Patent No. D850,617.

[0113] Applicant of the present application owns the following patent applications that were filed on April 1, 2016 and which are each herein incorporated by reference in their respective entirety:

- U.S. Patent Application Serial No. 15/089,325, entitled METHOD FOR OPERATING A SURGICAL STAPLING SYSTEM, now U.S. Patent Application Publication No. 2017/0281171;
- U.S. Patent Application Serial No. 15/089,321, entitled MODULAR SURGICAL STAPLING SYSTEM COMPRISING A DISPLAY, now U.S. Patent No. 10,271,851;
- U.S. Patent Application Serial No. 15/089,326, entitled SURGICAL STAPLING SYSTEM COMPRISING A DISPLAY INCLUDING A RE-ORIENTABLE DISPLAY FIELD, now U.S. Patent No. 10,433,849;
- U.S. Patent Application Serial No. 15/089,263, entitled SURGICAL INSTRUMENT HANDLE ASSEMBLY WITH RECONFIGURABLE GRIP PORTION, now U.S. Patent No. 10,307,159;
- U.S. Patent Application Serial No. 15/089,262, entitled ROTARY POWERED SURGICAL INSTRUMENT WITH MANUALLY ACTUATABLE BAILOUT SYSTEM, now U.S. Patent No. 10,357,246;
- U.S. Patent Application Serial No. 15/089,277, entitled SURGICAL CUTTING AND STAPLING END EFFECTOR WITH ANVIL CONCENTRIC DRIVE MEMBER, now U.S. Patent No. 10,531,874;

- U.S. Patent Application Serial No. 15/089,296, entitled INTERCHANGEABLE SURGICAL TOOL ASSEMBLY WITH A SURGICAL END EFFECTOR THAT IS SELECTIVELY ROTATABLE ABOUT A SHAFT AXIS, now U.S. Patent No. 10,413,293;
- U.S. Patent Application Serial No. 15/089,258, entitled SURGICAL STAPLING SYSTEM COMPRISING A SHIFTABLE TRANSMISSION, now U.S. Patent No. 10,342,543;
- U.S. Patent Application Serial No. 15/089,278, entitled SURGICAL STAPLING SYSTEM CONFIGURED TO PROVIDE SELECTIVE CUTTING OF TISSUE, now U.S. Patent No. 10,420,552;
- U.S. Patent Application Serial No. 15/089,284, entitled SURGICAL STAPLING SYSTEM COMPRISING A CONTOURABLE SHAFT, now U.S. Patent Application Publication No. 2017/0281186;
- U.S. Patent Application Serial No. 15/089,295, entitled SURGICAL STAPLING SYSTEM COMPRISING A TISSUE COMPRESSION LOCKOUT, now U.S. Patent 10,856,867;
- U.S. Patent Application Serial No. 15/089,300, entitled SURGICAL STAPLING SYSTEM COMPRISING AN UNCLAMPING LOCKOUT, now U.S. Patent No. 10,456,140;
- U.S. Patent Application Serial No. 15/089,196, entitled SURGICAL STAPLING SYSTEM COMPRISING A JAW CLOSURE LOCKOUT, now U.S. Patent No. 10,568,632;
- U.S. Patent Application Serial No. 15/089,203, entitled SURGICAL STAPLING SYSTEM COMPRISING A JAW ATTACHMENT LOCKOUT, now U.S. Patent No. 10,542,991;
- U.S. Patent Application Serial No. 15/089,210, entitled SURGICAL STAPLING SYSTEM COMPRISING A SPENT CARTRIDGE LOCKOUT, now U.S. Patent No. 10,478,190;
- U.S. Patent Application Serial No. 15/089,324, entitled SURGICAL INSTRUMENT COMPRISING A SHIFTING MECHANISM, now U.S. Patent No. 10,314,582;

- U.S. Patent Application Serial No. 15/089,335, entitled SURGICAL STAPLING INSTRUMENT COMPRISING MULTIPLE LOCKOUTS, now U.S. Patent No. 10,485,542;
 - U.S. Patent Application Serial No. 15/089,339, entitled SURGICAL STAPLING INSTRUMENT, now U.S. Patent Application Publication No. 2017/0281173;
 - U.S. Patent Application Serial No. 15/089,253, entitled SURGICAL STAPLING SYSTEM CONFIGURED TO APPLY ANNULAR ROWS OF STAPLES HAVING DIFFERENT HEIGHTS, now U.S. Patent No. 10,413,297;
 - U.S. Patent Application Serial No. 15/089,304, entitled SURGICAL STAPLING SYSTEM COMPRISING A GROOVED FORMING POCKET, now U.S. Patent No. 10,285,705;
 - U.S. Patent Application Serial No. 15/089,331, entitled ANVIL MODIFICATION MEMBERS FOR SURGICAL STAPLERS, now U.S. Patent No. 10,376,263;
 - U.S. Patent Application Serial No. 15/089,336, entitled STAPLE CARTRIDGES WITH ATRAUMATIC FEATURES, now U.S. Patent No. 10,709,446;
 - U.S. Patent Application Serial No. 15/089,312, entitled CIRCULAR STAPLING SYSTEM COMPRISING AN INCISABLE TISSUE SUPPORT, now U.S. Patent Application Publication No. 2017/0281189;
 - U.S. Patent Application Serial No. 15/089,309, entitled CIRCULAR STAPLING SYSTEM COMPRISING ROTARY FIRING SYSTEM, now U.S. Patent No. 10,675,021;
- and
- U.S. Patent Application Serial No. 15/089,349, entitled CIRCULAR STAPLING SYSTEM COMPRISING LOAD CONTROL, now U.S. Patent No. 10,682,136.

[0114] Applicant of the present application also owns the U.S. Patent Applications identified below which were filed on December 30, 2015 which are each herein incorporated by reference in their respective entirety:

- U.S. Patent Application Serial No. 14/984,488, entitled MECHANISMS FOR COMPENSATING FOR BATTERY PACK FAILURE IN POWERED SURGICAL INSTRUMENTS, now U.S. Patent No. 10,292,704;

- U.S. Patent Application Serial No. 14/984,525, entitled MECHANISMS FOR COMPENSATING FOR DRIVETRAIN FAILURE IN POWERED SURGICAL INSTRUMENTS, now U.S. Patent No. 10,368,865; and
- U.S. Patent Application Serial No. 14/984,552, entitled SURGICAL INSTRUMENTS WITH SEPARABLE MOTORS AND MOTOR CONTROL CIRCUITS, now U.S. Patent No. 10,265,068.

[0115] Applicant of the present application also owns the U.S. Patent Applications identified below which were filed on February 9, 2016, which are each herein incorporated by reference in their respective entirety:

- U.S. Patent Application Serial No. 15/019,220, entitled SURGICAL INSTRUMENT WITH ARTICULATING AND AXIALLY TRANSLATABLE END EFFECTOR, now U.S. Patent No. 10,245,029;
- U.S. Patent Application Serial No. 15/019,228, entitled SURGICAL INSTRUMENTS WITH MULTIPLE LINK ARTICULATION ARRANGEMENTS, now U.S. Patent No. 10,433,837;
- U.S. Patent Application Serial No. 15/019,196, entitled SURGICAL INSTRUMENT ARTICULATION MECHANISM WITH SLOTTED SECONDARY CONSTRAINT, now U.S. Patent No. 10,413,291;
- U.S. Patent Application Serial No. 15/019,206, entitled SURGICAL INSTRUMENTS WITH AN END EFFECTOR THAT IS HIGHLY ARTICULATABLE RELATIVE TO AN ELONGATE SHAFT ASSEMBLY, now U.S. Patent No. 10,653,413;
- U.S. Patent Application Serial No. 15/019,215, entitled SURGICAL INSTRUMENTS WITH NON-SYMMETRICAL ARTICULATION ARRANGEMENTS, now U.S. Patent Application Publication No. 2017/0224332;
- U.S. Patent Application Serial No. 15/019,227, entitled ARTICULATABLE SURGICAL INSTRUMENTS WITH SINGLE ARTICULATION LINK ARRANGEMENTS, now U.S. Patent Application Publication No. 2017/0224334;
- U.S. Patent Application Serial No. 15/019,235, entitled SURGICAL INSTRUMENTS WITH TENSIONING ARRANGEMENTS FOR CABLE DRIVEN ARTICULATION SYSTEMS, now U.S. Patent No. 10,245,030;

- U.S. Patent Application Serial No. 15/019,230, entitled ARTICULATABLE SURGICAL INSTRUMENTS WITH OFF-AXIS FIRING BEAM ARRANGEMENTS, now U.S. Patent No. 10,588,625; and

- U.S. Patent Application Serial No. 15/019,245, entitled SURGICAL INSTRUMENTS WITH CLOSURE STROKE REDUCTION ARRANGEMENTS, now U.S. Patent No. 10,470,764.

[0116] Applicant of the present application also owns the U.S. Patent Applications identified below which were filed on February 12, 2016, which are each herein incorporated by reference in their respective entirety:

- U.S. Patent Application Serial No. 15/043,254, entitled MECHANISMS FOR COMPENSATING FOR DRIVETRAIN FAILURE IN POWERED SURGICAL INSTRUMENTS, now U.S. Patent No. 10,258,331;

- U.S. Patent Application Serial No. 15/043,259, entitled MECHANISMS FOR COMPENSATING FOR DRIVETRAIN FAILURE IN POWERED SURGICAL INSTRUMENTS, now U.S. Patent No. 10,448,948;

- U.S. Patent Application Serial No. 15/043,275, entitled MECHANISMS FOR COMPENSATING FOR DRIVETRAIN FAILURE IN POWERED SURGICAL INSTRUMENTS, now U.S. Patent Application Publication No. 2017/0231627; and

- U.S. Patent Application Serial No. 15/043,289, entitled MECHANISMS FOR COMPENSATING FOR DRIVETRAIN FAILURE IN POWERED SURGICAL INSTRUMENTS, now U.S. Patent Application Publication No. 2017/0231628.

[0117] Applicant of the present application owns the following patent applications that were filed on June 18, 2015 and which are each herein incorporated by reference in their respective entirety:

- U.S. Patent Application Serial No. 14/742,925, entitled SURGICAL END EFFECTORS WITH POSITIVE JAW OPENING ARRANGEMENTS, now U.S. Patent No. 10,182,818;

- U.S. Patent Application Serial No. 14/742,941, entitled SURGICAL END EFFECTORS WITH DUAL CAM ACTUATED JAW CLOSING FEATURES, now U.S. Patent No. 10,052,102;

- U.S. Patent Application Serial No. 14/742,933, entitled SURGICAL STAPLING INSTRUMENTS WITH LOCKOUT ARRANGEMENTS FOR PREVENTING FIRING SYSTEM ACTUATION WHEN A CARTRIDGE IS SPENT OR MISSING, now U.S. Patent No. 10,154,841;
- U.S. Patent Application Serial No. 14/742,914, entitled MOVABLE FIRING BEAM SUPPORT ARRANGEMENTS FOR ARTICULATABLE SURGICAL INSTRUMENTS, now U.S. Patent No. 10,405,863;
- U.S. Patent Application Serial No. 14/742,900, entitled ARTICULATABLE SURGICAL INSTRUMENTS WITH COMPOSITE FIRING BEAM STRUCTURES WITH CENTER FIRING SUPPORT MEMBER FOR ARTICULATION SUPPORT, now U.S. Patent No. 10,335,149;
- U.S. Patent Application Serial No. 14/742,885, entitled DUAL ARTICULATION DRIVE SYSTEM ARRANGEMENTS FOR ARTICULATABLE SURGICAL INSTRUMENTS, now U.S. Patent No. 10,368,861; and
- U.S. Patent Application Serial No. 14/742,876, entitled PUSH/PULL ARTICULATION DRIVE SYSTEMS FOR ARTICULATABLE SURGICAL INSTRUMENTS, now U.S. Patent No. 10,178,992.

[0118] Applicant of the present application owns the following patent applications that were filed on March 6, 2015 and which are each herein incorporated by reference in their respective entirety:

- U.S. Patent Application Serial No. 14/640,746, entitled POWERED SURGICAL INSTRUMENT, now U.S. Patent No. 9,808,246;
- U.S. Patent Application Serial No. 14/640,795, entitled MULTIPLE LEVEL THRESHOLDS TO MODIFY OPERATION OF POWERED SURGICAL INSTRUMENTS, now U.S. Patent No. 10,441,279;
- U.S. Patent Application Serial No. 14/640,832, entitled ADAPTIVE TISSUE COMPRESSION TECHNIQUES TO ADJUST CLOSURE RATES FOR MULTIPLE TISSUE TYPES, now U.S. Patent No. 10,687,806;
- U.S. Patent Application Serial No. 14/640,935, entitled OVERLAID MULTI SENSOR RADIO FREQUENCY (RF) ELECTRODE SYSTEM TO MEASURE TISSUE COMPRESSION, now U.S. Patent No. 10,548,504;

- U.S. Patent Application Serial No. 14/640,831, entitled MONITORING SPEED CONTROL AND PRECISION INCREMENTING OF MOTOR FOR POWERED SURGICAL INSTRUMENTS, now U.S. Patent No. 9,895,148;
- U.S. Patent Application Serial No. 14/640,859, entitled TIME DEPENDENT EVALUATION OF SENSOR DATA TO DETERMINE STABILITY, CREEP, AND VISCOELASTIC ELEMENTS OF MEASURES, now U.S. Patent No. 10,052,044;
- U.S. Patent Application Serial No. 14/640,817, entitled INTERACTIVE FEEDBACK SYSTEM FOR POWERED SURGICAL INSTRUMENTS, now U.S. Patent No. 9,924,961;
- U.S. Patent Application Serial No. 14/640,844, entitled CONTROL TECHNIQUES AND SUB-PROCESSOR CONTAINED WITHIN MODULAR SHAFT WITH SELECT CONTROL PROCESSING FROM HANDLE, now U.S. Patent No. 10,045,776;
- U.S. Patent Application Serial No. 14/640,837, entitled SMART SENSORS WITH LOCAL SIGNAL PROCESSING, now U.S. Patent No. 9,993,248;
- U.S. Patent Application Serial No. 14/640,765, entitled SYSTEM FOR DETECTING THE MIS-INSERTION OF A STAPLE CARTRIDGE INTO A SURGICAL STAPLER, now U.S. Patent No. 10,617,412;
- U.S. Patent Application Serial No. 14/640,799, entitled SIGNAL AND POWER COMMUNICATION SYSTEM POSITIONED ON A ROTATABLE SHAFT, now U.S. Patent No. 9,901,342; and
- U.S. Patent Application Serial No. 14/640,780, entitled SURGICAL INSTRUMENT COMPRISING A LOCKABLE BATTERY HOUSING, now U.S. Patent No. 10,245,033.

[0119] Applicant of the present application owns the following patent applications that were filed on February 27, 2015, and which are each herein incorporated by reference in their respective entirety:

- U.S. Patent Application Serial No. 14/633,576, entitled SURGICAL INSTRUMENT SYSTEM COMPRISING AN INSPECTION STATION, now U.S. Patent No. 10,045,779;

- U.S. Patent Application Serial No. 14/633,546, entitled SURGICAL APPARATUS CONFIGURED TO ASSESS WHETHER A PERFORMANCE PARAMETER OF THE SURGICAL APPARATUS IS WITHIN AN ACCEPTABLE PERFORMANCE BAND, now U.S. Patent No. 10,180,463;
- U.S. Patent Application Serial No. 14/633,560, entitled SURGICAL CHARGING SYSTEM THAT CHARGES AND/OR CONDITIONS ONE OR MORE BATTERIES, now U.S. Patent Application Publication No. 2016/0249910;
- U.S. Patent Application Serial No. 14/633,566, entitled CHARGING SYSTEM THAT ENABLES EMERGENCY RESOLUTIONS FOR CHARGING A BATTERY, now U.S. Patent No. 10,182,816;
- U.S. Patent Application Serial No. 14/633,555, entitled SYSTEM FOR MONITORING WHETHER A SURGICAL INSTRUMENT NEEDS TO BE SERVICED, now U.S. Patent No. 10,321,907;
- U.S. Patent Application Serial No. 14/633,542, entitled REINFORCED BATTERY FOR A SURGICAL INSTRUMENT, now U.S. Patent No. 9,931,118;
- U.S. Patent Application Serial No. 14/633,548, entitled POWER ADAPTER FOR A SURGICAL INSTRUMENT, now U.S. Patent No. 10,245,028;
- U.S. Patent Application Serial No. 14/633,526, entitled ADAPTABLE SURGICAL INSTRUMENT HANDLE, now U.S. Patent No. 9,993,258;
- U.S. Patent Application Serial No. 14/633,541, entitled MODULAR STAPLING ASSEMBLY, now U.S. Patent No. 10,226,250; and
- U.S. Patent Application Serial No. 14/633,562, entitled SURGICAL APPARATUS CONFIGURED TO TRACK AN END-OF-LIFE PARAMETER, now U.S. Patent No. 10,159,483.

[0120] Applicant of the present application owns the following patent applications that were filed on December 18, 2014 and which are each herein incorporated by reference in their respective entirety:

- U.S. Patent Application Serial No. 14/574,478, entitled SURGICAL INSTRUMENT SYSTEMS COMPRISING AN ARTICULATABLE END EFFECTOR AND MEANS FOR ADJUSTING THE FIRING STROKE OF A FIRING MEMBER, now U.S. Patent No. 9,844,374;

- U.S. Patent Application Serial No. 14/574,483, entitled SURGICAL INSTRUMENT ASSEMBLY COMPRISING LOCKABLE SYSTEMS, now U.S. Patent No. 10,188,385;
- U.S. Patent Application Serial No. 14/575,139, entitled DRIVE ARRANGEMENTS FOR ARTICULATABLE SURGICAL INSTRUMENTS, now U.S. Patent No. 9,844,375;
- U.S. Patent Application Serial No. 14/575,148, entitled LOCKING ARRANGEMENTS FOR DETACHABLE SHAFT ASSEMBLIES WITH ARTICULATABLE SURGICAL END EFFECTORS, now U.S. Patent No. 10,085,748;
- U.S. Patent Application Serial No. 14/575,130, entitled SURGICAL INSTRUMENT WITH AN ANVIL THAT IS SELECTIVELY MOVABLE ABOUT A DISCRETE NON-MOVABLE AXIS RELATIVE TO A STAPLE CARTRIDGE, now U.S. Patent No. 10,245,027;
- U.S. Patent Application Serial No. 14/575,143, entitled SURGICAL INSTRUMENTS WITH IMPROVED CLOSURE ARRANGEMENTS, now U.S. Patent No. 10,004,501;
- U.S. Patent Application Serial No. 14/575,117, entitled SURGICAL INSTRUMENTS WITH ARTICULATABLE END EFFECTORS AND MOVABLE FIRING BEAM SUPPORT ARRANGEMENTS, now U.S. Patent No. 9,943,309;
- U.S. Patent Application Serial No. 14/575,154, entitled SURGICAL INSTRUMENTS WITH ARTICULATABLE END EFFECTORS AND IMPROVED FIRING BEAM SUPPORT ARRANGEMENTS, now U.S. Patent No. 9,968,355;
- U.S. Patent Application Serial No. 14/574,493, entitled SURGICAL INSTRUMENT ASSEMBLY COMPRISING A FLEXIBLE ARTICULATION SYSTEM, now U.S. Patent No. 9,987,000; and
- U.S. Patent Application Serial No. 14/574,500, entitled SURGICAL INSTRUMENT ASSEMBLY COMPRISING A LOCKABLE ARTICULATION SYSTEM, now U.S. Patent No. 10,117,649.

[0121] Applicant of the present application owns the following patent applications that were filed on March 1, 2013 and which are each herein incorporated by reference in their respective entirety:

- U.S. Patent Application Serial No. 13/782,295, entitled ARTICULATABLE SURGICAL INSTRUMENTS WITH CONDUCTIVE PATHWAYS FOR SIGNAL COMMUNICATION, now U.S. Patent No. 9,700,309;
- U.S. Patent Application Serial No. 13/782,323, entitled ROTARY POWERED ARTICULATION JOINTS FOR SURGICAL INSTRUMENTS, now U.S. Patent No. 9,782,169;
- U.S. Patent Application Serial No. 13/782,338, entitled THUMBWHEEL SWITCH ARRANGEMENTS FOR SURGICAL INSTRUMENTS, now U.S. Patent Application Publication No. 2014/0249557;
- U.S. Patent Application Serial No. 13/782,499, entitled ELECTROMECHANICAL SURGICAL DEVICE WITH SIGNAL RELAY ARRANGEMENT, now U.S. Patent No. 9,358,003;
- U.S. Patent Application Serial No. 13/782,460, entitled MULTIPLE PROCESSOR MOTOR CONTROL FOR MODULAR SURGICAL INSTRUMENTS, now U.S. Patent No. 9,554,794;
- U.S. Patent Application Serial No. 13/782,358, entitled JOYSTICK SWITCH ASSEMBLIES FOR SURGICAL INSTRUMENTS, now U.S. Patent No. 9,326,767;
- U.S. Patent Application Serial No. 13/782,481, entitled SENSOR STRAIGHTENED END EFFECTOR DURING REMOVAL THROUGH TROCAR, now U.S. Patent No. 9,468,438;
- U.S. Patent Application Serial No. 13/782,518, entitled CONTROL METHODS FOR SURGICAL INSTRUMENTS WITH REMOVABLE IMPLEMENT PORTIONS, now U.S. Patent Application Publication No. 2014/0246475;
- U.S. Patent Application Serial No. 13/782,375, entitled ROTARY POWERED SURGICAL INSTRUMENTS WITH MULTIPLE DEGREES OF FREEDOM, now U.S. Patent No. 9,398,911; and
- U.S. Patent Application Serial No. 13/782,536, entitled SURGICAL INSTRUMENT SOFT STOP, now U.S. Patent No. 9,307,986.

[0122] Applicant of the present application also owns the following patent applications that were filed on March 14, 2013 and which are each herein incorporated by reference in their respective entirety:

- U.S. Patent Application Serial No. 13/803,097, entitled ARTICULATABLE SURGICAL INSTRUMENT COMPRISING A FIRING DRIVE, now U.S. Patent No. 9,687,230;
- U.S. Patent Application Serial No. 13/803,193, entitled CONTROL ARRANGEMENTS FOR A DRIVE MEMBER OF A SURGICAL INSTRUMENT, now U.S. Patent No. 9,332,987;
- U.S. Patent Application Serial No. 13/803,053, entitled INTERCHANGEABLE SHAFT ASSEMBLIES FOR USE WITH A SURGICAL INSTRUMENT, now U.S. Patent No. 9,883,860;
- U.S. Patent Application Serial No. 13/803,086, entitled ARTICULATABLE SURGICAL INSTRUMENT COMPRISING AN ARTICULATION LOCK, now U.S. Patent Application Publication No. 2014/0263541;
- U.S. Patent Application Serial No. 13/803,210, entitled SENSOR ARRANGEMENTS FOR ABSOLUTE POSITIONING SYSTEM FOR SURGICAL INSTRUMENTS, now U.S. Patent No. 9,808,244;
- U.S. Patent Application Serial No. 13/803,148, entitled MULTI-FUNCTION MOTOR FOR A SURGICAL INSTRUMENT, now U.S. Patent No. 10,470,762;
- U.S. Patent Application Serial No. 13/803,066, entitled DRIVE SYSTEM LOCKOUT ARRANGEMENTS FOR MODULAR SURGICAL INSTRUMENTS, now U.S. Patent No. 9,629,623;
- U.S. Patent Application Serial No. 13/803,117, entitled ARTICULATION CONTROL SYSTEM FOR ARTICULATABLE SURGICAL INSTRUMENTS, now U.S. Patent No. 9,351,726;
- U.S. Patent Application Serial No. 13/803,130, entitled DRIVE TRAIN CONTROL ARRANGEMENTS FOR MODULAR SURGICAL INSTRUMENTS, now U.S. Patent No. 9,351,727; and
- U.S. Patent Application Serial No. 13/803,159, entitled METHOD AND SYSTEM FOR OPERATING A SURGICAL INSTRUMENT, now U.S. Patent No. 9,888,919.

[0123] Applicant of the present application also owns the following patent application that was filed on March 7, 2014 and is herein incorporated by reference in its entirety:

- U.S. Patent Application Serial No. 14/200,111, entitled CONTROL SYSTEMS FOR SURGICAL INSTRUMENTS, now U.S. Patent No. 9,629,629.

[0124] Applicant of the present application also owns the following patent applications that were filed on March 26, 2014 and are each herein incorporated by reference in their respective entirety:

- U.S. Patent Application Serial No. 14/226,106, entitled POWER MANAGEMENT CONTROL SYSTEMS FOR SURGICAL INSTRUMENTS, now U.S. Patent Application Publication No. 2015/0272582;
- U.S. Patent Application Serial No. 14/226,099, entitled STERILIZATION VERIFICATION CIRCUIT, now U.S. Patent No. 9,826,977;
- U.S. Patent Application Serial No. 14/226,094, entitled VERIFICATION OF NUMBER OF BATTERY EXCHANGES/PROCEDURE COUNT, now U.S. Patent Application Publication No. 2015/0272580;
- U.S. Patent Application Serial No. 14/226,117, entitled POWER MANAGEMENT THROUGH SLEEP OPTIONS OF SEGMENTED CIRCUIT AND WAKE UP CONTROL, now U.S. Patent No. 10,013,049;
- U.S. Patent Application Serial No. 14/226,075, entitled MODULAR POWERED SURGICAL INSTRUMENT WITH DETACHABLE SHAFT ASSEMBLIES, now U.S. Patent No. 9,743,929;
- U.S. Patent Application Serial No. 14/226,093, entitled FEEDBACK ALGORITHMS FOR MANUAL BAILOUT SYSTEMS FOR SURGICAL INSTRUMENTS, now U.S. Patent No. 10,028,761;
- U.S. Patent Application Serial No. 14/226,116, entitled SURGICAL INSTRUMENT UTILIZING SENSOR ADAPTATION, now U.S. Patent Application Publication No. 2015/0272571;
- U.S. Patent Application Serial No. 14/226,071, entitled SURGICAL INSTRUMENT CONTROL CIRCUIT HAVING A SAFETY PROCESSOR, now U.S. Patent No. 9,690,362;
- U.S. Patent Application Serial No. 14/226,097, entitled SURGICAL INSTRUMENT COMPRISING INTERACTIVE SYSTEMS, now U.S. Patent No. 9,820,738;

- U.S. Patent Application Serial No. 14/226,126, entitled INTERFACE SYSTEMS FOR USE WITH SURGICAL INSTRUMENTS, now U.S. Patent No. 10,004,497;
- U.S. Patent Application Serial No. 14/226,133, entitled MODULAR SURGICAL INSTRUMENT SYSTEM, now U.S. Patent Application Publication No. 2015/0272557;
- U.S. Patent Application Serial No. 14/226,081, entitled SYSTEMS AND METHODS FOR CONTROLLING A SEGMENTED CIRCUIT, now U.S. Patent No. 9,804,618;
- U.S. Patent Application Serial No. 14/226,076, entitled POWER MANAGEMENT THROUGH SEGMENTED CIRCUIT AND VARIABLE VOLTAGE PROTECTION, now U.S. Patent No. 9,733,663;
- U.S. Patent Application Serial No. 14/226,111, entitled SURGICAL STAPLING INSTRUMENT SYSTEM, now U.S. Patent No. 9,750,499; and
- U.S. Patent Application Serial No. 14/226,125, entitled SURGICAL INSTRUMENT COMPRISING A ROTATABLE SHAFT, now U.S. Patent No. 10,201,364.

[0125] Applicant of the present application also owns the following patent applications that were filed on September 5, 2014 and which are each herein incorporated by reference in their respective entirety:

- U.S. Patent Application Serial No. 14/479,103, entitled CIRCUITRY AND SENSORS FOR POWERED MEDICAL DEVICE, now U.S. Patent No. 10,111,679;
- U.S. Patent Application Serial No. 14/479,119, entitled ADJUNCT WITH INTEGRATED SENSORS TO QUANTIFY TISSUE COMPRESSION, now U.S. Patent No. 9,724,094;
- U.S. Patent Application Serial No. 14/478,908, entitled MONITORING DEVICE DEGRADATION BASED ON COMPONENT EVALUATION, now U.S. Patent No. 9,737,301;
- U.S. Patent Application Serial No. 14/478,895, entitled MULTIPLE SENSORS WITH ONE SENSOR AFFECTING A SECOND SENSOR'S OUTPUT OR INTERPRETATION, now U.S. Patent No. 9,757,128;
- U.S. Patent Application Serial No. 14/479,110, entitled POLARITY OF HALL MAGNET TO IDENTIFY CARTRIDGE TYPE, now U.S. Patent No. 10,016,199;

- U.S. Patent Application Serial No. 14/479,098, entitled SMART CARTRIDGE WAKE UP OPERATION AND DATA RETENTION, now U.S. Patent No. 10,135,242;
- U.S. Patent Application Serial No. 14/479,115, entitled MULTIPLE MOTOR CONTROL FOR POWERED MEDICAL DEVICE, now U.S. Patent No. 9,788,836; and
- U.S. Patent Application Serial No. 14/479,108, entitled LOCAL DISPLAY OF TISSUE PARAMETER STABILIZATION, now U.S. Patent Application Publication No. 2016/0066913.

[0126] Applicant of the present application also owns the following patent applications that were filed on April 9, 2014 and which are each herein incorporated by reference in their respective entirety:

- U.S. Patent Application Serial No. 14/248,590, entitled MOTOR DRIVEN SURGICAL INSTRUMENTS WITH LOCKABLE DUAL DRIVE SHAFTS, now U.S. Patent No. 9,826,976;
- U.S. Patent Application Serial No. 14/248,581, entitled SURGICAL INSTRUMENT COMPRISING A CLOSING DRIVE AND A FIRING DRIVE OPERATED FROM THE SAME ROTATABLE OUTPUT, now U.S. Patent No. 9,649,110;
- U.S. Patent Application Serial No. 14/248,595, entitled SURGICAL SYSTEM COMPRISING FIRST AND SECOND DRIVE SYSTEMS, now U.S. Patent No. 9,844,368;
- U.S. Patent Application Serial No. 14/248,588, entitled POWERED LINEAR SURGICAL STAPLER, now U.S. Patent No. 10,405,857;
- U.S. Patent Application Serial No. 14/248,591, entitled SURGICAL INSTRUMENT COMPRISING A GAP SETTING SYSTEM, now U.S. Patent No. 10,149,680;
- U.S. Patent Application Serial No. 14/248,584, entitled MODULAR MOTOR DRIVEN SURGICAL INSTRUMENTS WITH ALIGNMENT FEATURES FOR ALIGNING ROTARY DRIVE SHAFTS WITH SURGICAL END EFFECTOR SHAFTS, now U.S. Patent No. 9,801,626;
- U.S. Patent Application Serial No. 14/248,587, entitled POWERED SURGICAL STAPLER, now U.S. Patent No. 9,867,612;

- U.S. Patent Application Serial No. 14/248,586, entitled DRIVE SYSTEM DECOUPLING ARRANGEMENT FOR A SURGICAL INSTRUMENT, now U.S. Patent No. 10,136,887; and
- U.S. Patent Application Serial No. 14/248,607, entitled MODULAR MOTOR DRIVEN SURGICAL INSTRUMENTS WITH STATUS INDICATION ARRANGEMENTS, now U.S. Patent No. 9,814,460.

[0127] Applicant of the present application also owns the following patent applications that were filed on April 16, 2013 and which are each herein incorporated by reference in their respective entirety:

- U.S. Provisional Patent Application Serial No. 61/812,365, entitled SURGICAL INSTRUMENT WITH MULTIPLE FUNCTIONS PERFORMED BY A SINGLE MOTOR;
- U.S. Provisional Patent Application Serial No. 61/812,376, entitled LINEAR CUTTER WITH POWER;
- U.S. Provisional Patent Application Serial No. 61/812,382, entitled LINEAR CUTTER WITH MOTOR AND PISTOL GRIP;
- U.S. Provisional Patent Application Serial No. 61/812,385, entitled SURGICAL INSTRUMENT HANDLE WITH MULTIPLE ACTUATION MOTORS AND MOTOR CONTROL; and
- U.S. Provisional Patent Application Serial No. 61/812,372, entitled SURGICAL INSTRUMENT WITH MULTIPLE FUNCTIONS PERFORMED BY A SINGLE MOTOR.

[0128] Applicant of the present application owns the following U.S. Provisional Patent Applications, filed on December 28, 2017, the disclosure of each of which is herein incorporated by reference in its entirety:

- U.S. Provisional Patent Application Serial No. 62/611,341, entitled INTERACTIVE SURGICAL PLATFORM;
- U.S. Provisional Patent Application Serial No. 62/611,340, entitled CLOUD-BASED MEDICAL ANALYTICS; and
- U.S. Provisional Patent Application Serial No. 62/611,339, entitled ROBOT ASSISTED SURGICAL PLATFORM.

[0129] Applicant of the present application owns the following U.S. Provisional Patent Applications, filed on March 28, 2018, each of which is herein incorporated by reference in its entirety:

- U.S. Provisional Patent Application Serial No. 62/649,302, entitled INTERACTIVE SURGICAL SYSTEMS WITH ENCRYPTED COMMUNICATION CAPABILITIES;
- U.S. Provisional Patent Application Serial No. 62/649,294, entitled DATA STRIPPING METHOD TO INTERROGATE PATIENT RECORDS AND CREATE ANONYMIZED RECORD;
- U.S. Provisional Patent Application Serial No. 62/649,300, entitled SURGICAL HUB SITUATIONAL AWARENESS;
- U.S. Provisional Patent Application Serial No. 62/649,309, entitled SURGICAL HUB SPATIAL AWARENESS TO DETERMINE DEVICES IN OPERATING THEATER;
- U.S. Provisional Patent Application Serial No. 62/649,310, entitled COMPUTER IMPLEMENTED INTERACTIVE SURGICAL SYSTEMS;
- U.S. Provisional Patent Application Serial No. 62/649,291, entitled USE OF LASER LIGHT AND RED-GREEN-BLUE COLORATION TO DETERMINE PROPERTIES OF BACK SCATTERED LIGHT;
- U.S. Provisional Patent Application Serial No. 62/649,296, entitled ADAPTIVE CONTROL PROGRAM UPDATES FOR SURGICAL DEVICES;
- U.S. Provisional Patent Application Serial No. 62/649,333, entitled CLOUD-BASED MEDICAL ANALYTICS FOR CUSTOMIZATION AND RECOMMENDATIONS TO A USER;
- U.S. Provisional Patent Application Serial No. 62/649,327, entitled CLOUD-BASED MEDICAL ANALYTICS FOR SECURITY AND AUTHENTICATION TRENDS AND REACTIVE MEASURES;
- U.S. Provisional Patent Application Serial No. 62/649,315, entitled DATA HANDLING AND PRIORITIZATION IN A CLOUD ANALYTICS NETWORK;
- U.S. Provisional Patent Application Serial No. 62/649,313, entitled CLOUD INTERFACE FOR COUPLED SURGICAL DEVICES;

- U.S. Provisional Patent Application Serial No. 62/649,320, entitled DRIVE ARRANGEMENTS FOR ROBOT-ASSISTED SURGICAL PLATFORMS;
- U.S. Provisional Patent Application Serial No. 62/649,307, entitled AUTOMATIC TOOL ADJUSTMENTS FOR ROBOT-ASSISTED SURGICAL PLATFORMS; and
- U.S. Provisional Patent Application Serial No. 62/649,323, entitled SENSING ARRANGEMENTS FOR ROBOT-ASSISTED SURGICAL PLATFORMS.

[0130] Applicant of the present application owns the following U.S. Patent Applications, filed on March 29, 2018, each of which is herein incorporated by reference in its entirety:

- U.S. Patent Application Serial No. 15/940,641, entitled INTERACTIVE SURGICAL SYSTEMS WITH ENCRYPTED COMMUNICATION CAPABILITIES, now U.S. Patent Application Publication No. 2019/0207911;
- U.S. Patent Application Serial No. 15/940,648, entitled INTERACTIVE SURGICAL SYSTEMS WITH CONDITION HANDLING OF DEVICES AND DATA CAPABILITIES, now U.S. Patent Application Publication No. 2019/0206004;
- U.S. Patent Application Serial No. 15/940,656, entitled SURGICAL HUB COORDINATION OF CONTROL AND COMMUNICATION OF OPERATING ROOM DEVICES, now U.S. Patent Application Publication No. 2019/0201141;
- U.S. Patent Application Serial No. 15/940,666, entitled SPATIAL AWARENESS OF SURGICAL HUBS IN OPERATING ROOMS, now U.S. Patent Application Publication No. 2019/0206551;
- U.S. Patent Application Serial No. 15/940,670, entitled COOPERATIVE UTILIZATION OF DATA DERIVED FROM SECONDARY SOURCES BY INTELLIGENT SURGICAL HUBS, now U.S. Patent Application Publication No. 2019/0201116;
- U.S. Patent Application Serial No. 15/940,677, entitled SURGICAL HUB CONTROL ARRANGEMENTS, now U.S. Patent Application Publication No. 2019/0201143;
- U.S. Patent Application Serial No. 15/940,632, entitled DATA STRIPPING METHOD TO INTERROGATE PATIENT RECORDS AND CREATE ANONYMIZED RECORD, now U.S. Patent Application Publication No. 2019/0205566;

- U.S. Patent Application Serial No. 15/940,640, entitled COMMUNICATION HUB AND STORAGE DEVICE FOR STORING PARAMETERS AND STATUS OF A SURGICAL DEVICE TO BE SHARED WITH CLOUD BASED ANALYTICS SYSTEMS, now U.S. Patent Application Publication No. 2019/0200863;
- U.S. Patent Application Serial No. 15/940,645, entitled SELF DESCRIBING DATA PACKETS GENERATED AT AN ISSUING INSTRUMENT, now U.S. Patent No. 10,892,899;
- U.S. Patent Application Serial No. 15/940,649, entitled DATA PAIRING TO INTERCONNECT A DEVICE MEASURED PARAMETER WITH AN OUTCOME, now U.S. Patent Application Publication No. 2019/0205567;
- U.S. Patent Application Serial No. 15/940,654, entitled SURGICAL HUB SITUATIONAL AWARENESS, now U.S. Patent Application Publication No. 2019/0201140;
- U.S. Patent Application Serial No. 15/940,663, entitled SURGICAL SYSTEM DISTRIBUTED PROCESSING, now U.S. Patent Application Publication No. 2019/0201033;
- U.S. Patent Application Serial No. 15/940,668, entitled AGGREGATION AND REPORTING OF SURGICAL HUB DATA, now U.S. Patent Application Publication No. 2019/0201115;
- U.S. Patent Application Serial No. 15/940,671, entitled SURGICAL HUB SPATIAL AWARENESS TO DETERMINE DEVICES IN OPERATING THEATER, now U.S. Patent Application Publication No. 2019/0201104;
- U.S. Patent Application Serial No. 15/940,686, entitled DISPLAY OF ALIGNMENT OF STAPLE CARTRIDGE TO PRIOR LINEAR STAPLE LINE, now U.S. Patent Application Publication No. 2019/0201105;
- U.S. Patent Application Serial No. 15/940,700, entitled STERILE FIELD INTERACTIVE CONTROL DISPLAYS, now U.S. Patent Application Publication No. 2019/0205001;
- U.S. Patent Application Serial No. 15/940,629, entitled COMPUTER IMPLEMENTED INTERACTIVE SURGICAL SYSTEMS, now U.S. Patent Application Publication No. 2019/0201112;

- U.S. Patent Application Serial No. 15/940,704, entitled USE OF LASER LIGHT AND RED-GREEN-BLUE COLORATION TO DETERMINE PROPERTIES OF BACK SCATTERED LIGHT, now U.S. Patent Application Publication No. 2019/0206050;
- U.S. Patent Application Serial No. 15/940,722, entitled CHARACTERIZATION OF TISSUE IRREGULARITIES THROUGH THE USE OF MONO-CHROMATIC LIGHT REFRACTIVITY, now U.S. Patent Application Publication No. 2019/0200905; and
- U.S. Patent Application Serial No. 15/940,742, entitled DUAL CMOS ARRAY IMAGING, now U.S. Patent Application Publication No. 2019/0200906.

[0131] Applicant of the present application owns the following U.S. Patent Applications, filed on March 29, 2018, each of which is herein incorporated by reference in its entirety:

- U.S. Patent Application Serial No. 15/940,636, entitled ADAPTIVE CONTROL PROGRAM UPDATES FOR SURGICAL DEVICES, now U.S. Patent Application Publication No. 2019/0206003;
- U.S. Patent Application Serial No. 15/940,653, entitled ADAPTIVE CONTROL PROGRAM UPDATES FOR SURGICAL HUBS, now U.S. Patent Application Publication No. 2019/0201114;
- U.S. Patent Application Serial No. 15/940,660, entitled CLOUD-BASED MEDICAL ANALYTICS FOR CUSTOMIZATION AND RECOMMENDATIONS TO A USER, now U.S. Patent Application Publication No. 2019/0206555;
- U.S. Patent Application Serial No. 15/940,679, entitled CLOUD-BASED MEDICAL ANALYTICS FOR LINKING OF LOCAL USAGE TRENDS WITH THE RESOURCE ACQUISITION BEHAVIORS OF LARGER DATA SET, now U.S. Patent Application Publication No. 2019/0201144;
- U.S. Patent Application Serial No. 15/940,694, entitled CLOUD-BASED MEDICAL ANALYTICS FOR MEDICAL FACILITY SEGMENTED INDIVIDUALIZATION OF INSTRUMENT FUNCTION, now U.S. Patent Application Publication No. 2019/0201119;
- U.S. Patent Application Serial No. 15/940,634, entitled CLOUD-BASED MEDICAL ANALYTICS FOR SECURITY AND AUTHENTICATION TRENDS AND REACTIVE MEASURES, now U.S. Patent Application Publication No. 2019/0201138;

- U.S. Patent Application Serial No. 15/940,706, entitled DATA HANDLING AND PRIORITIZATION IN A CLOUD ANALYTICS NETWORK, now U.S. Patent Application Publication No. 2019/0206561; and

- U.S. Patent Application Serial No. 15/940,675, entitled CLOUD INTERFACE FOR COUPLED SURGICAL DEVICES, now U.S. Patent No. 10,849,697.

[0132] Applicant of the present application owns the following U.S. Patent Applications, filed on March 29, 2018, each of which is herein incorporated by reference in its entirety:

- U.S. Patent Application Serial No. 15/940,627, entitled DRIVE ARRANGEMENTS FOR ROBOT-ASSISTED SURGICAL PLATFORMS, now U.S. Patent Application Publication No. 2019/0201111;

- U.S. Patent Application Serial No. 15/940,637, entitled COMMUNICATION ARRANGEMENTS FOR ROBOT-ASSISTED SURGICAL PLATFORMS, now U.S. Patent Application Publication No. 2019/0201139;

- U.S. Patent Application Serial No. 15/940,642, entitled CONTROLS FOR ROBOT-ASSISTED SURGICAL PLATFORMS, now U.S. Patent Application Publication No. 2019/0201113;

- U.S. Patent Application Serial No. 15/940,676, entitled AUTOMATIC TOOL ADJUSTMENTS FOR ROBOT-ASSISTED SURGICAL PLATFORMS, now U.S. Patent Application Publication No. 2019/0201142;

- U.S. Patent Application Serial No. 15/940,680, entitled CONTROLLERS FOR ROBOT-ASSISTED SURGICAL PLATFORMS, now U.S. Patent Application Publication No. 2019/0201135;

- U.S. Patent Application Serial No. 15/940,683, entitled COOPERATIVE SURGICAL ACTIONS FOR ROBOT-ASSISTED SURGICAL PLATFORMS, now U.S. Patent Application Publication No. 2019/0201145;

- U.S. Patent Application Serial No. 15/940,690, entitled DISPLAY ARRANGEMENTS FOR ROBOT-ASSISTED SURGICAL PLATFORMS, now U.S. Patent Application Publication No. 2019/0201118; and

- U.S. Patent Application Serial No. 15/940,711, entitled SENSING ARRANGEMENTS FOR ROBOT-ASSISTED SURGICAL PLATFORMS, now U.S. Patent Application Publication No. 2019/0201120.

[0133] 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.

[0134] 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.

[0135] 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.

[0136] 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.

[0137] 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.

[0138] 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.

[0139] 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.

[0140] 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.

[0141] A stapling instrument 1000 is illustrated in FIG. 1. The stapling instrument 1000 comprises a handle 1100, a shaft 1200 extending from the handle 1100, and a loading unit 1300 that is removably attachable to the shaft 1200. The shaft 1200 comprises a distal connection 1220 that is releasably attached to a proximal connection end 1320 of the loading unit 1300. The entire disclosure of U.S. Patent No. 5,865,361, entitled SURGICAL STAPLING APPARATUS, which issued on February 2, 1999 is incorporated by reference herein. The loading unit 1300 further comprises an end effector 1400 and an articulation joint 1500. The end effector 1400 comprises an anvil

jaw 1410 and a cartridge jaw 1420. The cartridge jaw 1420 is configured to receive a staple cartridge, such as staple cartridge 1900, for example, and is rotatable between an open unclamped position and a closed clamped position relative to the anvil jaw 1410. In various other embodiments, the anvil jaw 1410 is rotatable relative to the cartridge jaw 1420. In either embodiment, the stapling instrument 1000 comprises a firing drive actuatable to close the end effector 1400 and, during a separate actuation (or actuations), fire the staples from the staple cartridge 1900. Referring to FIG. 1, the firing drive includes a firing trigger 1120 which, when actuated (FIG. 2), advances a firing rod 1690 distally. When the loading unit 1300 is attached to the shaft 1200, the firing rod 1690 is coupled to a firing member 1390 of the loading unit 1300 which is advanced distally by the firing rod 1690 when the firing rod 1690 is advanced distally.

[0142] Further to the above, the firing trigger 1120 is actuated a first time to advance the firing rod 1690 and the firing member 1390 distally to close the end effector 1400. When the firing trigger 1120 is actuated toward a grip 1110 of the handle 1100, the firing trigger 1120 compresses a trigger spring, such as a torsion spring, for example, between the firing trigger 1120 and a frame of the handle 1100. The firing trigger 1120 is then released and the trigger spring returns the firing trigger 1120 back into its unactuated position. Notably, the firing rod 1690 and the firing member 1390 are not retracted proximally when the firing trigger 1120 is returned to its unactuated position. Instead, the firing rod 1690 and the firing member 1390 remain in their distally-advanced positions. The firing drive further comprises a retraction knob 1710 coupled to the firing rod 1690. If the clinician is unsatisfied with the positioning of the jaws 1410 and 1420 on the patient tissue, the clinician can pull the retraction knob 1710 proximally to manually retract the firing rod 1690 and the firing member 1390 proximally and open the end effector 1400. In at least one embodiment, the end effector 1400 comprises one or more springs, such as coil springs, for example, positioned between the jaws 1410 and 1420 such that the springs push the end effector 1400 open when the firing member 1390 is retracted by the firing rod 1690.

[0143] If the clinician is satisfied with the position of the jaws 1410 and 1420 on the patient tissue, further to the above, the clinician can depress a mode switch, which is discussed further below. When depressed, the mode switch electronically and/or

mechanically shifts the stapling instrument 1000 from a closure mode to a staple firing mode. As a result, a second actuation of the firing trigger 1120 drives the firing rod 1690 and firing member 1390 distally through a firing stroke to eject staples from the staple cartridge 1900. In at least one embodiment, the staple firing stroke is about 15 mm, for example. In some embodiments, a 15 mm staple firing stroke is sufficient to fire all of the staples of the staple cartridge 1900 while, in other embodiments, more than one staple firing stroke is needed to fire all of the staples from the staple cartridge 1900. In such multi-stroke embodiments, the firing trigger 1120 is releasable after the second actuation and then reactuated a third time to produce a second staple firing stroke. Like the first staple firing stroke, the second staple firing stroke is also about 15 mm. In various embodiments, the firing trigger 1120 is actuatable to produce a third staple firing stroke and/or a fourth staple firing stroke, or as many firing strokes that are needed, to fire all of the staples of the staple cartridge 1900. Regardless of the number of staple firing strokes needed to fully fire the staple cartridge 1900, the clinician can pull the retraction actuator 1710 proximally after less than all of the staple firing strokes have been completed to open the end effector 1400 and remove the stapling instrument 1000 from the patient. The entire disclosure of U.S. Patent No. 10,433,842, entitled SURGICAL HANDLE ASSEMBLY, which issued on October 8, 2019, is incorporated by reference herein.

[0144] Further to the above, an entire staple firing stroke can be comprised of multiple staple firing actuations, especially in embodiments comprising a reciprocating mechanism such as those discussed below, for example. That said, in various instances, each staple firing actuation can be referred to as a staple firing stroke even though each such staple firing stroke does not fire all of the staples of a staple cartridge. In such instances, such staple firing strokes are part of an entire staple firing stroke to eject all of the staples from a staple cartridge.

[0145] A surgical stapling instrument 2000 is illustrated in FIG. 3. The stapling instrument 2000 is similar to the stapling instrument 1000 in many respects which will not be discussed herein for the sake of brevity. The stapling instrument 2000 comprises a handle 2100 and a firing drive 2600. The handle 2100 comprises a grip 2110 and a firing actuator 2120 which includes an actuatable switch 2125. The firing drive 2600

comprises an electric motor 2630 and a battery 2640 configured to supply power to the electric motor 2630 through an electronic circuit 2620 that is controlled by the firing actuator 2120. The electric motor 2630 is mounted in the handle 2100 and comprises a rotatable motor output 2635 operably engaged with a gear train 2650 of the drive system 2600. The gear train 2650 comprises a drive gear 2655 operably engaged with a drive crank 2660 of the drive system 2600 which is rotatably mounted to the handle 2100 about a pivot 2665. The drive crank 2660 comprises a gear portion comprising gear teeth meshingly engaged with the drive gear 2655 and is rotatable about the pivot 2665 by the drive gear 2655. The drive system 2600 further comprises a pawl 2670 and a firing rack 2680. The pawl 2670 is rotatably connected to the drive crank 2660 about a pin 2675 and comprises a drive tooth 2672 configured to engage a longitudinal array of ratchet teeth 2682 defined on the bottom of the firing rack 2680 and drive the firing rack 2680 distally along longitudinal axis LA during a firing stroke.

[0146] As discussed above, the electronic circuit 2620 controls the operation of the electric motor 2630 in response to inputs from the firing actuator 2120. In various embodiments, the motor 2630 comprises a direct current (DC) motor, for example, but can comprise any suitable motor. In various embodiments, the electronic circuit 2620 comprises a microprocessor comprising at least one input gate in communication with the firing actuator switch 2125 and at least one output gate in communication with a relay configured to control the supply of power from the battery 2640 to the electric motor 2630. Although not illustrated in FIG.3, the electronic circuit 2620 comprises electrical conductors, wires, and/or flex circuits, for example, which connect the components of the electronic circuit such as the motor 2630 and the battery 2640, for example. In certain embodiments, the electronic circuit 2620 does not comprise a microprocessor and, instead, relies on switch logic to control the operation of the electric motor 2630. Such embodiments may be advantageous when the stapling instrument 2000 is exposed to a harsh sterilization process, for example. Thus, while the discussion provided below is presented using an embodiment including a microprocessor, the reader should appreciate that an equivalent analog circuit could be used to perform the same functions and operations discussed herein.

[0147] In use, referring to FIG. 4, the firing actuator 2120 is actuated a first time to close the end effector 1400 of the stapling instrument 2000. The actuation of the firing actuator 2120 closes the switch 2125 which is detected by the microprocessor. In response, the microprocessor applies a voltage potential to the electric motor 2630 from the battery 2640 to rotate the motor output 2635 in a first direction and drive the pawl 2670 distally. The firing drive comprises a pawl spring 2685 mounted to the pawl 2670 and the frame of the handle 2100 which applies a biasing force to the pawl 2670 to bias the drive tooth 2672 into engagement with the ratchet teeth 2682 defined on the firing rack 2680. When the pawl 2670 is advanced distally in response to the first actuation of the firing actuator 2120, referring to FIG. 5, the pawl 2670 drives the firing rack 2680 distally which, in turn, drives the firing rod 1690 and the firing member 1390 distally to close the end effector 1400. Stated another way, the pawl 2670, the firing rack 2680, the firing rod 1690, and the firing member 1390 are all advanced distally a closure stroke in response to the first actuation of the firing actuator 2120.

[0148] After the microprocessor determines that the closure stroke is complete, further to the above, the microprocessor stops the motor 2630 by disconnecting the voltage potential from the battery 2640. At such point, referring to FIG. 6, the pawl spring 2685, which was resiliently stretched when the pawl 2670 was advanced distally through the closure stroke, resiliently contracts and pulls the pawl 2670 proximally back into its unactuated position. Notably, the ratchet teeth 2682 defined on the firing rack 2680 are shaped to permit the drive tooth 2672 of the pawl 2670 to slide proximally relative to the ratchet teeth 2682 when the pawl 2670 is retracted. In such instances, the pawl spring 2685 can backdrive the electric motor 2630. In various alternative embodiments, the microprocessor can reverse the polarity of the voltage potential being applied to the motor 2630 to operate the motor output 2635 in an opposite direction to drive the pawl 2670 proximally. Such embodiments can be useful to overcome the inertia of the gear train 2650. Also, in such embodiments, the firing drive can include a beginning-of-stroke sensor in communication with the microprocessor which is closed when the pawl 2670 is retracted back into its unactuated position. When the beginning-of-stroke sensor is closed, the microprocessor disconnects the voltage polarity from the motor 2630.

[0149] As discussed above, the microprocessor is configured to determine when the closure stroke is complete. In various embodiments, the firing drive further comprises an encoder in communication with the microprocessor which is configured to monitor and count the rotations of the motor output 2635. In at least one such embodiment, a magnetic element is positioned on and/or within the motor output 2635 and the encoder is configured to detect the disturbances in a magnetic field created by the encoder when the motor output 2635 is rotated. Once the rotation count reaches a predetermined count threshold, the microprocessor disconnects and/or reverses the polarity being applied to the motor 2630. In various embodiments, the firing drive comprises an end-of-stroke sensor in communication with the microprocessor that is closed by the pawl 2670 when the pawl 2670 reaches the end of its stroke. The microprocessor is configured to sense the closure of the end-of-stroke sensor and, in response, disconnect and/or reverse the polarity being applied to the motor 2630.

[0150] After the pawl 2670 has been reset after the closure stroke, the clinician may decide to re-open the end effector 1400 by pulling the retraction knob 1710 proximally or initiate the staple firing stroke. To initiate the staple firing stroke, the clinician must first depress a mode switch in communication with the microprocessor, which is discussed further below. If the mode switch is not depressed, the microprocessor and motor 2630 are not responsive to a subsequent actuation of the firing actuator 2120. After the mode switch is depressed, referring to FIG. 7, the microprocessor and motor 2630 are responsive to a subsequent actuation of the firing actuator 2120. In such instances, the motor output 2635 is rotated in the first direction once again to drive the pawl 2670 distally through a second actuation stroke. In this actuation stroke, the pawl 2670 drives the firing member 1390 partially through the staple cartridge 1900 to eject staples therefrom. Once the pawl 2670 reaches the end of the second actuation stroke, the pawl 2670 closes the end-of-stroke switch and the microprocessor reverses the polarity of the voltage being applied to the electric motor 2630 such that the direction of the motor output 2635 is reversed and the pawl 2670 is retracted. This process is repeated automatically until either the microprocessor determines that the maximum number of staple firing strokes has been performed or the clinician releases the firing actuator 2120. In various instances, each staple firing stroke is about 15 mm, for

example, and in embodiments configured to deploy a 60 mm staple pattern, for example, the maximum number of staple firing strokes is four. In such instances, the pawl 2670 would be reciprocated once for the closure stroke and then four times to deploy the staples.

[0151] If the clinician releases the firing actuator 2120 prior to the maximum number of staple firing strokes being reached, further to the above, the microprocessor disconnects the voltage polarity from the electric motor 2630. In various embodiments, the inertia of the gear train 2650 holds the pawl 2670 in position and the firing drive is held in a paused condition. In certain embodiments, in such instances, the microprocessor can apply a voltage potential to the electric motor 2630 that is sufficient to temporarily hold the pawl 2670 in position. If the clinician no longer wishes to continue deploying the staples, the clinician can pull the retraction knob 1710 proximally to retract the firing rack 2680 proximally. To reset the stapling firing rive in such instances, the clinician can depress the mode switch once again which causes the microprocessor to return the pawl 2670 back into its unactuated position. If the clinician wishes to continue deploying the staples, on the other hand, the clinician can re-depress the firing actuator 2120 to re-start the motor 2630.

[0152] As discussed above, the stapling instrument 2000 can comprise an analog control circuit for controlling the above-described series of operations. Referring to FIG. 9, the stapling instrument 2000 can comprise a control circuit 2620' configured to control the operation of the motor 2630. The control circuit 2620' comprises a firing actuator 2120', a mode switch 2720', and a relay 2730'. The firing actuator 2120' comprises a mom-off-mom switch, for example, in communication with the mode switch 2720' and the relay 2730'. The relay 2730' comprises a set/re-set function capable of reversing the voltage polarity applied to the motor 2630. The control circuit 2620' further comprises an end-of-stroke switch 2740 and a beginning-of-stroke switch 2750. In various instances, the operation of the motor 2630 is changed or interrupted if one or both of the switches 2740 and 2750 is opened, for example. In at least one such embodiment, the end-of-stroke switch 2740 is opened by the firing rack 2680 when the firing rack 2680 has been advanced through the maximum number of staple firing actuations. Similarly, in at least one such embodiment, the beginning-of-stroke switch

2750 is opened by the firing rack 2680 when the firing rack 2680 has been returned to its proximal unactuated position.

[0153] Further to the above, referring to FIG. 8, the surgical instrument 2000 can comprise an end-of-stroke switch 2790 that is closed by the drive gear 2655 at the end of an actuation stroke of the pawl 2670. The drive gear 2655 is fixedly mounted to a gear shaft 2652 and the drive gear 2655 is rotatably mounted in the handle 2100 about the gear shaft 2652. The gear shaft 2652 comprises a switch key 2654 extending therefrom which, during an initial portion of the drive gear 2655 rotation, is not in contact with a ring stack 2780 including a first switch ring 2782 and a second switch ring 2786 which are rotatably supported by the gear shaft 2652 and do not rotate with the gear shaft 2652 during the initial rotation of the drive gear 2655. As the drive gear 2655 is rotated, however, the switch key 2654 contacts the first switch ring 2782 and, as a result, the first switch ring 2782 and the gear shaft 2652 begin to rotate together. Notably, though, the second switch ring 2786 does not immediately rotate with the first switch ring 2782 and the gear shaft 2652; rather, the first switch ring 2782 and the gear shaft 2652 rotate relative to the second switch ring 2786 until a drive shoulder 2784 of the first switch ring 2782 contacts the second switch ring 2786. At such point, the gear shaft 2652, the first switch ring 2782, and the second switch ring 2786 rotate together until a switch key 2788 of the second switch ring 2786 contacts a switch element 2798 of the end-of-stroke switch 2790 and closes the end-of-stroke switch 2790. The pawl 2670 reaching the end of its actuation stroke coincides with the closure of the end-of-stroke switch 2790 and the closure of the end-of-stroke switch 2790 reverses the motor 2630 to retract the pawl 2670.

[0154] Referring again to FIG. 3, the motor 2630 of the stapling instrument 2000 is positioned in the grip 2110 of the handle 2100. In various other embodiments, the motor 2630 is positioned proximally relative to the grip 2110 within the handle 2100. In at least one such embodiment, the motor 2630 can drive a jack screw arrangement to move the firing rack 2680.

[0155] A stapling instrument 3000 is illustrated in FIG. 12. The stapling instrument 3000 comprises a motor-driven firing system that does not use a pawl. Instead, the firing drive 3600 of the stapling instrument 3000 comprises an electric motor 3630

including a gear output 3635, a drive gear 3655 operably intermeshed with the gear output 3635, and a firing rack 3680 including a longitudinal array of gear teeth 3682 intermeshed with the drive gear 3655. In use, a first voltage polarity is applied to the motor 3630 to rotate the gear output 3635 in a first direction and a second, or opposite, voltage polarity is applied to the motor 3630 to rotate the gear output 3635 in a second, or opposite, direction. The firing rack 3680 and the firing rod 2690 are driven distally when the motor 3630 is operated in the first direction and retracted proximally when the motor 3630 is operated in the second direction.

[0156] Further to the above, the stapling instrument 3000 comprises a control circuit including a firing actuator 2120 comprising a firing actuation switch 2125 that, when actuated, closes a sub-circuit that applies the first voltage polarity to the motor 3630 to advance the firing rack 3670 through a closure stroke to close the end effector 1400. The stapling instrument 3000 further comprises an end-of-closure-stroke switch that is opened when the firing rack 3680 reaches the end of the closure stroke to stop the electric motor 3630. The stapling instrument 3000 also comprises a second, or reverse, actuation switch that, when actuated, closes a sub-circuit that applies the second voltage polarity to the motor 3630 to retract the firing rack 3680 and the firing rod 2690 and open the end effector 1400. Once the end effector 1400 is closed and the clinician is satisfied with the position of the end effector 1400 on the patient tissue, the clinician can depress a mode switch of the control circuit that, when depressed, re-closes the end-of-closure-stroke switch such that the motor 3630 is responsive to the firing actuator switch 2125 once again. When the firing actuator 2120 is re-actuated by the clinician, at such point, the motor 3630 is operated in the first direction once again to advance the firing rack 3680 and the firing rod 2690 distally to perform the staple firing stroke. The stapling instrument 3000 further comprises an end-of-firing-stroke switch that is opened when the firing rack 3680 reaches the end of the staple firing stroke to stop the electric motor 3630. To retract the firing rack 3680 and the firing rod 2690 back into their unfired position, the clinician can depress the reverse actuation switch to apply the opposite voltage polarity to the electric motor 3630.

[0157] As discussed above, the motor 3630 is responsive to the actuation switch 2125 of the firing actuator 2120 being closed. FIG. 12A depicts a staple firing circuit 3620

including the actuation switch 2125 and the motor 3630 with the actuation switch 2125 being in a closed, or actuated, condition. The control circuit 3620 further comprises a clamp, or end-of-closure-stroke, switch 2770 and an end-of-firing-stroke switch 2750. When the end effector 1400 is in an open, or unclamped, configuration, as illustrated in FIG. 12B, the clamp switch 2770 is in an open condition thereby decoupling the battery 2640 from the electric motor 3630 and preventing the staple firing stroke from being performed even if the actuation switch 2125 is closed, or actuated, by the clinician. When the end effector 1400 is in a closed, or clamped, configuration, the clamp switch 2770 is closed. The end-of-firing-stroke switch 2750 is in a normally-closed condition and is opened by the firing drive at the end of the staple firing stroke, as discussed above, which opens the firing circuit to stop the electric motor 3630.

[0158] In various alternative embodiments, the motor 3630 is operated in a first direction in response to the firing actuator 2120 being actuated to perform the staple firing stroke. The motor 3630 continues to turn so long as the firing actuator 2120 is depressed and the firing rack 3680 is driven distally until the teeth 3682 of the firing rack 3680 run off the drive gear 3655. At such point, the staple firing stroke is complete and the firing rack 3680 is no longer advanced distally by the motor 3630 even though the firing actuator 2120 is depressed. To reset the staple firing system, the firing actuator 2120 is released and the retraction handle 1710 is pulled proximally to retract the firing rack 3680 and the firing rod 2690 back into their unfired positions. In such instances, pulling the firing rack 3680 proximally will, absent other considerations, backdrive the motor 3630. In at least one embodiment, the drive gear 3655 can be biased out of engagement with the firing rack 3680 as the firing rack 3680 is retracted proximally and then re-engaged with the firing rack 3680 after the firing rack 3680 has been returned to its proximal unfired position. In at least one embodiment, the handle of the surgical instrument comprises an actuator, such as a toggle switch, for example, that is actuated to disengage the drive gear 3655 from the firing rack 3680 before the retraction stroke of the firing rack 3680 and then switched back after the retraction stroke of the firing rack 3680 is completed.

[0159] In various embodiments, a surgical stapling instrument comprises an actuator including an actuator switch and an electric motor 3630 operated by the actuator which

drives the firing rack 3680 distally from a proximal unfired position when the actuator switch is closed. The stapling instrument further comprises an end-of-stroke switch which, when opened by the firing rack 3680 at the end of the staple firing stroke, automatically reverses the operation of the electric motor 3630 to retract the firing rack 3680 proximally. The stapling instrument further comprises a beginning-of-stroke switch which is opened by the firing rack 3680 when the firing rack 3680 is returned to its proximal unfired position to stop the electric motor 3630. In various alternative embodiments, the switch logic of such a stapling instrument can comprise one or more normally-open switches instead of a normally-closed switch. In any event, the staple firing stroke is stopped when the actuator is released by the clinician. If the clinician desires to return the firing rack 3680 back into its proximal unfired position without finishing the staple firing stroke, the clinician can retract the firing rack 3680 proximally by the retraction handle 1710.

[0160] In various embodiments, referring to FIG. 10, a stapling instrument can comprise a control circuit 2620". The control circuit 2620" comprises a double pole, double throw momentary switch 2730" configured to control the operation of the motor 2630. The momentary switch 2730" comprises a mom-off-mom switch that is switchable from an off state to a first on-state and a second-on state, but any suitable switch could be used. In the first on-state of the momentary switch 2730", a first voltage polarity is applied to the motor 2630 from the battery 2640 which advances the firing rack 2680 distally. In the second on-state of the momentary switch 2730", a second, or opposite, voltage polarity is applied to the motor 2630 from the battery 2640 which retracts the firing rack 2680 proximally.

[0161] A control circuit 2620'", which is similar to the control circuit 2620" in many respects, is illustrated in FIG. 11. In addition to the above, the control circuit 2620'" further comprises a normally-closed end-of-firing-stroke switch 2750'" which is opened by the firing rack 2680 when the firing rack 2680 reaches the end of the staple firing stroke. In such instances, further to the above, the power supplied to the motor 2630 from the battery 2640 is disconnected at the end of the staple firing stroke. At such point, the motor 2630 is no longer responsive to the first on-state of the momentary switch 2730". That said, the motor 2630 is responsive to the second on-state of the

momentary switch 2730". In order to retract the firing rack 2680 back into its unactuated position, the clinician must close the second on-state of the momentary switch 2730" to operate the motor 2630 in reverse. Notably, the control circuit 2620"" further comprises a normally-closed switch 2740"" that is opened when the firing rack 2680 has been fully retracted. When the switch 2740"" is opened by the firing rack 2680, the circuit connecting the motor 2630 to the battery 2640 is opened and the motor 2630 is no longer responsive to the second on-state of the momentary switch 2730".

[0162] In various instances, further to the above, the switch 2750"" is resettable so that the stapling instrument can be used to perform a second staple firing stroke after the spent staple cartridge in the end effector 1400 has been replaced with an unspent staple cartridge. In at least one embodiment, the switch 2750"" is manually reset. In at least one embodiment, the switch 2750"" comprises a biasing element, or feature, configured to automatically reset the switch 2750"" when the firing rack 2680 is retracted. In embodiments including a microprocessor, the switch 2750"" can be electronically reset. In at least one embodiment, seating an unspent staple cartridge in the end effector 1400 can be sensed by the microprocessor which then resets the switch 2750"". Similarly, the switch 2740"" is resettable so that the firing rack 2680 can be retracted by the motor 2630 after the second staple firing stroke. In at least one embodiment, the switch 2740"" is manually reset. In at least one embodiment, the switch 2740"" comprises a biasing element, or feature, configured to automatically reset the switch 2740"" when the firing rack 2680 is advanced distally to perform the second staple firing stroke. In embodiments including a microprocessor, the switch 2740"" can be electronically reset. In at least one embodiment, seating an unspent staple cartridge in the end effector 1400 can be sensed by the microprocessor which then resets the switch 2740"".

[0163] A firing drive including a ratcheting solenoid mechanism is illustrated in FIGS. 13 and 13A. The firing drive comprises a solenoid 4630 including a linear actuator 4635 which is moved proximally and distally by the solenoid 4630, depending on the voltage polarity applied to the solenoid 4630. When a first voltage polarity is applied to the solenoid, the linear actuator 4635 is advanced distally. Notably, the linear actuator 4635 comprises a slot and a pawl element 4632 movably seated within the slot which is

biased into engagement with the firing rack 2680 by a biasing element, such as a spring 4634, for example, contained in the linear actuator 4635. When the linear actuator 4635 is advanced distally, the pawl element 4632 is engaged with the pawl teeth 2682 defined in the bottom of the firing rack 2680 which drives the firing rack 2680 distally. At the end of the actuation stroke of the solenoid 4630, a second, or opposite, voltage polarity is applied to the solenoid 4630 to retract the linear actuator 4635 proximally. In such instances, the pawl element 4632 can slide relative to the pawl teeth 2682 defined in the firing rack 2680. Once the linear actuator 4635 has been retracted, the first voltage polarity can be applied to the solenoid once again to perform another actuation stroke. This process can be repeated until the closing stroke and/or staple firing stroke has been completed. In various instances, further to the above, the first actuation stroke of the linear actuator 4635 closes the end effector 1400 and the second actuation stroke, and any subsequent actuation strokes, fire the staples from the staple cartridge, for example.

[0164] In various embodiments, a surgical stapling instrument can comprise an electric motor including a rotatable output, a drive gear operably engaged with the rotatable output, and a pawl pivotably mounted to the drive gear. The pawl is engaged with a longitudinal rack of ratchet teeth defined on a firing rack and is configured to drive the firing rack distally when the drive gear is rotated in a first direction and slide relative to the firing rack when the drive gear is rotated in an opposite direction. To advance the firing rack through a staple firing stroke, the voltage polarity applied to the electric motor is repeatedly flipped between a positive polarity and a negative polarity to drive the gear back and forth within a drive range that is less than a full rotation of the drive gear.

[0165] A surgical stapling instrument 5000 including a handle 5100 and a firing drive 5600 is illustrated in FIGS. 14-18. The stapling instrument 5000 is similar to the stapling instruments 1000 and 2000 and other stapling instrument disclosed herein in many respects, most of which will not be discussed herein for the sake of brevity. The firing drive 5600 comprises an electric motor 5630 including a helical gear output 5635 meshingly engaged with a rack of teeth 5655 defined on a slideable rack 5650. When a first polarity is applied to the motor 5630 owing to the actuation of a firing actuator 5120, the motor 5630 is rotated in a first direction which drives the rack 5650 from an

unactuated position (FIG. 14) to an actuated position (FIG. 15). Similar to the above, the stapling instrument 5000 comprises an end-of-actuation sensor 2750 which changes state in response to the rack 5650 reaching its fully-actuated position to stop the motor 5630. The firing drive 5600 further comprises a drive crank 5660 pivotably mounted to the handle 5100 about one of a first pivot 5722 and a second pivot 5724, as discussed further below. The drive crank 5660 is coupled to the rack 5650 at a connection which allows the rack 5650 to drive the drive crank 5660 about its pivot and, at the same time, permit the drive crank 5660 to rotate relative to the rack 5650. In at least one instance, the drive crank 5660 comprises a pin 5661 which extends into a pin slot 5651 defined in the rack 5650 which permits such relative motion therebetween. The firing drive 5600 further comprises a pawl 5670 rotatably supported in a seat defined in the opposite end of the drive crank 5660 about a pawl pin 5675. The firing drive 5600 also comprises a firing rack 5680 which is slid distally by the pawl 5670, as discussed below.

[0166] Further to the above, the pawl 5670 comprises two drive teeth - a closure tooth 5674 and a staple firing tooth 5672. The closure tooth 5674 is in an extended position (FIGS. 14 and 15) during the initial actuation of the firing drive 5600 and a retracted position (FIGS. 16-18) after the initial actuation. When the closure tooth 5674 is in its extended position, referring to FIG. 14, the closure tooth 5674 extends into a closure drive aperture 5684 defined in the firing rack 5680 and, when the pawl 5670 is advanced distally during the initial actuation, referring to FIG. 15, the closure tooth 5674 pushes the firing rack 5680 and the firing rod 2690 distally through a closure stroke to close the end effector 1400. At such point, the electric motor 5630 is operated in a second, or opposite, direction to drive the rack 5650 back into its unactuated position, as illustrated in FIG. 16. Similar to the above, the stapling instrument 5000 comprises a beginning-of-actuation sensor 2740 which changes state in response to the rack 5650 reaching its fully-retracted position to stop the motor 5630. Notably, the closure tooth 5674 is in its retracted position when the pawl 5670 is reset by the rack 5650. In this embodiment, the closure tooth 5674 is pivotably coupled to the pawl 5670 and, when the pawl 5670 is retracted proximally after the initial actuation, the closure tooth 5674 contacts a backwall of the closure drive aperture 5684 and is rotated, or flipped, downwardly into its retracted position. In various alternative embodiments, a pawl tooth

actuator in communication with a controller of the surgical instrument 5000 controls the position of the closure tooth 5674.

[0167] Referring again to FIG. 14, the drive crank 5660 further comprises a plate 5655 mounted thereto. The plate 5655 is mounted to the drive crank 5660 such that the plate 5655 rotates with the drive crank 5660. The firing drive 5600 further comprises a retraction spring 5685 - coupled to the plate 5655 and the frame of the handle 5100 - which resiliently stretches when the drive crank 5660 is rotated distally to drive the pawl 5670 through an actuation stroke. At the end of the actuation stroke, as discussed above, an end-of-actuation switch is opened and power is no longer supplied to the motor 5630. As also discussed above, an opposite polarity can be applied to the motor 5630 to drive the drive crank 5660 and the pawl 5670 proximally after the actuation stroke. That said, the retraction spring 5685 can resiliently contract to pull the drive crank 5660 and pawl 5670 proximally after the actuation stroke without the motor 5630 being operated in reverse. In such instances, the proximal movement, or retraction, of the drive crank 5660 and the pawl 5670 can be limited by a physical stop in the handle 5100. In any event, the motor 5630 can be actuated a second time to advance the drive crank 5660 and pawl 5670 distally once again. During the second actuation, however, the closure tooth 5674 is in its retracted position and not engaged with the firing rack 5680. Instead, referring to FIG. 17, the staple firing tooth 5672 of the pawl 5670 is engaged with the ratchet teeth 5682 defined on the bottom of the firing rack 5680. Thus, during the second actuation, the pawl 5670 drives the firing rack 5680 distally via the staple firing tooth 5672 to eject staples from the staple cartridge. The reciprocation of the pawl 5670 can be repeated until all of the staples from the staple cartridge have been ejected. In various embodiments, two actuations, or reciprocations, of the pawl 5670 eject all of the staples while, in other embodiments, all of the staples of the staple cartridge are ejected as a result of four actuations of the pawl 5670, for example. In various embodiments, a separate actuation of the firing actuator 5120 is required to perform each actuation of the firing drive 5600. In other embodiments, a first actuation of the firing actuator 5120 performs the initial, or closure, actuation while a second actuation of the firing actuator 5120 performs all of the staple firing actuations sequentially unless the firing actuator 5120 is released.

[0168] Further to the above, the stapling instrument 5000 transitions between from an end effector closure mode to a staple firing mode between the first, or closure, actuation of the motor 5630 and the second, or staple firing, actuation of the motor 5630. Further to the above, the stapling instrument 5000 comprises a mode switch which must be depressed by a clinician after the closure actuation to place the stapling instrument 5000 in the staple firing mode such that the stapling instrument is responsive to a second actuation of the firing actuator 5120 to perform the staple firing actuation. If the clinician does not depress the mode switch after the closure actuation, the motor 5630 is not responsive to the second actuation of the firing actuator 5120. The stapling instrument 5000 further comprises a controller, such as a processor, for example, in communication with the switches and/or sensors of the stapling instrument 5000.

[0169] The stapling instrument 5000 also comprises a status indicator array 5800 in communication with the processor. The status indicator array 5800 comprises a first indicator 5810, a second status indicator 5820, and a third status indicator 5830, but could comprise any suitable number of indicators. Each status indicator 5810, 5820, and 5830 comprises a light emitting diode (LED), for example, in communication with the processor. In at least one embodiment, the stapling instrument 5000 comprises a sensor configured to detect the presence of an unspent staple cartridge in the end effector 1400 in communication with the processor. If an unspent staple cartridge seated in the end effector 1400 is detected by the processor, the processor applies a voltage potential to the first status indicator 5810 to illuminate the first status indicator 5810. If an unspent staple cartridge is not detected by the processor, the processor does not apply a voltage potential to the first status indicator 5810. In at least one embodiment, the stapling instrument 5000 can comprise a sensor in communication with the processor which is configured to detect the attachment of a loading unit 1300 to the stapling instrument. If a loading unit 1300 is detected by the sensor, the processor applies a voltage potential to the second status indicator 5820 to illuminate the second status indicator 5820. If a loading unit 1300 is not detected by the sensor, the processor does not apply a voltage potential to the second status indicator 5820.

[0170] Further to the above, the stapling instrument 5000 further comprises a sensor configured to detect the closure of the end effector 1400 in communication with the

processor. If the processor determines that the end effector 1400 is closed, or at least sufficiently closed, the processor applies a voltage potential to the third status indicator 5830 to illuminate the third status indicator 5830. If the processor determines that the end effector 1400 is open, the processor does not apply a voltage potential to the third status indicator 5830. In addition, the mode switch is in communication with the processor and the processor is configured to determine whether or not the mode switch has been depressed. If the processor determines that the mode switch has been depressed, the processor applies a voltage potential to a fourth status indicator to illuminate the fourth status indicator. If the processor does not determine that the mode switch has been depressed, the processor does not apply a voltage potential to the fourth status indicator.

[0171] When the stapling instrument 5000 is in its end effector closure mode (FIGS. 14 and 15), the drive crank 5660 is rotatable about the first pivot 5722. When the stapling instrument 5000 is in its staple firing mode (FIGS. 17 and 18), the drive crank 5660 is instead rotatable about the second pivot 5724. The first pivot 5722 comprises a first pin that extends into a first pin aperture defined in the drive crank 5660 when the mode switch is in an unactuated position. Notably, the second pivot 5724 is not engaged with the drive crank 5660 when the mode switch is in the unactuated position. The second pivot 5724 comprises a second pin that extends into a second pin aperture defined in the drive crank 5660 when the mode switch is in an actuated position. Notably, the first pivot 5722 is not engaged with the drive crank 5660 when the mode switch is in the actuated position. In at least one embodiment, the mode switch comprises a rocker switch having two positions - a first position in which the first pivot 5722 is engaged with the drive crank 5660 and a second position in which the second pivot 5724 is engaged with the drive crank 5660. In at least one embodiment, the mode switch is in communication with a first solenoid and a second solenoid. When the mode switch is in its first position, the first solenoid is actuated to extend the first pin and, when the mode switch is in its second position, the second solenoid is actuated to extend the second pin.

[0172] When the mode switch is in its first position and the stapling instrument 5000 is in its end effector closure mode, referring to FIG. 15, the drive crank 5660 defines two

torque arms about the first pivot 5722. More specifically, a first torque arm D1 is defined between the pin 5661 and the first pivot 5722 and a second torque arm L1 is defined between the first pivot 5722 and the pawl pin 5675. Notably, the first torque arm D1 is longer than the second torque arm L1. When the mode switch is in its second position and the stapling instrument 5000 is in its staple firing mode, referring to FIG. 17, the drive crank 5660 defines two torque arms about the second pivot 5724. More specifically, a first torque arm D2 is defined between the pin 5661 and the second pivot 5724 and a second torque arm L2 is defined between the second pivot 5724 and the pawl pin 5675. Notably, the first torque arm D1 is longer than the second torque arm D2. Also, notably, the torque arm L2 is longer than the torque arm L1. As a result of the above, the staple-firing actuations of the pawl 5670 and the firing rack 5680 are longer than the end effector closing actuation of the pawl 5670 and the firing rack 5680. Such an arrangement is useful as a short closure actuation allows the end effector 1400 to be closed quickly and longer staple firing actuations may reduce the number of pawl reciprocations that are needed to complete the entire staple firing stroke.

[0173] Further to the above, referring to FIG. 16, the stapling instrument 5000 is switched from its closure mode to its staple firing mode after the closure actuation has been completed but before the driver crank 5660 and the pawl 5670 are retracted. In this position, the first pin aperture in the drive crank 5660 is aligned with the first pivot 5722 and the second pin aperture in the drive crank 5660 is aligned with the second pivot 5724. As a result, this particular position of the drive crank 5660 can be used to switch from the first pivot 5722 to the second pivot 5724 and, likewise, from the second pivot 5724 back to the first pivot 5722. That said, any other suitable position of the drive crank 5660 can be used to switch between the first pivot and the second pivot in other embodiments. In at least one embodiment, the mode switch is in communication with the control system of the stapling instrument 5000 and the control system is not responsive to the mode switch until after the closure stroke has been completed. That said, various other embodiments are envisioned in which the stapling instrument 5000 is switchable from a first state to a second state between any two actuations of the stapling instrument 5000. In such embodiments, for instance, the controller can switch the stapling instrument 5000 from a first, or low, leverage state to a second, or high,

leverage state in which a larger drive force is transmitted to the firing rack 5680 during a subsequent actuation than during a previous actuation. In at least one such embodiment, the clinician can sense that the force being transmitted to the staple firing member is high and then selectively actuate an actuator in communication with the controller which, in response, stops the reciprocation of the driver crank 5660 and the pawl 5670 in the transition position and switches the stapling instrument from the first state to the second state. Once the stapling instrument has been switched into its second state by the controller, the controller is responsive to the firing actuator 5120 to finish the staple firing stroke.

[0174] In various embodiments, further to the above, the controller of a stapling instrument is configured to automatically switch the stapling instrument from a first state to a second state between the pawl reciprocations of a staple firing stroke. In at least one such embodiment, the controller comprises a sensing system configured to sense the force being transmitted through the firing rack 5680 to the firing rod 5690 and the firing member 1390 which is configured to switch the stapling instrument from the first state to the second state when the force exceeds a predetermined force threshold. In at least one embodiment, the sensing system comprises a load cell sensor configured to directly measure the force being transmitted through the firing rack 5680. In at least one embodiment, the sensing system comprises a strain gauge mounted to the firing rack 5680 configured to measure the strain in the firing rack 5680 which is a proxy for the force being transmitted through the firing rack 5680. In such instances, the sensing system switches the stapling instrument from the first state to the second state when the measured strain exceeds a predetermined strain threshold. In at least one embodiment the sensing system comprises a current sensor configured to measure the current through the electric motor 5630 which is a proxy for the force being transmitted through the firing rack 5680. In such instances, the sensing system switches the stapling instrument from the first state to the second state when the measured current exceeds a predetermined current threshold. In any event, in the second state of the stapling instrument, the stapling instrument transmits a larger firing load to the firing rack 5680 for the remainder of the staple firing stroke. In various embodiments, the controller is configured to switch the stapling instrument back into the first state when the sensed

firing load, or a sensed parameter related to the firing load, falls below the corresponding threshold.

[0175] In various embodiments, referring to FIG. 19, a firing drive of a stapling instrument can comprise a transmission including a high speed, low torque gear or gear set (a “high speed gear H”) and a low speed, high torque gear or gear set (a “low speed gear L”). In at least one such embodiment, the low speed gear L comprises a first low speed gear L1 and the stapling instrument further comprises a second low speed gear L2. The second low speed gear L2 is slower than the first low speed gear L1 and has a higher torque than the first low speed gear L1. That said, a transmission can comprise any suitable number of gears or gear sets. In use, the stapling instrument shifts between the high speed gear H, the first low speed gear L1, and the second low speed gear L2. The transmission comprises an automatic transmission configured to shift from the high speed gear H to the first low speed gear L1 when the force transmitted through the firing drive exceeds a first force threshold F1. The automatic transmission is also configured to shift from the first low speed gear L1 to the second low speed gear L2 when the force transmitted through the firing drive exceeds a second force threshold F2. FIG. 19 comprises a graph 5200 describing the operational steps of the stapling instrument and the transmission shifting during those operational steps, as described further below.

[0176] At step 5205, further to the above, the firing trigger of the stapling instrument is closed to clamp the end effector. Neither force threshold F1 nor force threshold F2 are exceeded during step 5205 and, as a result, the transmission remains in its high speed gear H. If the force threshold F1 had been exceeded during step 5205, the transmission would have shifted from the high speed gear H to the first low speed gear L1. If the force threshold F2 had been exceeded during step 5205, the transmission would have shifted to the second low speed gear L2. At step 5210, the motor is operated in reverse and the end effector is unclamped. During step 5210, the force threshold F1 was exceeded and the transmission shifted from the high speed gear H to the first low speed gear L1. Notably, the force threshold F2 was not exceeded during step 5210 and, thus, the transmission did not shift into the second low speed gear L2. If the force threshold F2 had been exceeded during step 5210, then the transmission

would have shifted into the second low speed gear L2. During step 5215, the end effector is re-closed. Notably, the step 5215 is operationally similar to the step 5205; however, the step 5215 may be operationally different owing to changes in the fluid content of the tissue being clamped. Also, notably, the operation of the surgical instrument does not require steps 5210 and 5215. Instead, steps 5210 and 5215 can be skipped and the operation of the surgical instrument can skip from step 5205 to step 5220 which comprises shifting the stapling instrument from the end effector closure mode to the staple firing mode, which is discussed below.

[0177] Once step 5220 is complete, further to the above, the staple firing stroke can be initiated which is represented by step 5225. During the staple firing stroke, the firing force can fluctuate greatly. At step 5225, the firing force has exceeded the force threshold F1, but not the force threshold F2. As such, the transmission is in the first low speed gear L1 at the outset of the staple firing stroke. At step 5230, the firing force has exceeded the force threshold F2 and, as a result, the transmission is in the second low speed gear L2. The firing force can increase as the result of the tissue cutting knife of the firing member and/or the staples passing through tough, dense, and/or thick tissue, for example, during the staple firing stroke. At step 5235, the firing force fell back below the force threshold F2 but remained above the force threshold F1 and, as a result, the transmission shifted into the first low speed gear L1. Had the firing force fallen back below the force threshold F1, the transmission would have shifted in the high speed gear H, as it did during step 5240 which is at the end of the staple firing stroke. That said, the firing force may not always drop below the force threshold F1 at the end of the staple firing stroke and, in such instances, the transmission would not shift into the high speed gear H. In fact, it's possible for the firing force to exceed the force threshold F2 at the end of the staple firing stroke which would cause the transmission to shift into the second low gear L2. That said, embodiments are envisioned in which the controller of the stapling instrument holds the transmission in a particular gear during a particular part of the staple firing stroke. For instance, embodiments are envisioned in which the firing drive moves slowly during the beginning and/or end of the staple firing stroke resulting in a "soft start" and/or "soft stop" to the staple firing stroke. In such embodiments, the stapling instrument may be in the first low speed gear L1 or the

second low speed gear L2 at the beginning and/or end of the firing stroke regardless of the measured firing force. In any event, the tissue cutting knife is retracted after the staple firing stroke has been completed such that the end effector can be re-opened which is represented by step 5250. Notably, the transmission is in the first low speed gear L1 during step 5250 despite the fact that there is very little force being transmitted through the firing drive. Similar to the above, in this embodiment, the stapling instrument controller can hold the transmission in the first low speed gear L1, for example, when the tissue cutting knife is being retracted. The entire disclosures of U.S. Patent No. 9,028,529, entitled MOTORIZED SURGICAL INSTRUMENT, which issued on May 12, 2015 and U.S. Patent No. 8,602,287, entitled MOTOR DRIVEN SURGICAL CUTTING INSTRUMENT, which issued on December 10, 2013 are incorporated by reference herein.

[0178] As discussed above, a stapling instrument can comprise a shifting device to increase the firing force being transmitted through a firing drive. In some instances, though, the increased firing force may exceed the strength of one or more components in the firing drive. In various embodiments, a firing drive can comprise a slip clutch to limit the force transmitted by the firing drive. One such stapling instrument, i.e., stapling instrument 6000, is illustrated in FIG. 20. The stapling instrument 6000 is similar to the stapling instruments 1000 and 2000 and other stapling instruments disclosed herein in many respects, most of which will not be discussed herein for the sake of brevity. The stapling instrument 6000 comprises a handle 6100, a firing drive 6600, and a controller 6800. The handle 6000 comprises a grip 6110 and a rotatable firing trigger 6120. The firing drive 6600 comprises a motor 6630, a gear train 6650 operably engaged with the motor 6630, a slip clutch 6670 operably engaged with a drive gear 6654 of the gear train 6650, a firing rack 6680 operably engaged with the slip clutch 6670, and a firing rod 6690 mounted to and translatable with the firing rack 6680. The controller 6800 is in communication with the motor 6630, a battery 2640, and a firing trigger switch 6125 which is closed by the firing trigger 6120 when the firing trigger 6120 is actuated. When the controller 6800 detects that the firing trigger switch 6125 has been closed, the controller 6800 supplies power to the electric motor 6630 from the battery 2640.

[0179] Further to the above, referring to FIG. 20A, the slip clutch 6670 comprises an input gear 6674 including a full circumference of gear teeth (not illustrated) operably engaged with the drive gear 6654 of the gear train 6650. The slip clutch 6670 further comprises an output gear 6672 operably engaged with a longitudinal array of teeth 6682 defined on the bottom of the firing rack 6680. The slip clutch 6670 further comprises a shaft 6676 and a bearing 6675 which rotatably supports the shaft 6676. The input gear 6674 is fixedly mounted to the shaft 6676 such that the rotation of the input gear 6674 is transmitted to the shaft 6676. The slip clutch 6670 further comprises an array of annular clutch plates 6678 mounted to the shaft 6676 and an array of annular friction plates 6679 mounted to the output gear 6672 which are engaged with the clutch plates 6678. When the static friction threshold between the clutch plates 6678 and the friction plates 6679 is not exceeded, the output gear 6672 rotates with the shaft 6676 and the input gear 6674. On the other hand, the clutch plates 6678, the shaft 6676, and the input gear 6674 slip relative to the friction plates 6679 and the output gear 6672 when the static friction threshold between the clutch plates 6678 and the friction plates 6679 has been exceeded. As a result, the firing force that can be transmitted to the firing rack 6680 is limited by the slip clutch 6670.

[0180] Further to the above, a surgical stapling instrument can comprise any suitable force limiting device to prevent the staple firing drive from being overloaded. In at least one such embodiment the bottom of the firing rack comprises a rough surface and the gear drive comprises a friction wheel including a grit perimeter in contact with the rough surface. When the force transmitted from the friction wheel to the firing rack is below the static friction threshold, the friction wheel drives the firing rack proximally or distally depending on the direction in which the friction wheel is rotated. When the force transmitted from the friction wheel to the firing rack exceeds the static friction threshold, the friction wheel slips relative to the firing rack and does not drive the firing rack.

[0181] A stapling instrument 7000 is illustrated in FIG. 21 and is similar to the stapling instruments 1000 and 2000 and other stapling instruments disclosed herein in many respects, most of which are not discussed herein for the sake of brevity. The stapling instrument 7000 comprises a handle 7100 and a firing drive 7600. The firing drive 7600 comprises an electric motor 7630, a gear train 7650, a firing rack 7680, and a firing rod

7690 mounted to the firing rack 7680. The gear train 7650 comprises a planetary gear arrangement 7654 operably coupled to an output of the electric motor 7630 and a drive gear 7652 which operably couples the planetary gear arrangement 7654 to the firing rack 7680. The motor 7630 is operated in a first direction when a first voltage potential is supplied to the motor 7630 from a battery 2640 in response to an actuation of a firing actuator 6120. In such instances, the gear train 7650 drives the firing rack 7680 and firing rod 7690 distally. The motor 7630 is operated in an opposite direction when an opposite polarity is applied to the motor 7630 from the battery 2640. In such instances, the gear train 7650 drives the firing rack 7680 and the firing rod 7690 proximally. In various instances, however, the motor 7630 may fail and/or the battery 2640 may not be able to suitably supply power the motor 7630 to retract the firing rack 7680 and the firing rod 7690. As such, the stapling instrument 7000 further comprises a manually-driven bailout drive 7900 which is operable to retract the firing rack 7680 and firing rod 7690 proximally, as discussed below.

[0182] The bailout drive 7900, referring again to FIG. 21, comprises a bailout lever 7902 rotatably mounted to a housing of the handle 7100 and a bailout rack 7904 coupled to the bailout lever 7902 at a pin joint 7903 which transmits the motion of the bailout lever 7902 to the bailout rack 7904. The bailout rack 7904 comprises an array of teeth 7906 defined thereon which are meshingly engaged with a bailout gear 7656 of the gear drive 7650. When the bailout lever 7902 is in a stowed position, i.e., in a position lying flat against the handle housing, the bailout rack 7904 is not engaged with the bailout gear 7656. In such instances, the bailout gear 7656 rotates relative to the bailout rack 7904 when the gear drive 7650 is driven by the electric motor 7630. When the bailout lever 7902 is moved out of its stowed position, i.e., rotated away from the handle housing, the bailout lever 7902 is rotated into an engaged position in which the bailout rack 7904 is engaged with the bailout gear 7656. At such point, the bailout lever 7902 is rotatably cranked from its engaged position to an actuated position to drive the bailout rack 7904 upwardly and rotate the bailout gear 7656. Notably, the bailout gear 7656 and the planetary gear arrangement 7654 are driven by a common input shaft in the gear train 7650 such that, when the bailout gear 7656 is driven by the rack 7904, the bailout gear 7656 drives the planetary gear arrangement 7654 which drives the firing

rack 7680 and firing rod 7690 proximally. In such instances, the tissue cutting knife in the end effector 1400 is retracted proximally such that the end effector 1400 can be opened and released from the patient tissue. In various embodiments, a single actuation of the bailout lever 7902 sufficiently opens the end effector 1400. In other embodiments, the bailout lever 7902 is ratcheted back and forth to sufficiently retract the tissue cutting knife. In at least one embodiment, the rack teeth 7906 comprise ratchet teeth which slide over the bailout gear 7656 when the bailout rack 7904 is retracted. In at least one embodiment, the rack 7680 lifts away from the bailout gear 7656 when the bailout lever 7656 is rotated from its actuated position back into its engaged position and then re-engages with the bailout gear 7656 when the bailout 7656 is re-actuated. In at least one embodiment, the rack teeth 7906 comprise gear teeth which are operably intermeshed with the teeth of the bailout gear 7656 and, in this embodiment, the bailout gear 7656 comprises a ratchet face engaged with the input shaft extending into the planetary gear arrangement 7654. As a result of the ratchet face being driveable in only one direction, the bailout gear 7656 is not driven by the electric motor 7630 but is driveable by the bailout drive. In any event, the actuation of the bailout drive 7900 does not destroy the firing drive 7600 and, as a result, the stapling instrument 7000 can be used once again once the issue that required the bailout drive 7900 to be used is resolved.

[0183] In various embodiments, a stapling instrument can comprise a firing drive configured to advance and retract a firing rack and bailout drive configured to retract the firing rack. In at least one such embodiment, the firing drive comprises a firing gear drive operably engaged with the firing rack which drives and/or retracts the firing rack in response to a rotational input. The bailout drive comprises a bailout gear drive which is selectively engageable with the firing drive. More specifically, the stapling instrument comprises a shiftable gear which is shiftable between a first position in which the

[0184] A stapling instrument 5000' is illustrated in FIG. 22 and is similar to the stapling instruments 1000 and 5000 and other stapling instruments disclosed herein in many respects, most of which will not be discussed herein for the sake of brevity. The stapling instrument 5000' comprises a handle 5100' including a firing drive 5600' which includes the motor 5630 powered by the battery 2640, the rack 5650 which is driven by

the motor 5630, and the drive crank 5660 which is driven by the rack 5650. The firing drive 5600' is operated in a similar manner to that of the firing drive 5600, but the firing drive 5600' further comprises a pawl 5670' instead of the pawl 5670 and a firing rack 5680' instead of a firing rack 5680. Unlike the pawl 5670, the pawl 5670' comprises a single drive tooth 5672' which engages a longitudinal array of ratchet teeth 5682' defined on the bottom of the firing rack 5680' to drive the firing rack 5680' distally during every actuation, or reciprocation, of the pawl 5670'.

[0185] Further to the above, the stapling instrument 5000' further comprises a control system including an indicator array 5800' configured to indicate the status of the stapling instrument 5000'. The indicator array 5800' comprises four indicator lights 5810, 5820, 5830, and 5840, but could comprise any suitable number of indicator lights. The control system further comprises a proximal switch 2740' and a distal switch 2750'. When the firing rack 5680' is in its proximal-most, unactuated, position (FIG. 22), the firing rack 5680' is in contact with the proximal switch 2740' which holds the proximal switch 2740' in an open state. The stapling instrument 5000' further comprises a mode switch 5720' in communication with the indicator array 5800' that is switchable between a first position to place the stapling instrument 5000' in an end effector closure mode and a second position to place the stapling instrument 5000' in a staple firing mode. When the mode switch 5720' is in its first position and the firing rack 5680' is in its proximal-most position, referring now to FIG. 22A, the indicator light 5840 is illuminated by the battery 2640. When the firing rack 5680' is advanced distally to perform the closure stroke, the firing rack 5680' disengages from the proximal switch 2740' which allows the proximal switch 2740' to close. In such instances, the indicator light 5840 is no longer illuminated and, instead, the indicator light 5830 is illuminated. This change in the indicator lights indicates to the clinician that the end effector 1400 is closed. Once the mode switch 2740' is shifted to its second position, neither of the indicator lights 5830 and 5840 are illuminated and, instead, the indicator light 5810 is illuminated owing to the distal switch 2750' being in a normally-closed condition. At the end of the staple firing stroke, the firing rack 5680' contacts the distal switch 2750' and opens the distal switch 2750'. In such instances, the indicator light 5810 is no longer illuminated and,

instead, the indicator light 5820 is illuminated. This change in the indicator lights indicates to the clinician that the staple firing stroke has been completed.

[0186] In various embodiments, a surgical stapling instrument comprises a firing drive including an electric motor and a firing rack driven distally by the electric motor to perform a closure stroke and then a staple firing stroke. In at least one embodiment, the firing drive further comprises a closure actuator and a separate firing actuator in communication with a processor of the stapling instrument. When the closure actuator is actuated to close the end effector, the electric motor is rotated in a first direction to drive the firing rack distally. When the end effector is closed, the processor stops the electric motor. That said, the processor is not responsive to an actuation of the firing actuator while the end effector is open. After the end effector has been closed, the processor is no longer responsive to an actuation of the closure actuator. To open the end effector, at such point, the firing rack is retraced proximally when a retraction knob extending from the firing rack is pulled proximally. Once the end effector has been closed, the processor is now responsive to an actuation of the firing actuator to operate the electric motor in the first direction to perform the staple firing stroke. Once the staple firing stroke has been completed, the processor stops the electric motor. Once the electric motor has been stopped - either at the end of the staple firing stroke or before the end of the staple firing stroke - the firing rack can be retracted proximally by the retraction knob to re-open the end effector. In various embodiments, the stapling instrument comprises a retraction actuator in communication with the processor that, when actuated, operates the electric motor in an opposite direction to retract the firing rack and open the end effector.

[0187] In various embodiments, a surgical stapling instrument comprises two firing drives - a manually-driven closure drive and a motor-driven staple firing drive. The manually-driven closure drive comprises a rotatable trigger and a firing rack. The trigger is engaged with the firing rack such that an actuation of the trigger drives the firing rack distally through a closure stroke. When the trigger is rotated into its actuated position, the trigger is releasably held in its actuated position by a trigger lock. If the clinician wants to re-open the end effector, the clinician can release the trigger lock and allow a trigger spring to bias the trigger back into its unactuated position and drive the

firing rack proximally. The motor-driven staple firing drive comprises an electric motor configured to drive the firing rack distally through a staple firing stroke once the firing rack has been moved through the closure stroke. The closure stroke moves the firing rack from a proximal unactuated position in which the firing rack is not operably engaged with the electric motor to an actuated position in which the firing rack is operably engaged with the electric motor. At such point, a firing actuator in communication with the electric motor is actuatable to operate the electric motor to drive the firing rack through the staple firing stroke. In at least one embodiment, the electric motor is controlled by a processor and, prior to the end effector being closed, the processor is not responsive to an actuation of the firing actuator. Once the end effector has been closed, the processor is responsive to the firing actuator. In any event, the closure trigger is disengaged from the firing rack once the end effector has been closed. In such instances, as a result, the staple firing stroke is performed without the closure trigger being operably engaged with the firing rack. Once the staple firing stroke has been completed, the processor automatically operates the electric motor in an opposite direction to retract the firing rack. Alternatively, a retraction knob extending from the firing rack can be pulled proximally to retract the firing rack. When the firing rack is retracted back to the actuated position, i.e., the position between the closure stroke and the staple firing stroke, the firing rack is re-engaged with the closure trigger. Once the firing trigger is re-engaged with the closure trigger, the closure trigger can be released to drive the firing rack back into its unactuated position to re-open the end effector.

[0188] Further to the above, a manually-driven closure system allows the clinician to feel the clamping load being applied to the tissue captured within the end effector via the trigger. If the clamping load is high, for instance, the clinician can feel the force needed to clamp the end effector thereby giving the clinician an intuitive feel of what is occurring in the end effector. That said, the force needed to drive the firing rack distally to fire the staples and cut the tissue is often very high, or at least high enough that some clinicians may struggle to advance the firing rack distally with a manual trigger. A motor-driven staple firing drive can alleviate this issue and make the stapling instrument easy to operate by all clinicians.

[0189] In various embodiments, a surgical stapling instrument comprises a pneumatic firing drive. The firing drive comprises an air pump in communication with an air reservoir configured to store compressed air supplied to the air reservoir from the air pump. The firing drive further comprises a normally-closed valve in communication with the air reservoir and a linear air piston. The linear air piston comprises a firing rod that is moved distally when the valve is opened by a rotatable trigger. The linear air piston further comprises a pawl rotatably mounted to the firing rod. When the firing rod is driven distally, the pawl drives a firing rack of the firing drive distally through an actuation stroke. When the valve is re-closed, the compressed air in the air piston is exhausted through the valve and the firing rod and the pawl are retracted proximally by a compression spring positioned in the linear air piston. In such instances, the pawl slides proximally relative to the firing rack back into an unactuated position. At such point, the valve can be re-opened to drive the pawl and firing rack distally through another actuation stroke. In various instances, the first actuation stroke can comprise a closure stroke to close the end effector and the second actuation stroke can comprise a staple firing stroke. In such instances, the firing drive can be actuated as many times as needed to fire all of the staples from the staple cartridge.

[0190] Referring again to FIG. 1, the loading unit 1300 is removably attachable to the shaft 1200 of the stapling instrument 1000. In various instances, the loading unit 1300 comprises a lock that releasably locks the loading unit 1300 to the shaft 1200. When the stapling instrument 1000 is not positioned in the patient, a clinician can easily move the lock from a locked position to an unlocked position and detach the loading unit 1300 from the shaft 1200. If, however, the loading unit 1300 is positioned in a patient, such as through a trocar or tube, for example, the clinician may not be able to access the lock to disconnect the loading unit 1300 from the shaft 1200. As a result, the options for a clinician to resolve a failure in the stapling instrument 1000 may be limited. Referring to FIG. 23, a stapling instrument 8000 comprises a handle 1100 and a shaft 8200 that is rotatably coupled to the shaft 8200 about a rotation joint positioned within a nozzle grip 8210 of the shaft 8200. Similar to the stapling instrument 1000, the stapling instrument 8000 comprises a loading unit that is releasably attachable to the shaft 8200. The stapling instrument 8000 further comprises a loading unit lock release 8900 which is

configured to unlock the loading unit from the shaft 8200. Notably, the lock release 8900 is supported by the shaft 8200 adjacent the handle 1100. More specifically, the lock release 8900 comprises an actuator 8910 slideably mounted to the nozzle grip 8210 such that a clinician holding the handle 1100 can access the actuator 8910 with the same hand and pull the actuator 8910 proximally. The lock release 8900 further comprises an elongate lock bar 8990 including a first end mounted to the actuator 8910 and a second end releasably engaged with the loading unit lock. When the actuator 8910 is in its unactuated position, the loading unit is locked to the shaft 8200. When the actuator 8910 is slid into its actuated position, the loading unit lock is unlocked and the shaft 8200 can be detached from the loading unit. In at least one embodiment, the loading unit lock is rotatable between a locked position and an unlocked position when the actuator 8910 is moved proximally. The lock release 8900 further comprises a spring configured to bias the actuator 8910 back into its actuated position when the clinician releases the actuator 8910. As a result of the above, a clinician can easily unlock the loading unit from the shaft 8200 to resolve a failure in the stapling instrument 8000, such as when the tissue cutting knife in the loading unit becomes stuck during the staple firing stroke and/or cannot otherwise be retracted.

[0191] As discussed above, a stapling instrument can comprise a loading unit that is removably attached to a shaft of the stapling instrument. A stapling instrument 9000 is illustrated in FIG. 24 and is similar to the stapling instruments 1000, 2000, and 8000 in many respects, most of which will not be discussed herein for the sake of brevity. The stapling instrument 9000 comprises a handle 9100 and a releasable shaft assembly 9200. The shaft assembly 9200 comprises an end effector 1400, an articulation joint 1500, an elongate portion 9230 extending proximally from the articulation joint 1500, and a proximal attachment end 9240 configured to be attached to a rotatable nozzle grip 9210 of the handle 9100. The nozzle grip 9210 comprises a door, or hatch, 9220 that is rotatable from a closed position to an open position. When the door 9220 is in its closed position, a clinician cannot access the interconnection between the proximal attachment end 9240 and the handle 9100. When the door 9220 is in its open position, however, a clinician can access the interconnection between the proximal attachment end 9240 and the handle 9100 and decouple the shaft assembly 9200 from the handle

9100. The shaft assembly 9200 comprises a shaft frame that is disengageable from a frame of the handle 9100. The shaft assembly 9200 further comprises a firing member 9290 that is disengageable from a firing rack in the handle 9100 and an articulation actuator that is disengageable from an articulation input actuator 1510 (FIG. 23) supported on the nozzle grip 9210. When the shaft assembly 9200 is detached from the handle 9100, the clinician can pull on the proximal end of the firing member 9290 to retract the firing member 9290 proximally and open the end effector 1400. Such an arrangement can be particularly useful in situations where the end effector 1400 has been inserted into a patient through a trocar, or tube, and the end effector 1400 is stuck on the patient tissue, for example. In such instances, the firing member 9290 is accessible from outside of the patient and the trocar. The entire disclosure of U.S. Patent No. 7,624,902, entitled SURGICAL STAPLING APPARATUS, which issued on December 1, 2009 is incorporated by reference herein. A linear pull bailout, such as those described herein, for example, is usable with the stapling instruments disclosed in U.S. Patent No. 7,624,902, among others. In any event, the shaft assembly 9200 can be re-assembled to the handle 9100 and re-used once the issue that required the bailout to be used is resolved.

[0192] In various alternative embodiments, referring to FIG. 25, a shaft assembly 9200' comprises a nozzle grip 9210' and an elongate portion 9230' mounted to the nozzle grip 9210' where the nozzle grip 9210' is releasably attachable to a handle. Similar to the handle nozzle grip 9210, the shaft nozzle grip 9210' comprises an openable door, or hatch, 9220 rotatably mounted to the nozzle grip 9210'. When the door 9220 is open, referring primarily to FIG. 25A, the clinician has access to a bailout mechanism 9250' which is actuatable to engage a ratchet pawl 9270' with a longitudinal rack 9280' defined on the proximal end of a firing member 9290' extending through the shaft 9200'. Thus, when the shaft assembly 9200' has been detached from the handle, the clinician can manually drive the firing member 9290' proximally by ratcheting the bailout mechanism 9250' and open the end effector 1400. The shaft assembly 9200' can be re-assembled to the handle and re-used once the issue that required the bailout to be used is resolved.

[0193] A staple cartridge 10900 for use with a stapling instrument is illustrated in FIG. 26. The staple cartridge 10900 comprises a cartridge body 10910 including a proximal end 10912, a distal end, a deck 10913 extending between the proximal end 10912 and the distal end, and longitudinal rows of staple cavities 10920 defined in the deck 10913. The cartridge body 10910 further comprises a longitudinal slot 10914 extending from the proximal end 10912 toward the distal end. The staple cavities 10920 are arranged in three longitudinal rows on each side of the longitudinal slot 10914, although embodiments are envisioned in which the staple cavities 10920 are arranged in two longitudinal rows on each side of the longitudinal slot 10914. That said, the staple cavities 10920 can be arranged in any suitable number of longitudinal rows and/or oriented in any suitable manner. A staple is removably stored in each staple cavity 10920; however, alternative embodiments are envisioned in which a staple is not positioned in each staple cavity 10920. In at least one such embodiment, the outermost rows of staple cavities 10920 do not have a staple in each staple cavity 10920. Such an embodiment may provide a more flexible staple line in the stapled tissue. The cartridge body 10910 further comprises lock supports 10916 and 10918 extending proximally from the proximal end 10912, which are discussed in greater detail further below.

[0194] The staple cartridge 10900 further comprises staple drivers and a sled 10950. The sled 10950 is positioned in the cartridge body 10910 and is movable from a proximal unfired position to a distal fired position by a firing member 10990 during a staple firing stroke. The sled 10950 comprises a center portion 10954 positioned in the longitudinal slot 10914 and ramps 10952 positioned on opposite sides of the central portion 10954. As the sled 10950 is progressed distally by the firing member 10990 during the staple firing stroke, the ramps 10952 contact the staple drivers and drive the staple drivers and the staples toward an anvil of the stapling instrument positioned opposite the staple cartridge 10900. The sled 10950 further comprises lock supports 10956 and 10958 extending proximally therefrom. When the sled 10950 is in its proximal unfired position, referring to FIG. 27, the lock support 10956 of the sled 10950 extends under the lock support 10916 of the cartridge body 10910 and, similarly, the lock support 10958 of the sled 10950 extends under the lock support 10918 of the cartridge body 10910. In such instances, the sled lock supports 10956 and 10958 co-

operate with the cartridge lock supports 10916 and 10918 to hold a firing lockout of the stapling instrument in an unlocked position. More specifically, the firing lockout comprises two lock arms 10980 rotatably mounted to a shaft of the stapling instrument about pivot pins 10982 which are held in an unlocked position by the lock supports 10916, 10918, 10956, and 10958 when the sled 10950 is in its proximal unfired position, as illustrated in FIG. 27. In such instances, the distal ends 10988 of the lock arms 10980 are held in position by the lock supports 10916, 10918, 10956, and 10958 against a biasing force applied to their proximal ends by springs 10985 compressed between the lock arms 10980 and a shaft frame of the stapling instrument. Moreover, each lock arm 10980 further comprises an inwardly-extending lock 10986 that, in such instances, is not engaged with a lock window 10996 defined in the firing member 10990 and, as a result, the firing member 10990 can be moved distally to push the sled 10950 through the staple firing stroke.

[0195] When the sled 10950 is advanced distally during the staple firing stroke, referring to FIG. 28, the sled lock supports 10956 and 10958 are no longer positioned under the cartridge lock supports 10916 and 10918. The cartridge lock supports 10916 and 10918 are not strong enough by themselves to support the lock arms 10980 in their unlocked positions owing to the biasing forces being applied to the proximal ends of the lock arms 10980 by the springs 10985. As such, the cartridge lock supports 10916 and 10918, which comprise cantilevers, deflect downwardly under the load being applied thereto thereby allowing the lock arms 10980 to rotate into the locked positions. Notably, at this point, the firing member 10990 has already been advanced distally, at least partially, and the lock windows 10996 defined in the firing member 10990 are no longer aligned with the inwardly-extending locks 10986 of the lock arms 10980. As such, the distal movement of the firing member 10990 during the rest of the staple firing stroke is unimpeded by the lock arms 10980. When the firing member 10990 is retracted back into its unactuated position after the staple firing stroke, however, the inwardly-extending locks 10986 of the lock arms 10980 swing into the lock windows 10996 of the firing member 10990. In such instances, the lock arms 10980 provide a gate that prevents the firing member 10990 from being advanced distally through another staple firing stroke through the now-spent staple cartridge 10900 positioned in

the cartridge jaw. In order to reset the stapling instrument so that it can be used once again, the spent staple cartridge 10900 must be removed from the cartridge jaw and replaced with another unspent staple cartridge 10900. In such instances, the lock arms 10980 are rotated back into their unlocked positions by the lock supports 10916, 10918, 10956, and 10958 of the new, or unspent, staple cartridge 10900. The reader should appreciate that this lockout system serves as both a spent cartridge lockout and as a missing cartridge lockout. The entire disclosure of U.S. Patent No. 9,566,064, entitled SURGICAL STAPLING APPARATUS, which issued on February 14, 2017 is incorporated by reference herein.

[0196] Further to the above, the sled lock supports 10956 and 10958 are in contact with the cartridge lock supports 10916 and 10918 when the sled 10950 is in its proximal unfired position. In such instances, the cartridge lock supports 10916 and 10918 releasably hold the sled 10950 in its proximal unfired position until the sled 10950 is pushed distally by the firing member 10990 owing to frictional resistance between the cartridge lock supports 10916 and 10918 and the sled lock supports 10956 and 10958, respectively. Such an arrangement can prevent, or at least inhibit, the sled 10950 from being moved distally accidentally prior to the staple firing stroke.

[0197] In various embodiments, further to the above, the lock arms 10980 can also serve as a closure lockout. More specifically, as discussed above, the firing member 10990 is advanceable distally to close the end effector of the surgical instrument and then advanceable distally again to perform a staple firing stroke. If the firing member 10990 is not unlocked by the staple cartridge 10900 as discussed above, then the lock arms 10980 would be engaged with the firing member 10990 at the outset of the closure stroke and, as a result, the firing member 10990 would not be advanceable distally to close the end effector. In various alternative embodiments, the lock windows 10996 defined in the firing member 10990 are sized and configured to permit the firing member 10990 to move distally far enough to close the end effector even if the lock arms 10980 have not been moved into their unlocked positions by an unfired staple cartridge 10900. In such embodiments, referring to FIGS. 26B and 26C, the stapling instrument can further comprise a separate closure lockout which prevents the end effector from

closing if a staple cartridge is missing from the stapling instrument, as discussed further below.

[0198] In various embodiments, a surgical instrument can further comprise lock arms 10980' which are rotatable between a locked position in which they are engaged with a sidewall of a lock window 10986' defined in a firing member 10990' and an unlocked position in which the lock arms 10980' are not engaged with the firing member 10990'. A staple cartridge 10900', which is similar to the staple cartridge 10900 in many respects, comprises closure keys 10916' extending from a cartridge body 10910' of the staple cartridge 10900' which can engage the lock arms 10986' and move the lock arms 10986' into their unlocked position. In at least one embodiment, the closure keys 10916' of the staple cartridge 10900' unlock the lock arms 10986' when the staple cartridge 10900' is seated in the surgical instrument. At such point, the firing member 10990' is in an unlocked closure state and can be advanced distally to perform a closure stroke to close the end effector. That said, whether or not the firing member 10990' is in an unlocked firing state to then perform a staple firing stroke is determined by the position of the lock arms 10980, as discussed above.

[0199] In various alternative embodiments, further to the above, the closure keys 10916' do not automatically unlock the lock arms 10980' when the staple cartridge 10900' is seated in the surgical instrument. Instead, the closure keys 10916' can engage the lock arms 10980' when the cartridge jaw supporting the staple cartridge 10990' is moved toward its closed, or clamped, position. In such embodiments, the lock window 10996' defined in the firing member 10990' is sized and configured to permit some initial distal movement of the firing member 10990' when the closure stroke is initiated and, if the closure keys 10916' engage and unlock the lock arms 10980' during this initial movement, the firing member 10990' enters into its unlocked closure state and can be advanced distally to complete the closure stroke. If, however, the staple cartridge seated in the cartridge jaw does not comprise the closure keys 10916', the lock arms 10980' are not unlocked by the initial movement of the firing member 10990' and the lock arms 10980' will stop the firing member 10990' from completing the closure stroke. Such an arrangement can prevent incompatible staple cartridges from being used with a surgical instrument.

[0200] The firing lockout discussed above in connection with FIGS. 26-26C keys off of the presence of the sled 10950 being positioned in the proximal end of the staple cartridge 10900 when the staple firing stroke is initiated. Another embodiment is illustrated in FIG. 29 which comprises a staple cartridge 11900 for use with a stapling instrument comprising a firing lockout. The staple cartridge 11900 comprises a cartridge body, staple drivers, and staples removably stored in staple cavities defined in the cartridge body. The staple cartridge 11900 further comprises a sled 11950 including a lock support 11958 that is moved from a proximal unfired position (FIG. 29) to a distal fired position (FIG. 30) by a tissue cutting knife 11990 of the stapling instrument during a staple firing stroke. The staple cartridge 11900 further comprises a pan 11960 attached to the cartridge body which prevents the staple drivers and/or staples from falling out of the bottom of the cartridge body. The pan 11960 comprises a lock support 11968 which sits on top of the lock support 11958 of the sled 11950 when the sled 11950 is in its proximal unfired position (FIG. 29). In such instances, the pan lock support 11968 and the sled lock support 11958 co-operate to hold a lock arm 11980 of the stapling instrument in an unlocked position against a biasing force being applied to the lock arm 11980 by a biasing spring 11985 positioned intermediate the lock arm 11980 and a frame of the stapling instrument. In such instances, a lock end 11986 of the lock arm 11980 is not positioned in a lock notch 11996 defined in the tissue cutting knife 11990 and, as a result, the tissue cutting knife 11990 can be moved distally through the staple firing stroke. When the sled 11950 is moved distally by the tissue cutting knife 11990, referring to FIG. 30, the sled lock support 11958 no longer supports the pan lock support 11968 and, as a result, the biasing spring 11985 pushes the lock arm 11980 downwardly which bends, or deflects, the pan lock support 11968 downwardly. At such point, the lock notch 11996 is no longer aligned with the lock end 11986 of the lock arm 11980 and, as a result, the lock end 11986 is pushed against the bottom of the tissue cutting knife 11990 by the spring 11985 throughout the remainder of the staple firing stroke. When the tissue cutting knife 11990 is retracted, however, the lock notch 11996 is re-aligned with the lock end 11986 which is pushed into the lock notch 11996 by the spring 11985. In such instances, the tissue cutting knife 11990 is locked from being advanced distally through another staple firing stroke without the

spent staple cartridge 11900 being replaced with an unspent staple cartridge 11900. The reader should appreciate that this lockout system serves as both a spent cartridge lockout and as a missing cartridge lockout.

[0201] A staple cartridge 12900 comprising a spent cartridge lockout is illustrated in FIGS. 31-31D. The staple cartridge 12900 comprises a cartridge body including longitudinal rows of staple cavities, staples positioned within the staple cavities, and a sled 12950 movable from a proximal unfired position (FIG. 31A) to a distal fired position (FIG. 31B) to eject the staples from the staple cavities. The staple cartridge 12900 is seatable in a cartridge jaw 12420 of a stapling instrument such that the sled 12950 is positioned in front of a tissue cutting knife 12990 of the stapling instrument. When the sled 12950 is in its proximal unfired position, referring to FIG. 31A, the sled 12950 is held in position between two springs 12980 extending from the cartridge body positioned on opposite sides of the sled 12950. Referring to FIG. 31, each spring 12980 comprises an apex 12982, a proximal side 12984 on the proximal side of the apex 12982, and a distal side 12986 on the distal side of the apex 12982. When the sled 12950 is in its proximal unfired position, as illustrated in FIG. 31A, the sled 12950 is wedged between the apexes 12982 of the springs 12980 and compresses the springs 12980 laterally. Stated another way, the sled 12950 holds open a larger opening between the springs 12980 such that the tissue cutting knife 12990 can move between the springs 12980 to push the sled 12950 distally through the staple firing stroke, which is illustrated in FIG. 31B. During the staple firing stroke, the springs 12980 resiliently return to their unflexed states to partially close the gap between the apexes 12982 of the springs 12980 owing to the absence of the sled 12950 positioned therebetween. After the staple firing stroke, referring to FIG. 31C, the tissue cutting knife 12990 is retracted proximally until it contacts the distal sides 12986 of the springs 12980. The distal sides 12986 are angled, or sloped, such that the tissue cutting knife 12990 can deflect the springs 12980 laterally as the tissue cutting knife 12990 is retracted proximally until the tissue cutting knife 12990 passes by the springs 12980. At such point, the springs 12980 resiliently return to their unflexed configurations to partially close the gap between the spring apexes 12988, as illustrated in FIG. 31D. Notably, the sled 12950 is not retracted proximally with the tissue cutting knife 12990 and, as such,

the sled 12950 is not positioned to expand the gap between the spring axes 12982 after the staple firing stroke. If the tissue cutting knife 12990 is advanced distally once again without replacing the now-spent staple cartridge 12900, the tissue cutting knife 12990 contacts the proximal sides 12984 of the springs 12980 in their unflexed state and, owing to slope or angle of the proximal sides 12984, the tissue cutting knife 12990 is unable to pass by the springs 12980. Such an arrangement, as a result, provides a spent cartridge lockout. When the spent staple cartridge is replaced with an unspent staple cartridge, the tissue cutting knife 12990 can be advanced distally through another staple firing stroke.

[0202] As described above, referring again to FIG. 31, the proximal sides 12984 of the springs 12980 and the distal sides 12986 of the springs 12980 extend at different angles. More specifically, the distal sides 12986 extend at more shallow angles than the proximal sides 12984. Another way of describing this arrangement is that the distal sides 12986 have a length L1 which is longer than the length L2 of the proximal sides 12984. In various embodiments, the springs 12980 are comprised of metal, for example. In at least one such embodiment, the springs 12980 are part of a metal pan extending under and attached to the staple cartridge 12900. In another embodiment, the springs 12980 comprise metal inserts in a plastic cartridge body of the staple cartridge 12900. In various other embodiments, the springs 12980 are comprised of plastic and are integrally formed with a plastic cartridge body of the staple cartridge 12900, for example.

[0203] An alternative spent cartridge lockout comprising springs 13980 is illustrated in FIG. 32. The springs 13980 are connected to the cartridge body and/or the pan of the staple cartridge at a pivot 13981 and, similar to the springs 12980, are held in a compressed state by the sled 12950 when the sled 12950 is in its proximal unfired position such that the tissue cutting knife 12990 can pass between the springs 13980 to push the sled 12950 through its staple firing stroke. Each spring 13980 comprises a proximal link 13984 and a distal link 13986 connected at an apex 13982 of the spring 13980. The apex 13982 comprises a pivot joint connecting the proximal link 13984 and the distal link 13986. In at least one embodiment, the apex 13982 includes a score or notch in the body of the spring 13980 which allows the links 13984 and 13986 to pivot

relative to one another. Each spring 13980 further comprises a base link 13988 pivotably mounted to the proximal link 13984 at a pivot 13985. Similar to the above, the pivot 13985 can comprise a score or notch in the body of the spring 13980, for example. Notably, the base link 13988 comprises a free end which is unconnected to any other portion of the staple cartridge that allows the base link 13988 to slide relative to the cartridge body. When the tissue cutting knife 12990 is retracted after the staple firing stroke, referring to FIG. 32, the tissue cutting knife 12990 passes over the pivots 13981 and contacts the distal links 13986. Owing to the free ends of the base links 13988, the springs 13980 collapse to permit the tissue cutting knife 12990 to be retracted to its proximal unfired position. In such instances, the base links 13988 slide proximally to accommodate this change in the configuration of the springs 13980. Once the tissue cutting knife 12990 is retracted past the springs 13980, the springs 13980 resiliently return to their unflexed shape. If the spent staple cartridge is not replaced and the tissue cutting knife 12990 is advanced distally once again, referring to FIG. 33, the tissue cutting knife 12990 contacts the proximal links 13984 of the springs 13980 and pushes the base links 13988 distally which, in turn, pushes the opposing apexes 13982 toward one another to close the gap between the springs 13980 to prevent the tissue cutting knife 12990 from being moved through the spent staple cartridge. When the spent staple cartridge is replaced with an unspent staple cartridge, the tissue cutting knife 12990 can be advanced distally through another staple firing stroke.

[0204] In various embodiments, as discussed above, a spent staple cartridge is replaceable with an unspent staple cartridge. In certain embodiments, referring to FIG. 1, a staple cartridge, such as staple cartridge 1900, for example, is snap-fit into the cartridge jaw 1420. In at least one such embodiment, the staple cartridge 1900 is positioned between the anvil jaw 1410 and the cartridge jaw 1420 with the pan of the staple cartridge 1900 facing toward the cartridge jaw 1420 and the deck of the staple cartridge 1900 generally facing the anvil jaw 1410. With the proximal end of the staple cartridge 1900 being aligned with the proximal end of the cartridge jaw 1420 and the distal nose of the staple cartridge 1900 extending from the distal end of the cartridge jaw 1420, the clinician pushes down on the deck of the staple cartridge 1900 to seat the staple cartridge 1900 in the cartridge jaw 1420. In many instances, a considerable

amount of force is needed to insert the staple cartridge 1900 into the cartridge jaw 1420. To remove the staple cartridge 1900 from the cartridge jaw 1420, an impact force is often applied to the nose of the staple cartridge 1900 to dislodge the staple cartridge 1900 from its snap-fit arrangement with the cartridge jaw 1420. Although this design is suitable for its intended purpose, improvements to this design are discussed below.

[0205] Referring to FIGS. 34-36, a stapling instrument comprises a cartridge jaw 14420 configured to releasably receive a staple cartridge 14900 therein. Similar to the cartridge jaw 1420, the cartridge jaw 14420 comprises a bottom wall 14422 and opposing lateral sidewalls 14424 extending upwardly from the bottom wall 14422. The walls 14422 and 14424 are comprised of metal, such as stainless steel, for example, but could be comprised of any suitable metal. The staple cartridge 14900 is configured to be closely received between the lateral sidewalls 14420 when the staple cartridge 14900 is seated in the cartridge jaw 14420 such that there is no relative lateral movement between the staple cartridge 14900 and the cartridge jaw 14420. In various instances, there is a line-to-line lateral fit between the staple cartridge 14900 and the cartridge jaw 14420 with little, if any, clearance therebetween. The cartridge jaw 14420 further comprises alignment notches 14425 defined in the lateral sidewalls 14424 which are configured to closely receive alignment projections 14905 extending from the staple cartridge 14900. The alignment notches 14425 and the alignment projections 14905 are sized and configured to co-operatively align the staple cartridge 14900 longitudinally within the cartridge jaw 14420. Moreover, the alignment notches 14425 and the alignment projections 14905 are sized and configured such that there is no relative longitudinal movement between the staple cartridge 14900 and the cartridge jaw 14420. In various instances, there is a line-to-line fit between the alignment notches 14425 and the cartridge jaw 14420 with little, if any, clearance therebetween. In various instances, further to the below, the fit between the staple cartridge 14900 and the cartridge jaw 14420 may be a slight friction fit and/or a zero-insertion-force (ZIF) fit.

[0206] Further to the above, the cartridge jaw 14420 further comprises a cartridge lock, such as cartridge lock 14980, for example, which is configured to lock the staple cartridge 14900 into the cartridge jaw 14420. The cartridge lock 14980 is slideable between an unlocked position (FIG. 35) and a locked position (FIG. 36) to engage the

cartridge lock 14980 with the staple cartridge 14900 after the staple cartridge 14900 has been positioned in the cartridge jaw 14420. The cartridge lock 14980 comprises a base 14982 (FIGS. 37 and 38) slideable along the base wall 14422 of the cartridge jaw 14420 and lock arms 14984 extending distally therefrom. The cartridge lock 14980 is comprised of stamped stainless steel, for example, but could be comprised of any suitable material. When the cartridge lock 14980 is moved from its unlocked position (FIG. 35) to its locked position (FIG. 36), the lock arms 14984 engage lock windows 14904 defined in the staple cartridge 14900. In various embodiments, the cartridge lock 14980 further comprises a biasing spring configured to push the cartridge lock into its locked position. In at least one embodiment, the lateral sidewalls 14424 of the cartridge jaw 14420 comprise cam features which cam the lock arms 14984 into the lock windows 14904. In at least one embodiment, the lock arms 14984 are resiliently flexed outwardly when the staple cartridge 14900 is seated in the cartridge jaw 14420 and then relax inwardly into the lock windows 14904 when the cartridge lock 14980 is moved into its locked position. To unlock the staple cartridge 14900 and remove the staple cartridge 14900 from the cartridge jaw 14420, the cartridge lock 14980 is pulled proximally into its unlocked position to disengage the cartridge lock 14980 from the staple cartridge 14900. Such an arrangement can avoid the need to apply an impact force to the staple cartridge 14900 to remove the staple cartridge 14900 from the cartridge jaw 14420.

[0207] As discussed herein, a firing member, such as a tissue cutting knife, for example, is movable distally to close an end effector of a stapling instrument and then movable distally once again to perform a staple firing stroke. Referring to FIGS. 27 and 28 once again, the firing member 10990 comprises a first cam 10991 configured to engage a cartridge jaw, such as cartridge jaw 1420, for example, and a second cam 10992 configured to engage an anvil jaw, such as anvil jaw 1410, for example. When the firing member 10990 is advanced distally from an unactuated position, the firing member 10990 contacts the anvil jaw 1410 and the cartridge jaw 1420 to close the end effector 1400. In such instances, the cams 10991 and 10992 co-operatively work together during a closure stroke to move the cartridge jaw 1420 from an open, unclamped position to a closed, clamped position. To re-open the end effector 1400, the firing member 10990 is retracted proximally to disengage the cam 10991 from the

cartridge jaw 1420 so that the cartridge jaw 1420 can be re-opened. Once the end effector 1400 is closed and the clinician is satisfied with the position of the end effector 1400 on the patient tissue, the firing member 10990 is moved distally once again to perform the staple firing stroke. Notably, the cams 10991 and 10992 co-operate to hold the cartridge jaw 1420 in position relative to the anvil jaw 1410 during the staple firing stroke. Also, notably, various embodiments are envisioned in which the anvil jaw 1410 rotates relative to the cartridge jaw 1420 between an open position and a closed position and the above-described arrangement is applicable to such embodiments.

[0208] A stapling instrument 15000 is illustrated in FIGS. 39-41 and is similar to stapling instruments 1000 and 2000 and/or other stapling instruments disclosed herein in many respects, most of which will not be discussed herein for the sake of brevity. Referring to FIG. 29, the stapling instrument 15000 comprises a shaft 15200, an end effector 15400, and a staple cartridge 15900 positioned in the end effector 15400. The staple cartridge 15900 comprises a cartridge body 15910 including staple cavities, staples removably stored in the staple cavities, staple drivers, and a sled 15950 movable from a proximal unfired position (FIG. 39) to a distal fired position (FIG. 41) during a staple firing stroke. The end effector 15400 comprises a cartridge jaw 15420 and an anvil jaw 15410 rotatable relative to the cartridge jaw 15420 about a jaw pivot 15405 between an open, unclamped position and a closed, clamped position. The stapling instrument 15000 further comprises a firing drive including a tissue cutting knife 15990 which is movable distally during a closure stroke to close the end effector 15400 and then movable distally once again during the staple firing stroke to push the sled 15950 distally and eject the staples from the staple cavities. The tissue cutting knife 15990 comprises a cartridge cam 15991, an anvil cam 15993, and a tissue cutting edge 15995 positioned intermediate the cartridge cam 15991 and the anvil cam 15993, and is discussed in greater detail below.

[0209] The stapling instrument 15000 further comprises a tissue compression lever 15800 which is engaged by the tissue cutting knife 15990 during the closure stroke to close the anvil jaw 15410. The tissue compression lever 15800 is rotatably mounted to a frame of the shaft 15200 about a pivot 15801 and comprises a distal end 15803 which extends distally relative to the pivot 15801 and a proximal end 15805 which extends

proximally relative to the pivot 15801. When the anvil jaw 15410 is in its open position, the tissue cutting knife 15990 is not engaged with the tissue compression lever 15800. When the tissue cutting knife 15990 is advanced distally during the closure stroke, referring to FIG. 39, the anvil cam 15993 of the tissue cutting knife 15990 contacts the distal end 15803 of the tissue compression lever 15800 and rotates the distal end 15803 downwardly. This rotation of the tissue compression lever 15800 causes the proximal end 15805 of the tissue compression lever 15800 to rotate upwardly. A spring 15810 is positioned intermediate the anvil jaw 15410 and the proximal end 15805 of the tissue compression lever 15800 at location which is proximal to the jaw pivot 15405. Another spring 15290 pushes the tissue cutting knife 15990 downwardly to hold the tissue cutting knife 15990 in contact with the compression lever 15800. As a result of the above, the distal movement of the tissue cutting knife 15990 rotates the tissue compression lever 15800 in a direction which, not only pushes the anvil jaw 15410 closed as illustrated in FIG. 39, but pushes the anvil jaw 15410 into an over-compressed orientation as illustrated in FIG. 40. Such over-compression of the tissue occurs before the staple firing stroke and advantageously pushes some of the fluid contained in the tissue clamped between the jaws 15410 and 15420 into the adjacent tissue. In many instances, the clinician may pause for about 10 seconds, for example after the closure stroke before performing the staple firing stroke to permit more fluid to flow out of the tissue. As a result of the above, the tissue may be thinner when it is stapled and/or the deformation of the staples against the anvil 15410 may be more consistent.

[0210] Further to the above, the anvil jaw 15410 comprises a longitudinal slot 15411 defined therein which is configured to receive the anvil cam 15993 of the tissue cutting knife 15990 during the staple firing stroke. The longitudinal slot 15411 comprises a proximal ramp 15413 positioned adjacent to the distal end 15803 of the tissue compression lever 15800 when the anvil jaw 15410 is in a closed position after the closure stroke. At the outset of the staple firing stroke, the tissue cutting knife 15990 moves distally such that the anvil cam 15993 of the tissue cutting knife 15990 disengages from the tissue compression lever 15800 and contacts the proximal ramp 15413 of the longitudinal slot 15411. At such point, the pre-compression provided by

the tissue compression lever 15800 is relieved and the compression of the tissue during the staple firing stroke is controlled by the anvil cam 15993 which slides along the bottom surface of the slot 15411 and the cartridge cam 15991 which slides along the bottom surface of the anvil jaw 15420. In such instances, the cams 15991 and 15993 co-operatively control the position of the anvil jaw 15410 relative to the staple cartridge 15900 and, also, co-operatively control the staple forming gap between the forming pockets in the anvil jaw 15410 and the drivers in the staple cartridge 15900 as the drivers are lifted toward the anvil jaw 15410 during the staple firing stroke. The tissue cutting knife 15990 also comprises a lateral flange 15992 which extends into a longitudinal slot 15421 defined in the cartridge jaw 15420 which can also assist in controlling the relative positioning of the anvil jaw 15410 and the cartridge jaw 15420. When the tissue cutting knife 15990 is retracted after the staple firing stroke, referring to FIG. 41, the anvil cam 15993 of the tissue cutting knife 15990 exits the longitudinal slot 15411, contacts the tissue compression lever 15880, and then disengages from the tissue compression lever 15880 as the tissue cutting knife 15990 is reset into its proximal unactuated position. At such point, the anvil jaw 15410 is pushed open by one or more jaw opening springs 15401 (FIG. 41) positioned intermediate the anvil jaw 15410 and the cartridge jaw 15420 that were resiliently compressed during the closure stroke.

[0211] 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.

[0212] Further to the above, referring now to FIGS. 42 and 43, a stapling instrument 16000 comprises a cartridge jaw 16420 and an anvil jaw 16410 rotatable relative to the cartridge jaw 16420. The stapling instrument 16000 further comprises a tissue cutting knife 16990 movable distally from a proximal unfired position (FIG. 42) to a distal position (FIG. 43) to perform a closure stroke and then a distal fired position to perform a staple firing stroke. The stapling instrument 16000 also comprises a tissue compression lever 16800 which, similar to the tissue compression lever 15800, is contacted by the tissue cutting knife 16990 to close the anvil jaw 16410 and apply a compression force to the tissue captured between the anvil jaw 16410 and the staple cartridge seated in the cartridge jaw 16420. Also similar to the tissue compression lever 15800, the tissue compression lever 16800 is rotatably coupled to the shaft of the stapling instrument 16000 about a pivot 16801 and comprises a distal end 16803 and a proximal end 16805. The tissue cutting knife 16990 comprises an anvil cam 16993 and, at the outset of the closure stroke, referring to FIG. 43, the anvil cam 16993 contacts the distal end 16803 of the tissue compression lever 16800 to rotate the tissue compression lever 16800 and apply a closing force to the anvil jaw 16993 via a compression spring 16810. Notably, as illustrated in FIG. 43, the anvil cam 16993 has moved distally off of the tissue compression lever 16800 by the end of the closure stroke and does not hold the tissue compression lever 16800 in its rotated position. Instead, as also illustrated in FIG. 43, the distal advancement of the tissue cutting knife 16990 to perform the closure stroke releases a spring-loaded closure latch 16820 which engages the tissue compression lever 16800 and holds the tissue compression lever 16800 in its rotated position and, as a result, holds the anvil jaw 16410 in its closed position. The latch 16820 is rotatably mounted to the frame of the stapling instrument 16000 and is held in an unlocked position (FIG. 42) by a lateral shoulder 16992 extending from the tissue cutting knife 16990 when the tissue cutting knife 16990 is in its proximal unactuated position. During the close stroke, the lateral shoulder 16992 disengages from the latch 16820 which, owing to a spring force applied to the latch 16820 by a torsion spring, for example, the latch 16820 rotates into a locked position (FIG. 42) in which a lock 16822 extending from the latch 16820 engages a lock shoulder 16802 defined in the tissue compression lever 16800. At such point, the latch 16820 is able to hold the anvil jaw

16410 in its closed position while the anvil cam 16993 of the tissue cutting knife 16900 transfers off of the tissue compression lever 16800 onto a ramp 16413 of a longitudinal slot 16411 defined in the anvil jaw 16410. Notably, the latch 16820 holds the tissue compression lever 16800 in a position which is distal to the jaw pivot connecting the anvil jaw 16410 and the cartridge jaw 16420.

[0213] Further to the above, the tissue cutting knife 16990 further comprises a cartridge cam 16991 that enters into a longitudinal slot 16421 defined in the cartridge jaw 16420 during the closure stroke of the tissue cutting knife 16990. As the tissue cutting knife 16990 is advanced distally through a staple firing stroke, the anvil cam 16993 and the cartridge cam 16991 co-operate to hold the anvil jaw 16410 in its closed position. That said, the latch 16820 also holds the anvil jaw 16410 in its closed position and provides a second jaw holding mechanism. When the tissue cutting knife 16990 is retracted proximally after the staple firing stroke, the lateral shoulder 16992 extending from the tissue cutting knife 16990 contacts the latch 16820 and pushes the latch 16820 back into its unlocked position (FIG. 42). At such point, the anvil jaw 16410 is no longer locked in position by the latch 16820 and/or the anvil cam 16993 and, as a result, the anvil jaw 16410 can be re-opened.

[0214] Further to the above, the shape and configuration of the longitudinal slot 16421 defined in the cartridge jaw 16420 is constant, or at least substantially constant, along the length thereof. Similarly, the shape and configuration of the longitudinal slot 16411 defined in the anvil jaw 16410 is constant, or at least substantially constant, along the length thereof. In this embodiment, the anvil cam 16991 and the cartridge cam 16992 co-operate to hold the anvil jaw 16410 at a fixed, or an at least substantially fixed, distance relative to the cartridge jaw 16420 during the staple firing stroke.

[0215] A stapling instrument 17000 is illustrated in FIG. 44 and is similar to the stapling instruments 1000 and 2000 and other stapling instruments disclosed herein in many respects, most of which will not be discussed herein out of the sake of brevity. The stapling instrument 17000 comprises an end effector 17400 including a cartridge jaw 17420 and an anvil jaw 17410, a staple cartridge 15900, for example, positioned in the cartridge jaw 17420, and a firing drive including a tissue cutting knife 15990. The cartridge jaw 17420 is pivotably coupled to the anvil jaw 17410 and is movable relative

to the anvil jaw 17410 from an open position to a closed position during the closure stroke of the tissue cutting knife 15990. The anvil jaw 17410 comprises a longitudinal slot 17411 defined therein which is configured to receive an anvil cam 15993 of the tissue cutting knife 15990 during the staple firing stroke of the tissue cutting knife 15990. The anvil longitudinal slot 17411 comprises a proximal end 17413 and a distal end 17415 and a cam surface 17419 extending between the proximal end 17413 and the distal end 17415. When the tissue cutting knife 15990 is advanced distally through the staple firing stroke, the anvil cam 15993 slides along the cam surface 17419 of the anvil jaw 17410. Similar to the above, the cartridge jaw 17420 comprises a longitudinal slot 17421 defined therein which is configured to receive a cartridge cam 15991 of the tissue cutting knife 15990 during the staple firing stroke. The cartridge longitudinal slot 17421 comprises a proximal end 17423 and a distal end 17425 and a cam surface 17429 extending between the proximal end 17423 and the distal end 17425. When the tissue cutting knife 15990 is advanced distally through the staple firing stroke, the cartridge cam 15991 slides along the cam surface 17429 of the cartridge jaw 17420. In various instances, the tissue compressed between the anvil jaw 17410 and the staple cartridge 15900 provides a resilient spring force to the anvil jaw 17410 and the staple cartridge 15900 which acts to push the jaws 17410 and 17420 away from one another. Owing to the cams 15991 and 15993 of the tissue cutting knife 15990, however, the relative position of the jaws 17410 and 17420 is constrained by the tissue cutting knife 15990.

[0216] Further to the above, referring to FIGS. 44-44B, the cartridge jaw 17420 comprises a bottom wall 17422 configured to support the staple cartridge 15900 and lateral sidewalls 17424 extending upwardly from the bottom wall 17422 which are sized and configured to closely receive the staple cartridge 15900 therebetween. The staple cartridge 15900 further comprises a tissue supporting deck 15913 which faces the anvil jaw 17410 when the cartridge jaw 17420 is in its closed, or clamped, position, as illustrated in FIGS. 44-44B. The anvil jaw 17410 comprises a tissue supporting portion 17412 which is positioned opposite the deck 15913 of the staple cartridge 15900 and comprises longitudinal rows of staple forming pockets defined therein configured to deform the staples ejected from the staple cartridge 15900 during the staple firing

stroke. Notably, referring primarily to FIG. 44, the tissue supporting portion 17412 also defines the longitudinal cam surface 17419 and comprises a constant thickness, or an at least substantially constant thickness, along the longitudinal length thereof. Also, notably, the bottom wall 17422 of the cartridge jaw 17420 defines the longitudinal cam surface 17429 and comprises a thickness that is not constant along the longitudinal length thereof. Rather, the thickness of the bottom wall 17422 is thinner at the proximal end 17423 and thicker at the distal end 17425. The thickness of the bottom wall 17422 tapers linearly, or at least substantially linearly, between the proximal end 17423 and the distal end 17425. That said, the thickness of the bottom wall 17422 can taper in any suitable manner. Owing to this arrangement, the distance between the anvil jaw cam surface 17419 and the cartridge jaw cam surface 17429 would change along the longitudinal length of the end effector 17400 for a given position of the cartridge jaw 17420. In many instances, however, the cartridge jaw 17420 moves relative to the anvil jaw 17410 during the staple firing stroke owing to the compressed tissue positioned between the staple cartridge 15900 and the anvil jaw 17410. During the staple firing stroke, the sloped longitudinal cam surface 17429 of the cartridge jaw 17420 causes the tissue cutting knife 15990 to draw the cartridge jaw 15420 toward the anvil jaw 15410 and narrow the gap, i.e., the tissue gap, between the staple cartridge 15900 and the anvil jaw 15410. This movement of the cartridge jaw 17420 can be readily noticed when comparing FIG. 44A, which depicts the beginning of the staple firing stroke, and FIG. 44B, which depicts the end of the staple firing stroke. As can be seen in FIGS. 44A and 44B, the tissue gap g_p closes significantly. Such an arrangement applies a larger clamping force and/or clamping pressure to the tissue at the distal end of the end effector 15400 as the staple firing stroke progresses which can inhibit the tissue from being pushed out the distal end of the end effector 15400. Moreover, such an arrangement can compensate for situations where the anvil jaw 17410 flexes away from the cartridge jaw 17420 during the staple firing stroke.

[0217] Further to the above, referring again to FIGS. 44-44B, the height of the anvil longitudinal slot 17411 narrows along the length thereof. That said, the height of the cartridge longitudinal slot 17421 also narrows along the length thereof but the thickness of the cartridge support 17422 increases along the length thereof. Various other

embodiments are envisioned in which the thickness of the cartridge support 17422 increases along the longitudinal length thereof but the height of the longitudinal slot 17421 does not change, or at least substantially change. Whether or not the longitudinal slots 17411 and 17421 are tapered, various embodiments are envisioned in which one or both of the longitudinal slots 17411 and 17421 comprise enlarged proximal openings so that they can reliably receive the tissue cutting member cams 15993 and 15991, respectively. In various instances, the anvil jaw cam 15993 is longitudinally longer than the cartridge jaw cam 15991. Such an arrangement can reliably hold the tissue cutting edge 15995 in alignment with the tissue captured between the staple cartridge 15900 and the anvil jaw 17410. In embodiments where the anvil jaw 17410 is rotatable and the cartridge jaw 17420 does not rotate, the cartridge jaw cam 15991 can be longer than the anvil jaw cam 15993 to achieve the same result. That said, the cams 15991 and 15993 can comprise any suitable length and/or configuration. The entire disclosure of U.S. Patent No. 9,844,369, entitled SURGICAL END EFFECTORS WITH FIRING ELEMENT MONITORING ARRANGEMENTS, which issued on December 19, 2017 is incorporated by reference herein.

[0218] Referring again to FIGS. 44A and 44B, the cartridge jaw 17420 defines a closed-bottom channel. In at least one embodiment, the bottom of the cartridge channel below the tissue cutting knife 15990 is entirely closed along the entire bottom of the cartridge jaw 17420. In such instances, the cartridge jaw 17420 is quite stiff and does not bend, or at least substantially bend, during the staple firing stroke. In at least one such embodiment, the bottom of the cartridge channel can be considered closed even though viewing windows are defined in the cartridge channel which can be used by a clinician to observe the position of the tissue cutting knife 15990. In other embodiments, the bottom of the cartridge channel is open, i.e., a longitudinal slot is defined therein which opens to the bottom of the cartridge jaw 17420 such that a portion of the tissue cutting knife 15990 is positioned outside of the cartridge jaw 17420. The reader should appreciate that an open cartridge channel may not be as stiff as a closed cartridge channel. In at least one embodiment, a portion of the sled extends down into the longitudinal slot of an open cartridge channel so as to stiffen the cartridge jaw 17420. The entire disclosure of U.S. Patent Application Publication No. 2015/0297228,

entitled FASTENER CARTRIDGES INCLUDING EXTENSIONS HAVING DIFFERENT CONFIGURATIONS, which published on October 22, 2015 is incorporated by reference herein.

[0219] As discussed above, a staple cartridge can be configured to fire three longitudinal rows of staples on each side of an incision made in patient tissue during a staple firing stroke. In various instances, the staple cartridge, and the stapling instrument used to fire the staples from the staple cartridge, is configured to deform all of the staples to the same, or at least substantially the same, deformed height. In other instances, the staple cartridge and the stapling instrument are configured to deform the staples to different formed heights. In at least one such instance, the staple cartridge and the stapling instrument are configured to fire six longitudinal rows of staples - three rows on each side of the incision - such that the innermost two rows of staples are deformed to a first height, the intermediate rows of staples adjacent the innermost two rows are deformed to a second height that is larger than the first deformed height, and the outermost rows of staples are deformed to a third height that is larger than the second deformed height. Such different deformed heights can be created in a number of different ways. For instance, the staple forming pockets in the anvil of the stapling instrument can be shallower in the innermost rows of forming pockets and deeper in the intermediate rows of forming pockets. Similarly, the staple forming pockets in the anvil can be deeper in the outermost rows of forming pockets than the intermediate rows of forming pockets. Also, for instance, the staple drivers that drive the innermost rows of staples can lift the innermost staples closer to the anvil than the intermediate staple drivers. Similarly, the staple drivers that drive the intermediate rows of staples can lift the intermediate staples closer to the anvil than the outermost staple drivers. In at least one such embodiment, the innermost staple drivers, the intermediate staple drivers, and the outermost staple drivers are unconnected to one another. In other embodiments, some of the staple drivers are connected to one another. In at least one such embodiment, an innermost staple driver, an intermediate staple driver, and an outermost staple driver are connected to one another such that they are lifted together by the cartridge sled. The entire disclosures of U.S. Patent No. 8,317,070, entitled SURGICAL STAPLING DEVICES THAT PRODUCE FORMED STAPLES HAVING

DIFFERENT LENGTHS, which issued on November 27, 2012, International Publication No. 2003/094747, entitled SURGICAL STAPLER AND DISPOSABLE LOADING UNIT HAVING DIFFERENT SIZE STAPLES, and U.S. Patent Application Publication No. 2010/0243707, entitled SURGICAL STAPLING APPARATUS, which published on September 30, 2010 are incorporated by reference herein.

[0220] Regardless of how the staples are deformed into different deformed heights during the staple firing stroke, further to the above, the innermost staples - which are deformed to a shorter deformed height than the intermediate staples - can apply a larger clamping pressure to the patient tissue than the intermediate staples. Similarly, the intermediate staples - which are deformed to a shorter deformed height than the outermost staples - can apply a larger clamping pressure to the patient tissue than the outermost staples. As a result of the above, the innermost staples and the intermediate staples can seal, or at least substantially seal, the incised margin of the patient tissue while the larger outermost staples can support the patient tissue while affording some flexibility to the tissue captured within the staples. As discussed above, the innermost staples are deformed to a first deformed height, the intermediate staples are deformed to a second deformed height that is taller than the first deformed height, and the outermost staples are deformed to a third deformed height that is taller than the second deformed height. These first, second, and third deformed heights are set during the staple firing stroke, but it should be understood that these deformed heights may increase, or grow, slightly after the stapled tissue is released from between the jaws of the stapling instrument. This phenomenon can be referred to as “spring back” and is the result of the internal pressure created within the captured tissue and the resiliency of the metal staples, among other things. That said, even after the spring back has increased the deformed heights of the innermost staples, the intermediate staples, and the outermost staples, the deformed innermost staples are still shorter than the deformed intermediate staples and, likewise, the deformed intermediate staples are shorter than the deformed outermost staples. For easy reference, the deformed height of the staples immediately after they are deformed can be called the “as-formed height” and the deformed height of the staples after they have relaxed - owing to spring back - can be called the “post-formed height”.

[0221] Further to the above, a staple cartridge 19900 is illustrated in FIG. 46 and is similar to the staple cartridge 1900 and other staple cartridges disclosed herein in many respects, most of which are not discussed herein for the sake of brevity. The staple cartridge 19900 comprises a cartridge body 19910 including a deck 19913 configured to support patient tissue, a longitudinal slot 19914 configured to receive a tissue cutting knife, and longitudinal rows of staple cavities 19920a, 19920b, and 19920c defined in the deck 19913 on each side of the longitudinal slot 19914. The longitudinal rows of staple cavities 19920a adjacent the longitudinal slot 19914 comprise the innermost staple cavities, the longitudinal rows of staple cavities 19920b comprise intermediate staple cavities, and the longitudinal rows of staple cavities 19920c comprise the outermost staple cavities. The staple cartridge 19900 further comprises first staples 19970a removably positioned in the innermost staple cavities 19920a, second staples 19970b removably positioned in the intermediate staple cavities 19920b, and third staples 19970c removably positioned in the outermost staple cavities 19920c. In at least one embodiment, the first staples 19970a have a first unformed height, the second staples 19970b have a second unformed height, and the third staples 19970c have a third unformed height where the first unformed height, the second unformed height, and third unformed height are the same. The reader should appreciate that the staples 19970a, 19970b, and 19970c have the same unformed height despite variations to the unformed heights owing to manufacturing tolerances. For instance, in at least one embodiment, the staples 19970a, 19970b, and 19970c have the same unformed height when their unformed heights fall between 3.8 mm and 4.2 mm, for example. In another embodiment, the staples 19970a, 19970b, and 19970c have the same unformed height when their unformed heights fall between 1.9 mm and 2.1 mm, for example. In various alternative embodiments, the first unformed height is shorter than the second unformed height, and the second unformed height is shorter than the third unformed height. In at least one such embodiment, the first unformed height is about 2.0 mm, the second unformed height is about 3.0 mm, and the third unformed height is about 4.0 mm, for example.

[0222] Further to the above, FIG. 46A depicts the progression of the first staples 19970a, the second staples 19970b, and the third staples 19970c from their unformed

heights to their as-formed heights and then to their post-formed heights. Notably, the staple cartridge 19900 is usable with a stapling instrument which is configured to cooperatively deform the first staples 19970a, the second staples 19970b, and the third staples 19970c to the same formed height. The reader should appreciate that, owing to manufacturing tolerances and/or variances in tissue thickness and density, that the staples 19970a, 19970b, and 19970c will not all be deformed to the exact same height. Rather, the staples 19970a, 19970b, and 19970c are deformed to the same formed height when their formed heights fall within the same range of heights. For instance, the staples 19970a, 19970b, and 19970c are deformed to the same formed height when their formed heights are within a range of 1.90 mm - 2.10 mm, for example. In other instances, the staples 19970a, 19970b, and 19970c are deformed to the same formed height when their formed heights are within a range of 1.35 mm - 1.65 mm, for example. That said, any suitable formed height, or formed height range, can be used.

[0223] Notably, referring again to FIG. 46A, the first staples 19970a do not relax much, if at all, between their as-formed height and their post-formed height. That said, the second staples 19970b relax a larger amount between their as-formed height and their post-formed height than the first staples 19970a. Moreover, the third staples 19970c relax a larger amount between their as-formed height and their post-formed height than the second staples 19970b. Stated another way, the first staples 19970a, the second staples 19970b, and the third staples 19970c relax to different post-formed heights even though their as-formed heights are the same. In various instances, these different post-formed heights occur owing to the softness, or compliance, of the metal used to make the first staples 19970a, the second staples 19970b, and the third staples 19970c. In at least one such instance, the second staples 19970b have less annealing than the first staples 19970a, and the third staples 19970c have less annealing than the second staples 19970b, for example, thereby making the third staples 19970c softer than the second staples 19970b and the second staples 19970b softer than the first staples 19970a.

[0224] Further to the above, various embodiments are envisioned in which the first staples 19970a, 19970b, and 19970c have the same as-formed heights but different post-formed heights regardless of whether the staples 19970a, 19970b, and 19970c

have the same unformed height or different unformed heights. In various embodiments, the staples 19970a, 19970b, and 19970c are comprised of stainless steel, titanium, and/or Nitinol - an alloy of nickel and titanium, for example. That said, embodiments are envisioned in which the first staples 19970a are comprised of a first material, the second staples 19970b are comprised of a second material, and third staples 19970c are comprised of a third material such that the first staples 19970a, the second staples 19970b, and the third staples 19970c can relax from the same as-formed heights to different post-formed heights. In at least one embodiment, the first staples 19970a are comprised of a material having a first modulus of elasticity, the second staples 19970b are comprised of a material have a second modulus of elasticity which is lower than the first modulus of elasticity, and the third staples 19970c are comprised of a material having a third modulus of elasticity which is lower than the second modulus of elasticity. In at least one embodiment, the first staples 19970a are comprised of a material having a first stiffness, the second staples 19970b are comprised of a material have a second stiffness which is lower than the first stiffness, and the third staples 19970c are comprised of a material having a third stiffness which is lower than the second stiffness.

[0225] In various alternative embodiments, referring now to FIG. 46B, the staple cartridge 19900 can comprise first staples 29970a, second staples 29970b, and staples 29970c having the same unformed shape. Notably, the first staples 29970a, second staples 29970b, and third staples 29970c have different as-formed shapes. In their as-formed shapes, the radius between the base of the first staples 29970a and the legs of the first staples 29970a have a first radius, the radius between the base of the second staples 29970b and the legs of the second staples 29970b have a second radius which is smaller than the first radius, and the radius between the base of the third staples 29970c and the legs of the third staples 29970c have a third radius which is smaller than the second radius. Owing to the radii of the as-formed staple shapes and the materials of the staples 29970a, 29970b, and 29970c, the third staples 29970c have more spring back than the second staples 29970b, and the second staples 29970b have more spring back than the first staples 29970a which result in different post-formed shapes for the staples 29970a, 29970b, and 29970c. In various instances, the first staple forming pockets, the second forming pockets, and the third forming pockets

of the anvil comprise different configurations which can produce the different as-formed shapes of the staples 29970a, 29970b, and 29970c. In at least one embodiment, the ratio of the entry radius to the exit radius of a staple forming pocket determines the as-formed shape of a staple. For instance, when the entry radius and the exit radius of a forming pocket are about the same, i.e. 1:1, the forming pocket deforms the staple to a large continuous radius. In at least one embodiment, staples that are deformed into a large continuous radius have little, if any, spring back. Such forming pockets can be suitable to deform an inner row of staples, for example. When the entry radius and the exit radius have a ratio of about 3:1, the deformed staples have a sharper radius and a larger spring back. Such forming pockets can be suitable to deform an outer row of staples, for example.

[0226] An end effector 21400 of a stapling instrument is illustrated in FIG. 48 and is similar to the other end effectors disclosed herein in many respects, many of which will not be discussed herein for the sake of brevity. The end effector 21400 comprises an anvil jaw 21410, a cartridge jaw 21420, and a staple cartridge 21900 positioned in the cartridge jaw 21420. The anvil jaw 21410 comprises a cap, or cover, 21411 and tissue support plates 21412 welded to the cap 21411. Each support plate 21412 comprises a longitudinal lateral flange 21417 extending therefrom which is positioned in a longitudinal slot, or rolled gutter, 21415 defined in a folded lateral lip of the cap 21411. In various instances, the longitudinal lateral flanges 21417 are press-fit into their respective longitudinal slots 21415 and then welded into place. In at least one instance, openings, or apertures, are defined in the cap 21411 which allow the lateral flanges 21417 to be directly welded to the cap 21411 so that the support plates 21412 are held securely in position relative to the cap 21411. The support plates 21412 are positioned and arranged such that a longitudinal slot 21414 is defined between the support plates 21412 and such that a longitudinal cavity 21416 is defined between the support plates 21412 and the cap 21411. The longitudinal slot 21414 and the longitudinal cavity 21416 are sized and configured to receive a tissue cutting knife therein. Each support plate 21412 comprises a longitudinal row of first, or innermost, staple forming pockets 21413a defined therein, a longitudinal row of second, or intermediate, staple forming pockets

21413b defined therein, and a longitudinal row of third, or outermost, staple forming pockets 21413c defined therein.

[0227] Further to the above, the staple cartridge 21900 comprises a cartridge body 21900 including a deck configured to support patient tissue, a longitudinal slot 21914 at least partially extending between first and second sides of the deck, and longitudinal rows of staple cavities 21920a, 21920b, and 21920c defined therein which are registered with the staple forming pockets 21413a, 21413b, and 21413c, respectively. Each side of the deck comprises a first, or inner, longitudinal step 21913a adjacent the longitudinal slot 21914, a second, or intermediate, longitudinal step 21913b extending alongside the first longitudinal step 21913a, and a third, or outer, longitudinal step 21913c extending alongside the second longitudinal step 21913b. Notably, the inner longitudinal step 21913a is closer to the anvil jaw 21410 than the longitudinal steps 21913b and 21913c and, owing to its height, the longitudinal step 21913a applies a larger clamping pressure to the patient tissue captured between the staple cartridge 21900 and the anvil jaw 21410 than the longitudinal steps 21913b and 21913c. Similarly, the intermediate longitudinal step 21913b is closer to the anvil jaw 21410 than the longitudinal step 21913c and, owing to its height, the longitudinal step 21913b applies a larger clamping pressure to the patient tissue captured between the staple cartridge 21900 and the anvil jaw 21410 than the longitudinal step 21913c. Such an arrangement can hold the patient tissue tightly alongside the longitudinal slot 21914 such that the tissue cutting knife passing through the longitudinal slot 21914 does not push and/or disorient the patient tissue during the staple firing stroke. Such an arrangement also provides relief to the patient tissue at the lateral edges of the end effector 21400 so that the patient tissue does not rip or tear.

[0228] Further to the above, the staple cartridge 21900 further comprises first staples 21970a positioned in the first staple cavities 21920a, second staples 21970b positioned in second staple cavities 21920b, and third staples 21970c positioned in third staple cavities 21920c. The first staples 21970a are comprised of wire having a first diameter, the second staples 21970b are comprised of wire having a second diameter that is smaller than the first diameter, and the third staples 21970c are comprised of wire having a third diameter than is smaller than the second diameter. During the staple

firing stroke, the first staples 21970a are deformed against their respective anvil forming pockets 21413a, the second staples 21970b are deformed against their respective anvil forming pockets 21413b, and the third staples 21970c are deformed against their respective forming pockets 21413c. In this embodiment, the staples 21970a, 21970b, and 21970c are all deformed to the same as-formed height, but spring back to different post-formed heights. More specifically, the first staples 21970a have a first post-formed height, the second staples 21970b have a second post-formed height which is taller than the first post-formed height, and the third staples 21970c have a third post-formed height which is taller than the second post-formed height. This arrangement is represented in FIG. 49 and can provide variable lateral compression within the tissue. As can be seen in FIG. 49, the staple cartridge 21900 comprises first staple drivers 21960a which fire the first staples 21970a to the same deformed height that the third staple drivers 21960c fire the third staples 21970c. The forming height of the staples is determined by the distance between the driver cradles 21961a and 21961c and the staple forming pockets 21413a and 21413c, respectively. As can also be seen in FIG. 49, each first staple 21970a comprises a base 21971a, legs 21973a extending from the base 21971a, and radiused portions 21972a connecting the legs 21973a to the base 21971a. Similarly, each third staple 21970c comprises a base 21971c, legs 21973c extending from the base 21971c, and radiused portions 21972c connecting the legs 21973c to the base 21971c. Notably, the radiused portions 21972c are the same size as the radiused portions 21972a in their as-fired configurations but the radiused portions 21972c are larger than the radiused portions 21972a after the staples reach their post-fired configurations.

[0229] As discussed above, a tissue cutting knife is advanced distally through a staple cartridge to eject the staples therefrom during a staple firing stroke. More specifically, in various embodiments, the tissue cutting knife contacts a sled stored in the staple cartridge which is pushed distally by the tissue cutting knife during the staple firing stroke. During the staple firing stroke, the sled contacts staple drivers contained within the staple cartridge which push, or fire, the staples upwardly toward the anvil positioned opposite the staple cartridge. Notably, the sled contacts and lifts the proximal-most staple drivers first and then sequentially contacts and lifts the staple

drivers positioned distally with respect to the proximal-most staple drivers until the distal-most staple drivers are contacted and lifted by the sled. As the sled is moved distally, however, the sled disengages from the drivers that it has just lifted to their fired positions. Thus, the time in which the sled is in contact with an individual staple driver may be brief as the sled lifts the staple driver to its fired position and then moves on. Thus, the staples spend very little time under compression (TUC) during the staple firing stroke. Staples that spend very little time under compression may undergo what can be described as a brief impact force that creates a large amount of plastic yielding within the staples. On the other hand, staples that spend a lot of time under compression may receive less of an impact force spike thereby resulting in less plastic yielding within the staples. Staples that undergo more plastic yielding tend to have less spring back than staples that undergo less plastic yielding. As discussed further below, the sled of a staple cartridge can be configured to create more plastic yielding within certain staples, or less plastic yielding within other staples, to create a desired arrangement of post-formed staple heights.

[0230] In various embodiments, referring to FIGS. 45-45B, a sled, such as sled 18950, for example, comprises a first ramp 18952a which engages and lifts the first staple drivers 21960a, second ramps 18952b which engage and lift the second staple drivers, and third ramps 18952c which engage and lift the third staple drivers 21960c. At the top of each ramp 18952a, 18952b, and 18952c is a forming plateau which defines the fully-formed position of the staple drivers being lifted by the ramps 18952a, 18952b, and 18952c. More specifically, the sled 18950 comprises a first forming plateau 18953a aligned with the first ramp 18952a, a second forming plateau 18953b aligned with each second ramp 18952b, and a third forming plateau 18953c aligned with each third ramp 18952c. When the first staple driver 21960a reaches the top of the first ramp 18952a, for example, the first staple driver 21960a slides along the first forming plateau 18953a and then falls off the back of the sled 18950 as the sled 18950 is advanced distally through its staple firing stroke. Similarly, the second staple drivers 21960b slide along their respective second forming plateaus 18953b and then fall off the back of the sled 18950 as the sled 18950 is advanced distally through its staple firing stroke. Likewise, the third staple drivers 21960c slide along their respective third

forming plateaus 18953c and then fall off the back of the sled 18950 as the sled 18950 is advanced distally through its staple firing stroke. Notably, the first forming plateau 18953a is shorter than the second forming plateaus 18953b and, as a result, the first staples may have more plastic yielding and less spring back than the second staples. Similarly, the second forming plateaus 18953b are shorter than the third forming plateaus 18953c and, as a result, the second staples may have more plastic yielding and less spring back than the third staples.

[0231] Controlling the time under compression, as discussed above, can be used to allow staples which have been deformed to the same as-formed height to have different post-formed heights. That said, the sled 18950 is also configured to deform the first staples, the second staples, and the third staples to different as-formed heights. For instance, the first forming plateau 18953a is higher than the second forming plateaus 18953b which means that the sled 18950 can lift the first staples to a higher forming height than the second staples and, in various instances, make the deformed first staples smaller than the deformed second staples. Similarly, the second forming plateaus 18953b are higher than the third forming plateaus 18953c which means that the sled 18950 can lift the second staples to a higher forming height than the third staples and, in various instances, make the deformed second staples smaller than the deformed third staples. In various instances, referring to FIG. 45B, the sled 18950 is comprised of an inner core and an outer layer surrounding the inner core. In at least one instance, the inner core can be comprised of a first material selected for its ability to withstand high forces without substantially deflecting and the outer layer can be comprised of a second material selected for its lubriciousness to reduce the friction forces between the sled 18950 and the staple drivers, for example.

[0232] An end effector 20400 is illustrated in FIG. 47 and is similar to the end effector 21400 and other end effectors disclosed herein in many respects, most of which will not be discussed herein for the sake of brevity. The end effector 20400 comprises an anvil jaw 20410, a cartridge jaw, and a staple cartridge 20900 seated in the cartridge jaw. The staple cartridge 20900 comprises a cartridge body 20910 including a longitudinal slot 20914 at least partially extending between first and second sides of the deck, and longitudinal rows of staple cavities 20920a, 20920b, and 20920c defined therein. Each

side of the deck comprises a first, or inner, longitudinal step 20913a adjacent the longitudinal slot 20914, a second, or intermediate, longitudinal step 20913b extending alongside the first longitudinal step 20913a, and a third, or outer, longitudinal step 20913c extending alongside the second longitudinal step 20913b. The staple cavities 20920a comprise openings defined in the first longitudinal steps 20913a, the staple cavities 20920b comprise openings defined in the second longitudinal steps 20913b, and the staple cavities 20920c comprise openings defined in the third longitudinal steps 20913c. Notably, the inner longitudinal step 20913a is closer to the anvil jaw 20410 than the longitudinal steps 20913b and 20913c and, owing to its height, the longitudinal step 20913a applies a larger clamping pressure to the patient tissue captured between the staple cartridge 20900 and the anvil jaw 20410 than the longitudinal steps 20913b and 20913c. Similarly, the intermediate longitudinal step 20913b is closer to the anvil jaw 20410 than the longitudinal step 20913c and, owing to its height, the longitudinal step 20913b applies a larger clamping pressure to the patient tissue captured between the staple cartridge 20900 and the anvil jaw 20410 than the longitudinal step 20913c. Such an arrangement can hold the patient tissue tightly alongside the longitudinal slot 20914 such that the tissue cutting knife passing through the longitudinal slot 20914 does not push and/or disorient the patient tissue during the staple firing stroke. Such an arrangement also provides relief to the patient tissue at the lateral edges of the end effector 20400 so that the patient tissue does not rip or tear.

[0233] In addition to or in lieu of the above, the tissue supporting surface of an anvil jaw can comprise longitudinal steps to create a tighter tissue gap along the tissue cut line and a wider tissue gap along the lateral outer edges of the end effector. Such an arrangement can also position the staple forming pockets of the anvil to create smaller as-deformed inner staples along the tissue cut line, larger intermediate as-deformed staples adjacent the inner staples, and outer as-deformed staples which are larger than the intermediate as-deformed staples, for example.

[0234] Further to the above, the anvil 20410 comprises a longitudinal slot 20414 defined therein which, like the longitudinal slot 20914, is configured to receive a tissue cutting knife. The anvil 20410 further comprises concentration features configured to concentrate the tissue forces between the anvil jaw 20410 and the staple cartridge

20900. For instance, the anvil 20410 comprises longitudinal concentration features 20413a, 20413b, and 20413c defined on both sides of the longitudinal slot 20914. The longitudinal concentration features 20413a are aligned with the first longitudinal steps 20913a of the staple cartridge 20900 when the anvil jaw 20410 is in its closed position; however, the concentration features 20413a do not extend over the entire width of the first longitudinal steps 20913a. As a result, the tissue gap between the anvil 20410 and the staple cartridge 20900 is narrow immediately under the concentration features 20413a which increases the compression being applied to the tissue immediately under and surrounding the concentration features 20413a. Similarly, the longitudinal concentration features 20413b are aligned with the second longitudinal steps 20913b of the staple cartridge 20900 when the anvil jaw 20410 is in its closed position; however, the concentration features 20413b do not extend over the entire width of the second longitudinal steps 20913b. As a result, the tissue gap between the anvil 20410 and the staple cartridge 20900 is narrow immediately under the concentration features 20413b which increases the compression being applied to the tissue immediately under and surrounding the concentration features 20413b. Likewise, the longitudinal concentration features 20413c are aligned with the third longitudinal steps 20913c of the staple cartridge 20900 when the anvil jaw 20410 is in its closed position; however, the concentration features 20413c do not extend over the entire width of the third longitudinal steps 20913c. As a result, the tissue gap between the anvil 20410 and the staple cartridge 20900 is narrow immediately under the concentration features 20413c which increases the compression being applied to the tissue immediately under and surrounding the concentration features 20413c.

[0235] Referring again to FIG. 47, each concentration feature 20413a has a first lateral width, each concentration feature 20413b has a second lateral width which is wider than the first lateral width, and each concentration feature 20413c has a third lateral width which is wider than the second lateral width. As a result, the force concentration under the concentration features 20413a is greater than the force concentration under the concentration features 20413b. Similarly, as a result, the force concentration under the concentration features 20413b is greater than the force concentration under the concentration features 20413c. As a result of the above, the

first staples deployed from the first staple cavities 20420a will have a shorter post-fired height than the second staples deployed from the second staple cavities 20420b.

Similarly, as a result of the above, the second staples deployed from the second staple cavities 20420b will have a shorter post-fired height than the third staples deployed from the third staple cavities 20420c.

[0236] Further to the above, a tissue cutting knife is moved through the staple cartridge 20900 to fire the staples stored therein during a staple firing stroke. In many instances, the tissue cutting knife is very sharp and/or the patient tissue is not very tough and/or dense. In such instances, the tissue cutting knife easily passes through the patient tissue without displacing the tissue distally. In other instances, the tissue cutting knife may not easily cut the tissue and may push some of the patient tissue captured within the end effector 20400 out of the distal end of the end effector 20400, thereby resulting in less tissue being stapled during the staple firing stroke. Referring again to FIG. 47, the cartridge body 20910 comprises distal tissue stops positioned at the distal end of the staple cartridge 20900 which prevent, or at least inhibit, the tissue from flowing distally out of the end effector 20400. The distal tissue stops comprise bumps, or domes, positioned at the distal ends of the longitudinal steps 20913a, 20913b, and 20913c, but could comprise any suitable configuration. The cartridge body 20910 comprises distal tissue stops 20919a positioned at the distal ends of the longitudinal steps 20913a, distal tissue stops 20919b positioned at the distal ends of the longitudinal steps 20913b, and distal tissue stops 20919c positioned at the distal ends of the longitudinal steps 20913a.

[0237] In various embodiments, further to the above, a staple cartridge can comprise a distal wall which can block the distal migration or flow of the tissue out of the end effector. In at least one embodiment, the perimeter of the staple cartridge is raised to control both longitudinal and lateral tissue flow. In various embodiments, the perimeter of the staple cartridge, including the distal end, for example, comprises a rough surface, or texture, which can prevent, or at least inhibit, the flow of the tissue out of the end effector. In at least one such embodiment, the rough surface texture around the perimeter of the cartridge deck can be about 10 times as rough as the rest of the deck surface, for example.

[0238] In various embodiments, referring now to FIG. 58, an end effector 29400 of a stapling instrument comprises an anvil jaw 29410 and a cartridge jaw 29420. The anvil jaw 29410 comprises a proximal end 29412 and a distal end 29411 where the proximal end 29412 is rotatably mounted to the cartridge jaw 29420 and is rotatable relative to the cartridge jaw 29420 between an open, or unclamped, position and a closed, or clamped, position (FIG. 58). Referring to FIG. 59, the anvil jaw 29410 further comprises a flat, or an at least substantially flat, tissue compression surface 29417 extending between the proximal end 29412 and the distal end 29411, a longitudinal slot 29414 extending from the proximal end 29412 toward the distal end 29411 which is configured to receive a tissue cutting knife, and longitudinal rows of staple forming pockets 29313 defined on opposite sides of the longitudinal slot 29414. The anvil jaw 29410 further comprises proximal tissue stops 29414 extending downwardly toward the cartridge jaw 29420, which are discussed further below.

[0239] Referring to FIG. 61, the cartridge jaw 29420 comprises a bottom wall 29922 and lateral sidewalls 29924 extending therefrom which define a channel configured to receive a staple cartridge therein. Referring to FIGS. 58 and 60, the end effector 29400 further comprises a staple cartridge 29900 seated in the channel defined by the cartridge jaw 29420. The staple cartridge 29900 comprises a cartridge body 29910 including a proximal end 29912 and a distal end 29911, a deck 29913 extending between the proximal end 29912 and the distal end 29911 which is configured to support patient tissue, and a longitudinal slot 29914 extending from the proximal end 29912 toward the distal end 29911 which is configured to receive the tissue cutting knife. Referring again to FIG. 61, the staple cartridge 29900 is configured to be closely received between the lateral sidewalls 29924 of the cartridge jaw 29420. Moreover, the cartridge body 29910 comprises lateral support flanges 29919 extending therefrom which are in contact with the top surfaces of the lateral sidewalls 29924 which support the staple cartridge 29900 within the cartridge jaw 29420. Referring again to FIG. 60, the staple cartridge 29900 further comprises longitudinal rows of staple cavities 29920 defined in the cartridge body 29910 on opposite sides of the longitudinal slot 29914 which contain staples removably stored therein. During a staple firing stroke, the

staples are ejected from the staple cavities 29920 by the tissue cutting knife and deformed against the staple forming pockets 29913 of the anvil jaw 29910.

[0240] Further to the above, referring to FIG. 60, the cartridge jaw 29420 further comprises proximal tissue stops 29429 extending upwardly toward the anvil jaw 29410. Referring to FIG. 58, the anvil tissue stops 29419 and the cartridge tissue stops 29429 co-operate to prevent patient tissue from moving proximally into the end effector 29400 where the tissue may accidentally contact the tissue cutting knife in its proximal unactuated position. Moreover, the anvil tissue stops 29419 and the cartridge tissue stops 29429 co-operate to keep the patient tissue over the staple cavities 29920 defined in the staple cartridge 29900 such that the proximal-most tissue captured within the end effector 29400 is stapled during the staple firing stroke. The reader should note that the staple cavities 29220 extend proximally to and/or proximally past the proximal tissue stops 29429, even though this is not depicted in FIG. 60. Similarly, the reader should note that the staple forming pockets 29413 defined in the anvil jaw 29410 extend proximally to and/or proximally past the proximal tissue stops 29419. The reader should also note, referring to FIG. 58, that the camber of the tissue compression surface 29417 of the anvil jaw 29410 is angled downwardly toward the staple cartridge 29900 to prevent, or at least inhibit, the tissue captured between the anvil jaw 29410 and the staple cartridge 29900 from flowing out of the distal end of the end effector 29400.

[0241] Further to the above, referring to FIGS. 59 and 61, the end effector 29400 further comprises an implantable layer, or adjunct, 29430 releasably attached to the anvil jaw 29410. The implantable layer 29430 comprises a longitudinal rib 29434 extending therefrom which is positioned in the longitudinal slot 29414 defined in the anvil jaw 29410. The longitudinal rib 29434 is sized and configured such that rib 29434 is compressed between the sidewalls of the longitudinal slot 29414. Such an arrangement releasably retains the implantable layer 29430 to the anvil jaw 29410. That said, the tissue cutting knife progressively transects the implantable layer 29430 through the longitudinal rib 29434 as the tissue cutting knife is progressed through the staple firing stroke to release the rib 29434 from the longitudinal slot 29414. Notably, the implantable layer 29430 covers all of the tissue forming pockets 29413 of the anvil jaw 29410, but other embodiments are envisioned in which less than all of the staple

forming pockets 29413 are covered by the implantable layer 29430. In addition to or in lieu of the longitudinal rib 29434 to secure the implantable layer 29430 to the anvil jaw 29410, the implantable layer 29430 comprises distal retention members 29435 extending from a distal end 29431 of the implantable layer 29430 which are press-fit and releasably received within distal retention apertures 29415 defined in the anvil jaw 29410. Similarly, the implantable layer 29430 comprises proximal retention members 29436 extending from a proximal end 29432 of the implantable layer 29430 which are press-fit within proximal retention apertures 29416 defined in the anvil jaw 29410. During the staple firing stroke, the staples ejected from the staple cartridge 29900 penetrate the patient tissue and the implantable layer 29430 and then capture the implantable layer 29430 against the patient tissue as the staples are deformed against the staple forming pockets 29413. After the staple firing stroke has been completed and the end effector 29400 is opened, the implantable layer 29430 releases from the anvil jaw 29410 and remains with the stapled patient tissue.

[0242] Further to the above, referring to FIGS. 60 and 61, the end effector 29400 further comprises an implantable layer, or adjunct, 29930 releasably attached to the cartridge jaw 29420. The implantable layer 29930 comprises a longitudinal rib 29934 extending therefrom which is positioned in the longitudinal slot 29914 defined in the cartridge body 29910. The longitudinal rib 29934 is sized and configured such that the rib 29934 is compressed between the sidewalls of the longitudinal slot 29914. Such an arrangement releasably retains the implantable layer 29930 to the cartridge jaw 29420. That said, the tissue cutting knife progressively transects the implantable layer 29930 through the longitudinal rib 29934 as the tissue cutting knife is progressed through the staple firing stroke to release the rib 29934 from the slot 29914. Notably, the implantable layer 29930 covers all of the staple cavities 29920 of the staple cartridge 29900, but other embodiments are envisioned in which less than all of the staple cavities 29920 are covered by the implantable layer 29930. In addition to or in lieu of the longitudinal rib 29934 to secure the implantable layer 29930 to the cartridge body 29910, the implantable layer 29930 comprises retention members 29935 extending from a distal end 29931, a proximal end 29932, and an intermediate portion of the implantable layer 29930 which are press-fit and releasably received within longitudinal

retention slots 29915 defined in the lateral sides of the cartridge jaw 29910. During the staple firing stroke, the staples ejected from the staple cartridge 29900 penetrate the implantable layer 29930 and the patient tissue and then capture the implantable layer 29930 against the patient tissue as the staples are deformed against the staple forming pockets 29413. After the staple firing stroke has been completed and the end effector 29400 is opened, the implantable layer 29930 releases from the cartridge body 29910 and remains with the stapled patient tissue.

[0243] Further to the above, referring again to FIG. 60, the longitudinal retention slots 29915 comprise open ends at the distal end 29911 of the cartridge body 29910. The open ends of the retention slots 29915 are configured to receive the retention members 29935 when the implantable layer 29930 is slid, or assembled, longitudinally onto the cartridge body 29910 from the distal end 29911 of the cartridge body 29910. Such distal openings also assist in the implantable layer 29930 detaching from the cartridge body 29910. More specifically, the end effector 29400 is often pulled longitudinally away from the stapled tissue after the end effector 29400 has been opened and, in such instances, the retention slots 29915, and their distal openings, are aligned with this commonly-used motion of the end effector 29400.

[0244] The implantable layers 29430 and 29930 provide several benefits. In various instances, the implantable layers 29430 and 29930 buttress the patient tissue being stapled which prevents, or at least inhibits, the patient tissue from tearing, especially when the patient tissue is thin, for example. Also, in various instances, the implantable layers 29430 and 29930 are comprised of a compressible material and can compensate for changes in tissue thickness within a line of implanted staples. Moreover, in various instances, the implantable layers 29430 and 29930 can prevent, or at least inhibit, the implanted staples from pulling through the patient tissue. These benefits can be obtained, in varying degrees, if both the implantable layers 29430 and 29930 are implanted against the patient tissue or if only one of the implantable layers 29430 and 29930 are implanted against the patient tissue. The entire disclosure of U.S. Patent No. 8,740,037, entitled COMPRESSIBLE FASTENER CARTRIDGE, filed on September 30, 2010, is incorporated by reference herein.

[0245] Further to the above, the press-fit and/or friction fit between the retention members 29935 and the retention slots 29915 prevents, or at least inhibits, the implantable layer 29930 from sliding relative to the cartridge body 29910 when the end effector 29400 is positioned relative to the patient tissue and also when the tissue cutting knife is advanced through the patient tissue during the staple firing stroke. Among other things, the interaction between the retention members 29935 and the retention slots 29915 prevents the implantable layer 29930 from sliding laterally and/or longitudinally relative to the cartridge body 29910.

[0246] Referring again to FIG. 58, the distal tip 29411 of the anvil jaw 29410 is cambered downwardly toward the distal nose 29911 of the staple cartridge 29900 when the anvil jaw 29410 is in its clamped position. As a result, the tissue gap between the anvil jaw 29410 and the staple cartridge 29900 may be small at the distal end of the end effector 29400. In such instances, the distal end of the end effector 29400 can be used as a dissector to grasp and move tissue, for example.

[0247] In various embodiments, the distal tip 29411 of the anvil jaw 29410 is movable relative to the main body of the anvil jaw 29410. In at least one such embodiment, the main body defines a guide rail and the distal tip 29411 is slideable along the guide rail. When the anvil jaw 29410 is closed and the distal tip 29411 contacts the tissue, the distal tip 29411 can slide along the rail in reaction to the clamping force being applied to the tissue. In at least one embodiment, the rail extends longitudinally and the distal tip 29411 slides distally along the longitudinal rail to expand the tissue gap between the distal ends of the anvil jaw 29410 and the staple cartridge 29900. In at least one embodiment, the rail extends vertically and the distal tip 29411 slides along the vertical rail to expand the tissue gap between the distal ends of the anvil jaw 29410 and the staple cartridge 29900. In either event, the anvil jaw 29410 further comprises a spring connecting the distal tip 29411 to the main body of the anvil jaw 29410 which biases the distal tip 29411 back into its undisplaced position when the anvil jaw 29410 is re-opened. As a result of the above, the sliding distal tip 29411 can reduce the possibility of the tissue being pinched between the anvil jaw 29410 and the staple cartridge 29900. Moreover, the displacement of the distal tip 29411 can provide a visual indicator to the

clinician that the tissue between the anvil jaw 29410 and the staple cartridge 29900 has been sufficiently compressed.

[0248] In addition to or in lieu of the above, the distal nose 29911 of the staple cartridge 29900 is movable relative to the main body of the cartridge body 29910. In at least one such embodiment, the cartridge body 29910 defines a guide rail and the distal nose 29911 is slideable along the guide rail. When the anvil jaw 29410 is closed, the cartridge nose 29911 can slide inwardly along the rail in reaction to the clamping force being applied to the tissue. In at least one embodiment, the rail extends longitudinally and the distal nose 29911 slides distally along the longitudinal rail to expand the tissue gap between the distal ends of the anvil jaw 29410 and the staple cartridge 29900. The entire disclosures of U.S. Patent No. 9,039,736, entitled SURGICAL STAPLING DEVICE WITH DISSECTING TIP, which issued on May 26, 2015, U.S. Patent No. 8,136,711, entitled DISSECTION TIP AND INTRODUCER FOR SURGICAL INSTRUMENT, which issued on March 20, 2012, U.S. Patent No. 8,714,429, entitled DISSECTING TIP FOR SURGICAL STAPLER, which issued on May 6, 2014, and European Patent No. EP 2,913,010, entitled INTRODUCER ASSEMBLY FOR A SURGICAL FASTENER APPLYING APPARATUS are incorporated by reference herein.

[0249] A staple cartridge 29900' is illustrated in FIG. 61A and is similar to the staple cartridge 29900 in many respects, most of which will not be discussed herein for the sake of brevity. The staple cartridge 29900' comprises a cartridge body 29910' and an implantable layer 29930' releasably attached to the cartridge body 29910'. The cartridge body 29910' comprises a deck 29913' and recesses, or dwells, 29918' defined therein which surround at least some of the openings of the staple cavities 29920 defined in the deck 29913'. The implantable layer 29930' comprises projections, or swells, 29938' extending therefrom which are positioned in the recesses 29918' which resist relative lateral and longitudinal sliding motion between the implantable layer 29930' and the cartridge body 29910'. The recesses 29918' comprise crescent-shaped pockets, but could comprise any suitable shape, and the projections 29938' are shaped and configured to complement or match the recesses 29918'. Such an arrangement can create an undulating or wavy top surface of the deck 29913', for example.

[0250] A staple cartridge 29900" is illustrated in FIG. 61B and is similar to the staple cartridges 29900 and 29900' in many respects, most of which will not be discussed herein for the sake of brevity. The staple cartridge 29900" comprises a cartridge body 29910" and an implantable layer 29930" releasably connected to the cartridge body 29910". The cartridge body 29910" comprises a deck 29913" and recesses 29918" defined therein which surround the openings of the staple cavities 29920 defined in the deck 29913". Each recess 29918" comprises a rounded profile and sloped walls. In at least one such embodiment, the recesses 29918" do not comprise vertical walls. The cartridge body 29910" further comprises a dimple 29919" extending upwardly from the bottom of each recess 29918". Similar to the recesses 29918", the dimples 29919" surround the openings of the staple cavities 29920 defined in the deck 29913" and comprise sloped walls. In at least one such embodiment, the dimples 29919" do not comprise vertical walls.

[0251] The implantable layer 29930" comprises recesses 29938" defined therein which define bumps that extend into the recesses 29918" defined in the cartridge body 29910". The implantable layer 29930" further comprises dimples 29939" in the recesses 29938" which are aligned, or at least substantially aligned, with the staples 29970" positioned in the staple cavities 29920. In at least one such embodiment, the tips of the staple legs are embedded in the dimples 29939" of the implantable layer 29930" when the staples 29970" are stored in their unfired positions in the staple cavities 29920. In other embodiments, the tips of the staple legs are positioned just below the dimples 29939" when the staples 29970" are stored in their unfired positions.

[0252] Further to the above, referring again to FIG. 61B, the implantable layer 29930" comprises a thickness 29937" and is comprised of a malleable material, for example. Notably, the thickness 29937" may or may not be constant across the entire implantable layer 29930". The height of the dimples 29919" is less than the thickness 29937" of the implantable layer 29930". Moreover, the recesses 29918" defined in the cartridge body 29910" have a depth 29917" which is larger than the height of the dimples 29919". As a result, the dimples 29919" do not extend above the deck 29913". That said, the layer 29930" is in contact with the dimples 29919" which prevents, or at least inhibits, the

layer 29930" from sliding laterally and/or longitudinally relative to the cartridge deck 29910".

[0253] Referring now to FIGS. 54 and 55, an end effector 26400 comprises an anvil jaw 26410 and a cartridge jaw comprising a staple cartridge 26900 positioned therein. The anvil jaw 26410 comprises a longitudinal slot 26414 which is configured to receive a tissue cutting knife. The anvil jaw 26410 further comprises a tissue compression surface 26417 and longitudinal rows of staple forming pockets 26413 defined in the tissue compression surface 26417. The staple cartridge 26900 comprises a cartridge body 26910 including a proximal end 26912 and a distal end 26911, a deck 26913 extending between the proximal end 26912 and the distal end 26911 which is configured to support patient tissue, and a longitudinal slot 26914 extending from the proximal end 26912 toward the distal end 26911 which is configured to receive the tissue cutting knife. The staple cartridge 26900 further comprises longitudinal rows of staple cavities 26920 defined in the deck 26913 on opposite sides of the longitudinal slot 26914 which contain staples removably stored therein. During a staple firing stroke, the staples are ejected from the staple cavities 26920 by the tissue cutting knife and deformed against the staple forming pockets 26913 of the anvil jaw 26910.

[0254] Further to the above, the staple cartridge 26900 further comprises an implantable layer 26930 releasably attached to the cartridge body 26910. The cartridge body 26910 comprises longitudinal retention slots 26915 defined therein which, similar to the above, comprise open distal ends which permit the implantable layer 26930 to be slid longitudinally onto the cartridge body 26910 when assembling the implantable layer 26930 onto the cartridge body 26910 and/or slid longitudinally off of the cartridge body 26910 after implanting the layer 26930 against the patient tissue. The implantable layer 26930 comprises lateral retention folds 26935 extending longitudinally along the lateral sides thereof which are positioned within and releasably secured within the longitudinal retention slots 26915. When the end effector 26400 is clamped against patient tissue, in various instances, the tissue may flow into the retention slots 26915 onto the retention folds 26935 which, absent other considerations, may loosen the grip of the end effector jaws on this portion of the patient tissue. Referring primarily to FIG. 55A, the anvil jaw 26410 comprises longitudinal rails 26415 defined thereon which are

aligned with the retention slots 26915 and are configured to push the patient tissue into the retention slots 26915 and improve the grip of the end effector jaws onto the patient tissue.

[0255] Referring again to FIG. 55A, the opposing sidewalls of the retention slots 26915 are vertical and the lateral retention folds 26935 comprise a corresponding configuration to that of the retention slots 26915. Similarly, the longitudinal rails 26415 comprise vertical sidewalls which correspond to the vertical sidewalls of the retention slots 26915. An alternative embodiment is illustrated in FIG. 55B which comprises a cartridge body 26910' including a longitudinal retention slot 26915', an implantable layer 26930' including a lateral retention fold 26935' releasably secured within the retention slot 26915', and an anvil jaw 26410' comprising a longitudinal rail 26415' configured to grip the patient tissue when the anvil jaw 26410' is in a closed position. Notably, the opposing sidewalls of the retention slot 26915' are not vertical; rather, the opposing sidewalls of the retention slot 26915' are angled inwardly. The lateral retention fold 26935' comprises a corresponding configuration to that of the retention slot 26915' and the longitudinal rail 26415' comprises a tapered configuration which can improve the tissue grip of the anvil jaw 26410'.

[0256] An alternative embodiment is illustrated in FIGS. 56 and 56A which comprises a cartridge body 27910 including longitudinal retention notches 27915, an implantable layer 27930 including lateral retention folds 27935 releasably secured within the retention notches 27915, and an anvil jaw 27410 comprising longitudinal rails 27415 configured to grip the patient tissue when the anvil jaw 27410 is in a closed position. Notably, the sidewalls of the retention notches 27915 are vertical. The lateral retention folds 27935 comprise a corresponding configuration to that of the retention slots 27915 and the longitudinal rails 27415 comprise vertical sidewalls which correspond to the sidewalls of the retention notches 27915. An alternative embodiment is illustrated in FIG. 56B which comprises a cartridge body 27910' including a longitudinal retention notch 27915', an implantable layer 27930' including a lateral retention fold 27935' releasably secured within the retention notch 27915', and an anvil jaw 27410 comprising a longitudinal rail 27415 configured to grip the patient tissue when the anvil jaw 27410 is in a closed position. Notably, the sidewall of the retention notch 27915' is not vertical;

rather, the sidewall of the retention notch 27915' is angled inwardly. The lateral retention fold 27935' comprises a corresponding configuration to that of the retention notch 27915'. Such an arrangement can improve the retention of the implantable layer 27930' to the cartridge body 27910'.

[0257] Referring to FIG. 57, a staple cartridge 28900 comprises a cartridge body 28910 and an implantable layer 28930 releasably attached thereto. The cartridge body 28910 comprises a longitudinal slot 28914 defined therein and longitudinal rows of staple cavities 28920 on opposite sides of the longitudinal slot 28914. The implantable layer 28930 comprises a longitudinal fold 28934 press-fit and/or friction-fit into the longitudinal slot 28914 which releasably holds the implantable layer 28930 to the cartridge body 28910.

[0258] Further to the above, the cartridge body 28910 further comprises longitudinal channels 28915 defined in the deck of the cartridge body 28910. More specifically, each side of the cartridge deck comprises a longitudinal channel 28915 which defines a lower portion of the cartridge deck aligned with the outer rows of staple cavities 28920. Each side of the cartridge deck further comprises an inner longitudinal row of staple cavities 28920 and an intermediate row of staple cavities 28920 defined in an upper portion of the cartridge deck. The implantable layer 28930 comprises longitudinal folds 28935 press-fit and/or friction-fit into the longitudinal channels 28915 which releasably hold the implantable layer 28930 to the cartridge body 28910. In various embodiments, the staple drivers configured to fire the staples stored in the outer longitudinal rows 28920 may not lift the outer staples to the same height as the inner and intermediate staples. In at least one such embodiment, the as-deformed size of the outer staples is larger than the as-deformed size of the inner staples and the intermediate staples. In at least one other embodiment, the outer staples are deformed to the same as-formed height as the inner staples and intermediate staples despite having a lower recessed deck.

[0259] An anvil jaw 22410 of a stapling instrument is illustrated in FIG. 50 and is similar to the other anvil jaws disclosed herein in many respects, many of which will not be discussed herein for the sake of brevity. The anvil jaw 22410 comprises a cap, or cover, 22411 and tissue support plates 22412 welded to the cap 22411. Each support

plate 22412 comprises a longitudinal lateral rib 22417 folded therein which is positioned in a longitudinal recess, or gutter, 22415 defined in a folded lateral lip of the cap 22411. In various instances, the longitudinal lateral ribs 22417 are press-fit into their respective longitudinal recesses 22415 and then welded into place. As a result of the above, the anvil jaw 22410 is stiff and resists bending during the staple firing stroke. The support plates 22412 are positioned and arranged such that a longitudinal slot 22414 is defined between the support plates 22412 and such that a longitudinal cavity 22416 is defined between the support plates 22412 and the cap 22411. The longitudinal slot 22414 and the longitudinal cavity 22416 are sized and configured to receive a tissue cutting knife therein. Each support plate 22412 comprises a longitudinal row of first, or innermost, staple forming pockets defined therein, a longitudinal row of second, or intermediate, staple forming pockets defined therein, and a longitudinal row of third, or outermost, staple forming pockets defined therein.

[0260] An anvil jaw 23410 of a stapling instrument is illustrated in FIG. 51 and is similar to the other anvil jaws disclosed herein in many respects, many of which will not be discussed herein for the sake of brevity. The anvil jaw 23410 comprises a cap, or cover, 23411 and tissue support plates 23412 welded to the cap 23411. Each support plate 23412 comprises a longitudinal lateral flange 23417 extending therefrom which abuts the cap 23411. In at least one instance, openings, or apertures, are defined in the cap 23411 which allow the lateral flanges 23417 to be directly welded to the cap 23411 so that the support plates 23412 are held securely in position relative to the cap 23411. As a result of the above, the anvil jaw 23410 is stiff and resists bending during the staple firing stroke. The support plates 23412 are positioned and arranged such that a longitudinal slot 23414 is defined between the support plates 23412 and such that a longitudinal cavity 23416 is defined between the support plates 23412 and the cap 23411. The longitudinal slot 23414 and the longitudinal cavity 23416 are sized and configured to receive a tissue cutting knife therein. Each support plate 23412 comprises a longitudinal row of first, or innermost, staple forming pockets defined therein, a longitudinal row of second, or intermediate, staple forming pockets defined therein, and a longitudinal row of third, or outermost, staple forming pockets defined therein.

[0261] An anvil jaw 24410 of a stapling instrument is illustrated in FIGS. 52 and 52A and is similar to the other anvil jaws disclosed herein in many respects, many of which will not be discussed herein for the sake of brevity. The anvil jaw 24410 comprises a cap, or cover, 24411 and tissue support plates 24412 welded to the cap 24411. Each support plate 24412 comprises a longitudinal lateral flange 24417 extending therefrom which is received in a folded lateral slot, or gutter, 24415 defined in the cap 24411. In at least one instance, openings, or apertures, are defined in the cap 24411 which allow the lateral flanges 24417 to be directly welded to the cap 24411 via welds 24418 so that the support plates 24412 are held securely in position relative to the cap 24411. As a result of the above, the anvil jaw 24410 is stiff and resists bending during the staple firing stroke. The support plates 24412 are positioned and arranged such that a longitudinal slot 24414 is defined between the support plates 24412 and such that a longitudinal cavity 24416 is defined between the support plates 24412 and the cap 24411. The longitudinal slot 24414 and the longitudinal cavity 24416 are sized and configured to receive a tissue cutting knife therein. Each support plate 24412 comprises a longitudinal row of first, or innermost, staple forming pockets defined therein, a longitudinal row of second, or intermediate, staple forming pockets defined therein, and a longitudinal row of third, or outermost, staple forming pockets defined therein.

[0262] An anvil jaw 25410 of a stapling instrument is illustrated in FIG. 53 and is similar to the other anvil jaws disclosed herein in many respects, many of which will not be discussed herein for the sake of brevity. The anvil jaw 25410 comprises a cap, or cover, 25411 and tissue support plates 25412 welded to the cap 25411 along the folded edges 25415 of the cap 25411. In at least one instance, openings, or apertures, are defined in the cap 25411 which allow the support plates 25412 to be directly welded to the cap 25411 so that the support plates 25412 are held securely in position relative to the cap 25411. As a result of the above, the anvil jaw 25410 is stiff and resists bending during the staple firing stroke. The support plates 25412 are positioned and arranged such that a longitudinal slot 25414 is defined between the support plates 25412 and such that a longitudinal cavity 25416 is defined between the support plates 25412 and the cap 25411. The longitudinal slot 25414 and the longitudinal cavity 25416 are sized and configured to receive a tissue cutting knife therein. Each support plate 25412

comprises a longitudinal row of first, or innermost, staple forming pockets defined therein, a longitudinal row of second, or intermediate, staple forming pockets defined therein, and a longitudinal row of third, or outermost, staple forming pockets defined therein.

[0263] As mentioned above, referring again to FIG. 1, the loading unit 1300 comprises an articulation joint 1500. Referring now to FIG. 62, the loading unit 1300 comprises a proximal shaft portion 1520 and a distal shaft portion 1530 connected by two links 1550 that pin the distal shaft portion 1530 to the proximal shaft portion 1520 but permit the distal shaft portion 1530 to rotate, or articulate, relative to the proximal shaft portion 1520, as illustrated in FIG. 64. The distal end of each link 1550 is pinned to the distal shaft portion 1530 by a pin 1540 and, similarly, the proximal end of each link 1550 is pinned to the proximal shaft portion 1520 by another pin 1540. The loading unit 1300 further comprises a first articulation actuator 1570 connected to a first side of the distal shaft portion 1530 and a second articulation actuator 1580 connected to a second side of the distal shaft portion 1530. The loading unit 1300 further comprises an articulation lock 1560 configured to be engaged with an annular array of lock teeth 1535 defined on the distal shaft portion 1530 when the articulation lock 1560 is in a locked position and disengaged from the distal shaft portion 1530 when the articulation lock 1560 is in an unlocked position (FIGS. 63 and 64). When the articulation lock 1560 is in its unlocked position (FIGS. 63 and 64), one or both of the articulation actuators 1570 can be pushed and/or pulled to articulate the end effector 1400 of the loading unit about the articulation joint 1500. In various embodiments, the articulation actuators 1560 and 1570 are coupled to an articulation input actuator 1510 (FIG. 3) which is rotatable in a first direction to push the first articulation actuator 1570 distally and pull the second articulation actuator 1580 proximally to rotate the end effector 1400 in a first direction and, similarly, rotatable in a second direction to pull the first articulation actuator 1570 proximally and push the second articulation actuator 1580 distally to rotate the end effector 1400 in a second direction. When the clinician is satisfied with the orientation of the end effector 1400, the clinician can move the articulation lock 1560 into its locked position to prevent the end effector 1400 from rotating. The entire disclosures of U.S. Patent No. 9,186,142, entitled SURGICAL INSTRUMENT END EFFECTOR

ARTICULATION DRIVE WITH PINION AND OPPOSING RACKS, and U.S. Patent No. 8,353,437, entitled SURGICAL STAPLING INSTRUMENT WITH A GEARED RETURN MECHANISM, which issued on January 15, 2013 are incorporated herein by reference.

[0264] A schematic representation of a surgical stapling instrument 30000 is illustrated in FIG. 65. The stapling instrument 30000 comprises three independent motor-driven actuation systems - a first actuation system 30200 for articulating an end effector of the stapling instrument 30000, a second actuation system 30300 for closing the end effector, and a third actuation system 30400 for performing a staple firing stroke. The stapling instrument 30000 further comprises a three-position switch 30120 for controlling the actuation systems 30200, 30300, and 30400. When the switch 30120 is in a first position, power from a power source, such as a battery, for example, is available to operate the first, or articulation, actuation system 30200. The articulation actuation system 30200 comprises an electric motor 30230 that is controlled by a directional switch 30240 and a relay switch 30260 with a set-reset function. When the switch 30120 is in a second position, power from the power source is available to operate the second, or closure, actuation system 30300. The closure actuation system 30300 comprises an electric motor 30330 that is controlled by an end-of-travel sensor 30340, a beginning-of-travel sensor 30350, and a momentary switch 30360. The closure actuation system 30300 further comprises indicator arrays 30370 and 30380 which comprise light emitting diodes (LEDs) that indicate the status of the closure actuation system. When the switch 30120 is in a third position, power from the power source is available to operate the third, or staple firing, actuation system 30400. The staple firing actuation system 30400 comprises an electric motor 30430 that is controlled by an end-of-travel sensor 30440, a beginning-of-travel sensor 30450, and a momentary switch 30460. The staple firing actuation system 30400 further comprises indicator arrays 30470 and 30480 which comprise light emitting diodes (LEDs) that indicate the status of the staple firing actuation system.

[0265] Further to the above, a surgical stapling instrument 35000 comprising an independent articulation system is illustrated in FIG. 66. The stapling instrument 35000 is similar to the stapling instruments 1000, 2000, 30000 and other stapling instruments disclosed herein. The stapling instrument 35000 comprises an end effector 35400

which is rotatable about an articulation joint 35500 by a motor-driven articulation drive. The articulation drive comprises an electric motor 35590 comprising a rotatable output 35595. The rotatable output 35595 comprises a helical or worm gear, for example, but can comprise any suitable configuration. The rotatable output 35595 is nested within a threaded socket 35585 of a proximal articulation drive rod 35580 and, when the rotatable output 35595 is rotated in a first direction, the proximal articulation drive rod 35580 is advanced distally to articulate the end effector 35400 in a first direction. Similarly, the proximal articulation drive rod 35580 is retracted proximally to articulate the end effector 35400 in a second direction when the rotatable output 35595 is rotated in a second, or opposite direction. As discussed in greater detail below, the motion of the proximal articulation drive rod 35580 is transmitted to the end effector 35400 by a transfer gear 35570 and a distal articulation rod 35570.

[0266] Further to the above, the proximal articulation drive rod 35580 comprises a rack of teeth operably engaged with a first gear perimeter 35572 of the transfer gear 35570 such that the longitudinal motion of the proximal articulation drive rod 35580 rotates the transfer gear 35570. The transfer gear 35570 is rotatably mounted to a shaft frame of the stapling instrument 35000 about a pin 35576 and further comprises a second gear perimeter 35574 operably engaged with the distal articulation drive rod 35560 such that the rotation of the transfer gear 35570 translates the distal articulation drive rod 35560. The distal articulation drive rod 35560 comprises an elongate opening 35562 defined therein including a sidewall which is configured to transmit the translation of the distal articulation drive rod 35560 to a frame 35420 of the end effector 35400 through a drive pin 35422 that extends from the frame 35420 and extends into the elongate opening 35562. Notably, the distal articulation drive rod 35560 extends across the articulation joint 35500 and, as a result, the translation of the distal articulation drive rod 35560 rotates the end effector 35400 about the articulation joint 35500.

[0267] As discussed above, the rotatable output 35595 of the motor 35590 is nested within the threaded socket 35585 of the proximal articulation drive rod 35580 to transfer the rotational motion of the output 35595 to the proximal articulation drive rod 35580. Notably, though, the threaded socket 35585 does not entirely enclose the rotatable output 35595. Instead, the threaded socket 35585 only engages half, or about half, of

the rotatable output 35595. As a result, it is possible for the threaded socket 35585 and the rotatable output 35595 to disengage from one another when the load transmitted therebetween exceeds a threshold. Such instances can occur when the motion of the end effector 35400 is blocked, for example, and the force needed to drive the end effector 35400 increases above the amount of force ordinarily needed to articulate the end effector 35400, which is usually low. When the threaded socket 35585 disconnects from the rotatable output 35595, the articulation drive is no longer driven by the motor 35590. The articulation drive further comprises an elastic sleeve 35550 surrounding or encompassing the interface between the threaded socket 35585 and the rotatable output 35595 that is configured to re-seat or re-engage the threaded socket 35585 and the rotatable output 35595 when the load transmitted through the firing drive falls back below the threshold. The elastic sleeve 35550 is comprised of rubber, for example, but could be comprised of any suitable material. When the threaded socket 35585 decouples from the rotatable output 35595, the elastic sleeve 35550 resiliently expands to accommodate the decoupling of the threaded socket 35585 and acts to resiliently contract to re-engage the threaded socket 35585 with the rotatable output 35595.

[0268] In various embodiments, further to the above, an articulation drive system can comprise one or more resilient features engaged with, or engageable with, the end effector 35400 which resist, but permit, the rotation of the end effector 35400. Such resilient features can prevent, or at least inhibit, small unintentional movements of the end effector 35400.

[0269] In various embodiments, further to the above, a surgical stapling instrument can comprise one motor that is operable to drive more than one drive system of the stapling instrument. In at least one such embodiment, the stapling instrument is switchable between a first configuration in which the motor is operable to drive the articulation drive system and a second configuration in which the motor is operable to drive the staple firing drive system, for example. The entire disclosure of U.S. Patent No. 9,101,358, entitled ARTICULATABLE SURGICAL INSTRUMENT COMPRISING A FIRING DRIVE, which issued on August 11, 2015, is incorporated by reference herein. The entire disclosure of U.S. Patent No. 5,865,361, entitled SURGICAL STAPLING APPARATUS, which issued on February 2, 2019, is incorporated by reference herein.

[0270] As discussed above, referring again to FIG. 1, the shaft 1200 of the stapling instrument 1000 is rotatable relative to the handle 1100 about a longitudinal axis. More specifically, the stapling instrument 1000 comprises a rotation joint positioned within the nozzle of the shaft that permits the shaft 1200 to rotate relative to the handle 1100. In various instances, a considerable amount of friction can be present within the rotation joint which prevents, or at least inhibits, the shaft 1200 from unintentionally rotating relative to the handle 1100. In at least one embodiment, the shaft 1200 comprises a spring-loaded lock element biased into engagement with the handle 1100 which holds the shaft 1200 in position relative to the handle 1100. The handle 1100 comprises a circumferential ring of lock recesses extending around the outer housing which are each configured to receive the spring-loaded lock element therein. The interaction between the spring-loaded lock element and a lock recess resists the rotation of the shaft 1200 relative to the handle 1100. This resistance can be overcome by the clinician to rotate the shaft 1200 without having to release, or hold open, the spring-loaded lock element. That said, the clinician can hold open the spring-loaded lock element to freely rotate the shaft 1200 relative to the handle 1100. In various alternative embodiments, the spring-loaded lock element is mounted to the handle 1100 and the circumferential ring of lock recesses is defined on the outer housing of the shaft 1200.

[0271] 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.

[0272] 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 ROTABLE 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.

[0273] 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 or

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.

[0274] 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.

[0275] 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.

[0276] 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 surgical stapling instrument, comprising:
 - a handle;
 - a shaft extending from said handle;
 - an end effector extending from said shaft, comprising:
 - a first jaw; and
 - a second jaw rotatable from an open position to a closed position;
 - a firing drive, comprising:
 - a longitudinal rack comprising a longitudinal array of teeth;
 - a firing member coupled to said longitudinal rack, wherein said firing member comprises a first cam configured to engage said first jaw and a second cam configured to engage said second jaw during a closure stroke to move said second jaw into said closed position;
 - an electric motor comprising a rotatable output; and
 - a reciprocable pawl operably coupled with said rotatable output, wherein said reciprocable pawl is driven distally a stroke length by said electric motor when said electric motor is operated in a first direction, wherein said reciprocable pawl drives said longitudinal rack and said firing member distally a first said stroke length when said reciprocable pawl is driven distally, wherein said reciprocable pawl is retracted proximally relative to said longitudinal rack when said reciprocable electric motor is operated in an opposite direction, wherein said reciprocable pawl is driven distally said stroke length by said electric motor a second time when said electric motor is operated in said first direction once again, and wherein said reciprocable pawl drives said longitudinal rack and said firing member distally a second said stroke length when said reciprocable pawl is driven distally said second time; and
 - a retraction knob extending laterally from said longitudinal rack, wherein said longitudinal rack and said firing member are manually retractable said second said stroke length and said first said stroke length when said retraction knob is pulled proximally by a clinician.

2. The surgical stapling instrument of Claim 1, wherein said first said stroke length comprises said closure stroke.
3. The surgical stapling instrument of Claim 2, wherein said first jaw comprises a staple cartridge including staples removably stored therein, and wherein said staples are ejected from said staple cartridge when said firing member is driven distally said second said stroke length.
4. The surgical stapling instrument of Claim 2, wherein said second jaw comprises a staple cartridge including staples removably stored therein, and wherein said staples are ejected from said staple cartridge when said firing member is driven distally said second said stroke length.
5. The surgical stapling instrument of Claim 2, wherein said first jaw comprises a staple cartridge including staples removably stored therein, wherein said staples comprise a proximal group of staples and a distal group of staples, wherein said proximal group of staples are ejected from said staple cartridge when said firing member is driven distally said second said stroke length, and wherein said distal group of staples are ejected from said staple cartridge when said firing member is driven distally a third said stroke length by said reciprocable pawl.
6. The surgical stapling instrument of Claim 1, further comprising a switch that is closed by said firing drive at the end of said stroke length to switch the operation of said electric motor from said first direction to said second direction.
7. The surgical stapling instrument of Claim 1, further comprising:
 - a gear train operably connecting said rotatable output and said reciprocable pawl, wherein said gear train comprises a rotatable gear including a switch shaft extending therefrom; and
 - a switch comprising an electrical contact, a first switch body, and a second switch body, wherein said switch shaft is rotatable relative to said first switch body until said

switch shaft rotates into contact with said first switch body which is then rotated by said switch shaft when said electric motor is rotated in said first direction, wherein said first switch body is rotatable relative to said second switch body until said first switch body is rotated into contact with said second switch body which is then rotated with said first switch body and said switch shaft when said electric motor is rotated in said first direction, and wherein said second switch body contacts and closes said electrical contact after being rotated by said first switch body and said switch shaft when said electric motor is rotated in said first direction.

8. A surgical stapling instrument, comprising:
- a handle;
 - a shaft extending from said handle;
 - an end effector extending from said shaft, comprising:
 - a first jaw; and
 - a second jaw rotatable from an open position to a closed position;
 - a firing drive, comprising:
 - a longitudinal rack comprising a longitudinal array of teeth;
 - a firing member coupled to said longitudinal rack, wherein said firing member comprises a first cam configured to engage said first jaw and a second cam configured to engage said second jaw during a closure stroke to move said second jaw into said closed position;
 - an electric motor comprising a rotatable output;
 - a reciprocable pawl operably coupled with said rotatable output; and
 - a pawl retraction spring, wherein said reciprocable pawl is driven distally a stroke pulse by said electric motor when said electric motor is operated in a first direction, wherein said reciprocable pawl drives said longitudinal rack and said firing member distally a first said stroke pulse when said reciprocable pawl is driven distally, wherein said reciprocable pawl is retracted proximally relative to said longitudinal rack by said pawl retraction spring when said reciprocable electric motor is stopped, wherein said reciprocable pawl is driven distally a stroke pulse by said electric motor a second time when said electric motor is operated in said first direction once again, and

wherein said reciprocable pawl drives said longitudinal rack and said firing member distally a second said stroke pulse when said reciprocable pawl is driven distally said second time; and

a retraction knob extending laterally from said longitudinal rack, wherein said longitudinal rack and said firing member are manually retractable said second said stroke pulse and said first said stroke pulse when said retraction knob is pulled proximally by a clinician.

9. The surgical stapling instrument of Claim 8, wherein said first said stroke pulse comprises said closure stroke.

10. The surgical stapling instrument of Claim 9, wherein said first jaw comprises a staple cartridge including staples removably stored therein, and wherein said staples are ejected from said staple cartridge when said firing member is driven distally said second said stroke pulse.

11. The surgical stapling instrument of Claim 9, wherein said second jaw comprises a staple cartridge including staples removably stored therein, and wherein said staples are ejected from said staple cartridge when said firing member is driven distally said second said stroke pulse.

12. The surgical stapling instrument of Claim 9, wherein said first jaw comprises a staple cartridge including staples removably stored therein, wherein said staples comprise a proximal group of staples and a distal group of staples, wherein said proximal group of staples are ejected from said staple cartridge when said firing member is driven distally said second said stroke pulse, and wherein said distal group of staples are ejected from said staple cartridge when said firing member is driven distally a third said stroke pulse by said reciprocable pawl.

13. The surgical stapling instrument of Claim 8, further comprising a switch that is closed by said pawl at the end of each said stroke pulse to switch the operation of said electric motor from said first direction to said second direction.

14. The surgical stapling instrument of Claim 8, further comprising:

a gear train operably connecting said rotatable output and said reciprocable pawl, wherein said gear train comprises a rotatable gear including a switch shaft extending therefrom; and

a switch comprising an electrical contact, a first switch body, and a second switch body, wherein said switch shaft is rotatable relative to said first switch body until said switch shaft rotates into contact with said first switch body which is then rotated by said switch shaft when said electric motor is rotated in said first direction, wherein said first switch body is rotatable relative to said second switch body until said first switch body is rotated into contact with said second switch body which is then rotated with said first switch body and said switch shaft when said electric motor is rotated in said first direction, and wherein said second switch body contacts and closes said electrical contact after being rotated by said first switch body and said switch shaft when said electric motor is rotated in said first direction.

15. A surgical stapling instrument, comprising:

a handle, comprising:

a frame;

an actuation trigger; and

a mode switch placeable in a first condition and a second condition;

a shaft extending distally from said handle;

an end effector extending distally from shaft, wherein said end effector comprises:

a first jaw;

a second jaw rotatable relative to said first jaw between an open position and a closed position; and

a staple cartridge comprising staples removably stored therein; and

a firing drive, comprising:

a firing bar;

a coupling member coupled to said firing bar, wherein said coupling member is movable distally to engage said first jaw and said second jaw and rotate said second jaw into said closed position during a closure stroke, and wherein said coupling member is movable distally to drive said staples from said staple cartridge during a staple firing actuation once said closure stroke has been completed;

a rack coupled to said firing bar, wherein said rack is movable distally from a proximal unactuated position during said closure stroke, wherein said rack is moved distally during said staple firing actuation, and wherein said rack comprises a longitudinal array of teeth defined thereon;

an electric motor;

a gear drive operably engaged with an output of said electric motor;

a coupler crank rotatably coupled to said frame, wherein said coupler crank is operably engaged with said gear drive; and

a pawl rotatably coupled to said coupler crank, wherein said pawl is driveable distally by said coupler crank when said output of said electric motor is rotated in a first direction, wherein said pawl is engaged with said longitudinal array of teeth on said rack when said pawl is driven distally, wherein said rack, said firing bar, and said coupling member are driven distally by said pawl when said pawl is driven distally, wherein said pawl is driven proximally by said coupler crank when said output of said electric motor is rotated in a second direction, wherein said pawl is slideable relative to said longitudinal array of teeth of said rack when said pawl is driven proximally, wherein said electric motor is driven in said first direction to move said coupling member through said closure stroke when said actuation trigger is actuated and said mode switch is in said first condition, wherein said electric motor is driven in said first direction to move said coupling member through said staple firing actuation when said actuation trigger is actuated and said mode switch is in said second condition, and wherein said electric motor is prevented from being operated to drive said coupling member through said staple firing stroke actuation when said mode switch is in said first condition.

16. The surgical stapling instrument of Claim 15, further comprising a retraction grip attached to said rack, wherein said retraction grip is positioned outside of said handle, wherein said retraction grip is configured to be gripped by a clinician operating said surgical stapling instrument, and wherein said rack is resettable into said proximal unactuated position when said retraction grip is pulled proximally by the clinician.

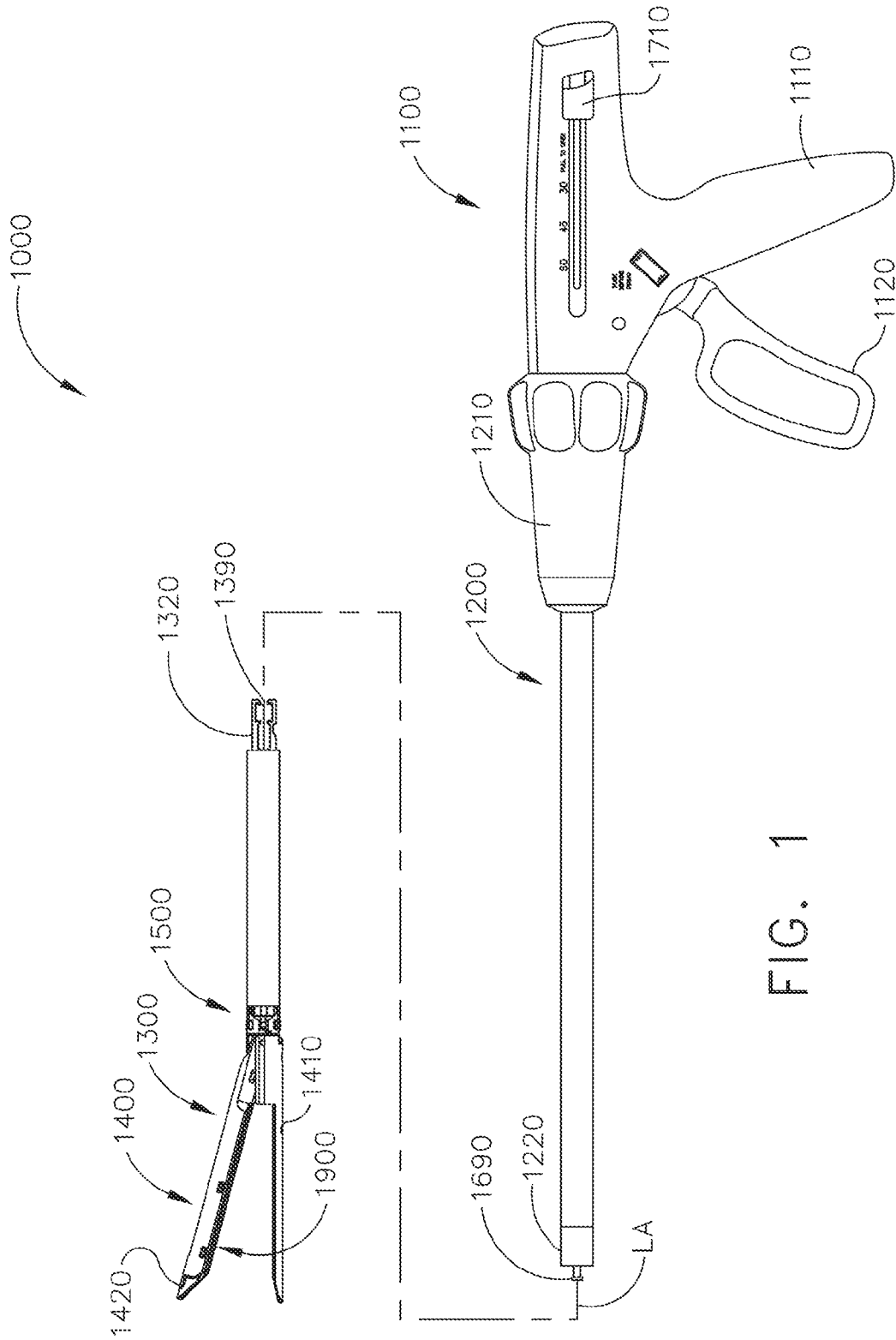


FIG. 1

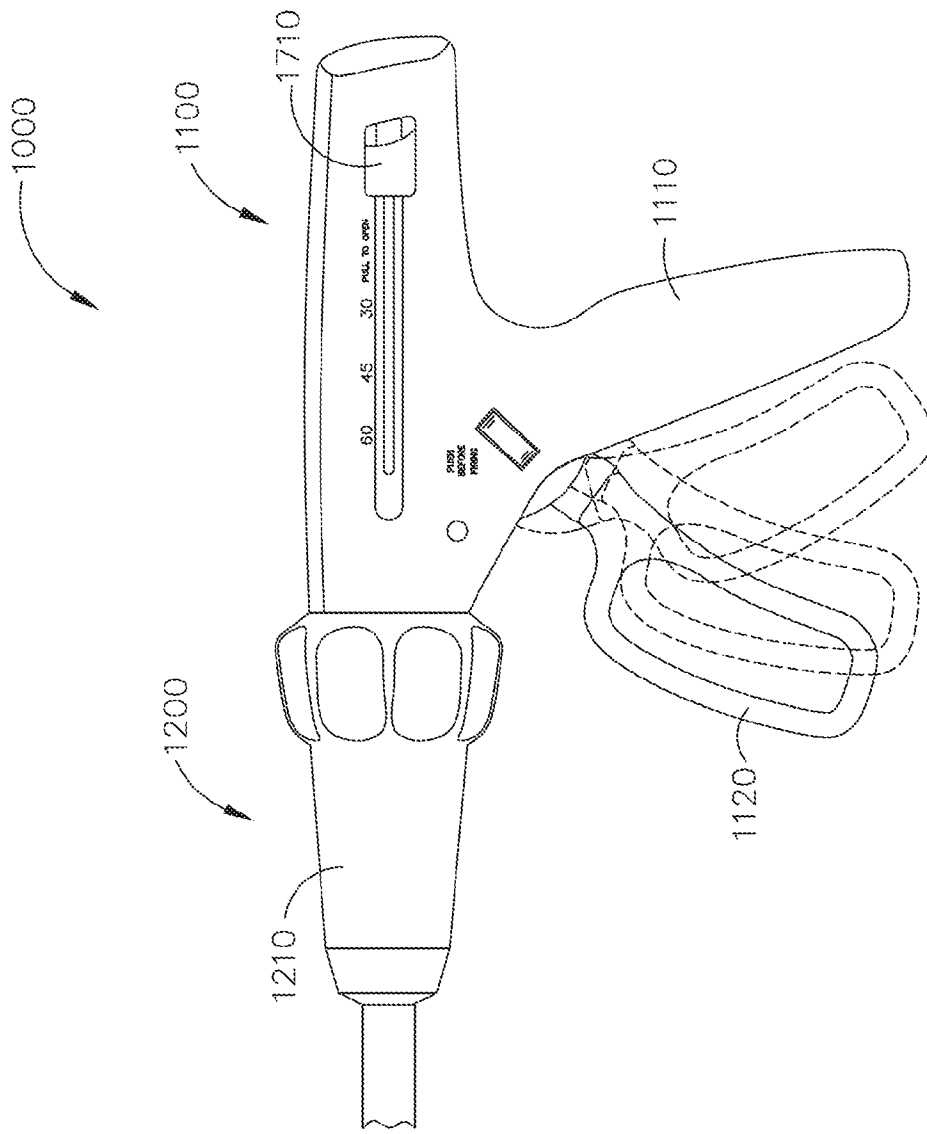


FIG. 2

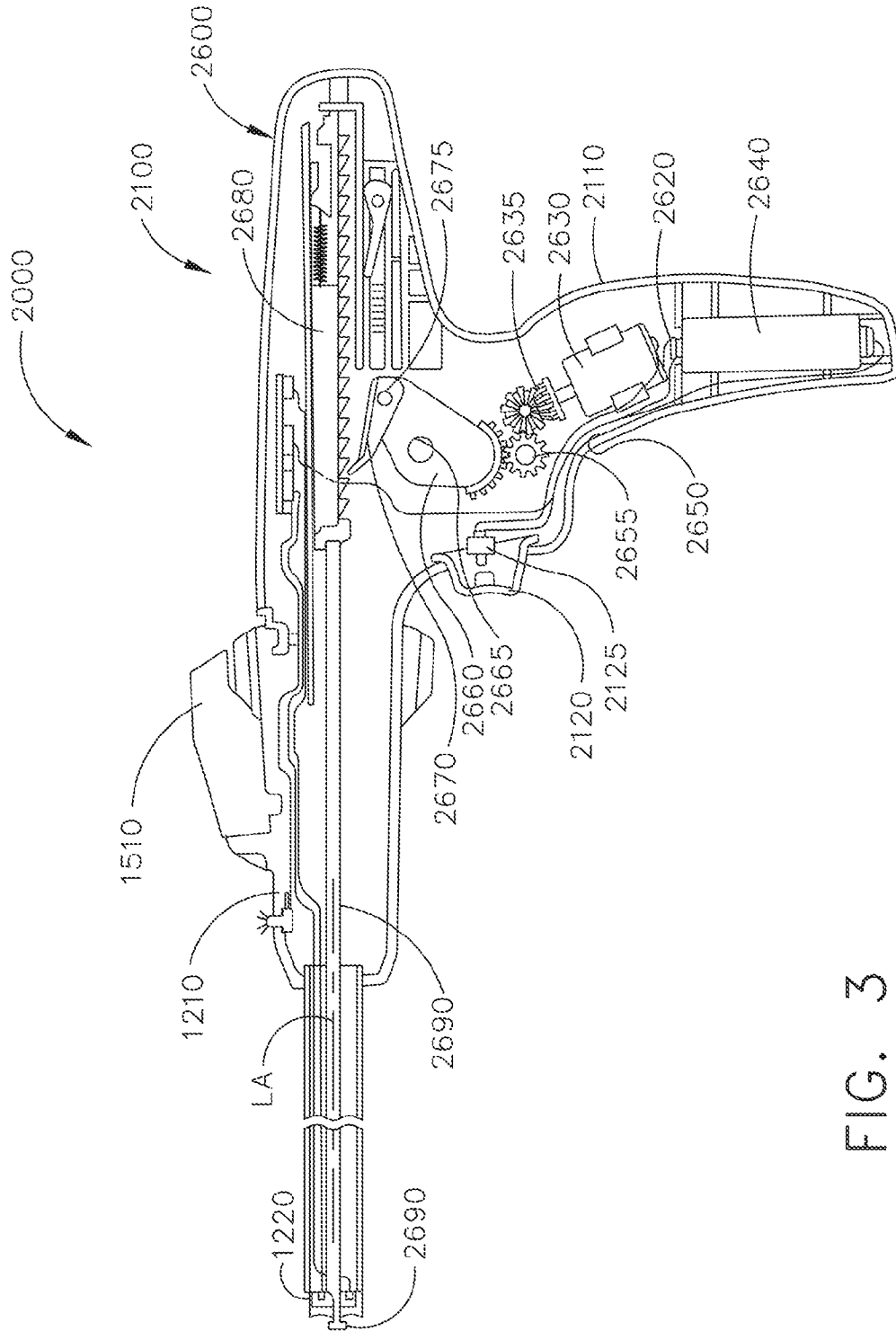


FIG. 3

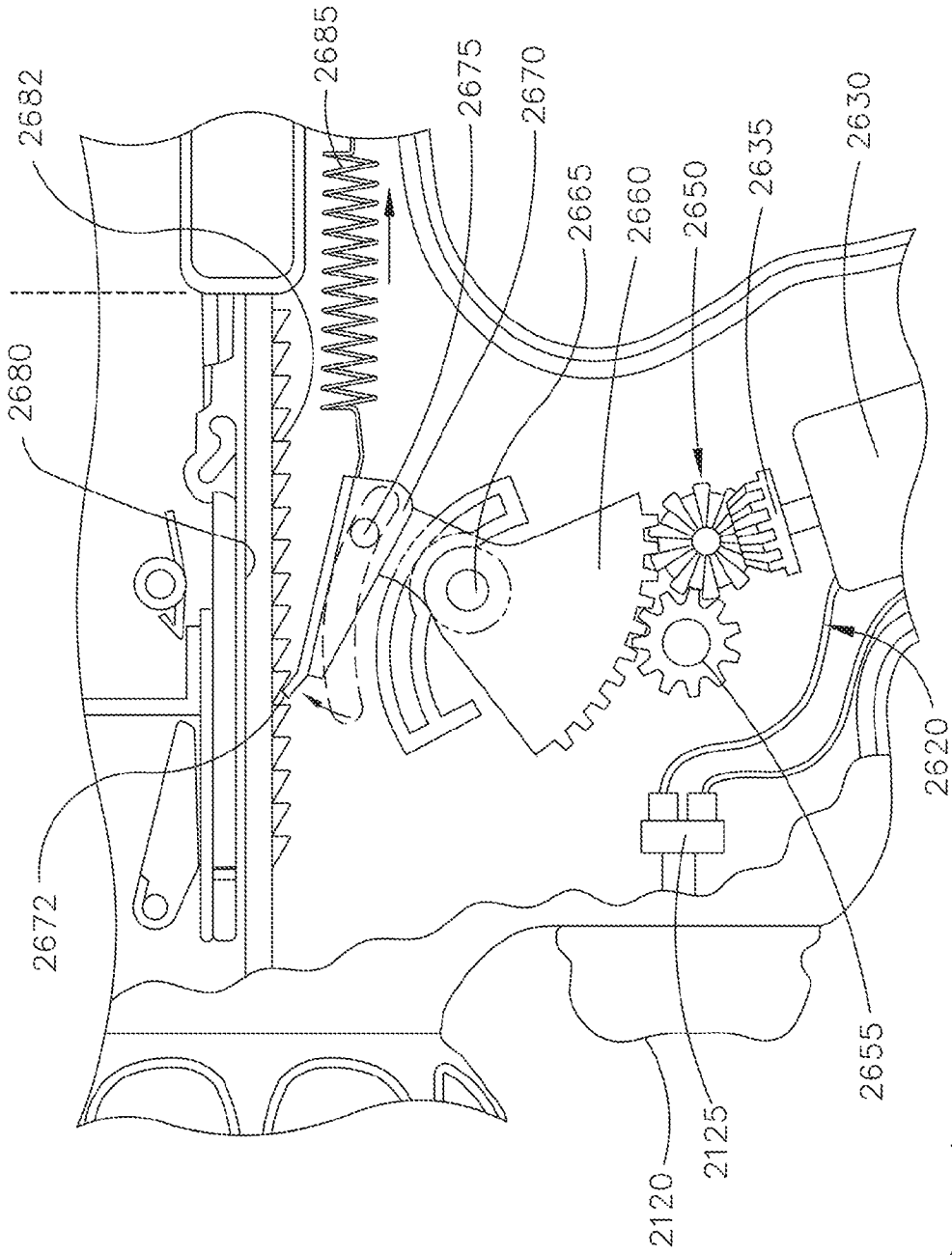


FIG. 4

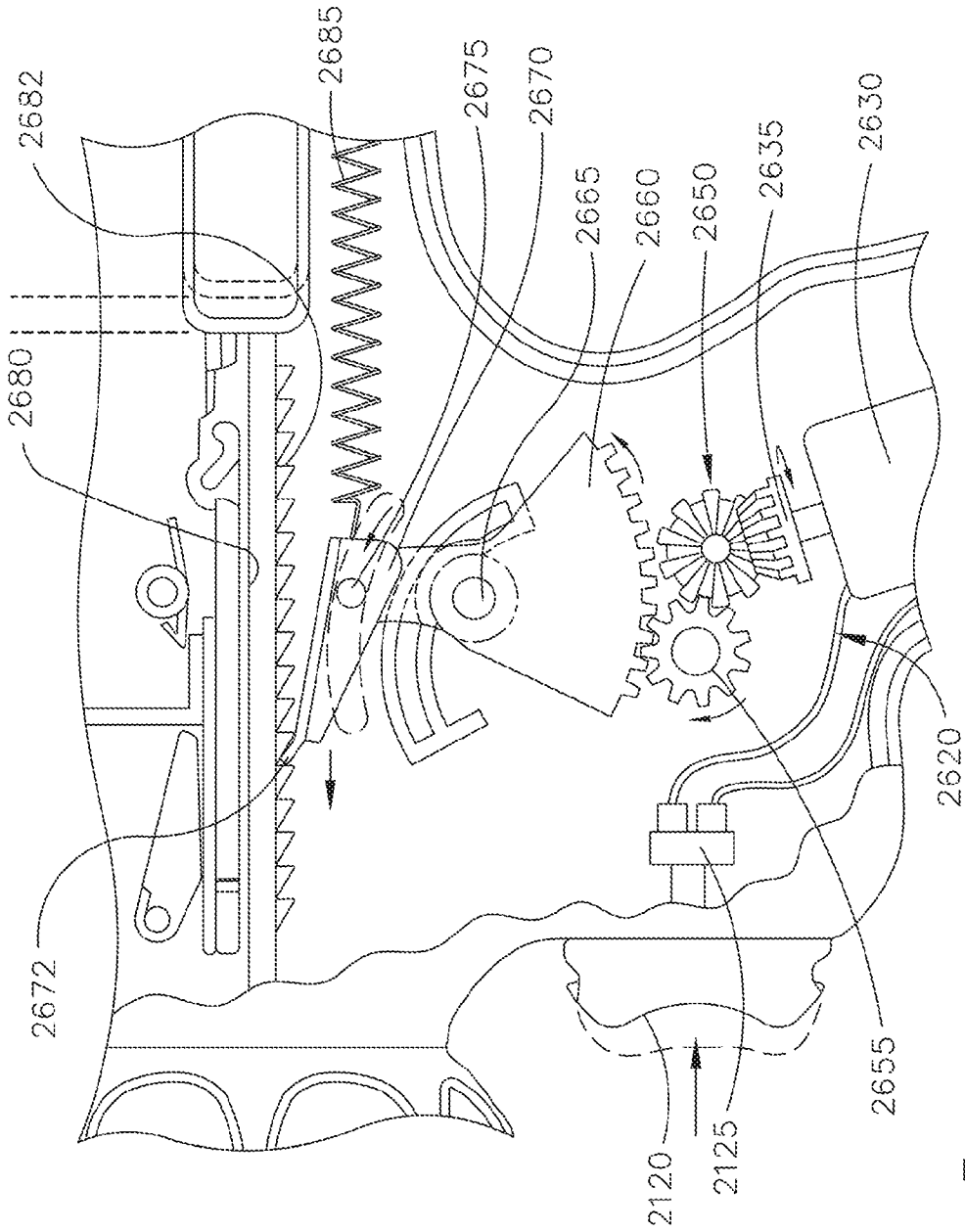


FIG. 5

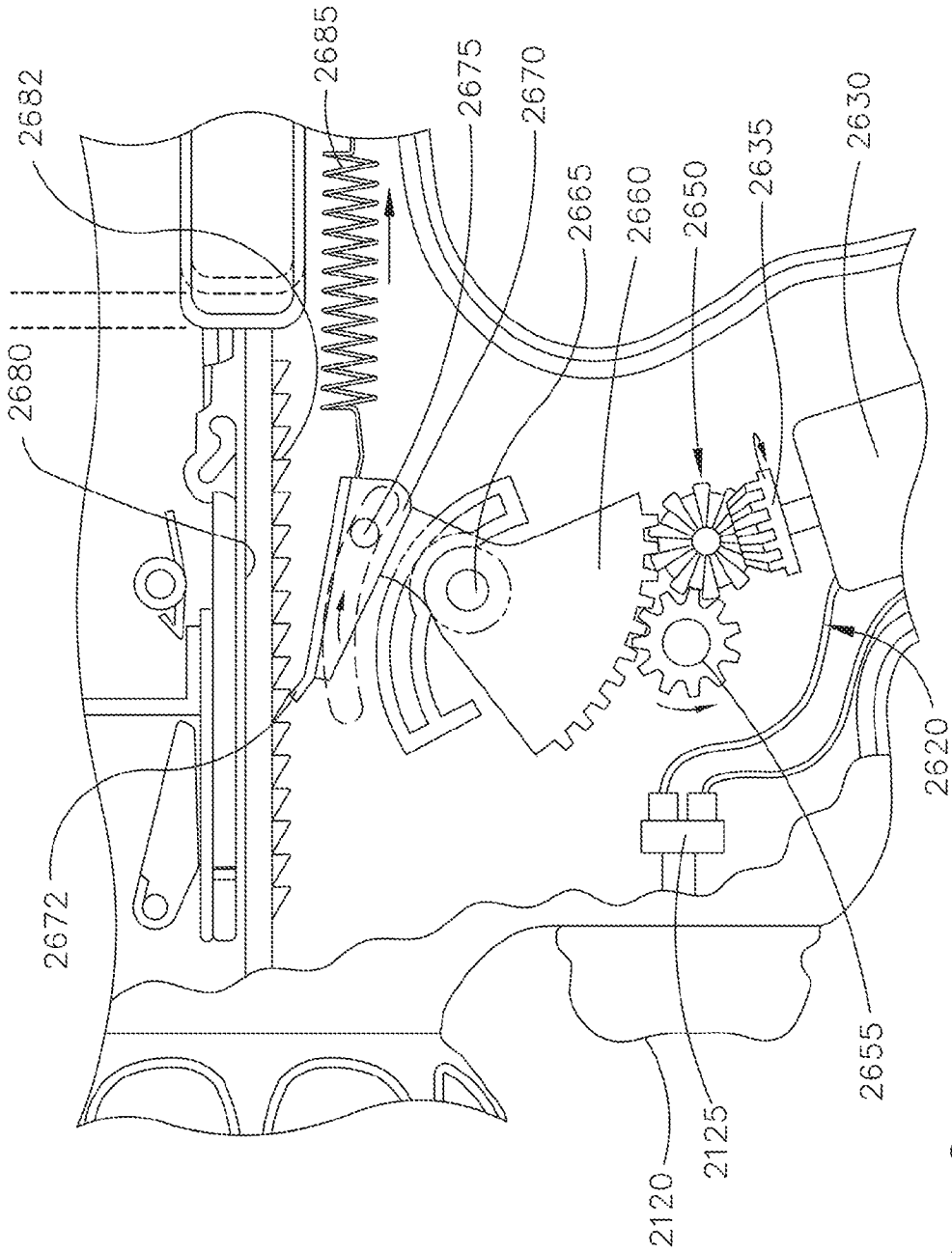


FIG. 6

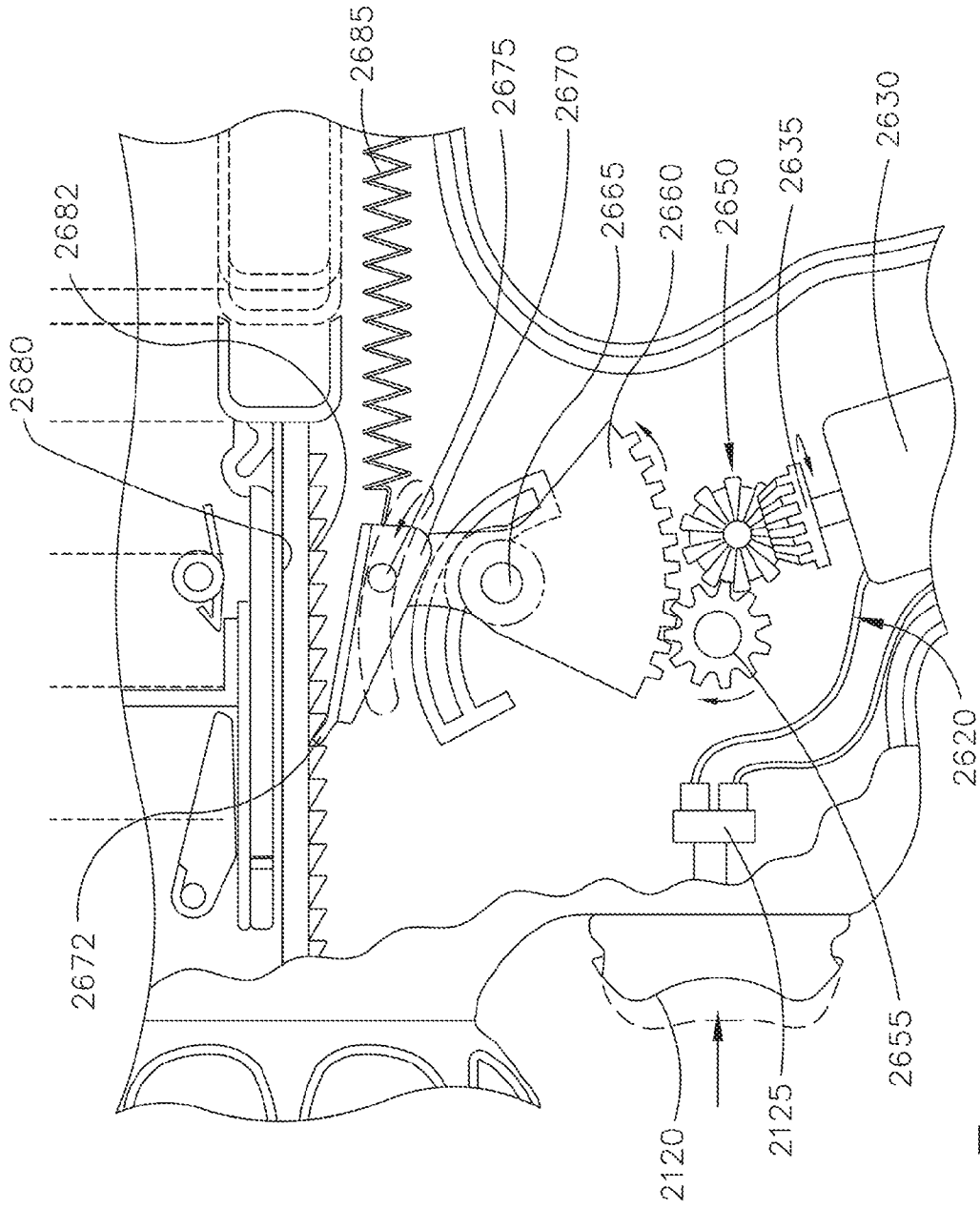


FIG. 7

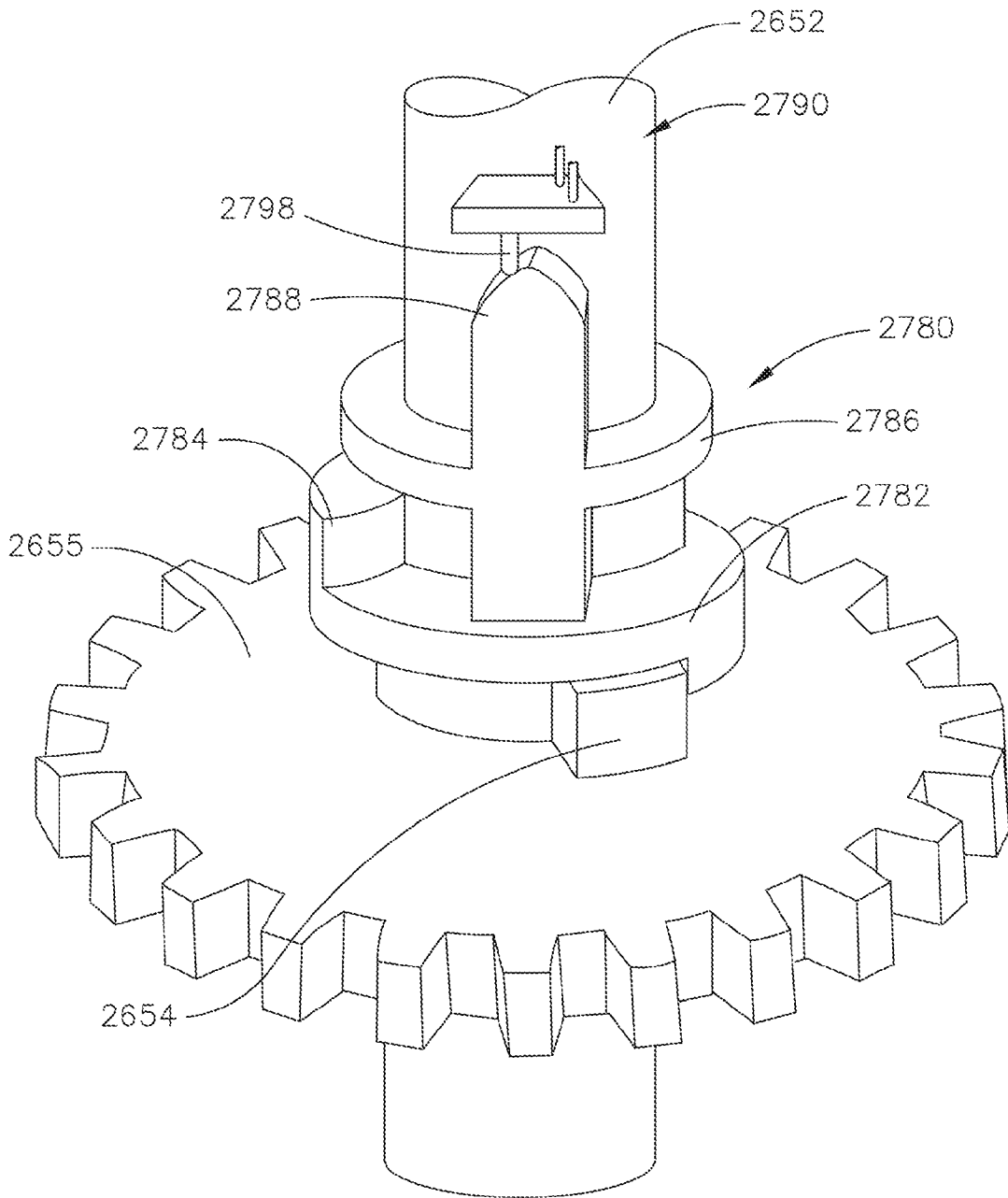


FIG. 8

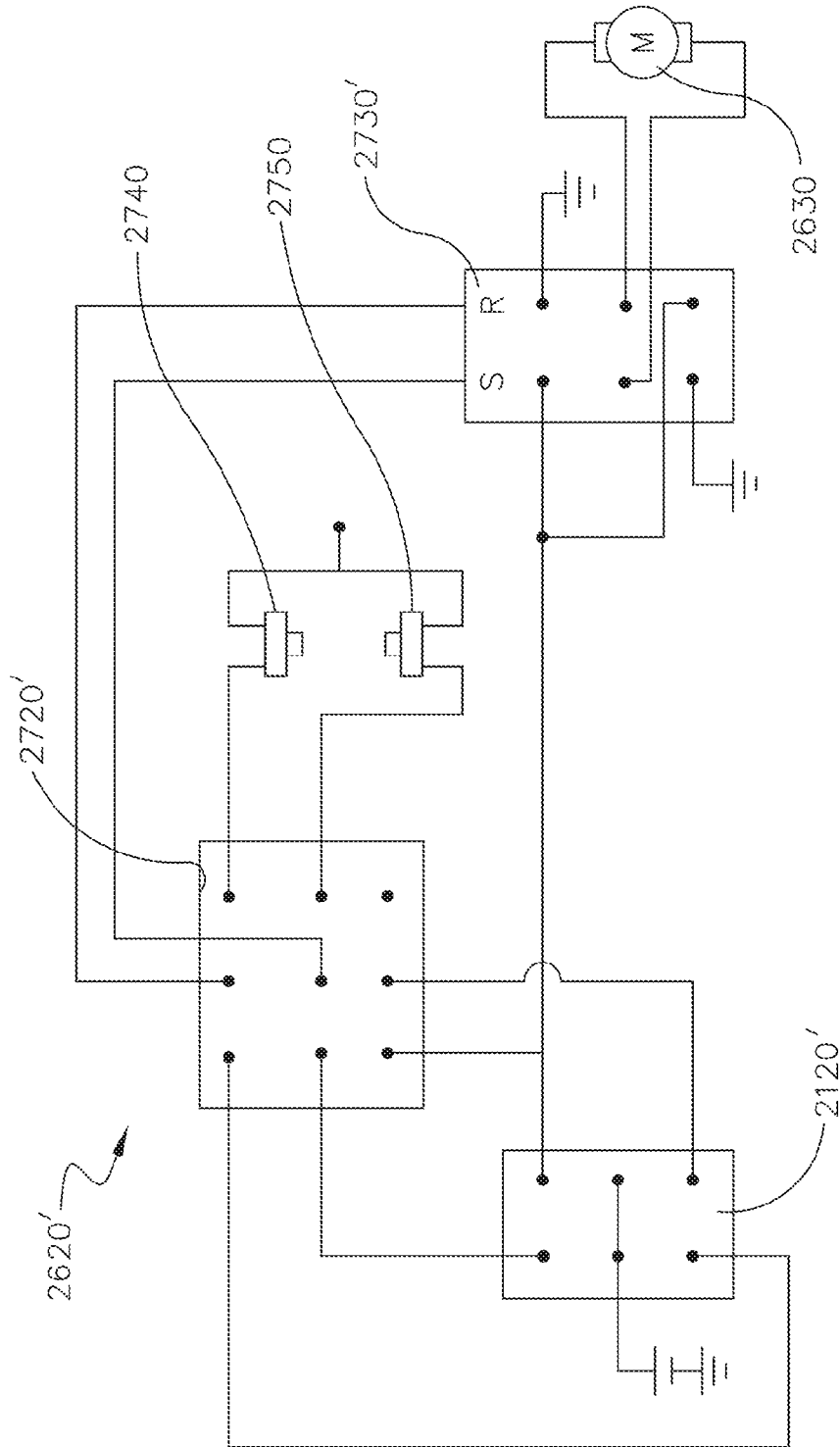


FIG. 9

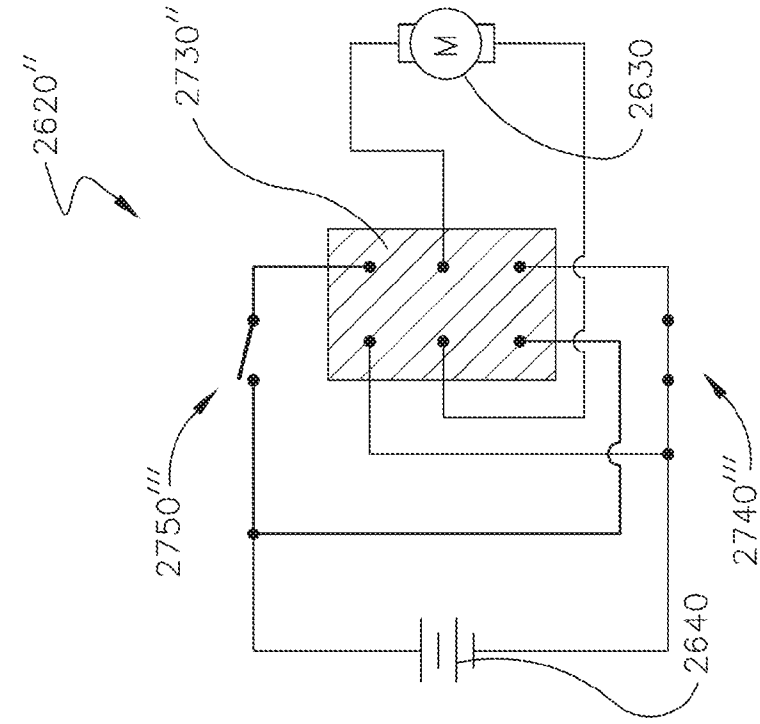


FIG. 10

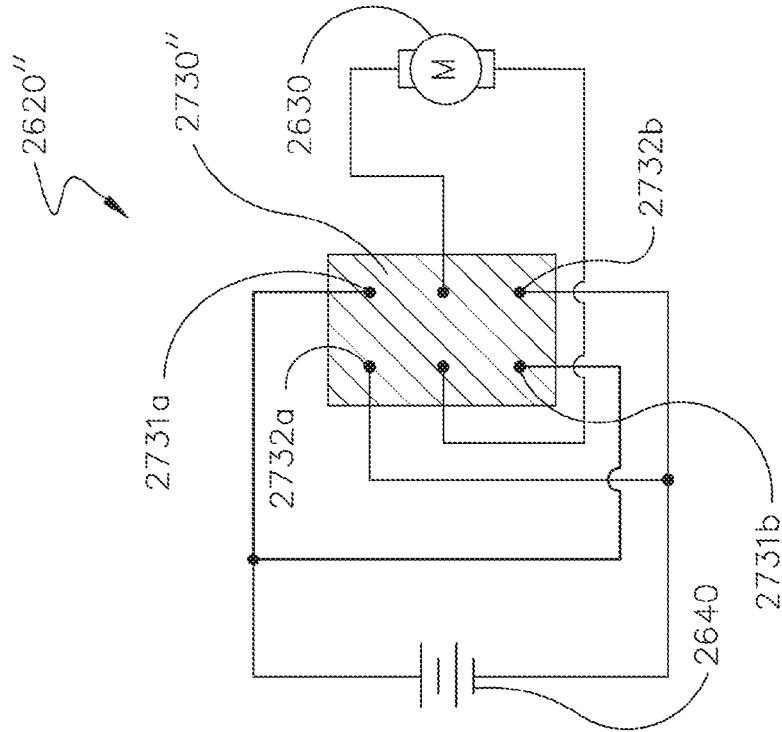


FIG. 11

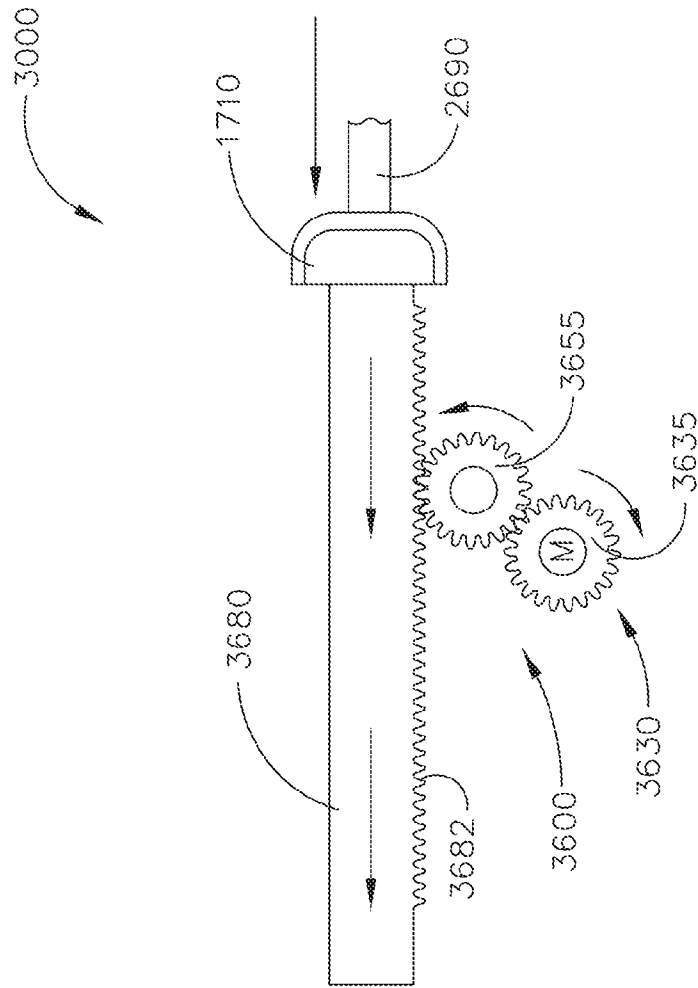


FIG. 12

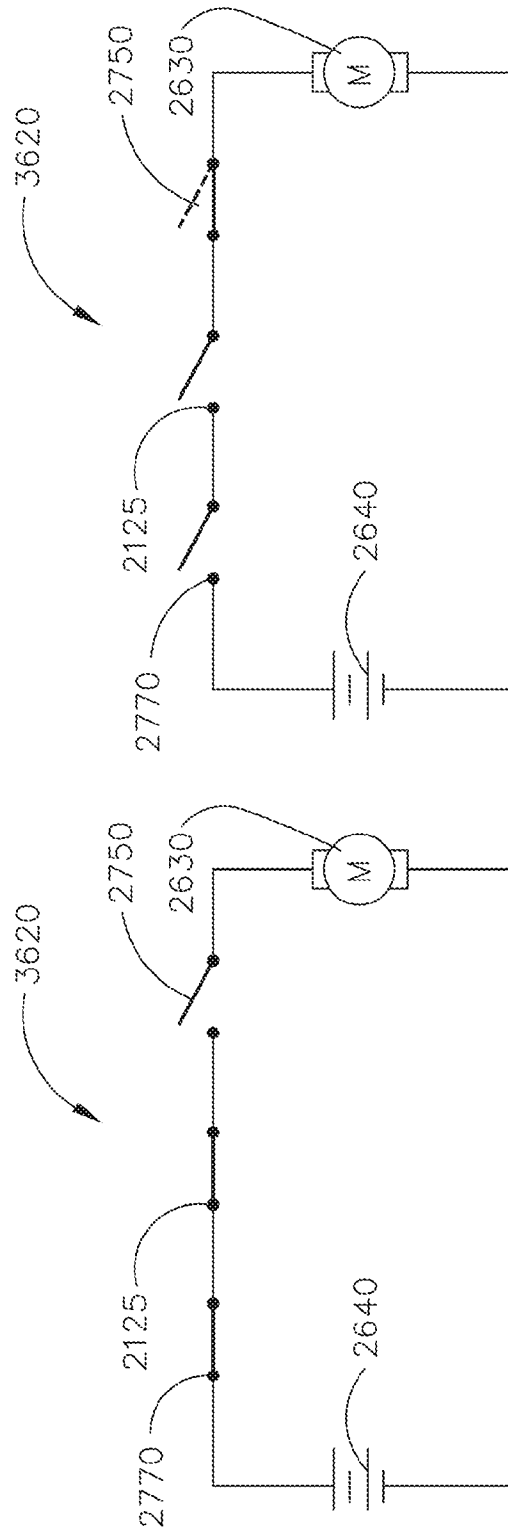


FIG. 12B

FIG. 12A

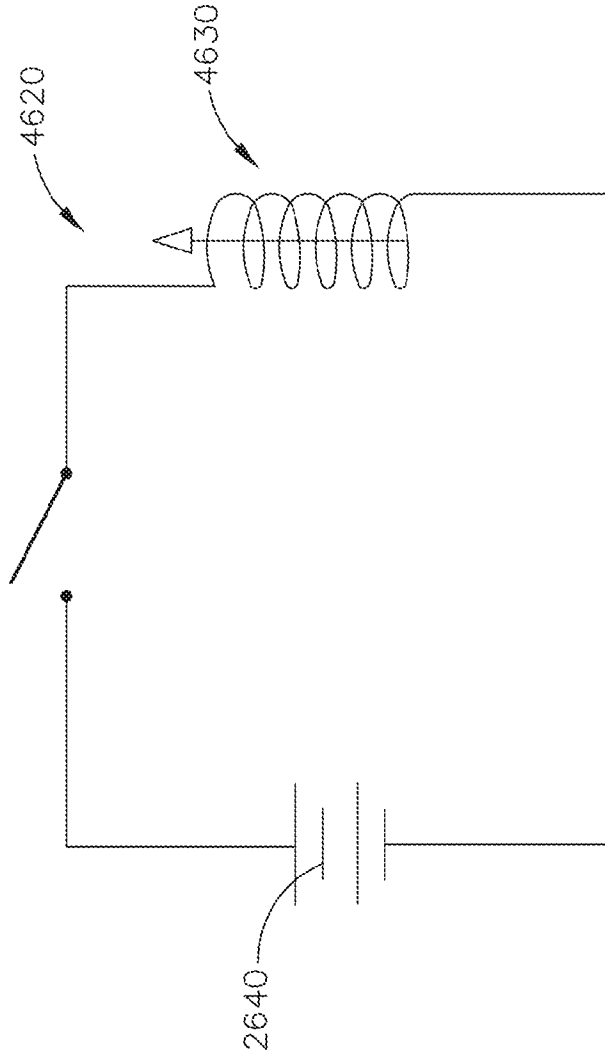


FIG. 13A

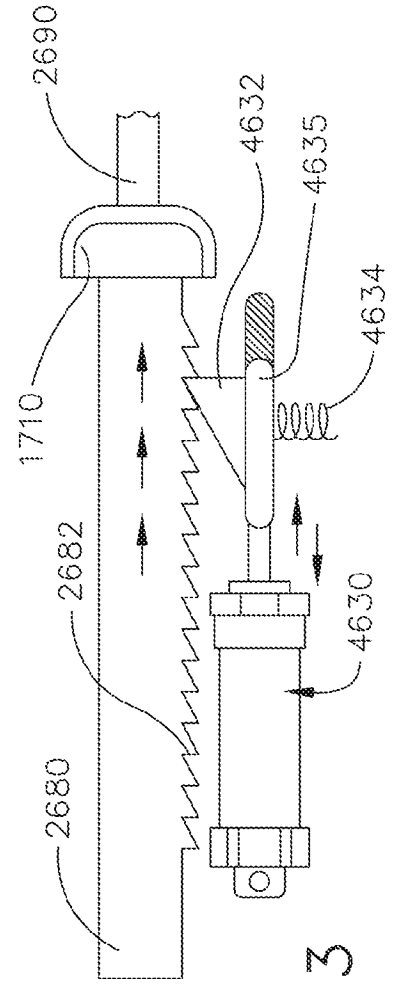


FIG. 13

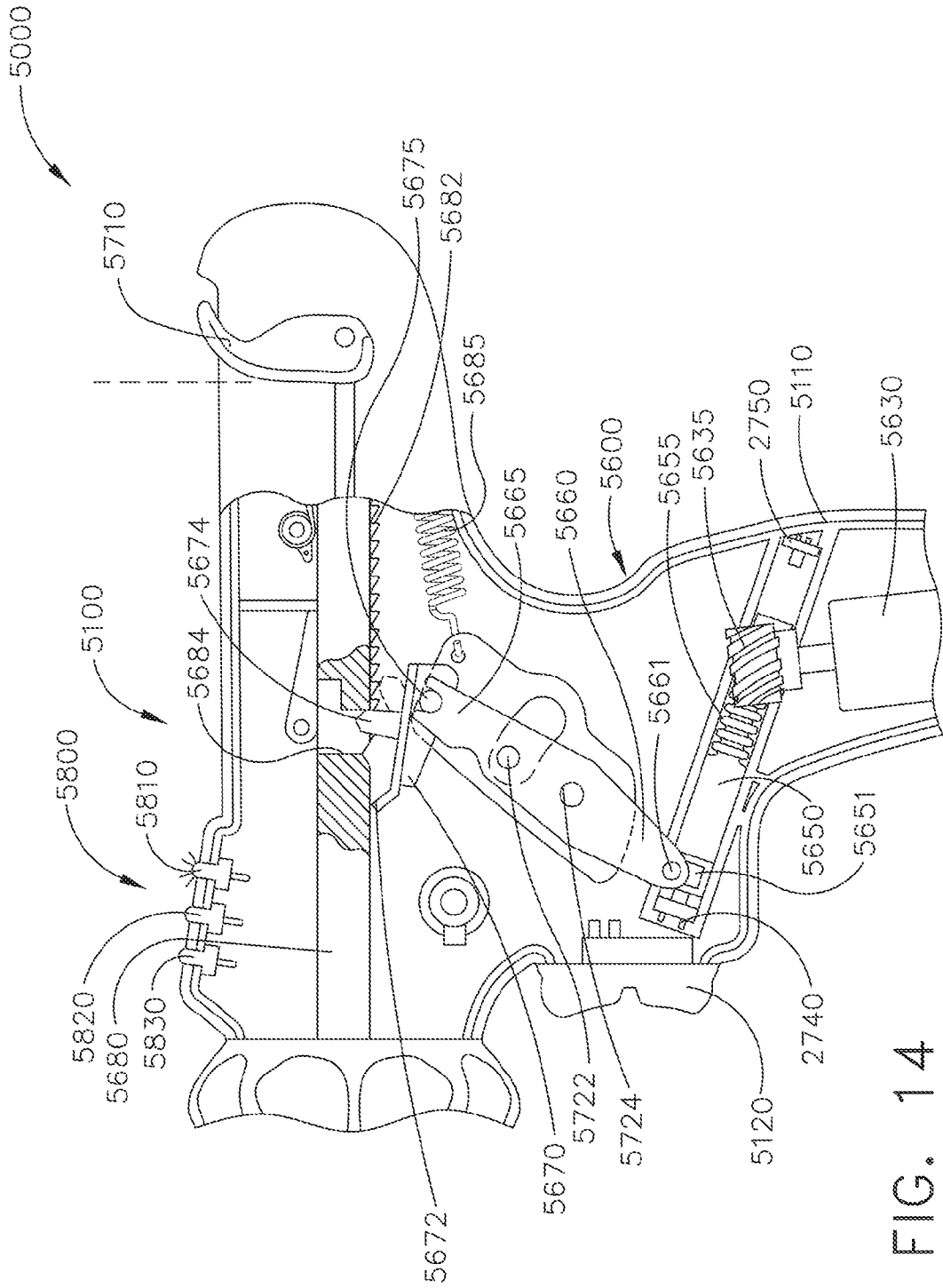


FIG. 14

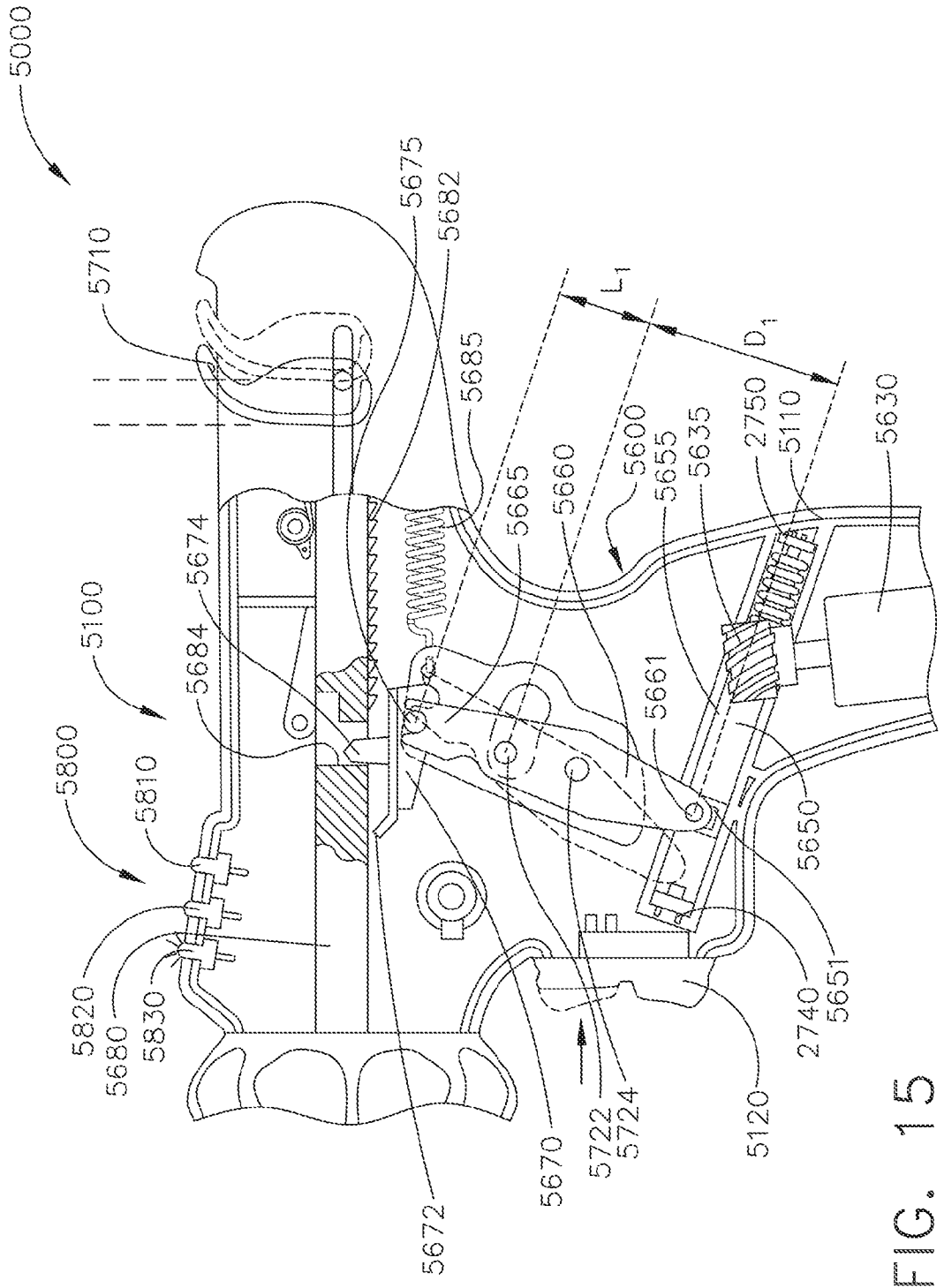


FIG. 15

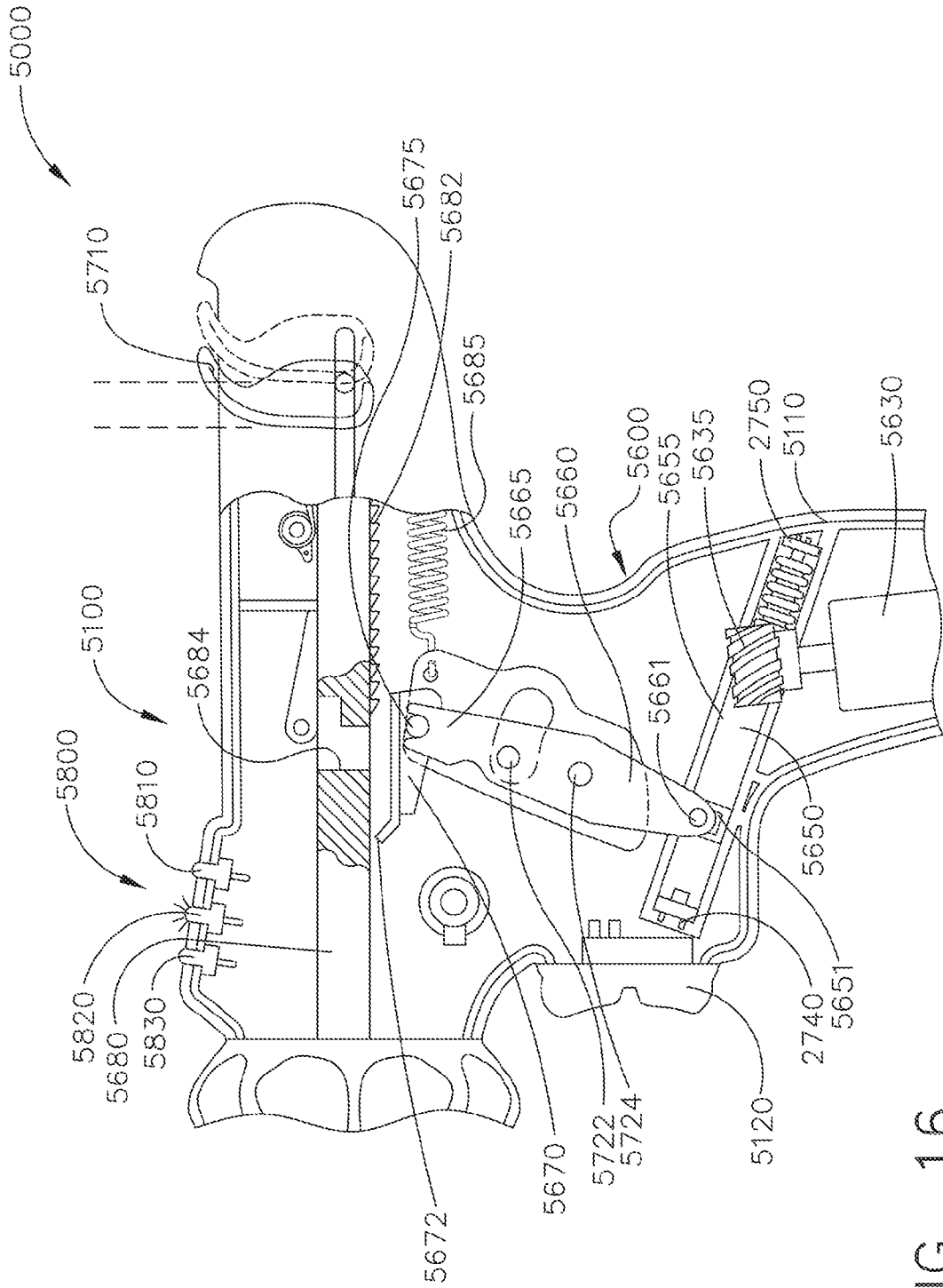


FIG. 16

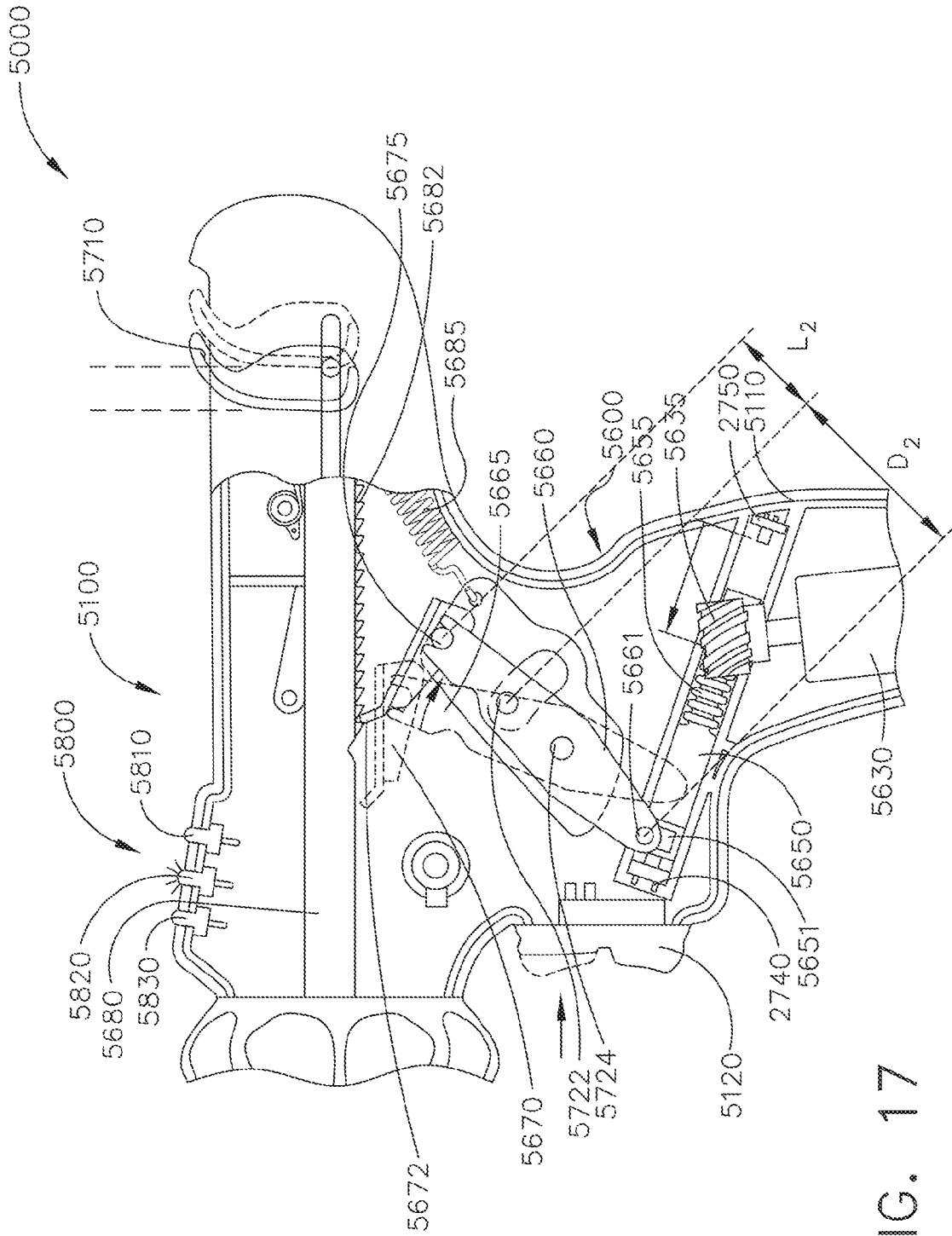


FIG. 17

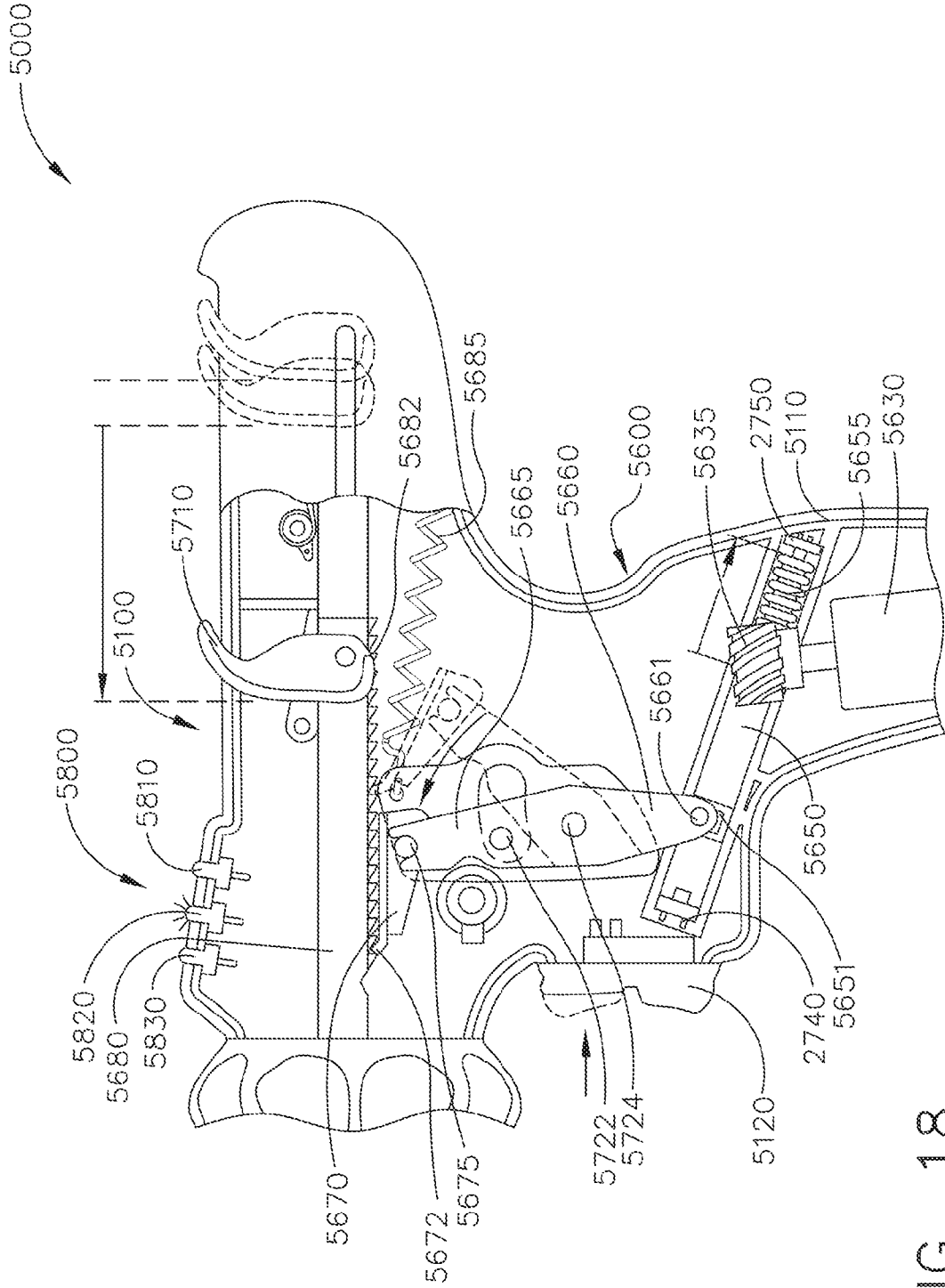


FIG. 18

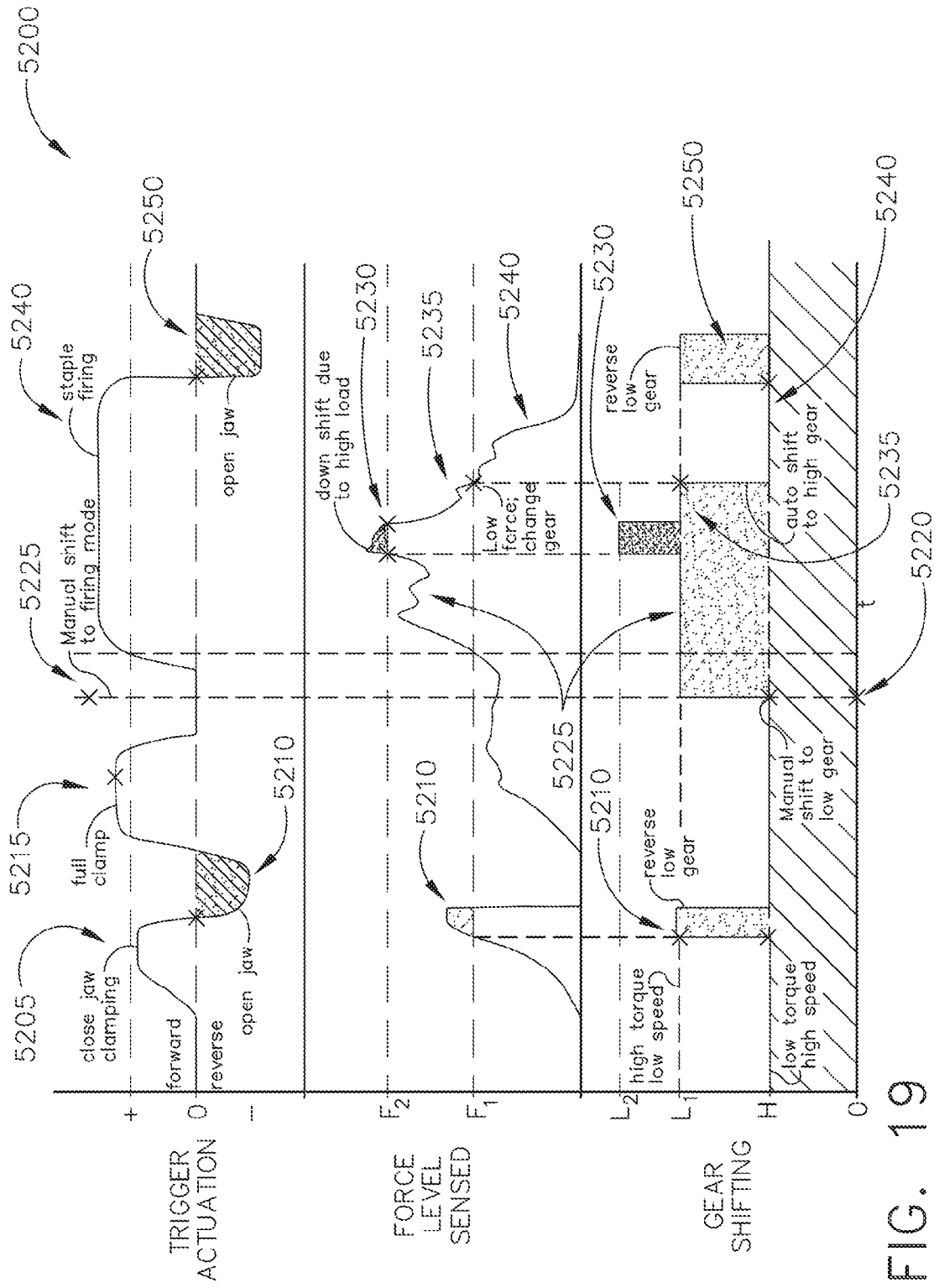


FIG. 19

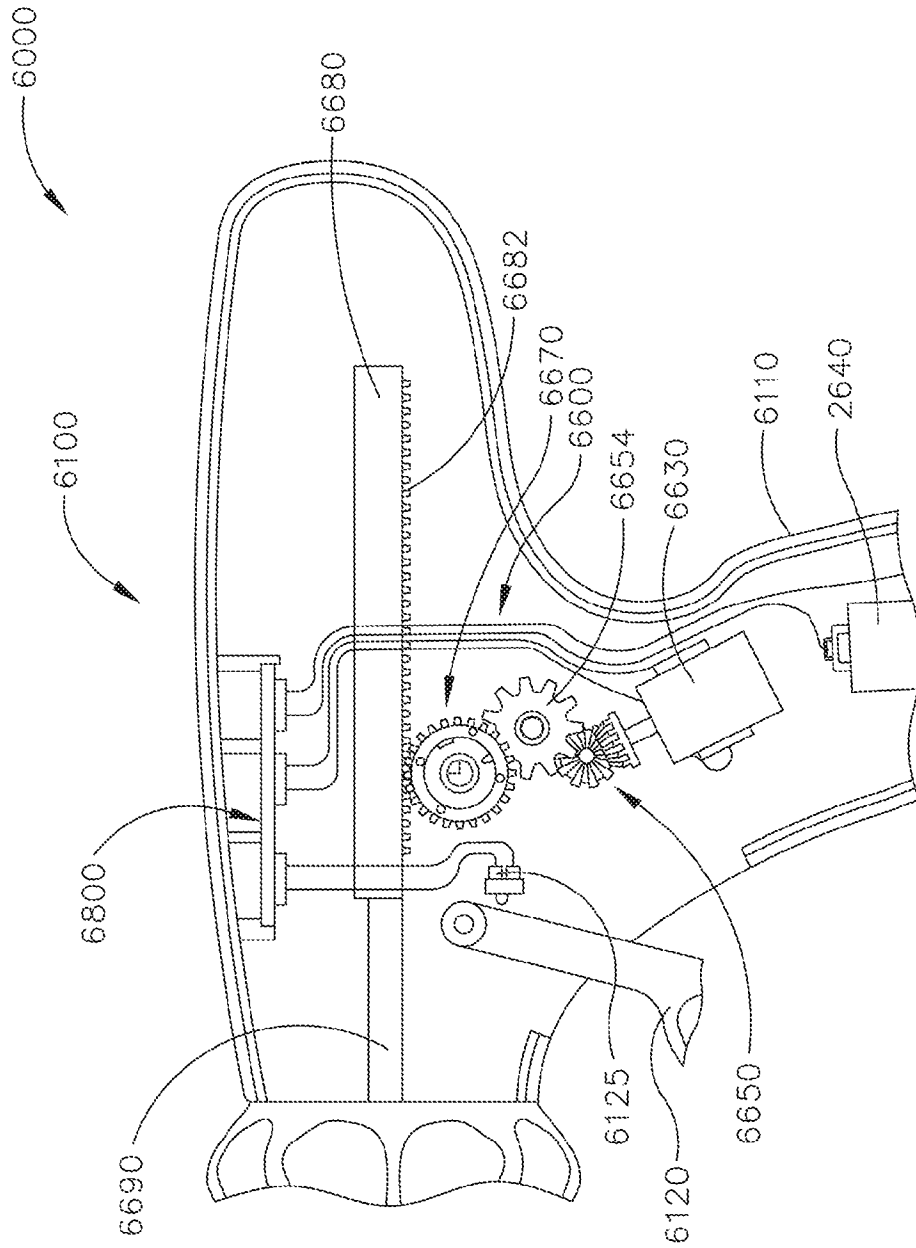


FIG. 20

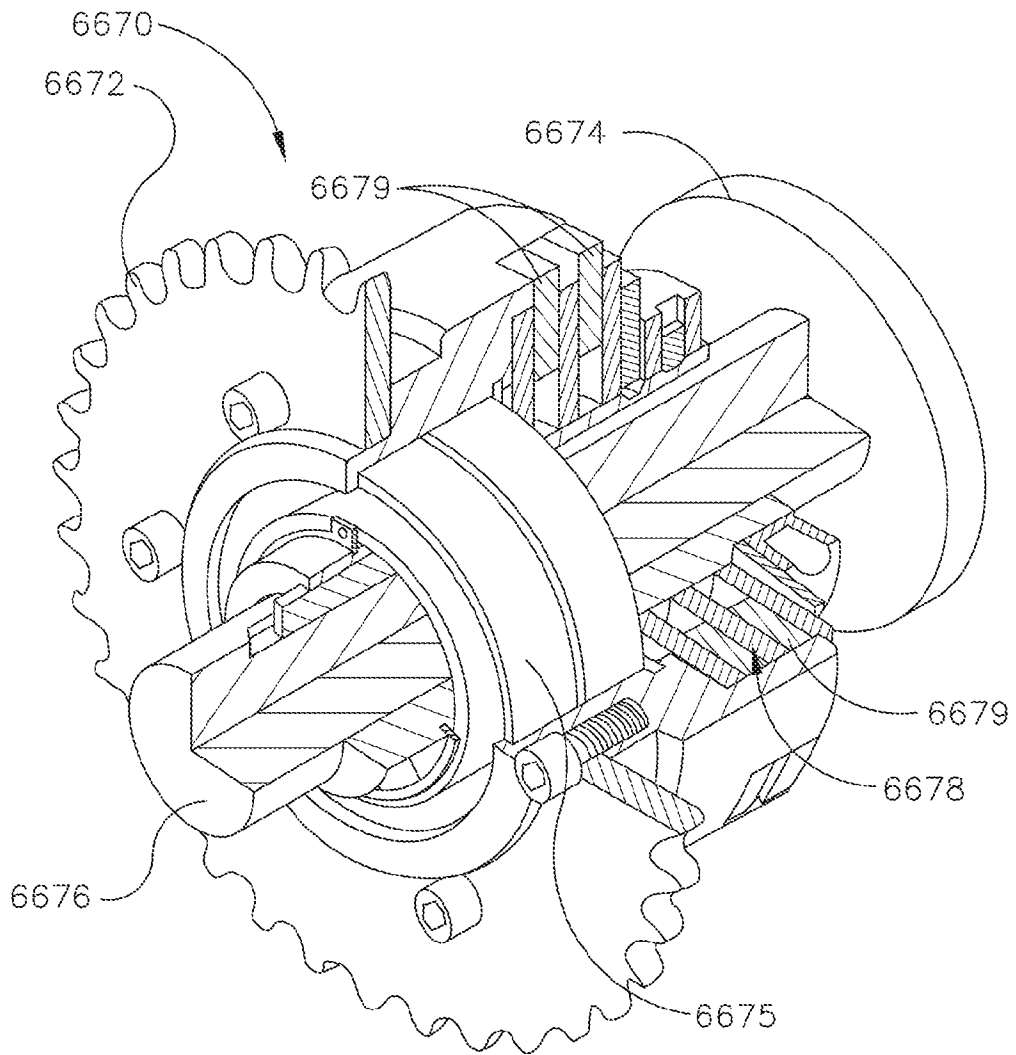


FIG. 20A

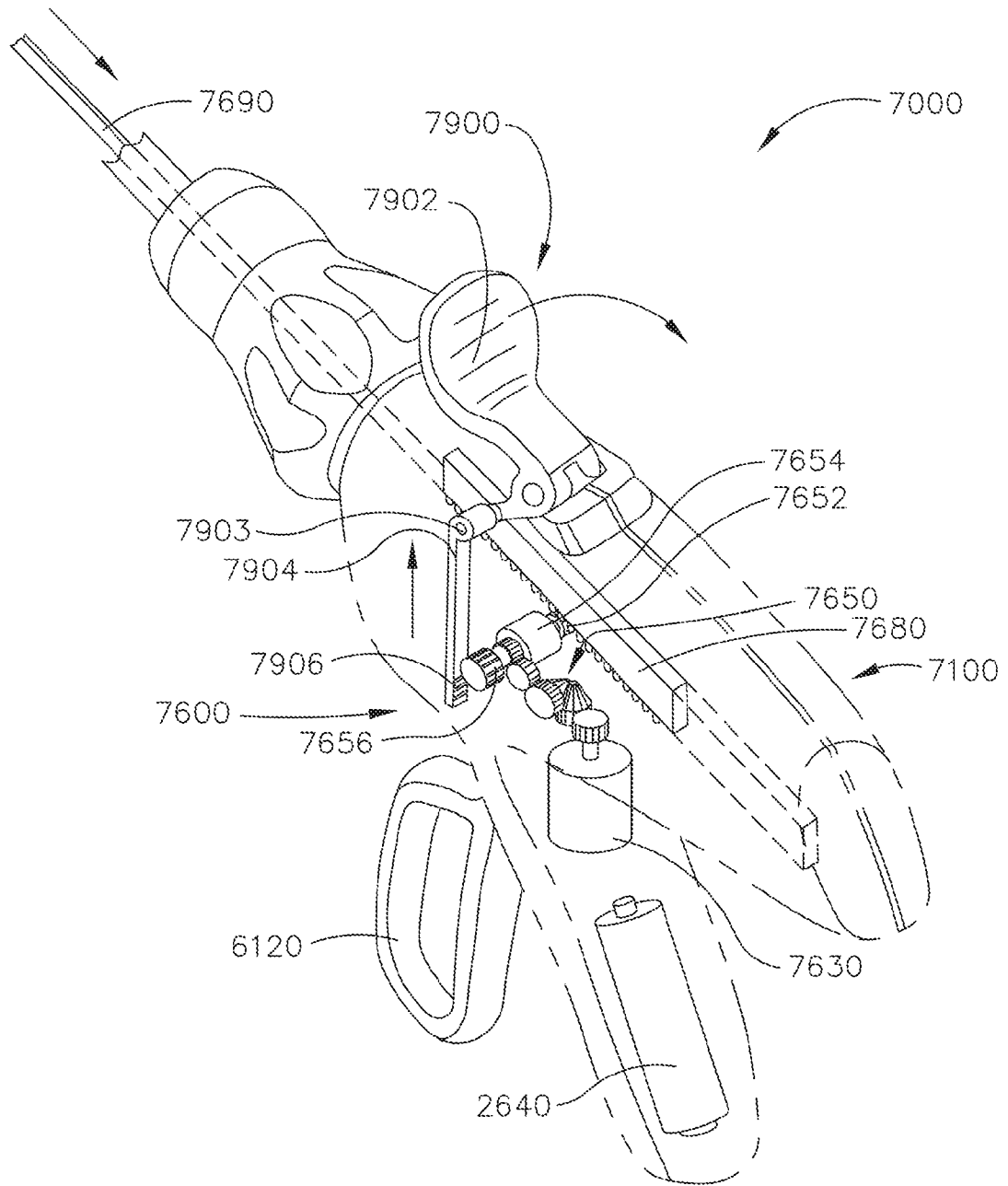


FIG. 21

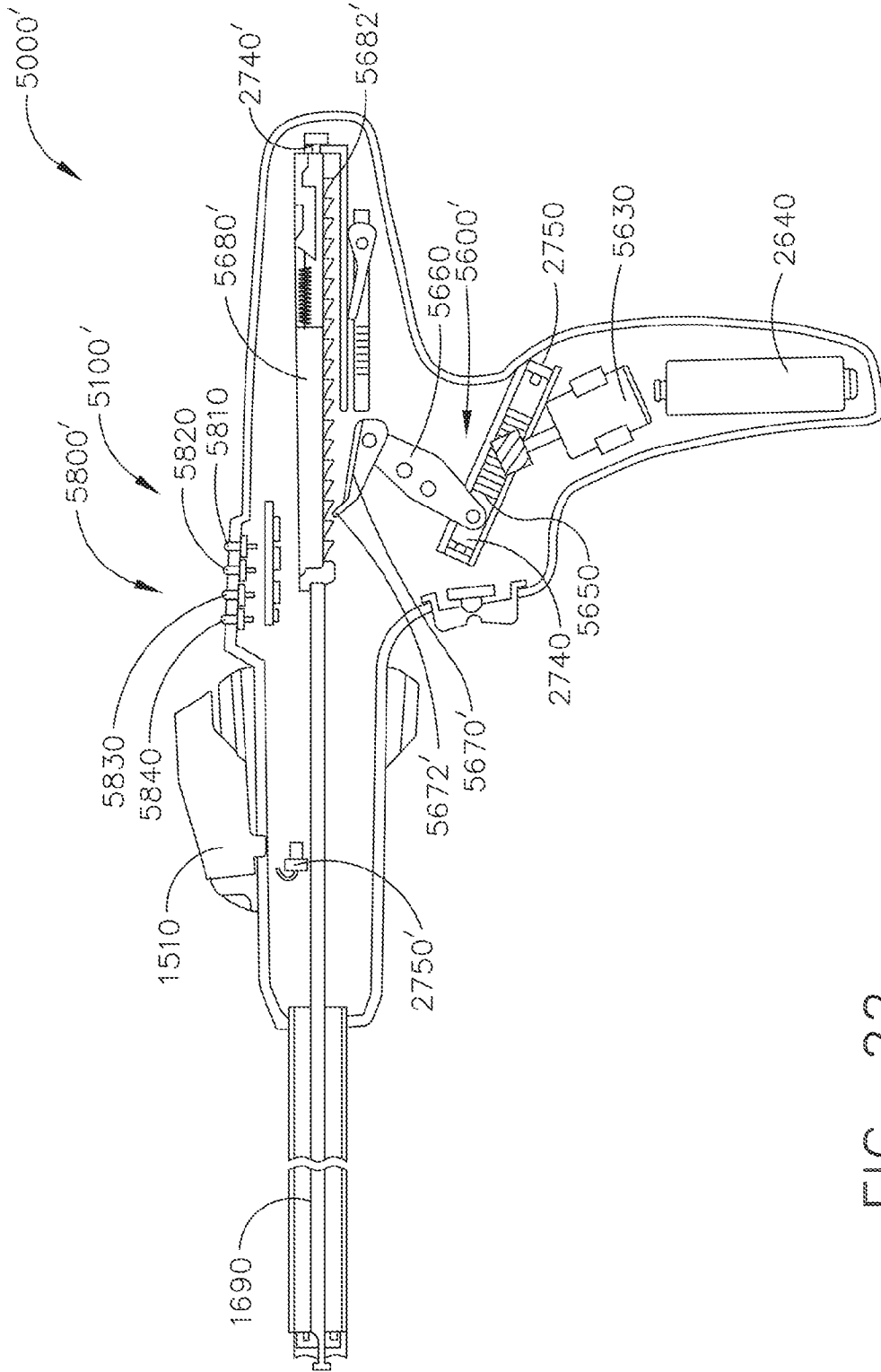
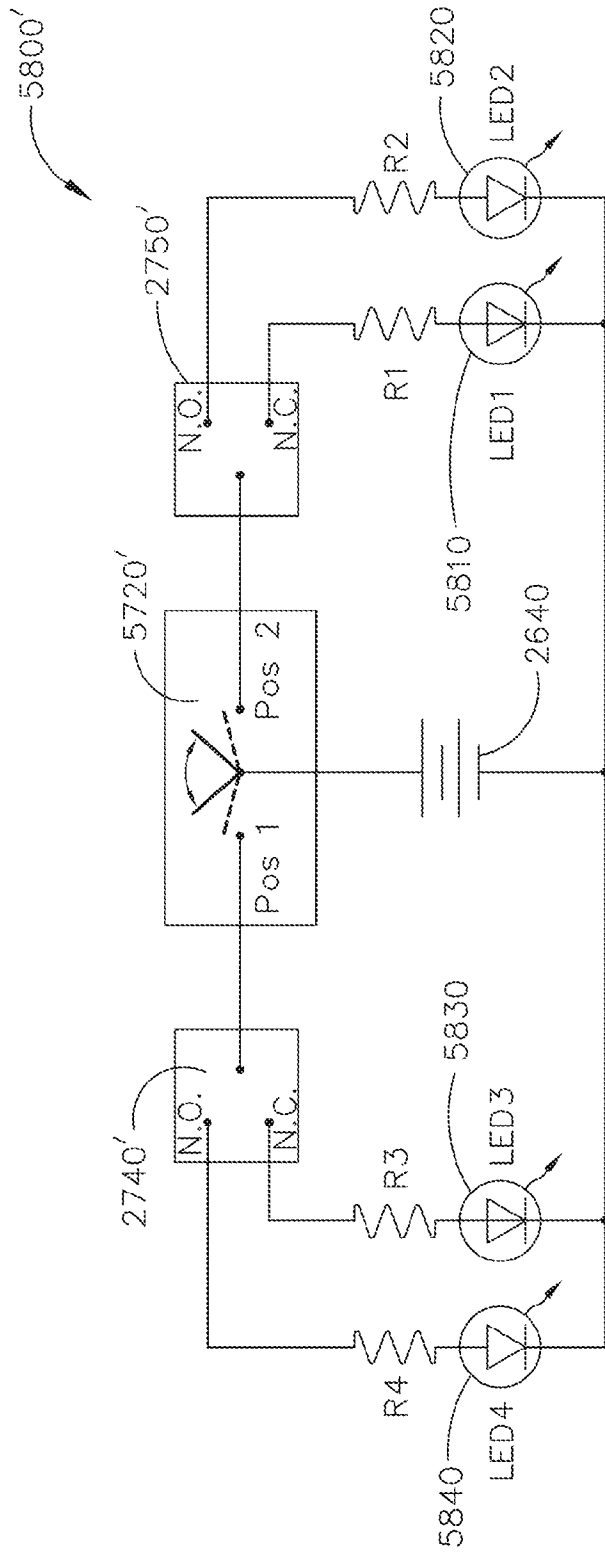


FIG. 22



(Position 1) Jaw Closure		(Position 2) Firing			
LED 1	N.C.	N.C.	LED 1	H	L
LED 2	N.C.	N.C.	LED 2	L	H
LED 3	H	L	LED 3	N.C.	N.C.
LED 4	L	H	LED 4	N.C.	N.C.

FIG. 22A

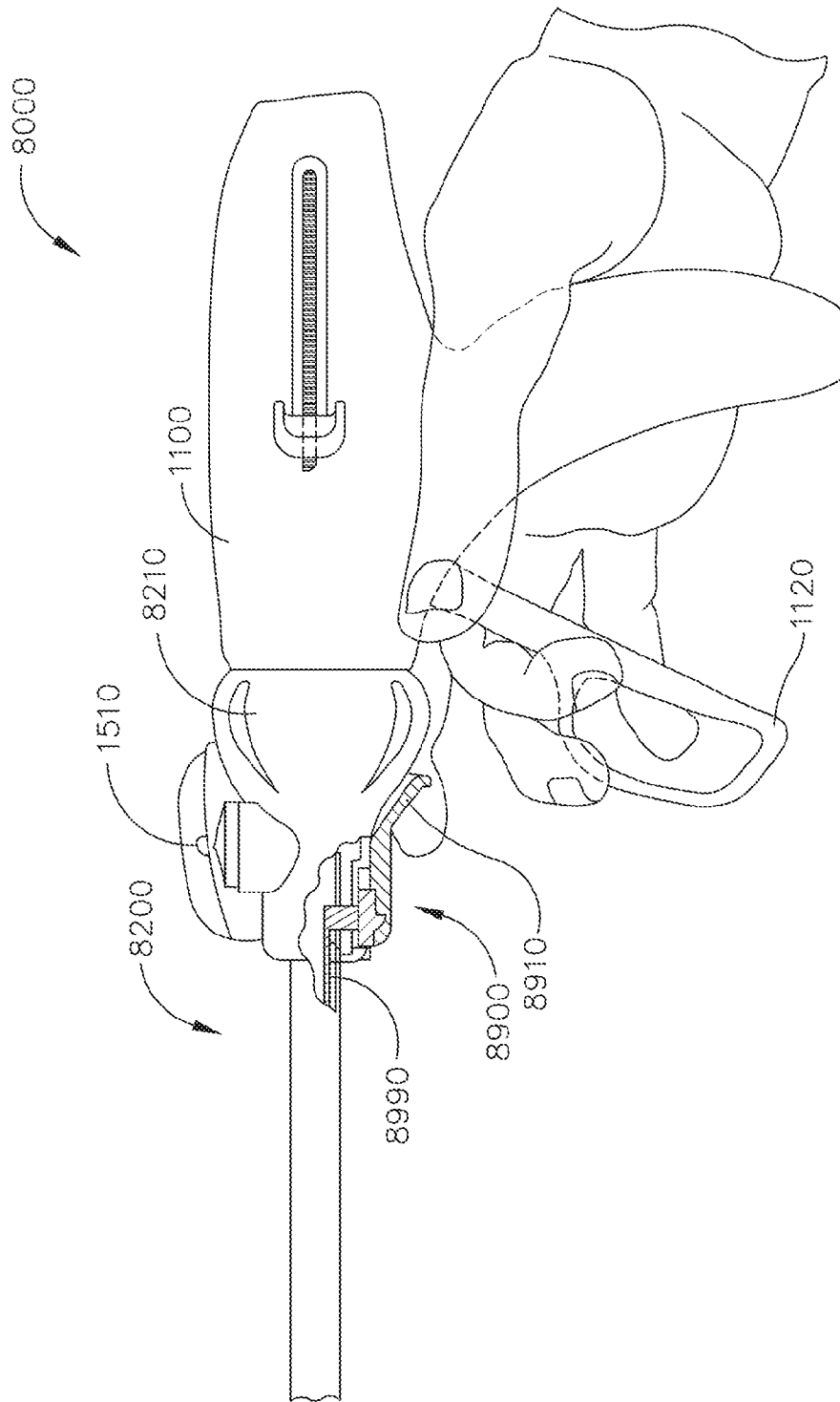


FIG. 23

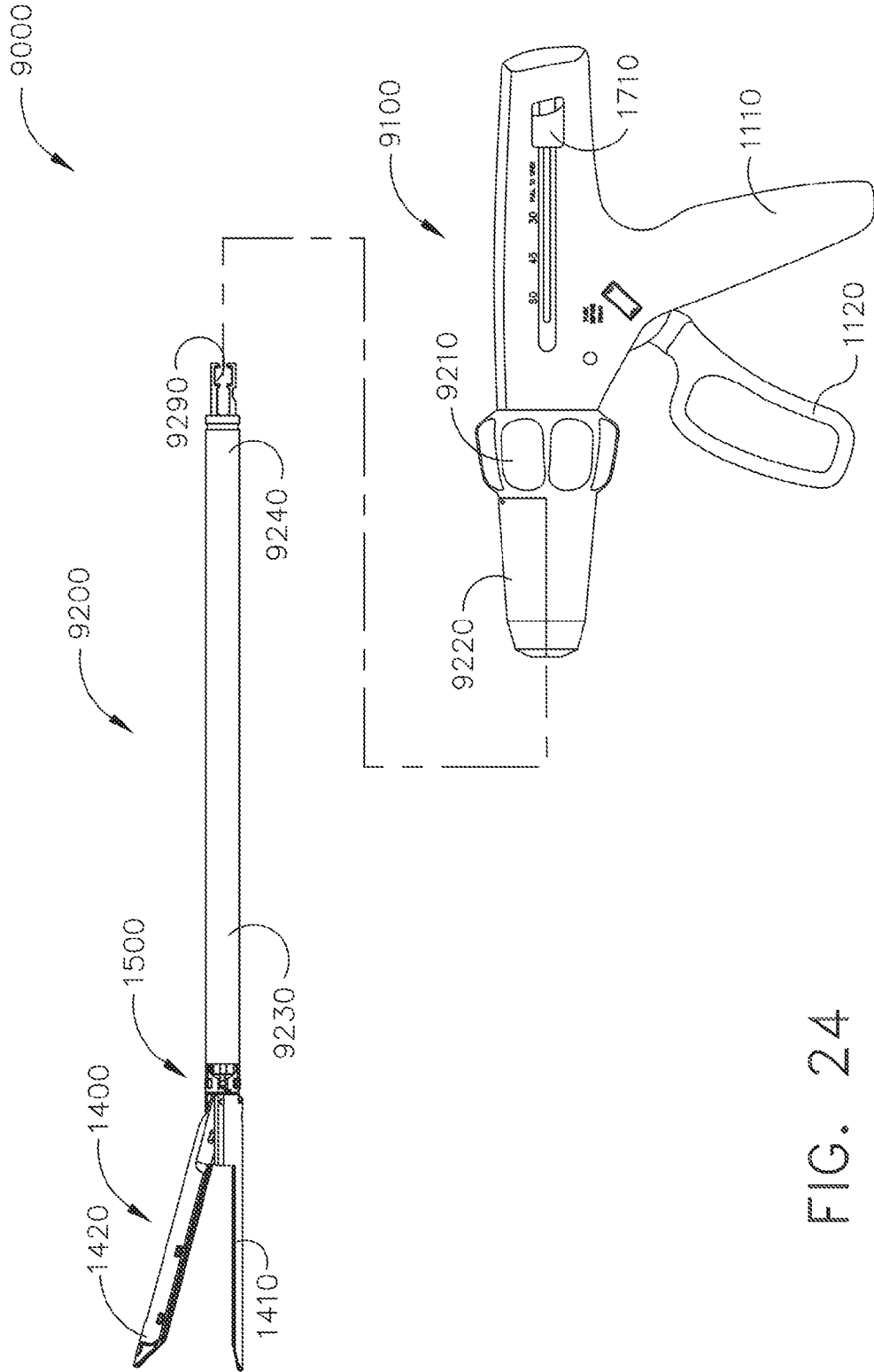


FIG. 24

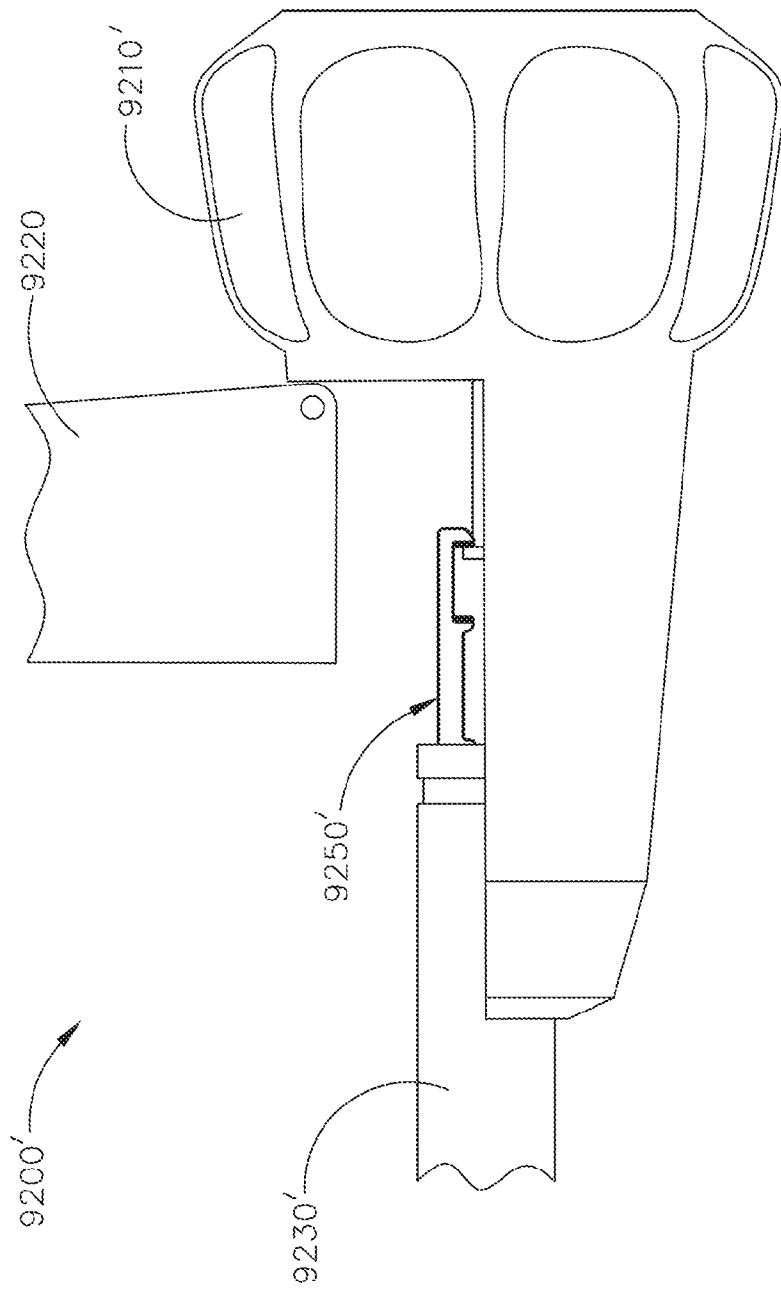


FIG. 25

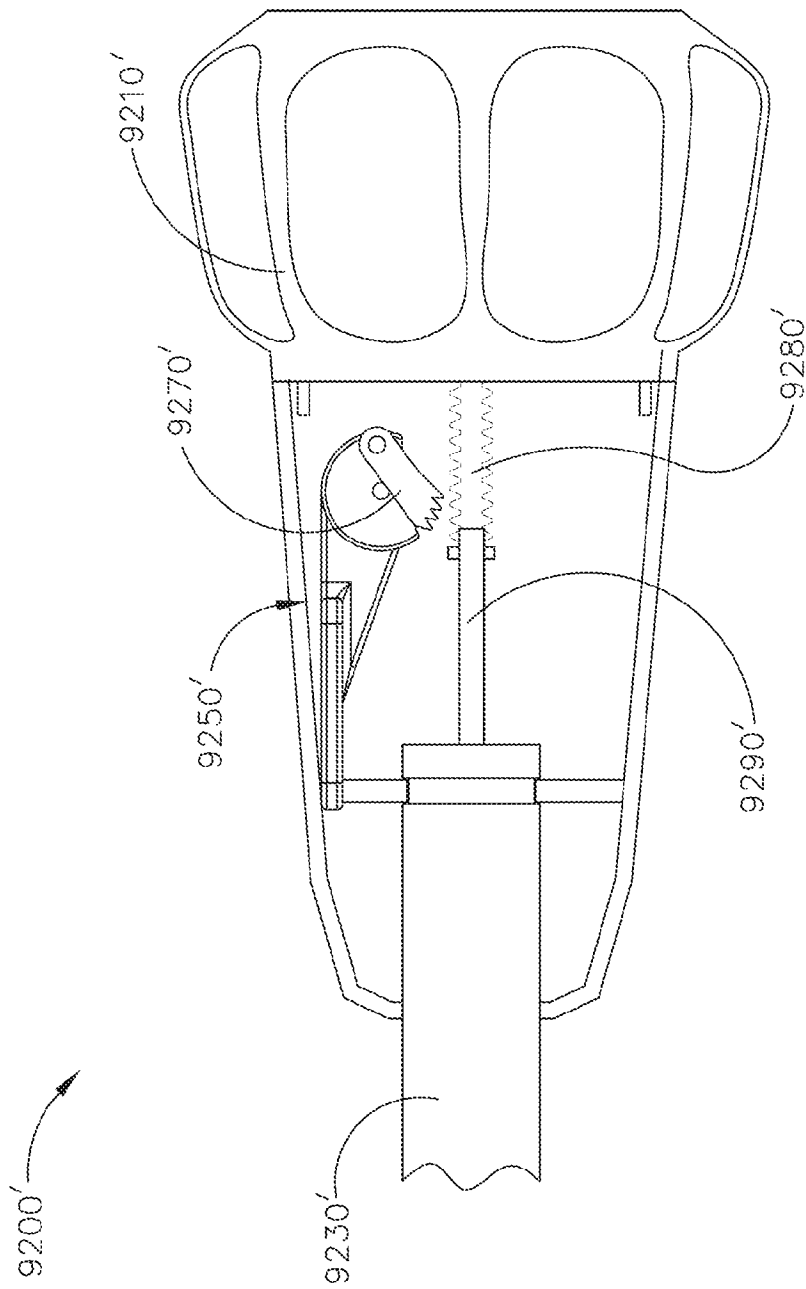


FIG. 25A

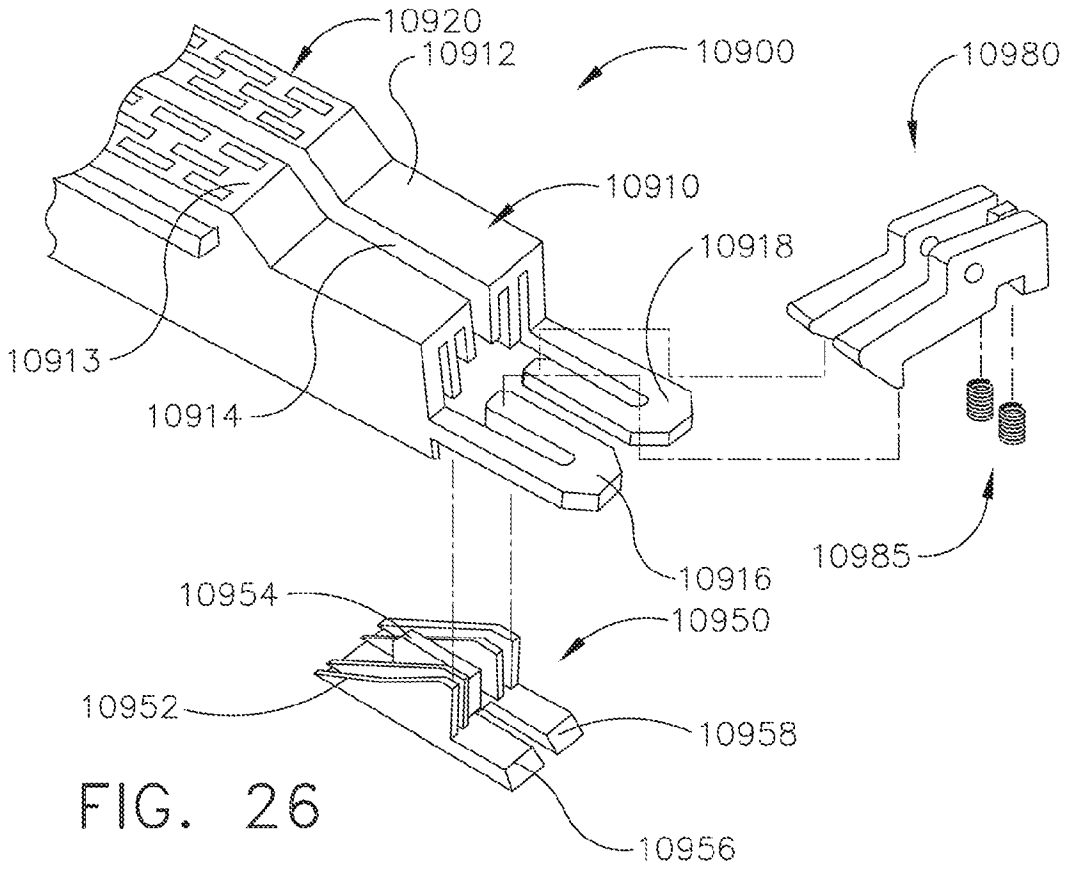


FIG. 26

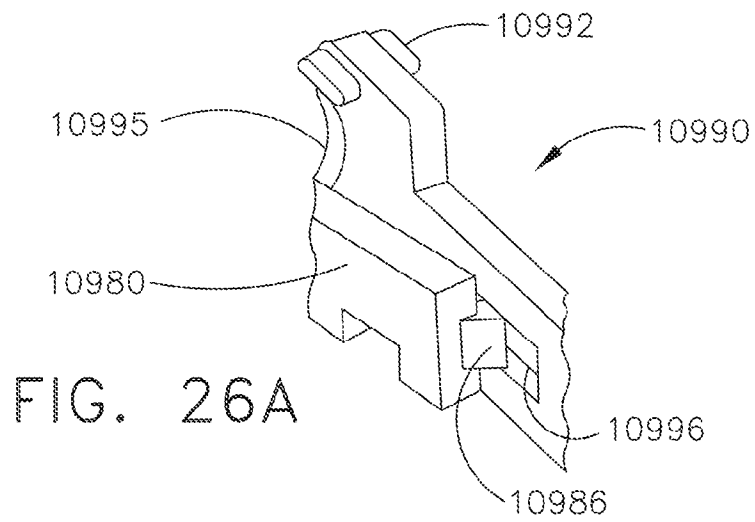


FIG. 26A

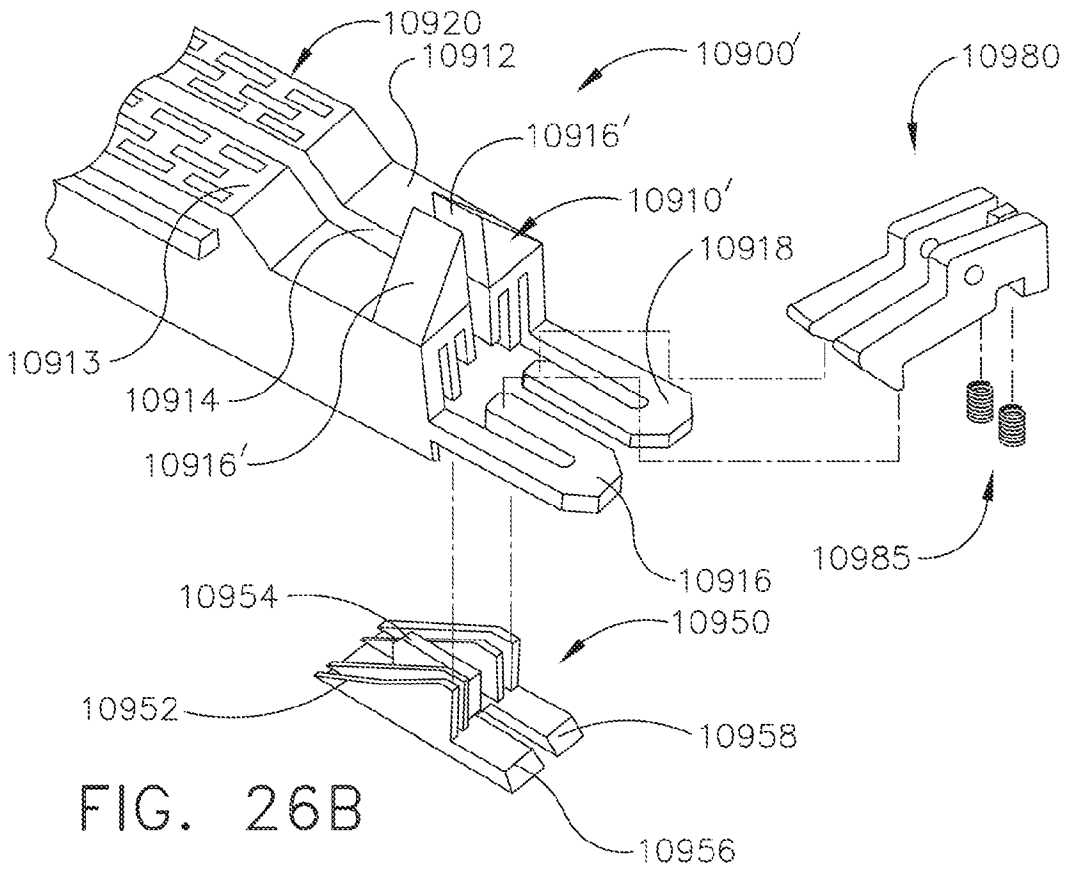


FIG. 26B

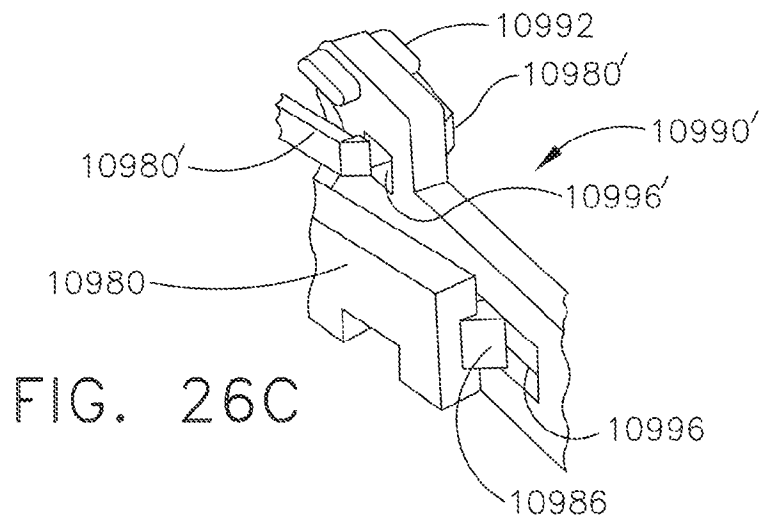


FIG. 26C

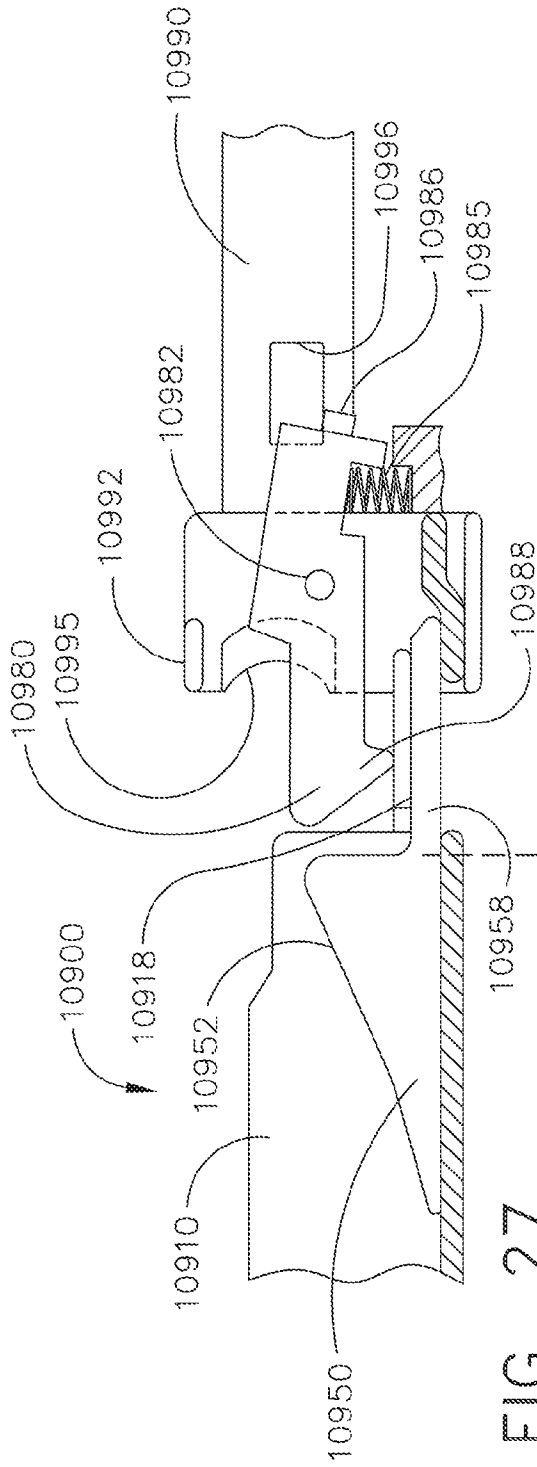


FIG. 27

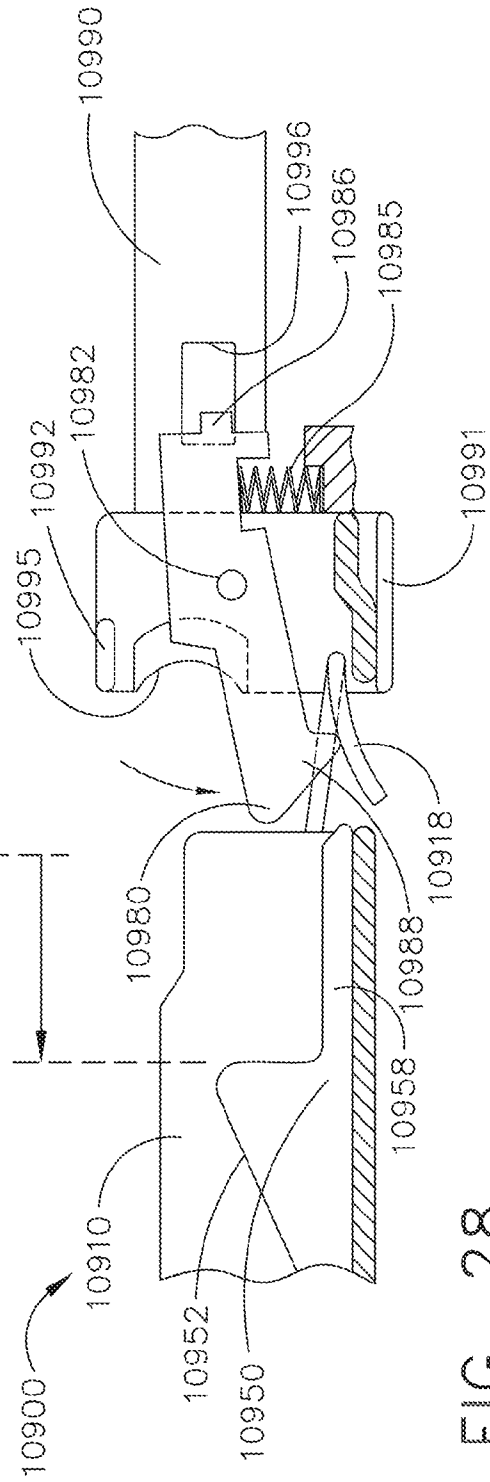


FIG. 28

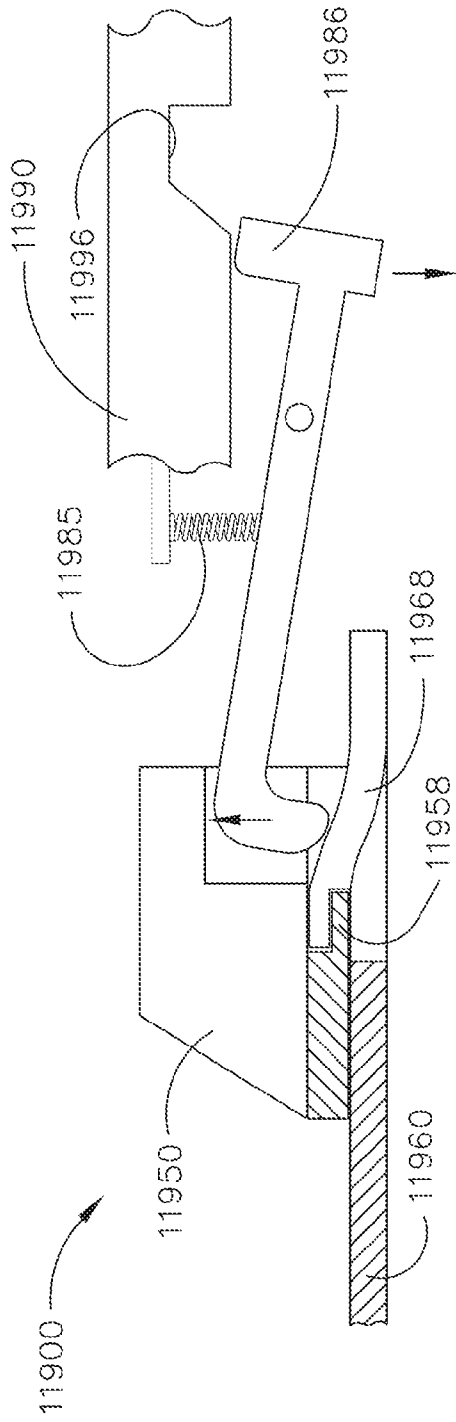


FIG. 29

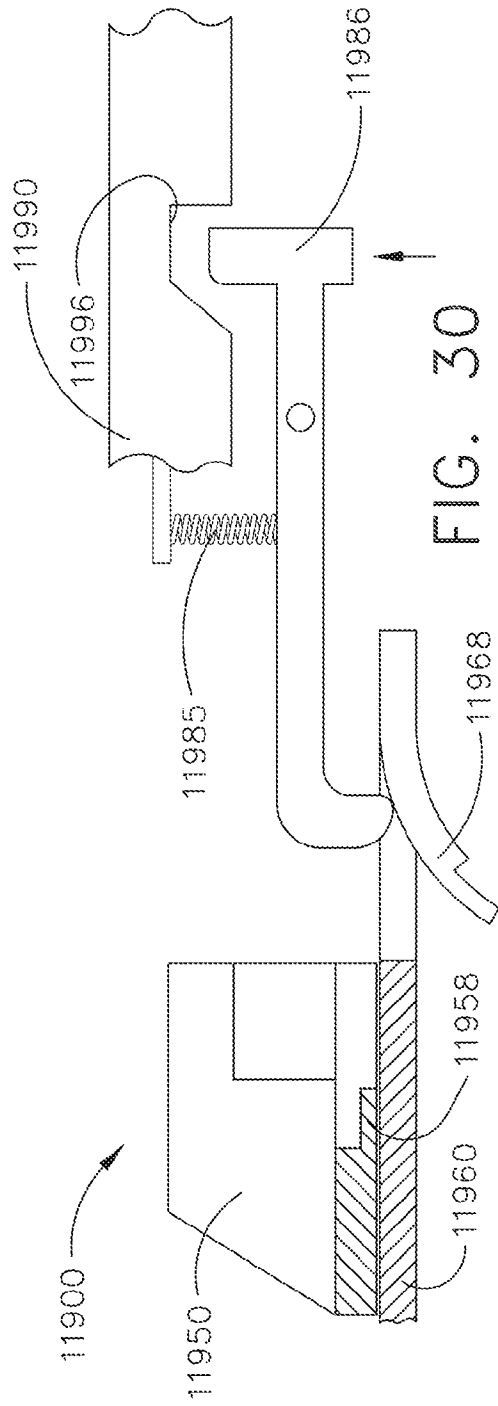


FIG. 30

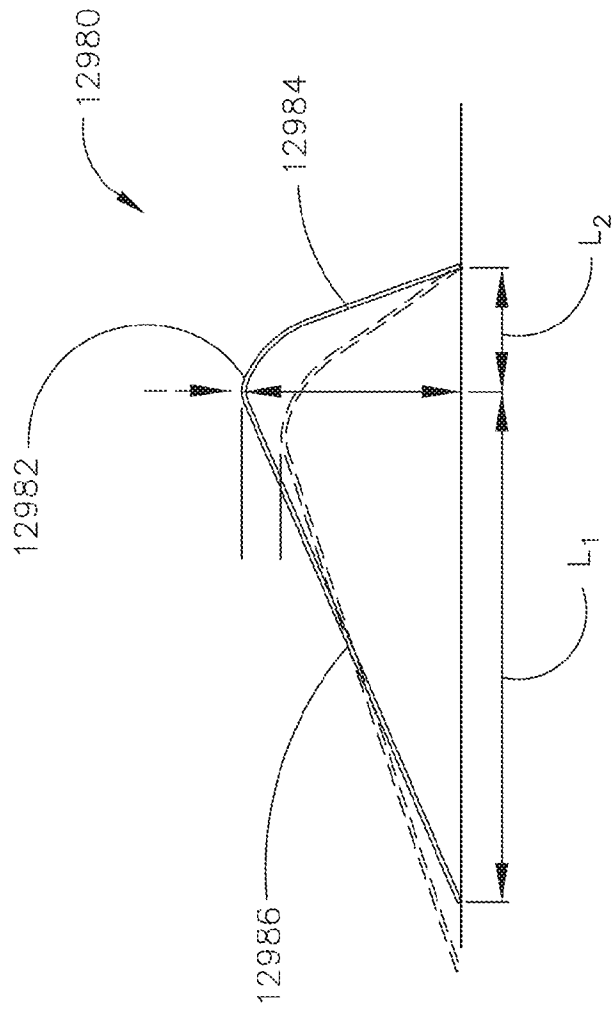


FIG. 31

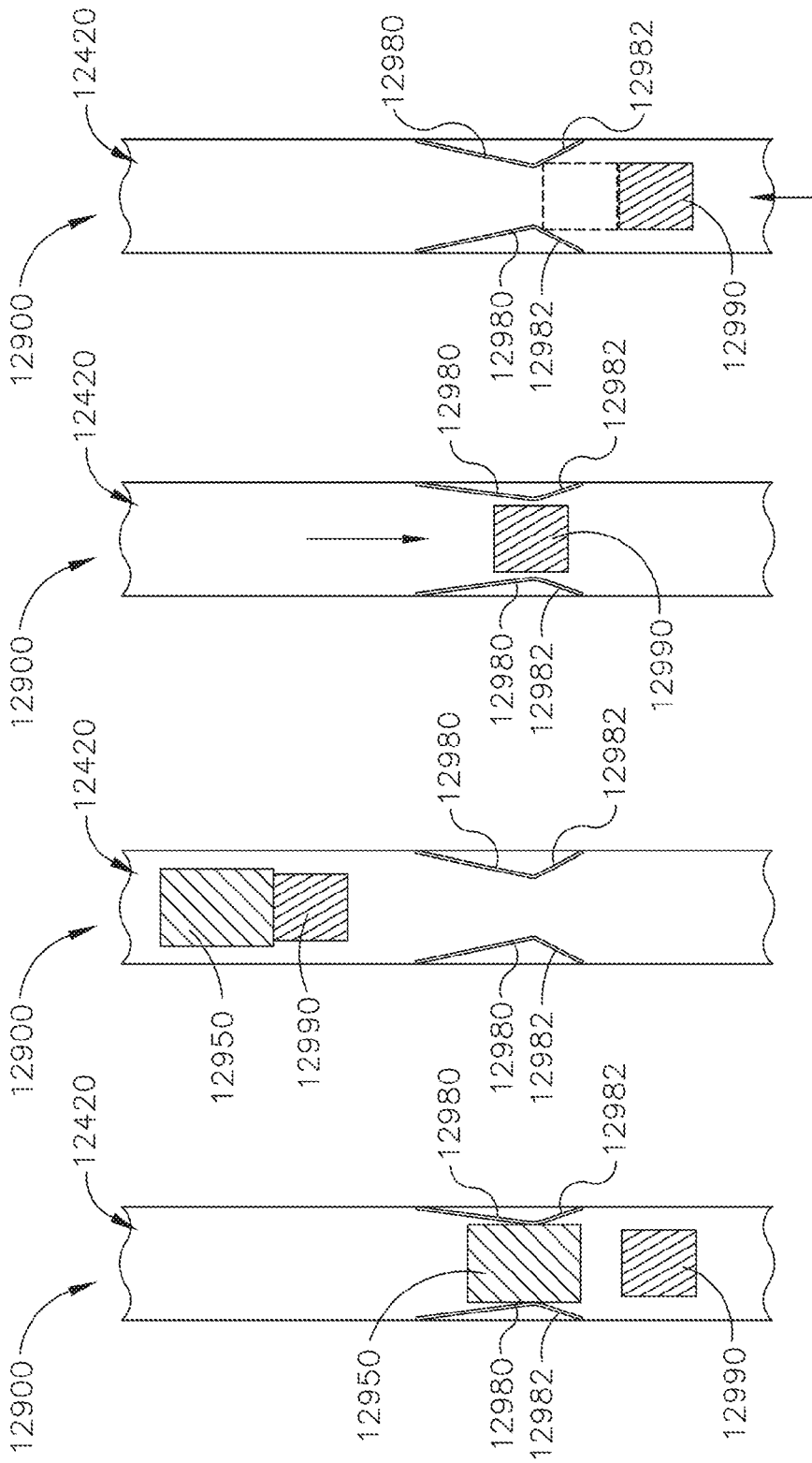


FIG. 31A FIG. 31B FIG. 31C FIG. 31D

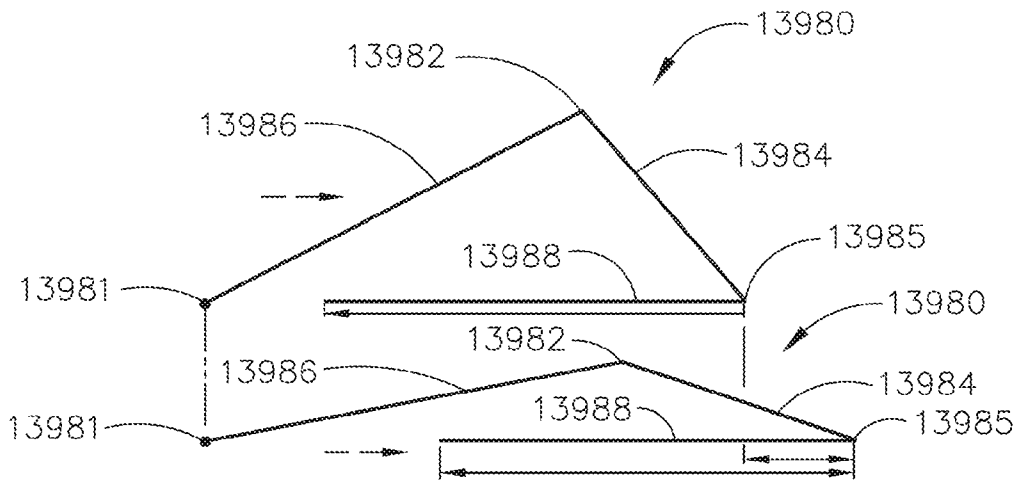


FIG. 32

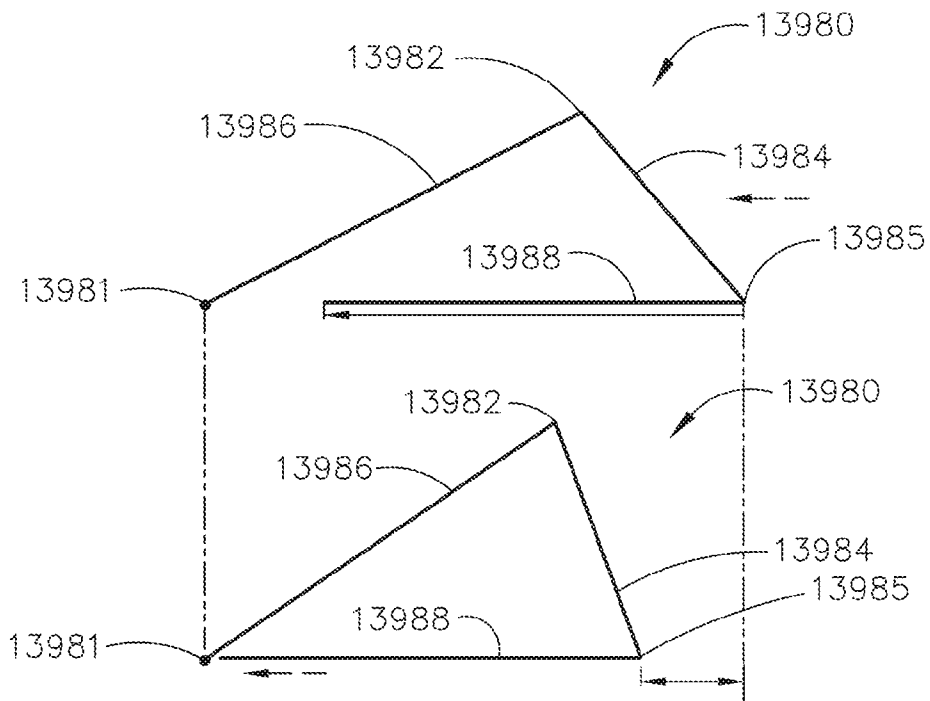


FIG. 33

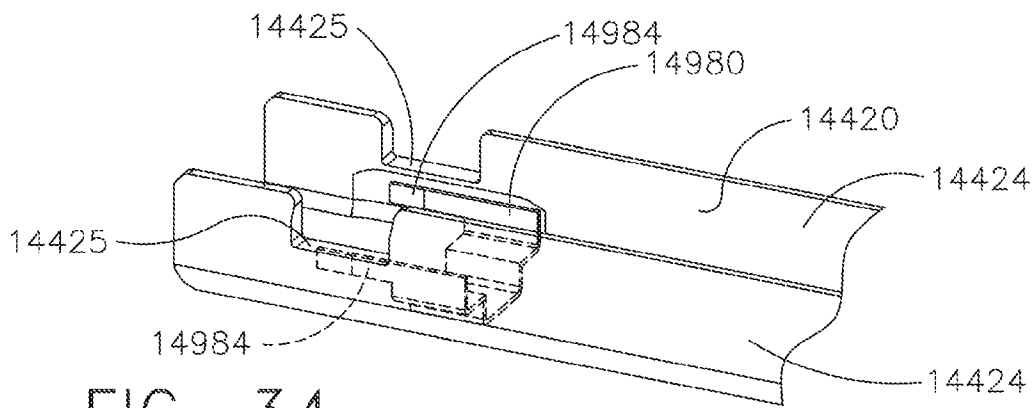


FIG. 34

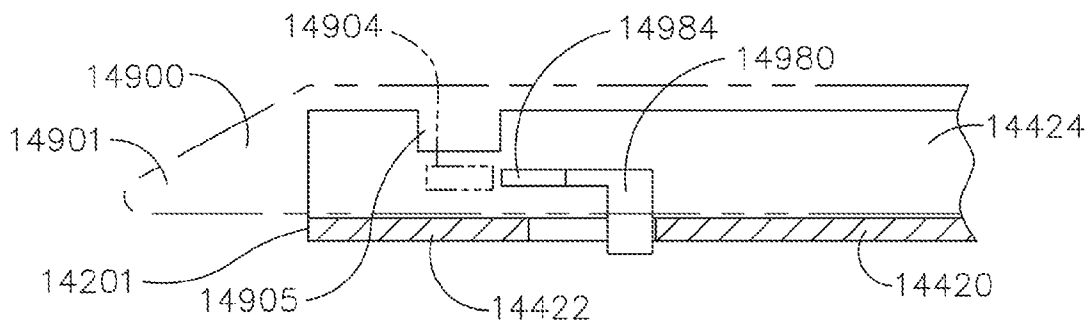


FIG. 35

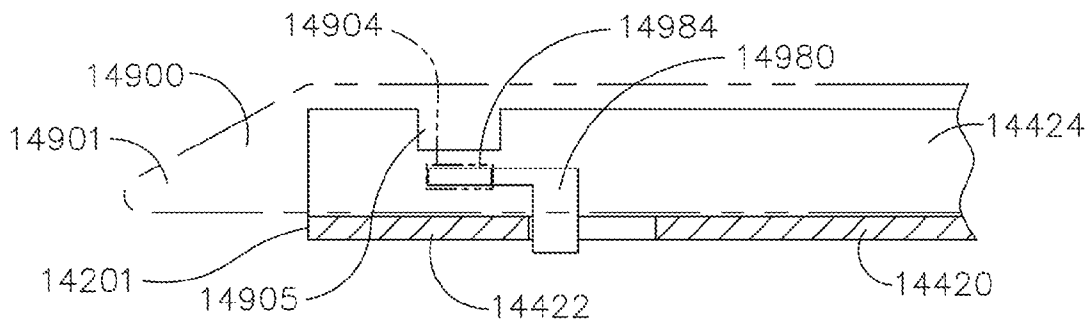


FIG. 36

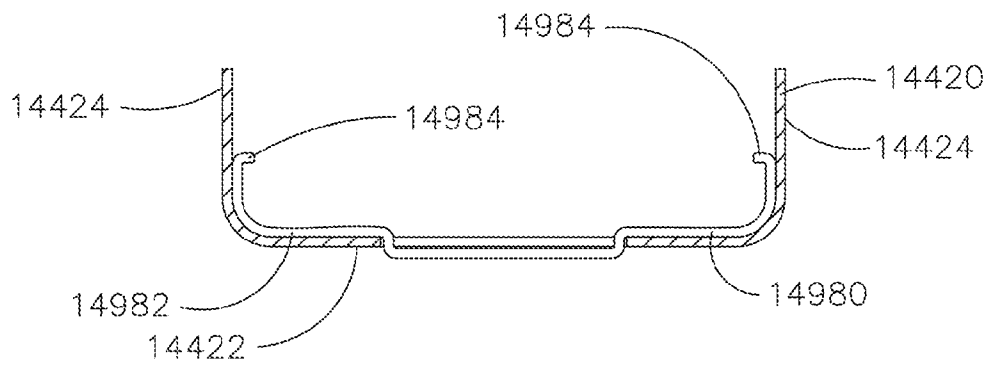


FIG. 37

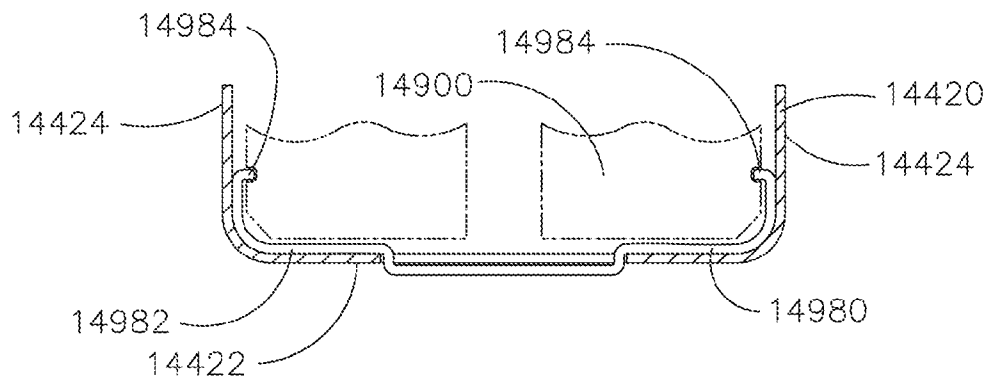


FIG. 38

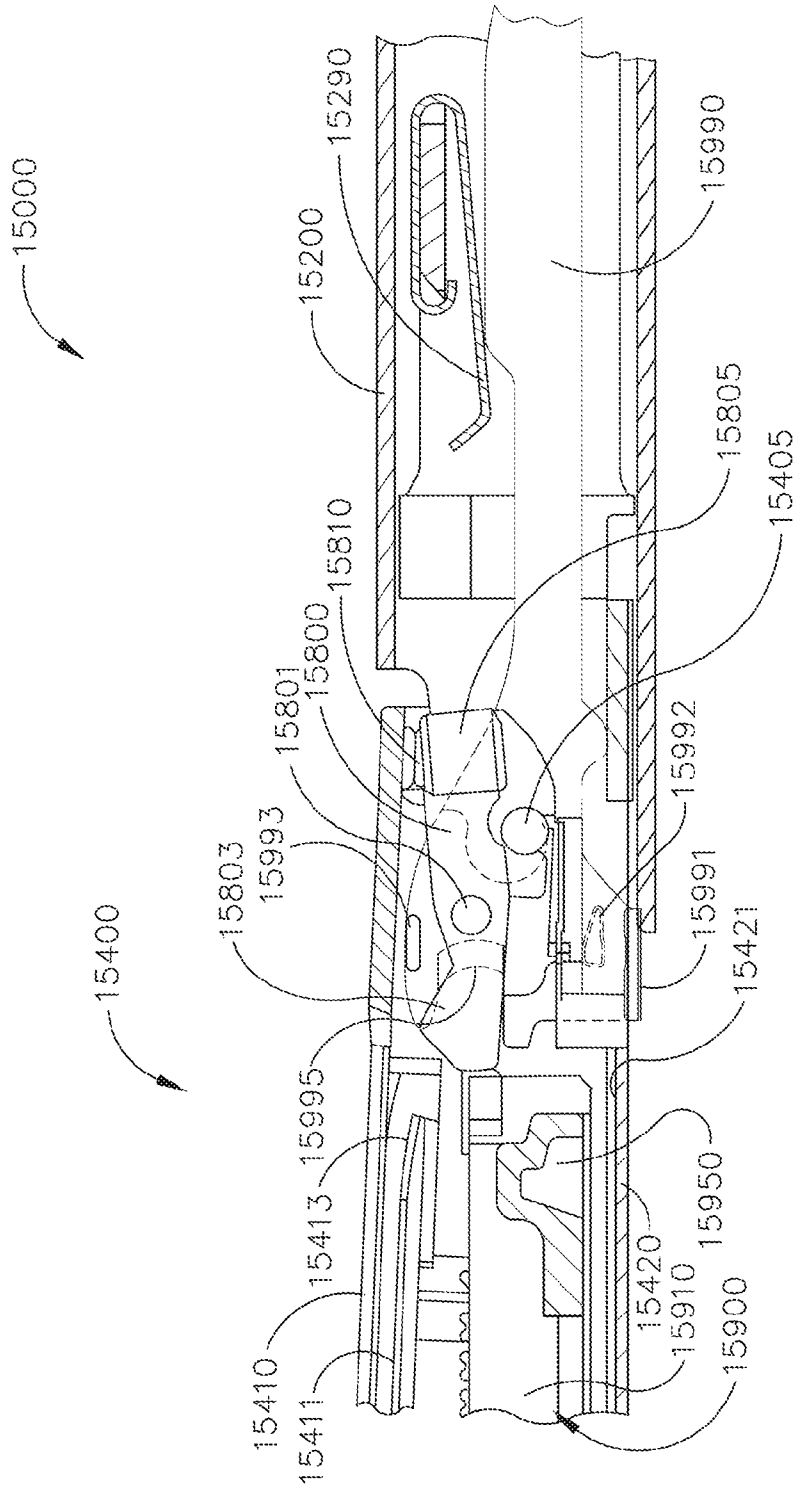


FIG. 39

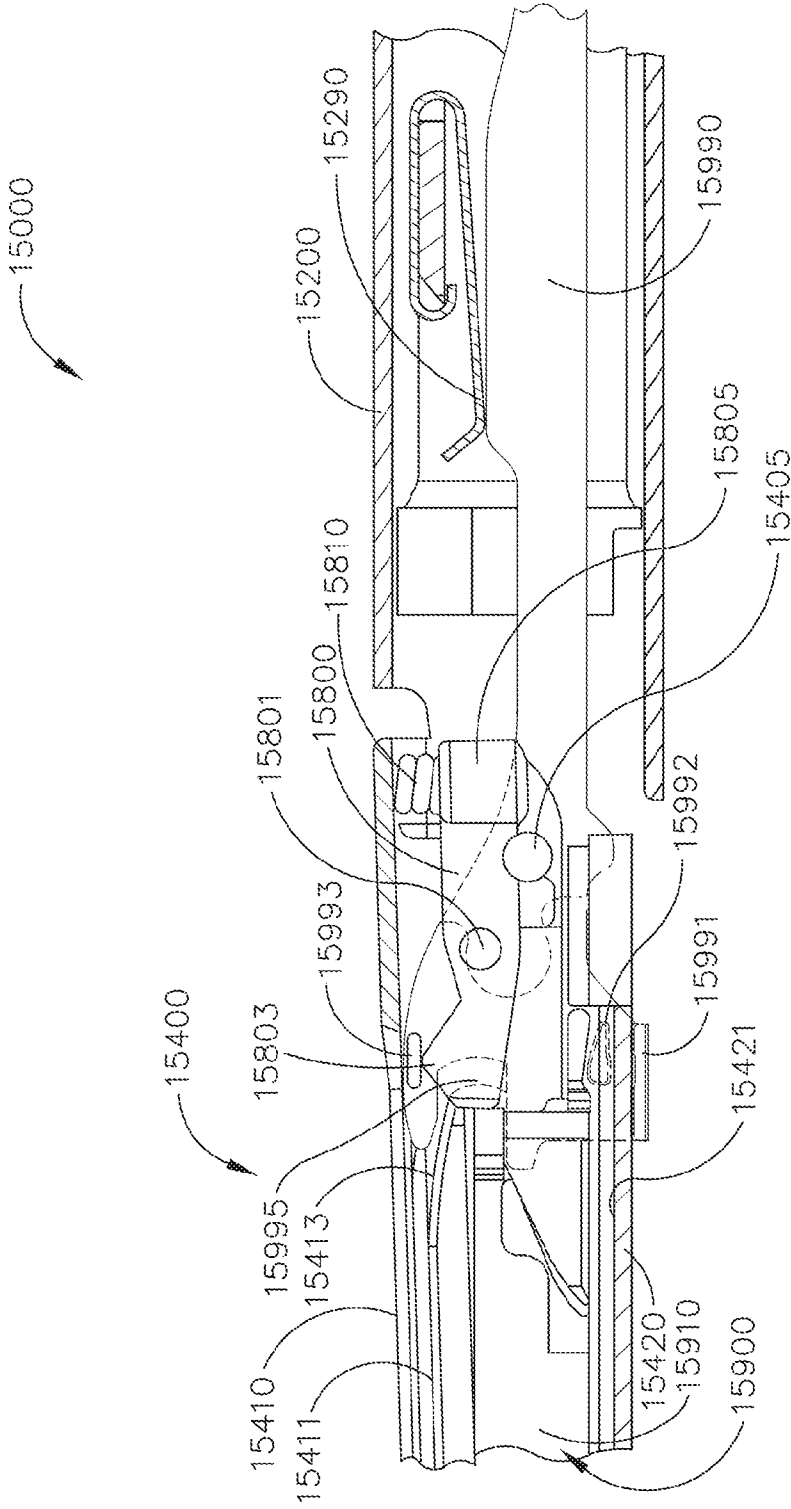


FIG. 40

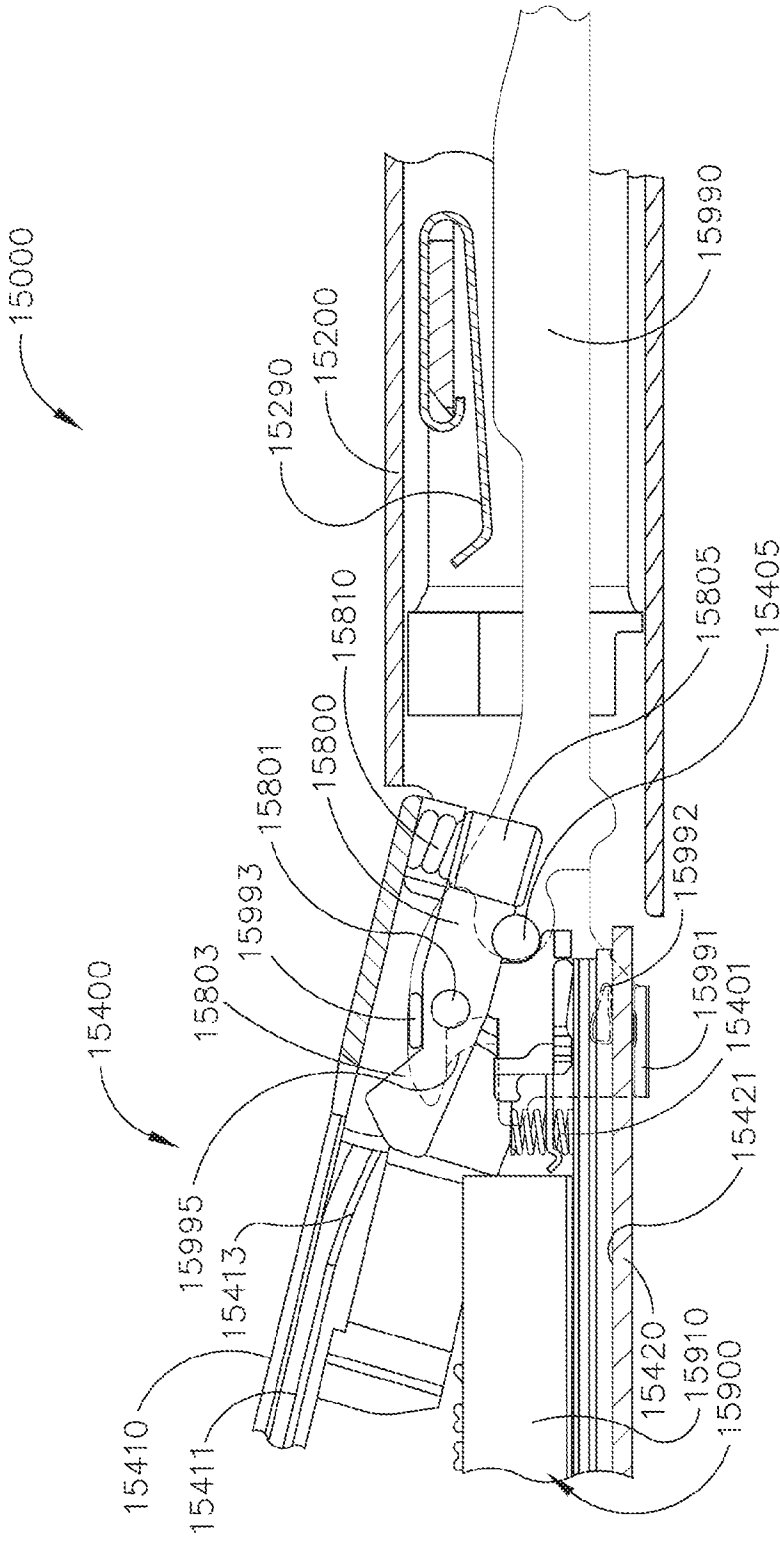


FIG. 41

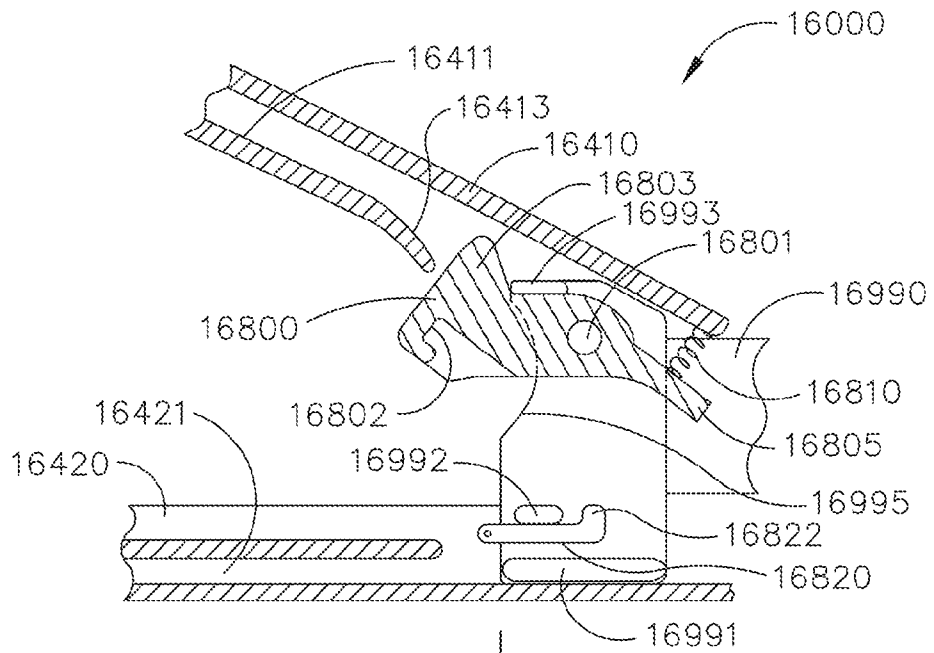


FIG. 42

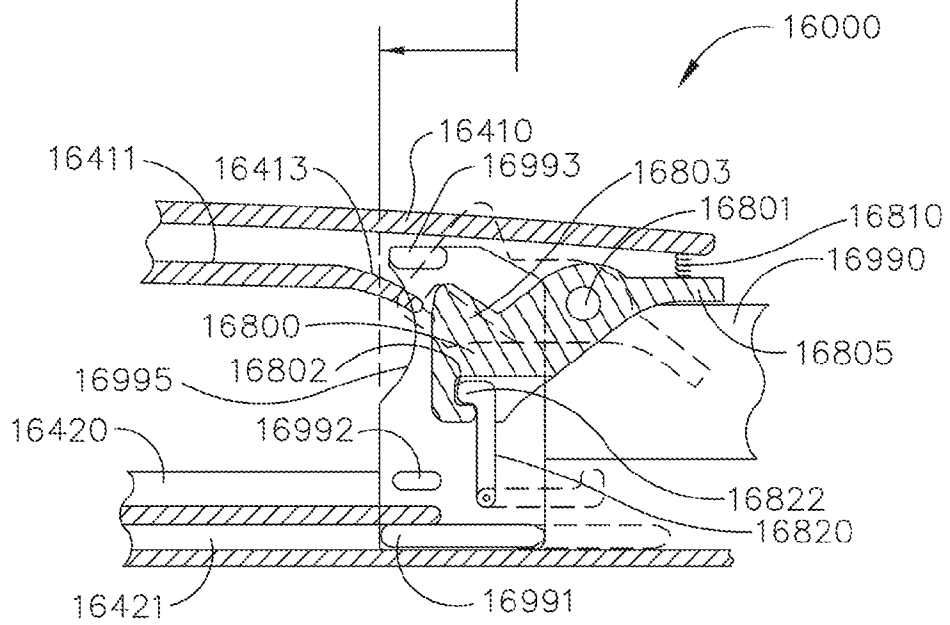


FIG. 43

17000

17400

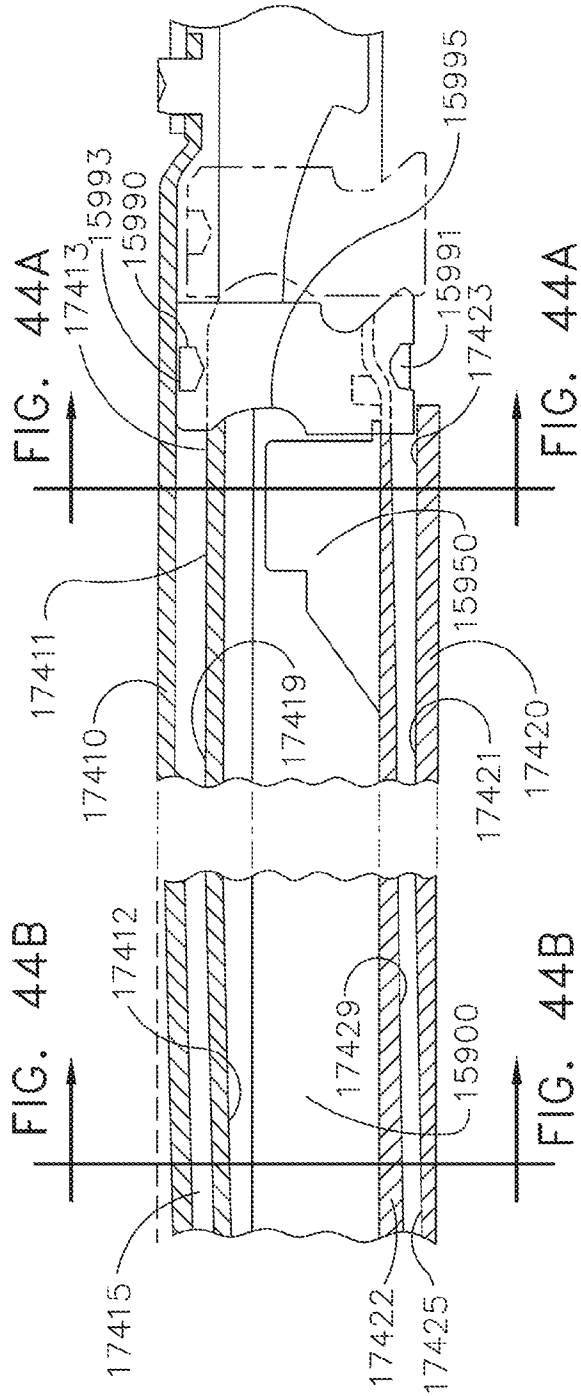


FIG. 44

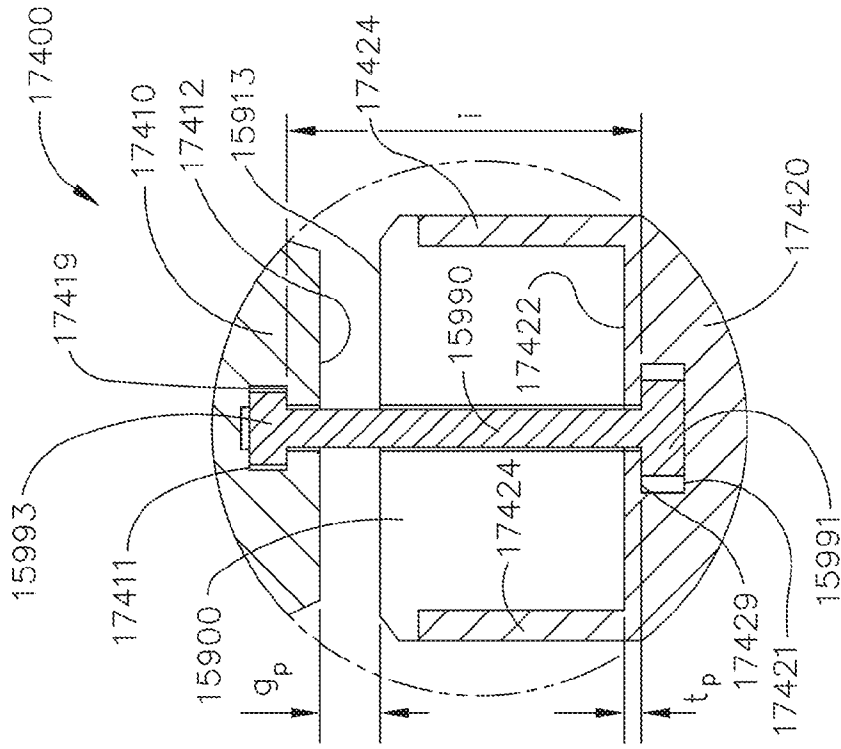


FIG. 44A

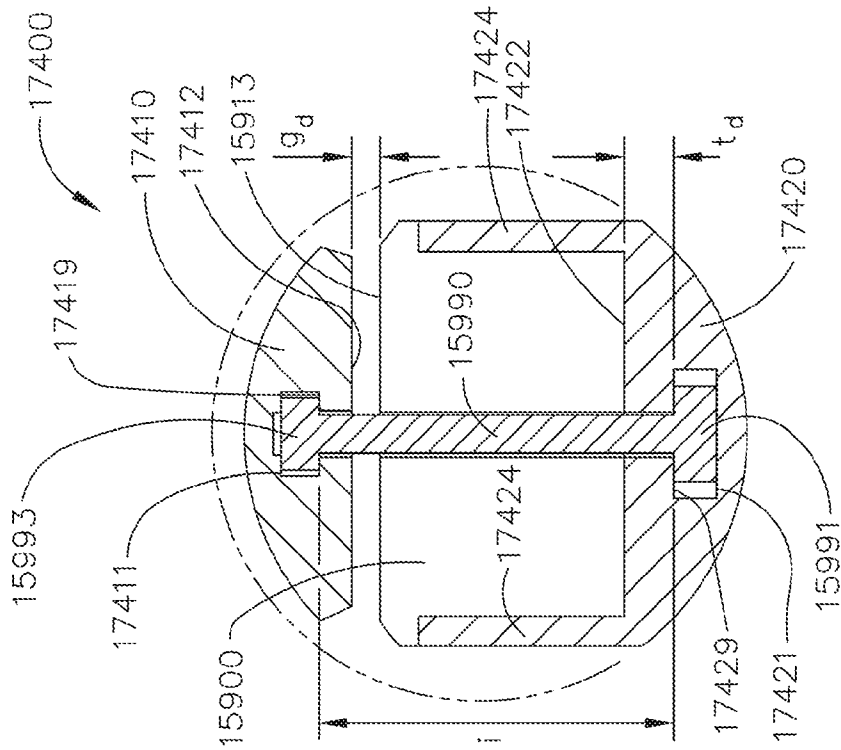


FIG. 44B

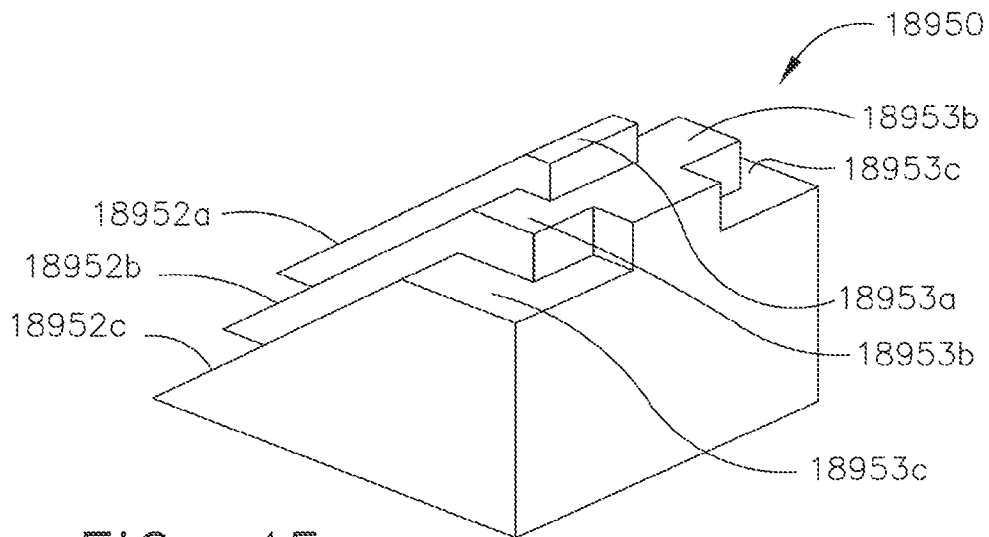


FIG. 45

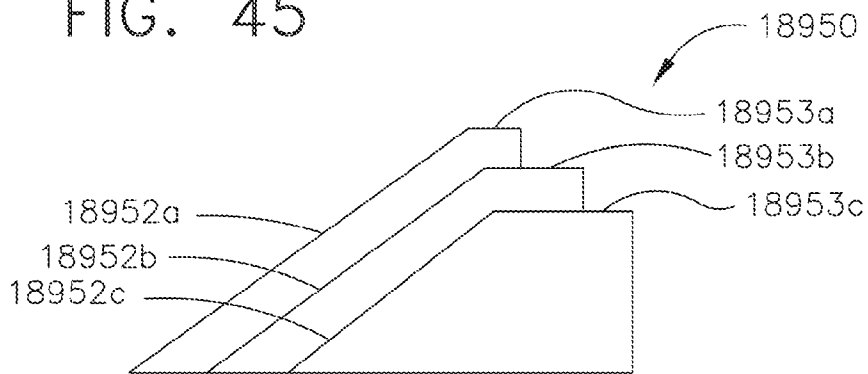


FIG. 45A

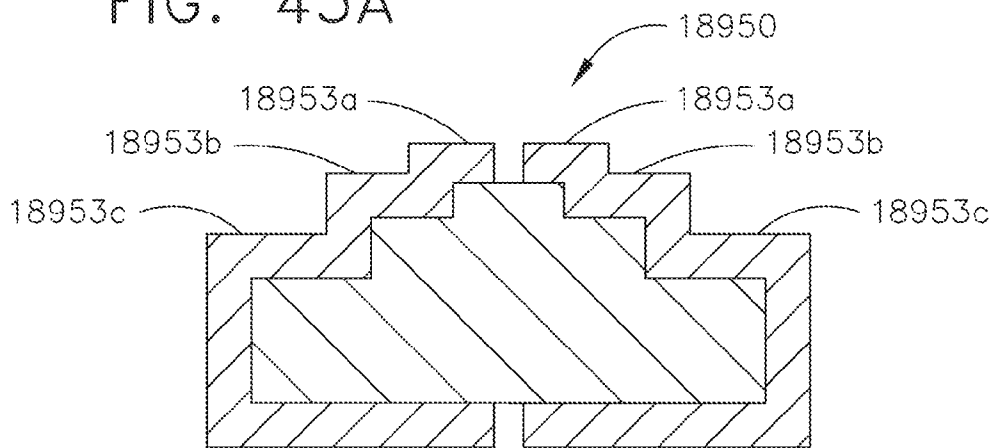


FIG. 45B

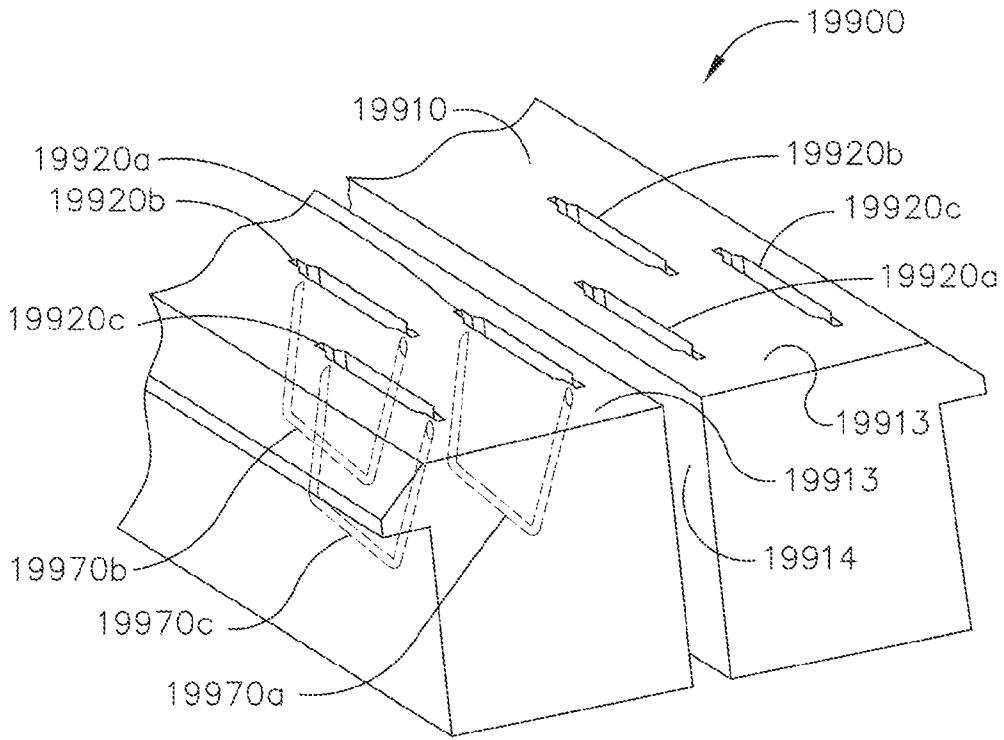


FIG. 46

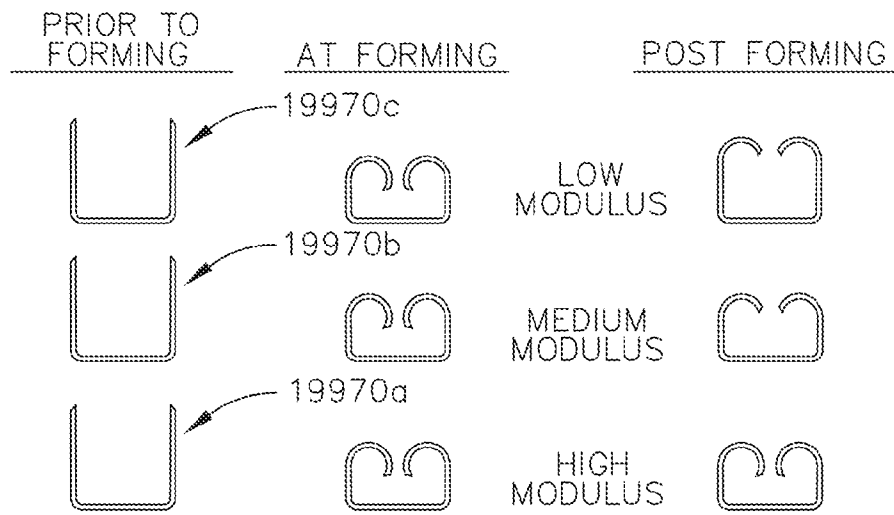


FIG. 46A

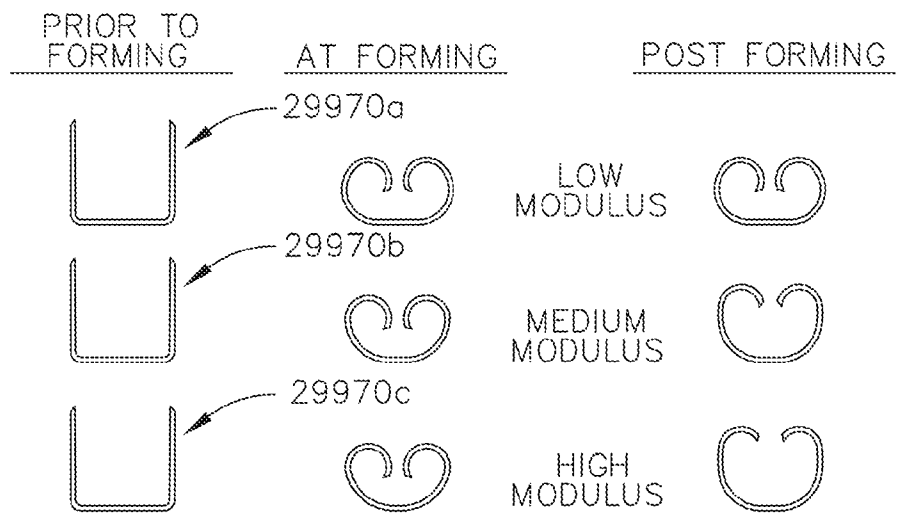


FIG. 46B

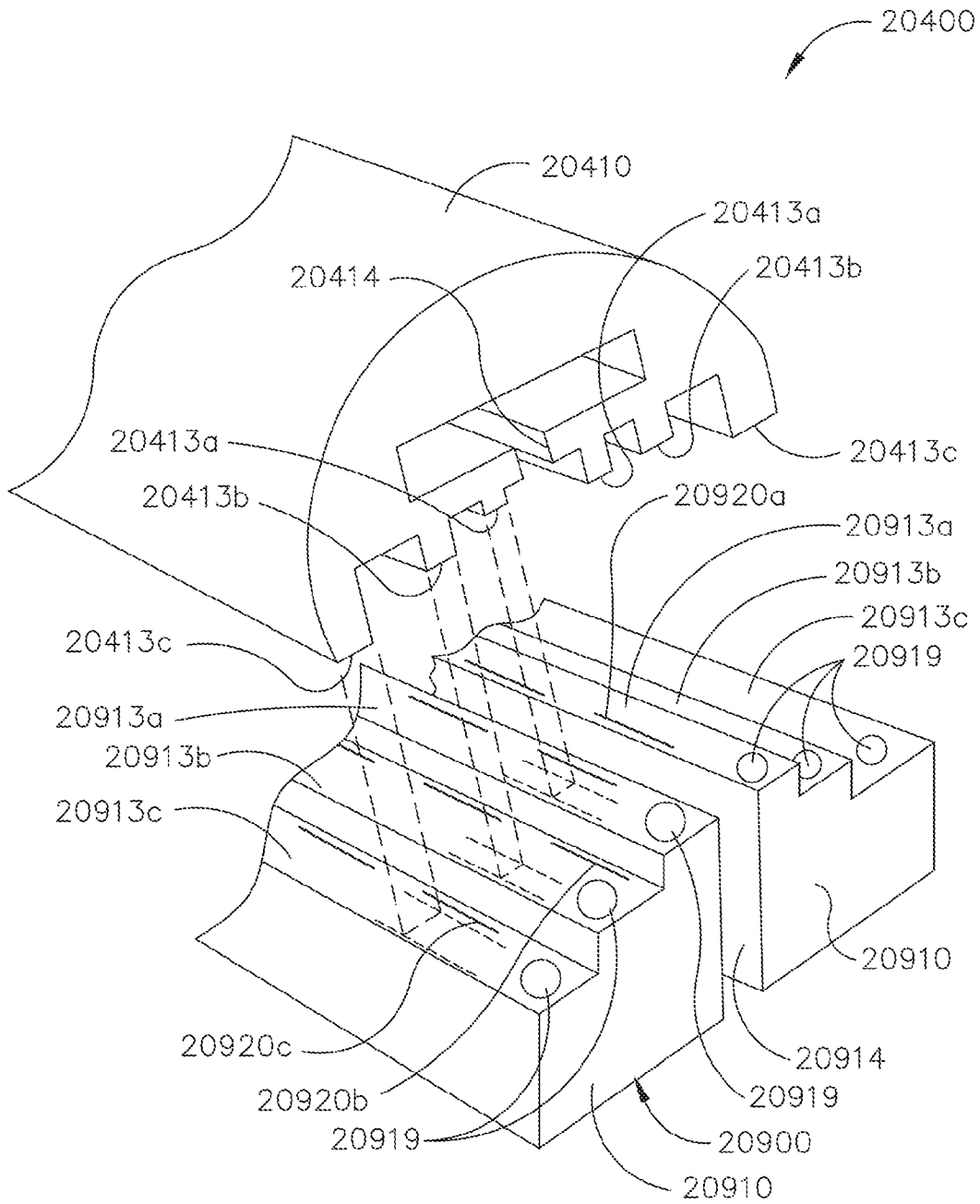


FIG. 47

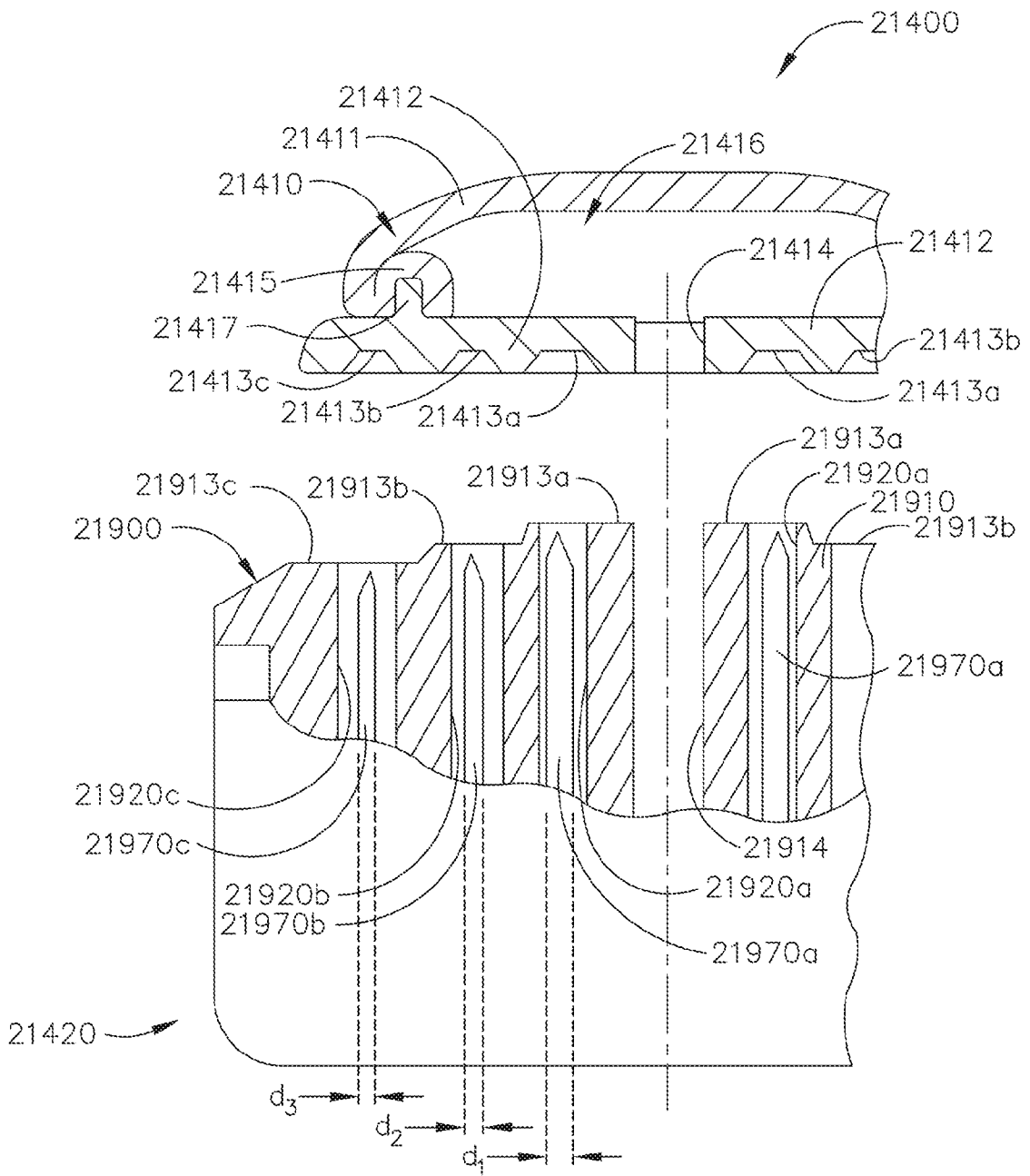


FIG. 48

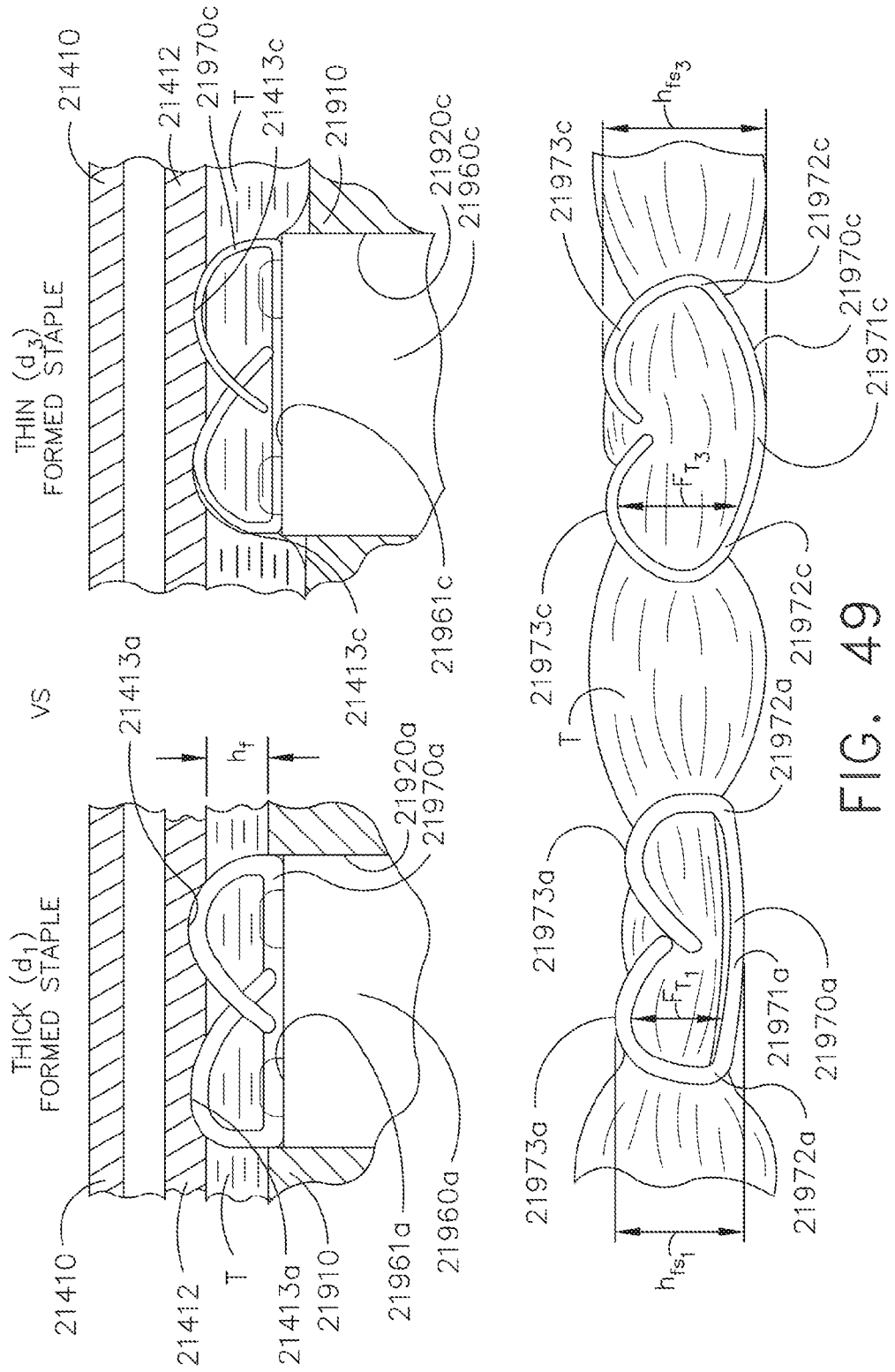


FIG. 49

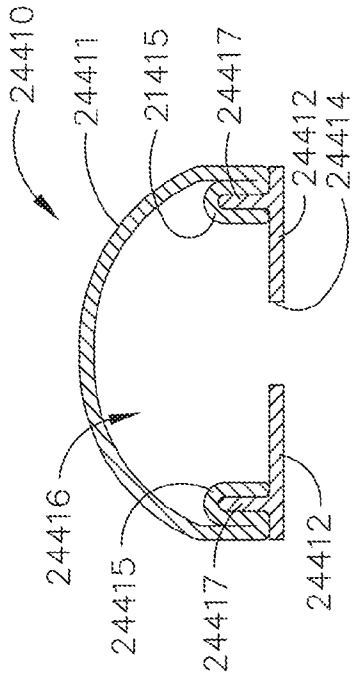


FIG. 50

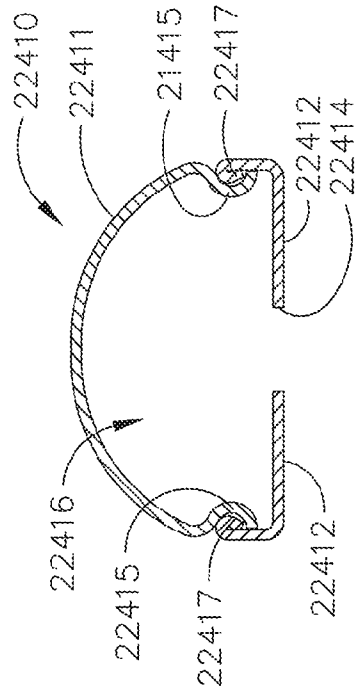


FIG. 51

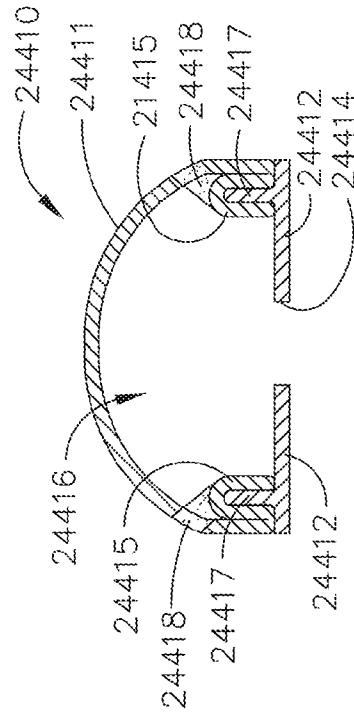


FIG. 52

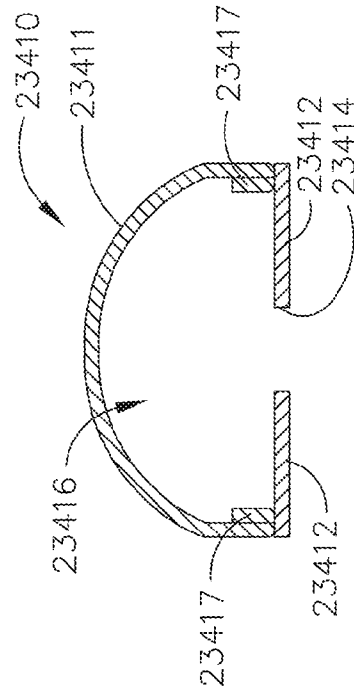


FIG. 52A

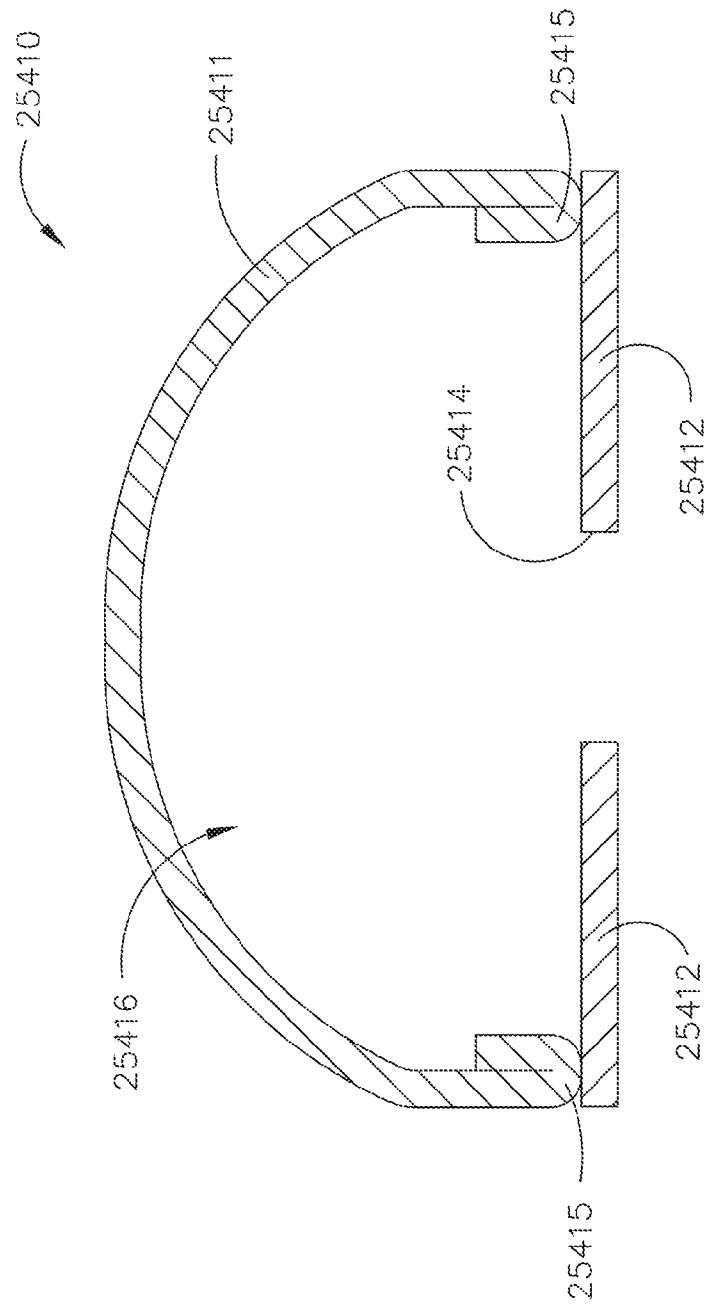


FIG. 53

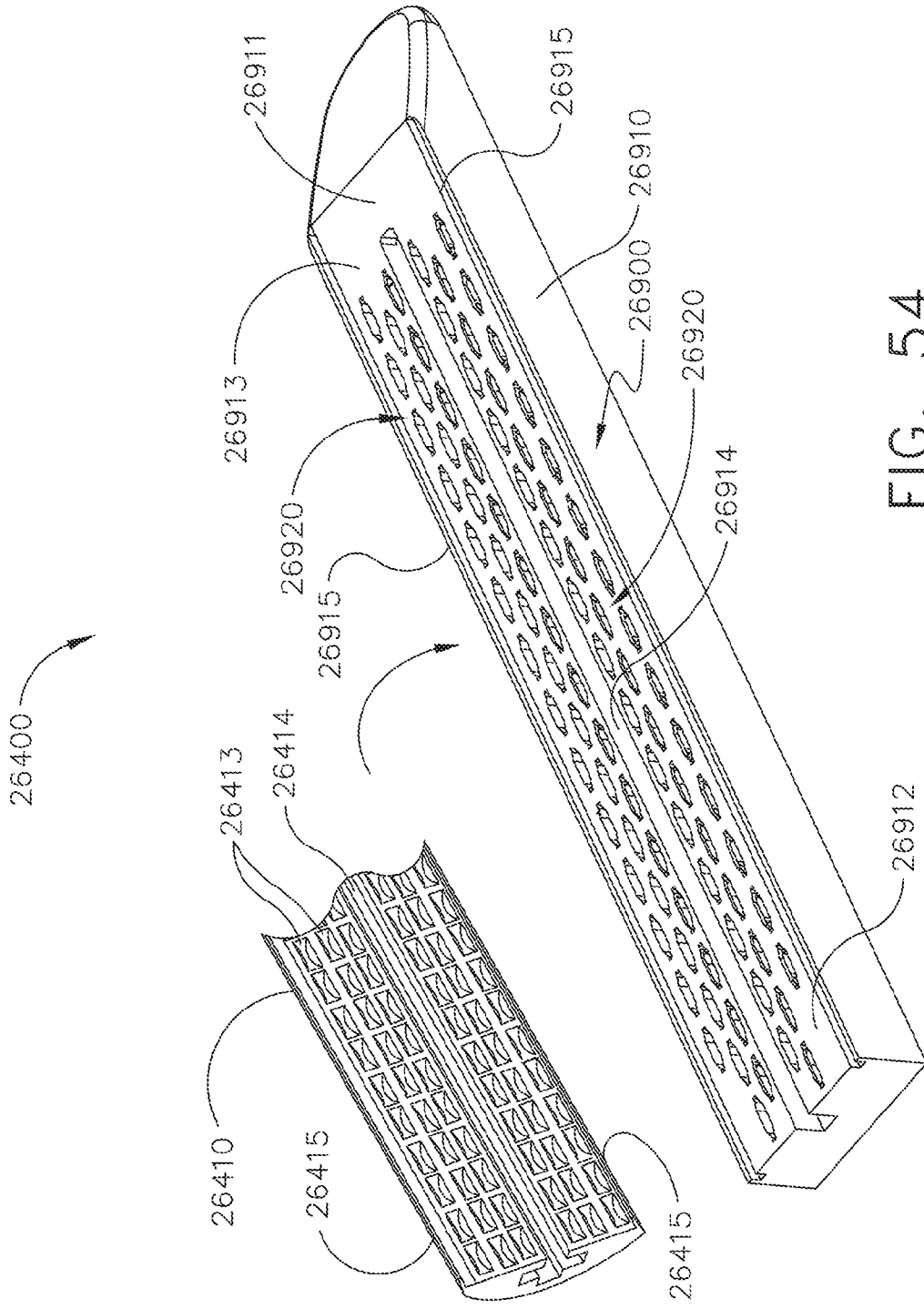


FIG. 54

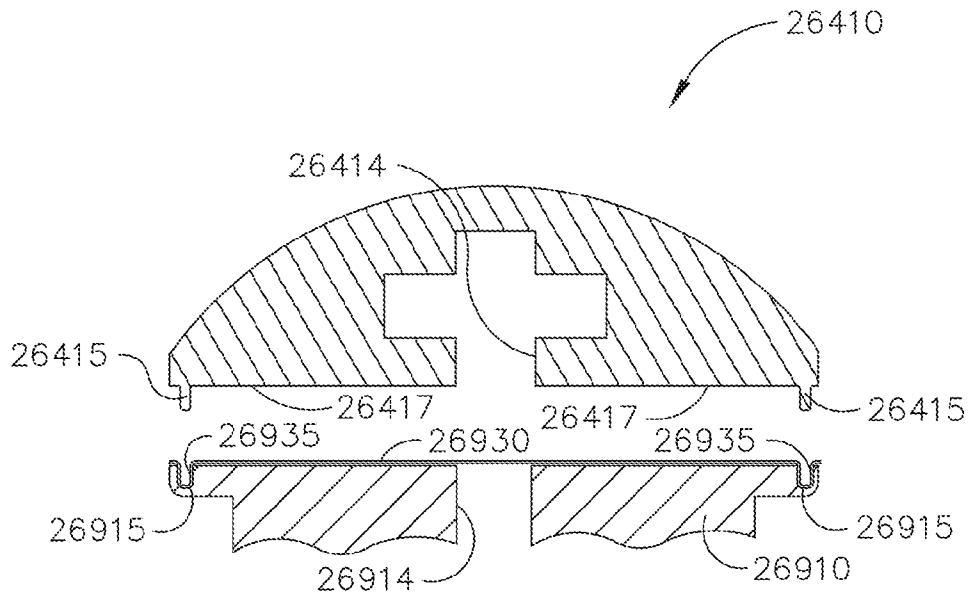


FIG. 55

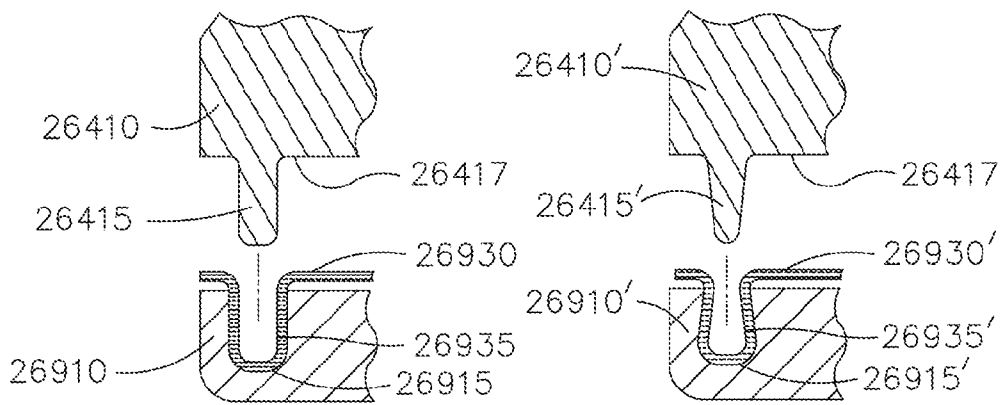


FIG. 55A

FIG. 55B

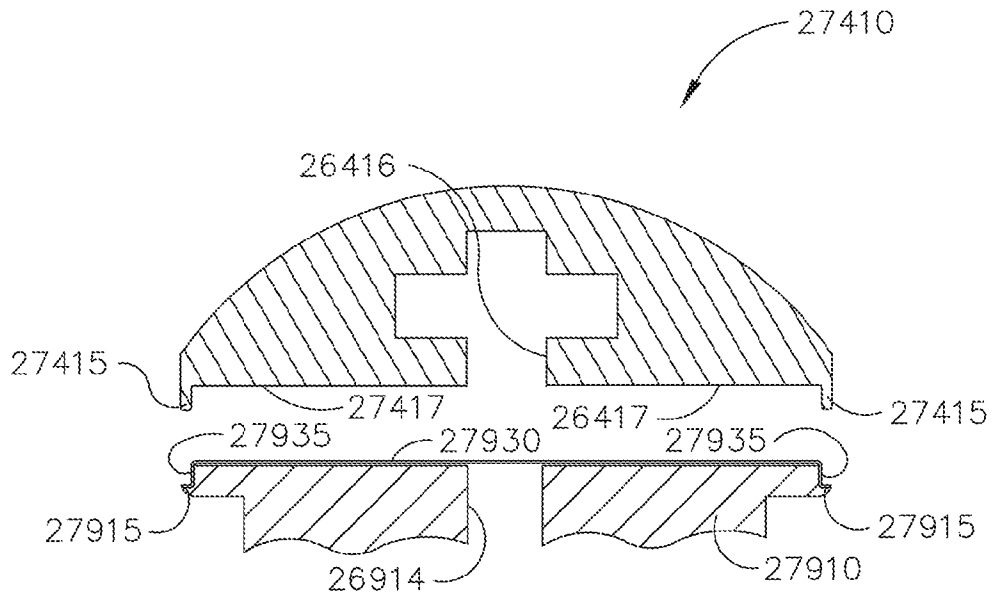


FIG. 56

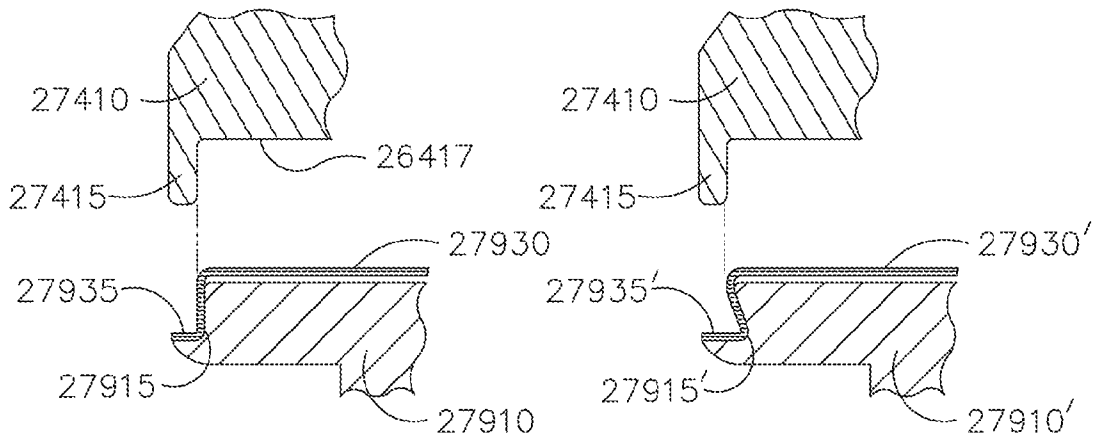


FIG. 56A

FIG. 56B

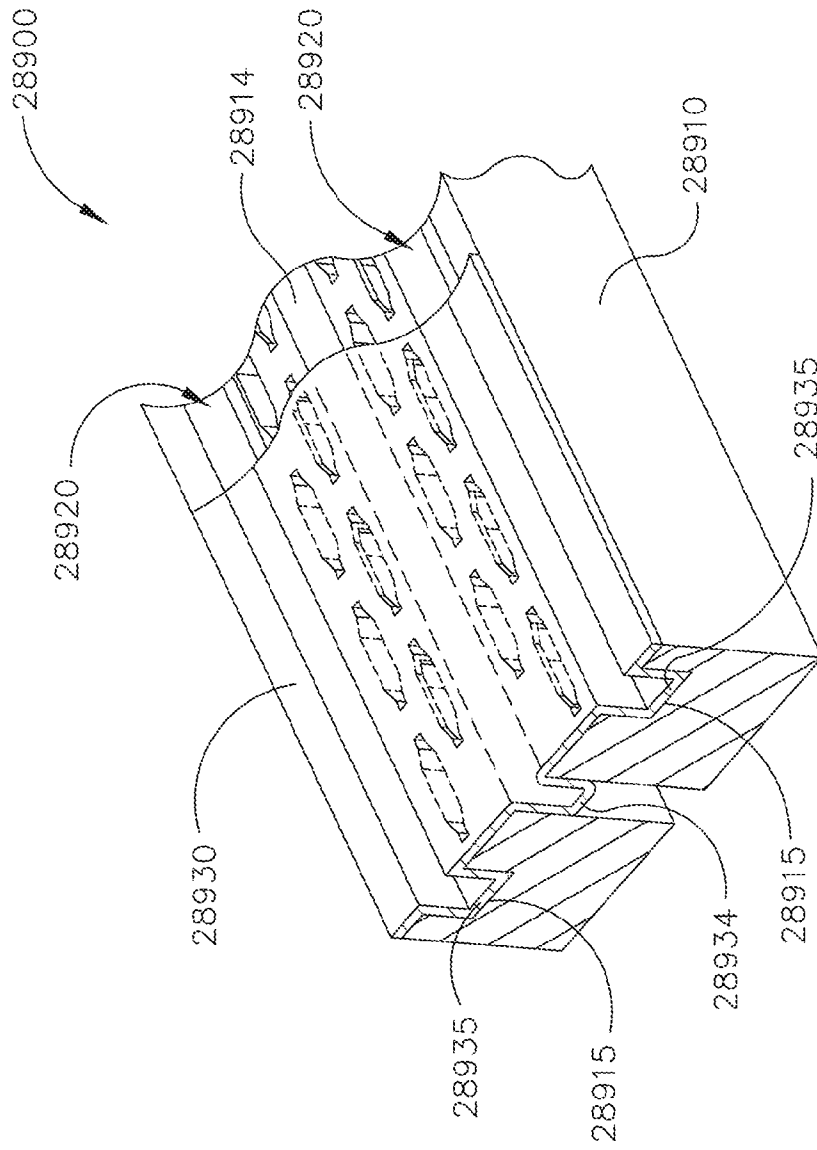


FIG. 57

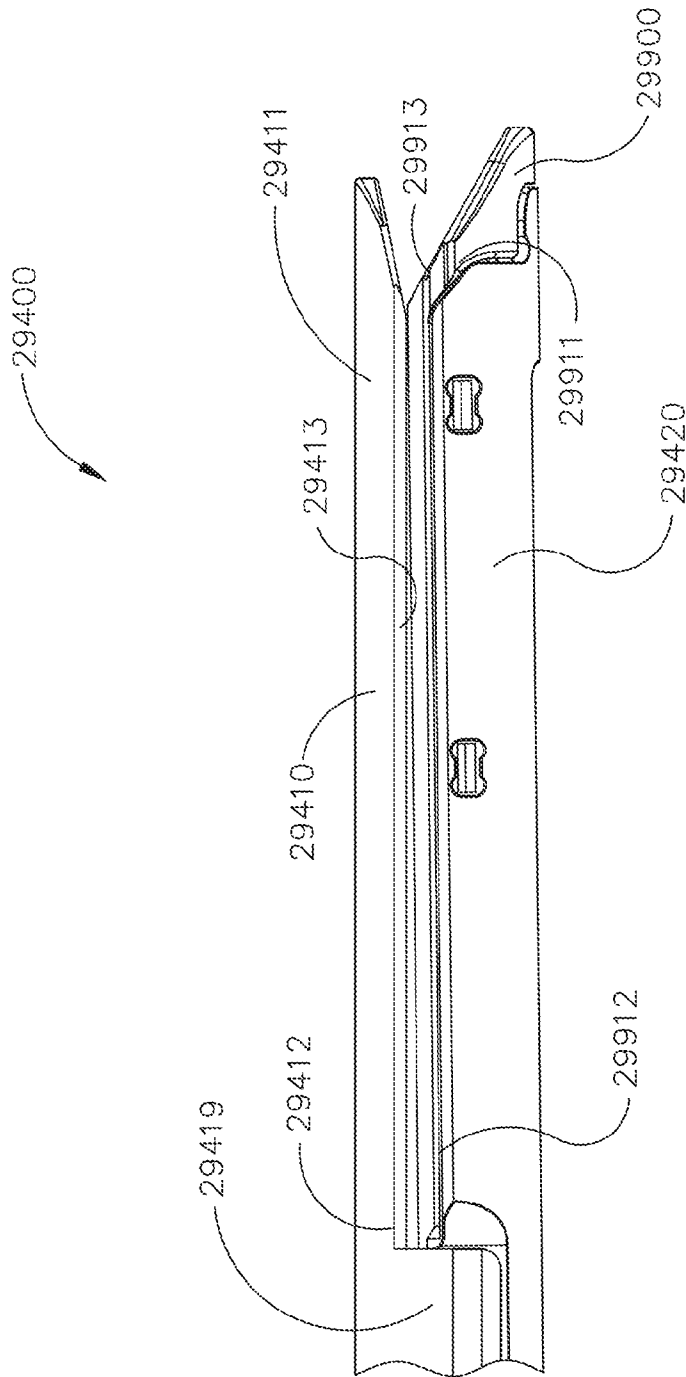


FIG. 58

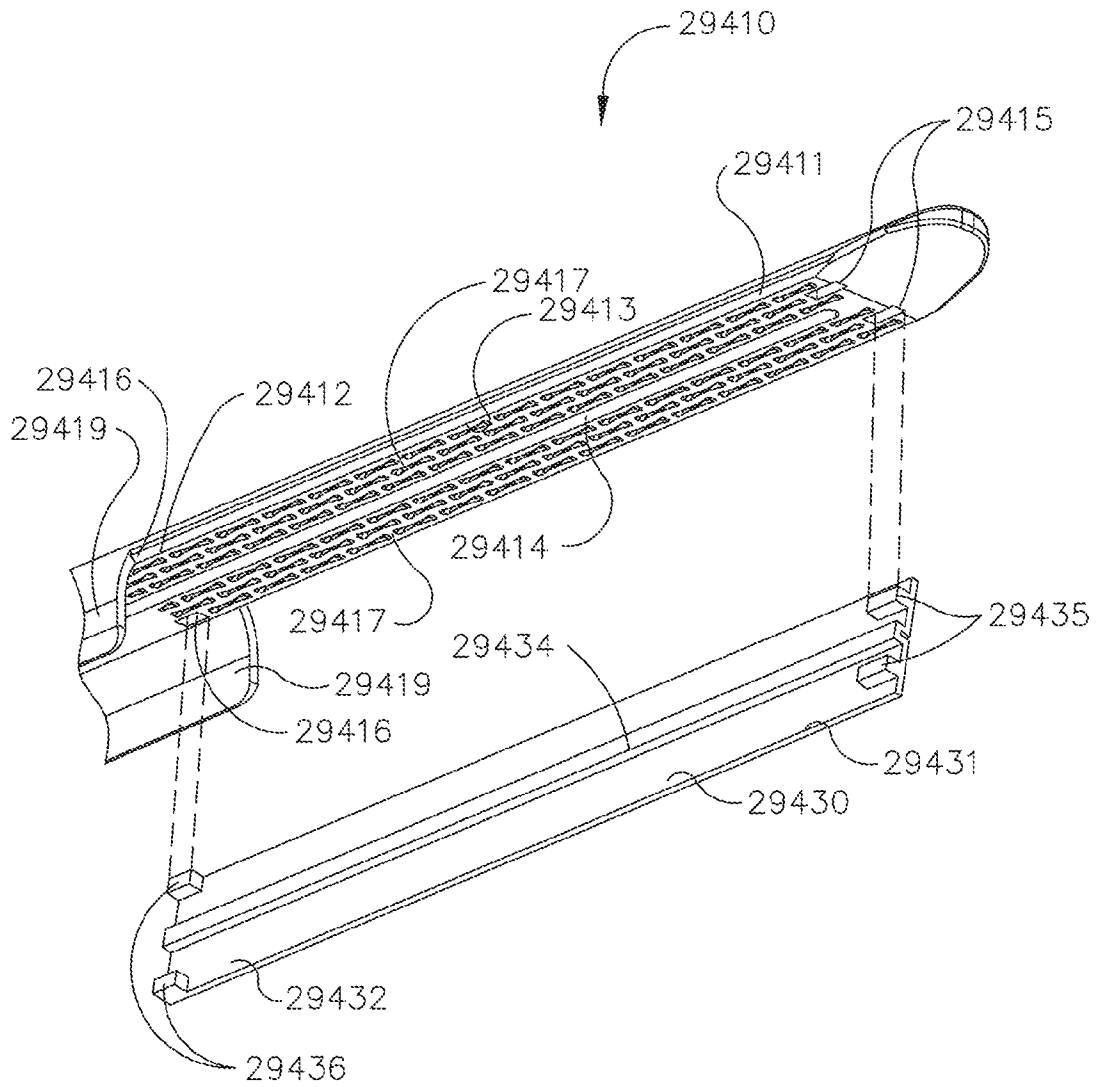


FIG. 59

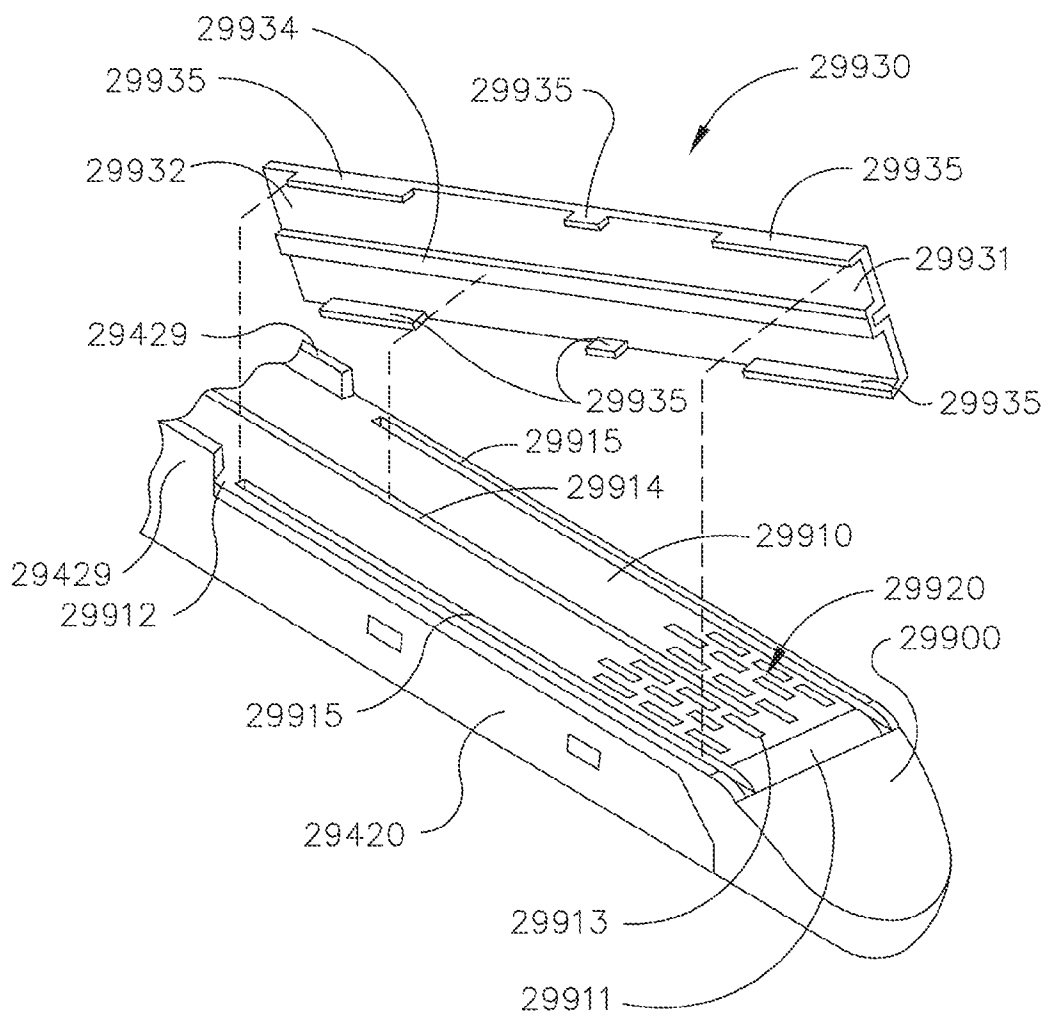


FIG. 60

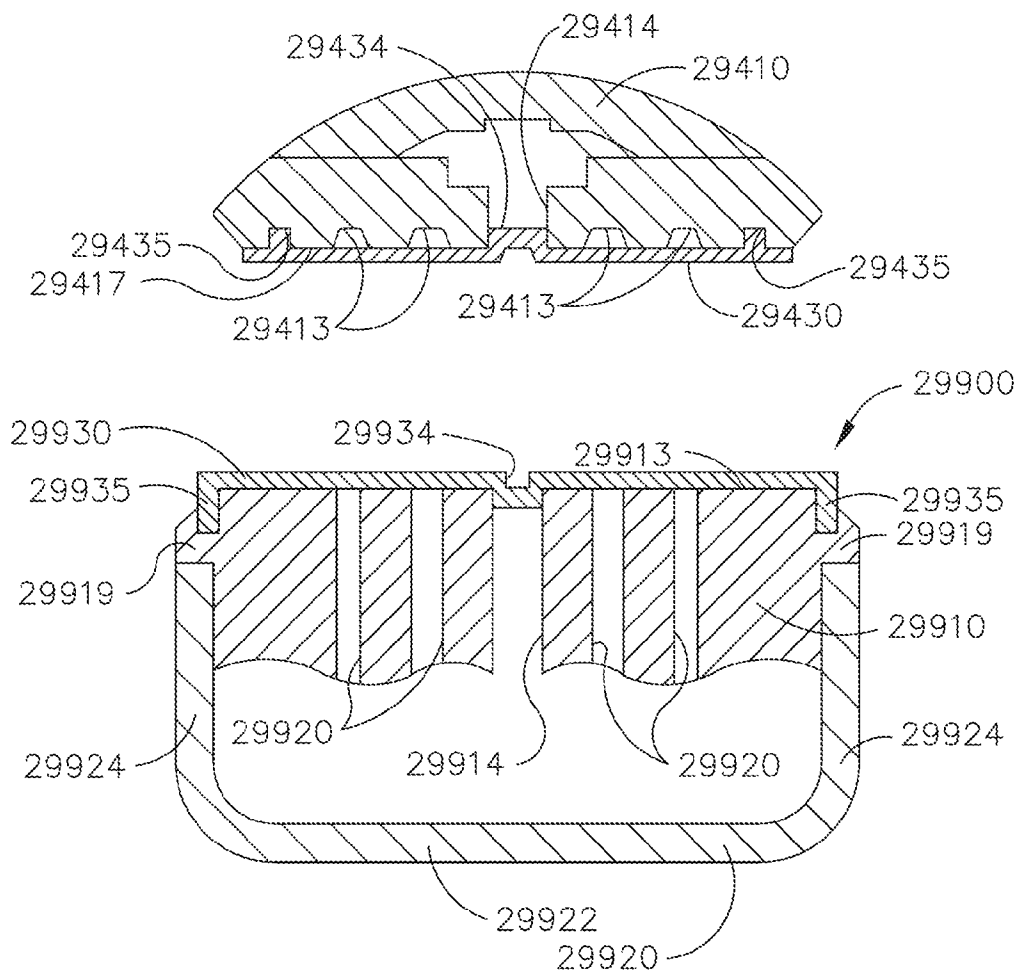


FIG. 61

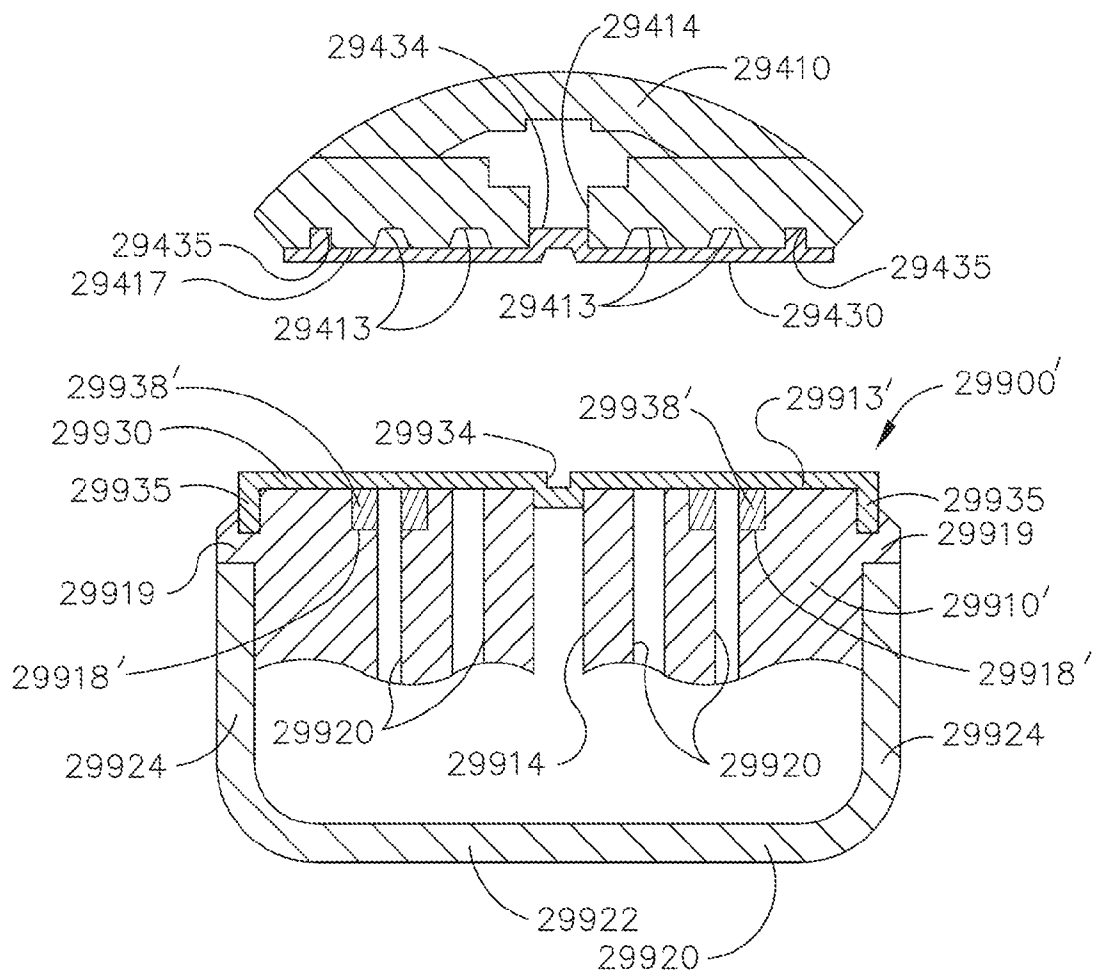


FIG. 61A

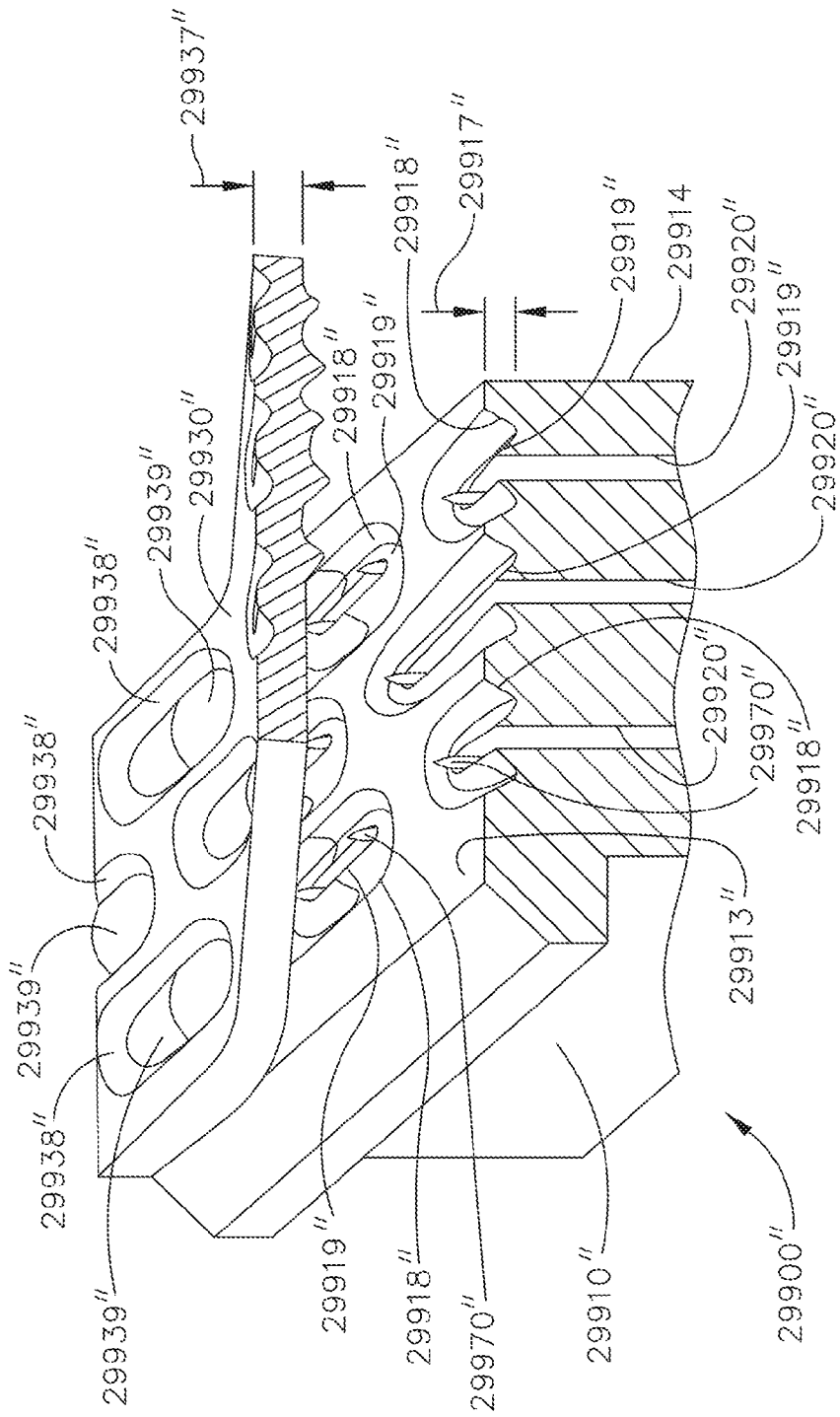


FIG. 61B

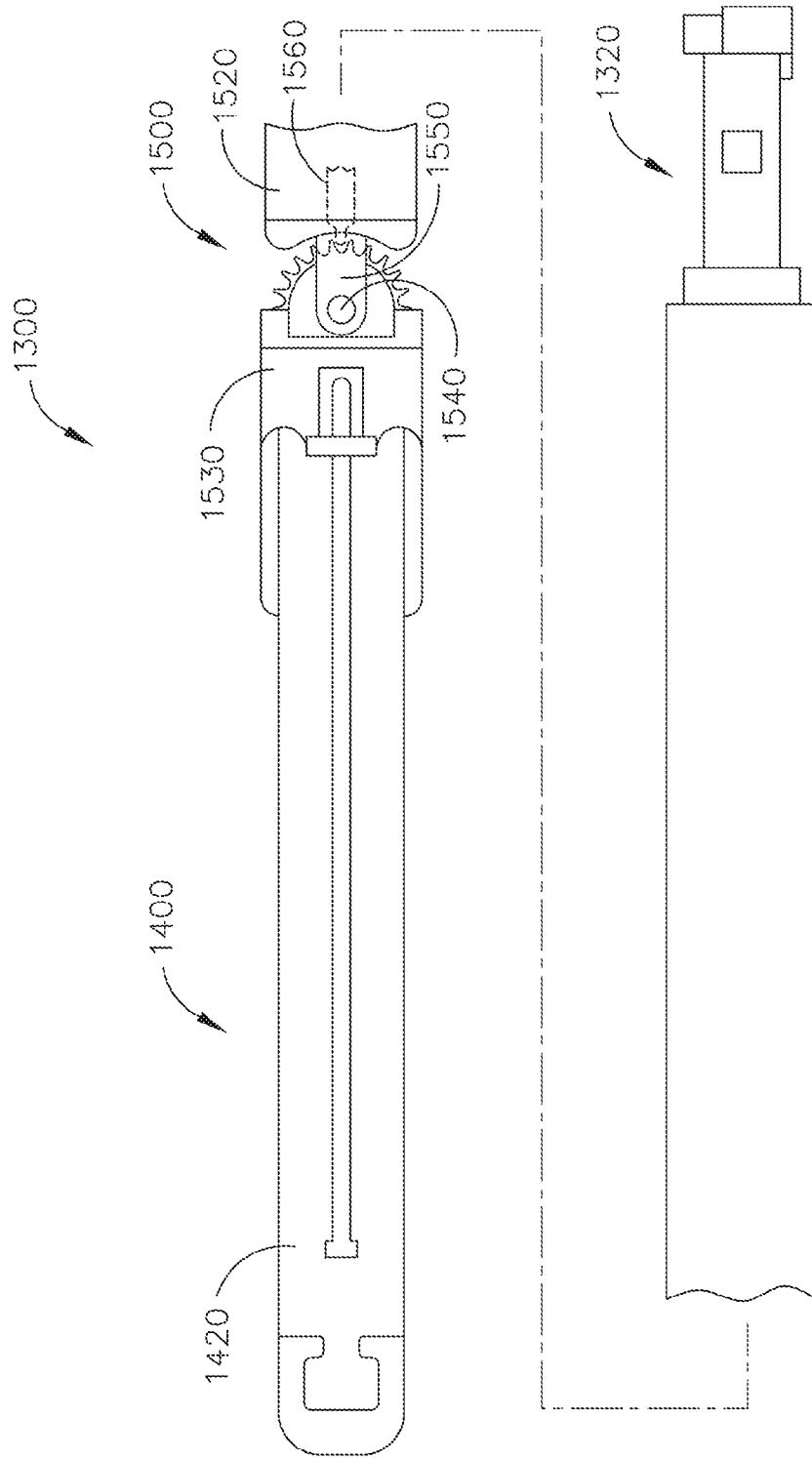
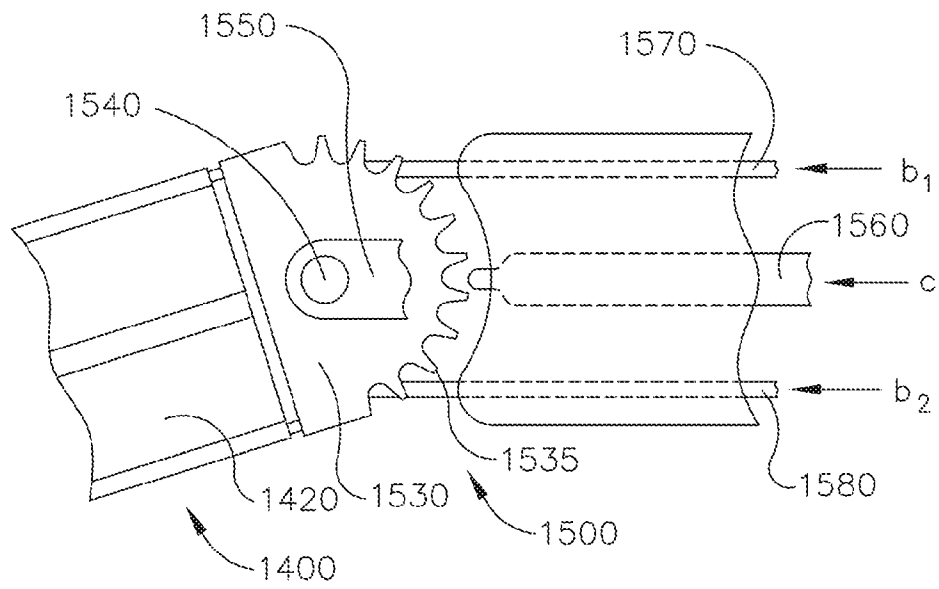
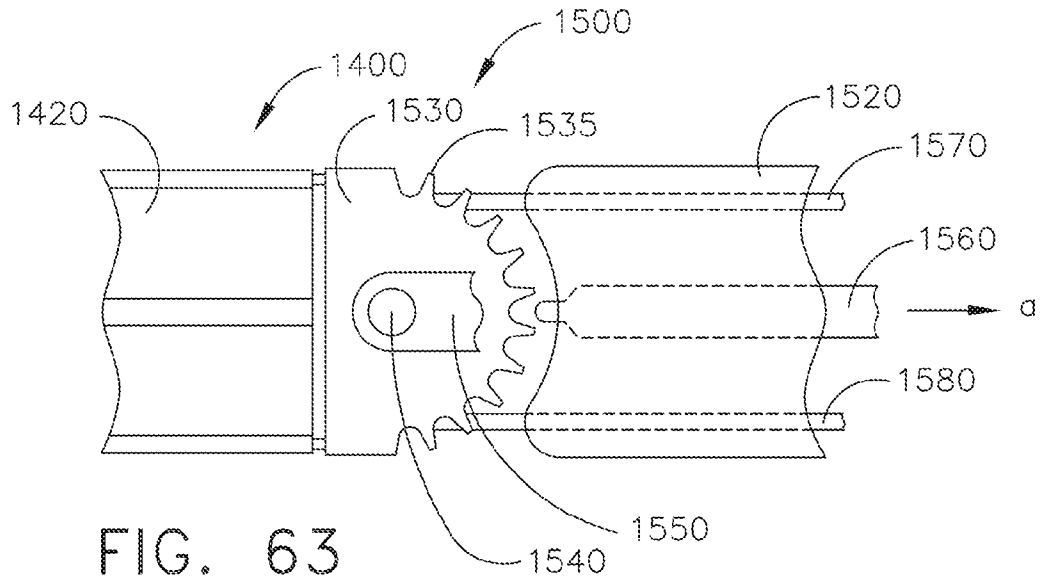


FIG. 62



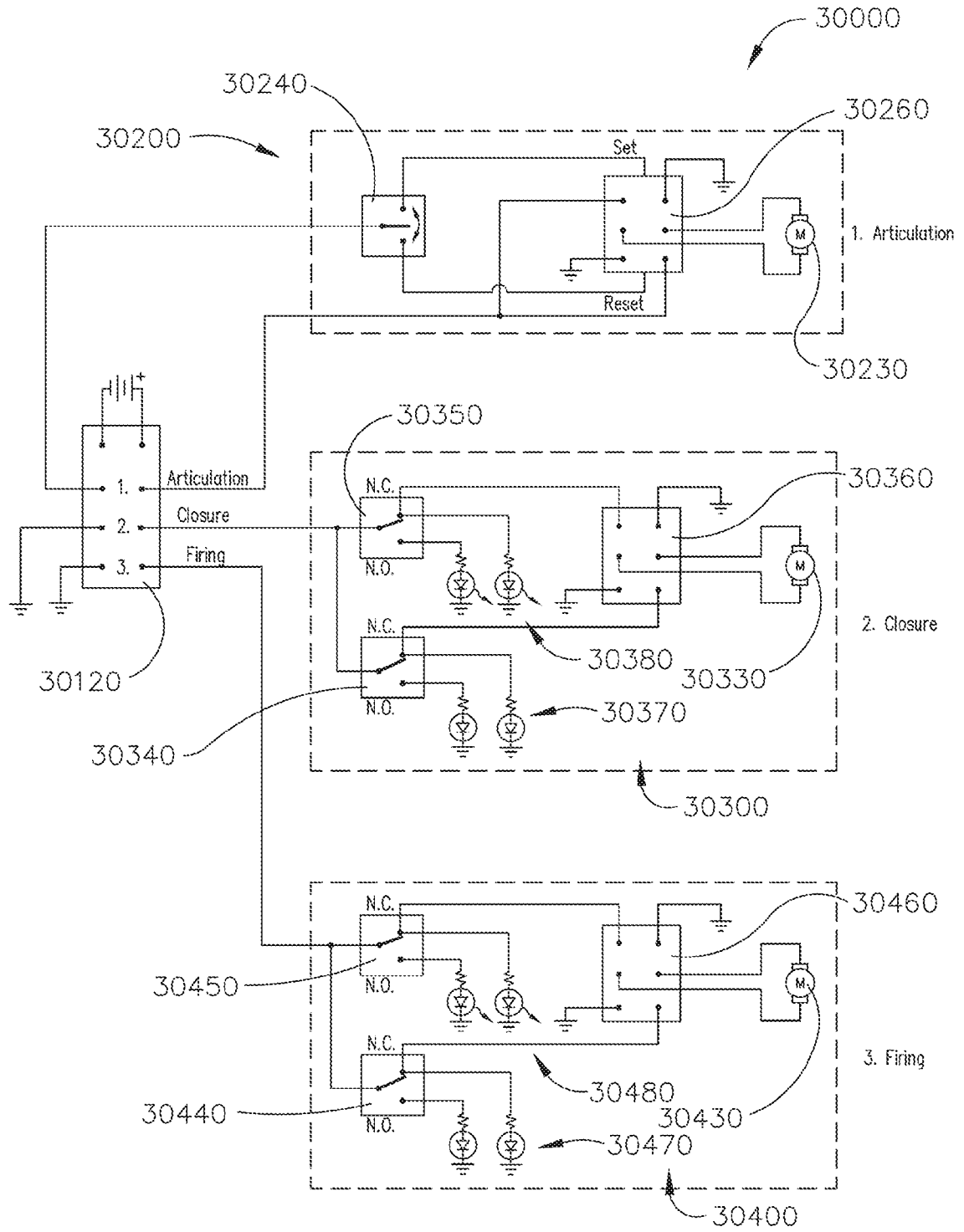


FIG. 65

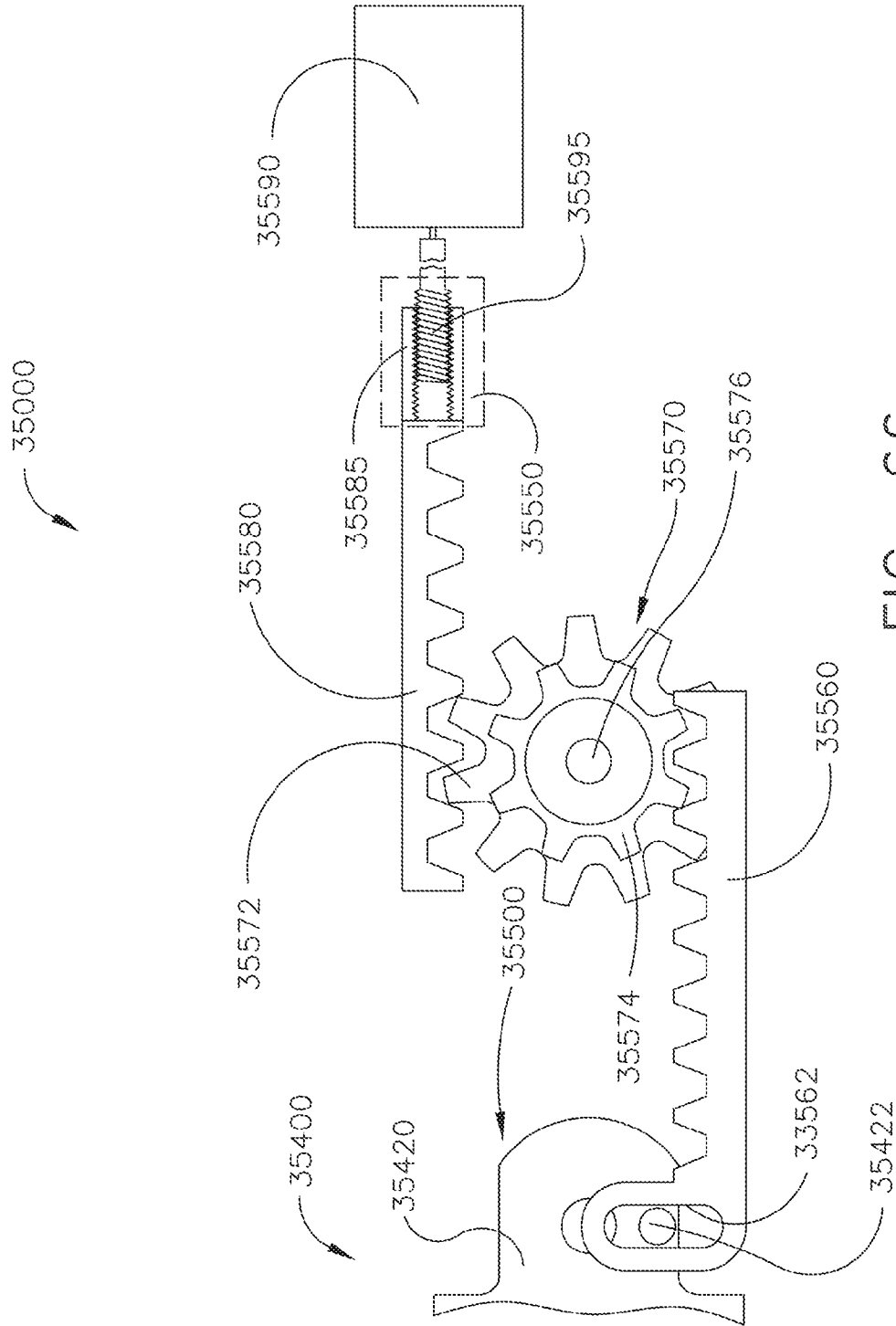


FIG. 66

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2022/052470

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B17/072
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.
A	EP 2 140 817 A1 (TYCO HEALTHCARE [US]) 6 January 2010 (2010-01-06) figures 1-14 paragraph [0099] - paragraph [0101] paragraph [0103] - paragraph [0106] paragraph [0108] paragraph [0111] - paragraph [0112] paragraph [0113] paragraph [0121] -----	1-16
A	EP 1 970 014 A1 (TYCO HEALTHCARE [US]) 17 September 2008 (2008-09-17) figure 1 paragraph [0014] - paragraph [0017] -----	1-16
A	US 5 865 361 A (MILLIMAN KEITH L [US] ET AL) 2 February 1999 (1999-02-02) abstract; figures 40-54 -----	1-16

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

22 June 2022

30/06/2022

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

Authorized officer

Roudaut, Tanguy

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2022/052470

Patent document cited in search report	Publication date	Patent family member(s)	Publication date				
EP 2140817	A1	06-01-2010	AU 2009202607 A1	21-01-2010			
			CA 2669719 A1	01-01-2010			
			EP 2140817 A1	06-01-2010			
			JP 5506257 B2	28-05-2014			
			JP 2010012264 A	21-01-2010			
			US 2010001036 A1	07-01-2010			
			US 2011301579 A1	08-12-2011			
			US 2014027494 A1	30-01-2014			
			US 2016345969 A1	01-12-2016			
			US 2020155145 A1	21-05-2020			
			US 2022175373 A1	09-06-2022			
			EP 1970014	A1	17-09-2008	AU 2008200957 A1	02-10-2008
						CA 2621096 A1	15-09-2008
EP 1970014 A1	17-09-2008						
EP 2324777 A1	25-05-2011						
JP 5393041 B2	22-01-2014						
JP 5705282 B2	22-04-2015						
JP 2008220956 A	25-09-2008						
JP 2014057855 A	03-04-2014						
US 7422136 B1	09-09-2008						
US 2008277449 A1	13-11-2008						
US 2010089972 A1	15-04-2010						
US 2011303735 A1	15-12-2011						
US 2012298720 A1	29-11-2012						
US 2013248575 A1	26-09-2013						
US 2017035421 A1	09-02-2017						
US 2019261986 A1	29-08-2019						
US 2021353291 A1	18-11-2021						
US 5865361	A	02-02-1999				AU 750646 B2	25-07-2002
			CA 2304750 A1	01-04-1999			
			CA 2552427 A1	01-04-1999			
			CA 2571468 A1	01-04-1999			
			CA 2571576 A1	01-04-1999			
			CA 2571579 A1	01-04-1999			
			CA 2666604 A1	01-04-1999			
			DE 69836436 T2	27-09-2007			
			EP 1021130 A1	26-07-2000			
			EP 1762190 A2	14-03-2007			
			EP 2113207 A2	04-11-2009			
			EP 2156796 A1	24-02-2010			
			EP 2286736 A1	23-02-2011			
			EP 2298185 A2	23-03-2011			
			EP 2298186 A2	23-03-2011			
			EP 2316348 A1	04-05-2011			
			EP 2818124 A1	31-12-2014			
			EP 3009079 A1	20-04-2016			
			ES 2275317 T3	01-06-2007			
			ES 2335523 T3	29-03-2010			
			ES 2372662 T3	25-01-2012			
			ES 2398916 T3	22-03-2013			
			ES 2399116 T3	26-03-2013			
			ES 2399811 T3	03-04-2013			
			ES 2557032 T3	21-01-2016			
			JP 4257029 B2	22-04-2009			
			JP 4500342 B2	14-07-2010			
			JP 4500343 B2	14-07-2010			

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2022/052470

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		JP 4500344 B2	14-07-2010
		JP 5084061 B2	28-11-2012
		JP 2001517473 A	09-10-2001
		JP 2008086786 A	17-04-2008
		JP 2008086787 A	17-04-2008
		JP 2008086788 A	17-04-2008
		JP 2008100085 A	01-05-2008
		JP 2010148890 A	08-07-2010
		JP 2010234061 A	21-10-2010
		US 5865361 A	02-02-1999
		US 6079606 A	27-06-2000
		US 6241139 B1	05-06-2001
		US 6330965 B1	18-12-2001
		US 2002117533 A1	29-08-2002
		US 2004108357 A1	10-06-2004
		US 2005067460 A1	31-03-2005
		US 2006049229 A1	09-03-2006
		US 2006255090 A1	16-11-2006
		US 2008041916 A1	21-02-2008
		US 2009261142 A1	22-10-2009
		US 2010237131 A1	23-09-2010
		US 2011233260 A1	29-09-2011
		US 2012043368 A1	23-02-2012
		US 2012055974 A1	08-03-2012
		US 2012241495 A1	27-09-2012
		US 2012305627 A1	06-12-2012
		US 2013140342 A1	06-06-2013
		US 2014110454 A1	24-04-2014
		US 2015090766 A1	02-04-2015
		US 2015209041 A1	30-07-2015
		US 2017112498 A1	27-04-2017
		WO 9915086 A1	01-04-1999
