



(51) International Patent Classification:

A61B 17/072 (2006.01)

A61B 34/30 (2016.01)

A61B 17/115 (2006.01)

(21) International Application Number:

PCT/US2020/025655

(22) International Filing Date:

30 March 2020 (30.03.2020)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

62/835,086

17 April 2019 (17.04.2019)

US

(71) Applicant: INTUITIVE SURGICAL OPERATIONS, INC. [US/US]; 1020 Kifer Road, Sunnyvale, CA 94086 (US).

(72) Inventor: WIXEY, Matthew; 3200 Zanker Road, Unit 1422, San Jose, CA 95134 (US).

(74) Agent: FARBER, Mark et al.; 4 Corporate Drive, Suite 287, Shelton, CT 06484 (US).

(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, 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, 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,

(54) Title: SURGICAL STAPLING INSTRUMENT

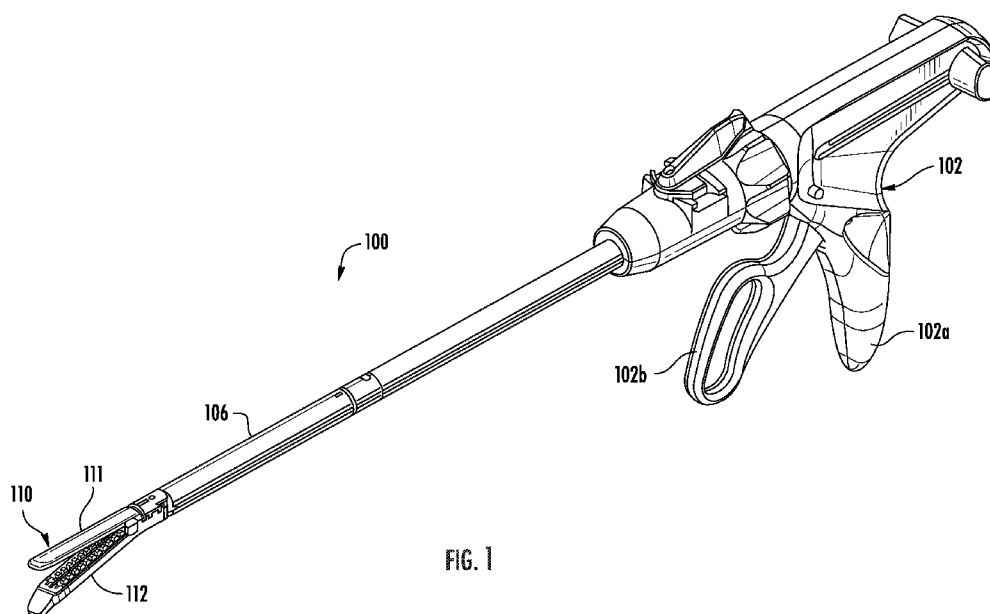


FIG. 1

(57) Abstract: A surgical instrument includes an elongate shaft and an end effector. The end effector includes a jaw, and a coupling member configured to receive a first and second reload and to removably couple the first and second reload to the end effector. The coupling member is configured to retain the first reload in a closed position relative to the jaw such that the jaw and the first reload have a tissue gap therebetween. The coupling member is configured to retain the second reload in a closed position relative to the jaw such that the jaw and the second reload have a tissue gap therebetween that is larger than the first tissue gap. The instrument is designed to accommodate reloads with different tissue gaps between the first jaw and the reload, thereby allowing an operator to treat tissue of varying sizes, shapes and thicknesses with the same surgical instrument.

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 the identity of the inventor (Rule 4.17(i))*
- *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))*

SURGICAL STAPLING INSTRUMENT

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No.
5 62/835,086, filed April 17, 2019, the entire disclosure of which is incorporated
herein by reference for all purposes.

BACKGROUND

[0002] The present disclosure relates to medical instruments and more
particularly to tissue clamping instruments for use in surgeries. Even more
10 particularly, the present disclosure relates to a surgical instrument configured to
provide for a desired tissue gap without the use of complicated gap-setting
mechanisms. The present disclosure further relates to a surgical stapling
instrument having a unique mechanism for securing cartridges within a stationary
jaw of the surgical stapling instrument.

15 [0003] Minimally invasive medical techniques are intended to reduce the
amount of extraneous tissue that is damaged during diagnostic or surgical
procedures, thereby reducing patient recovery time, discomfort, and deleterious
side effects. One effect of minimally invasive surgery, for example, is reduced
post-operative hospital recovery times. The average hospital stay for a standard
20 open surgery is typically significantly longer than the average stay for an analogous
minimally invasive surgery (MIS). Thus, increased use of MIS could save millions
of dollars in hospital costs each year. While many of the surgeries performed each
year in the United States could potentially be performed in a minimally invasive
manner, only a portion of the current surgeries uses these advantageous
25 techniques due to limitations in minimally invasive surgical instruments and the

additional surgical training involved in mastering them.

[0004] Improved surgical instruments such as tissue access, navigation, dissection and sealing instruments have enabled MIS to redefine the field of surgery. These instruments allow surgeries and diagnostic procedures to be performed with reduced trauma to the patient. A common form of minimally invasive surgery is endoscopy, and a common form of endoscopy is laparoscopy, which is minimally invasive inspection and surgery inside the abdominal cavity. In standard laparoscopic surgery, a patient's abdomen is insufflated with gas, and cannula sleeves are passed through small (approximately one-half inch or less) incisions to provide entry ports for laparoscopic instruments.

[0005] Laparoscopic surgical instruments generally include an endoscope (e.g., laparoscope) for viewing the surgical field and tools for working at the surgical site. The working tools are typically similar to those used in conventional (open) surgery, except that the working end or end effector of each tool is separated from its handle by an extension tube (also known as, e.g., an instrument shaft or a main shaft). The end effector can include, for example, a clamp, grasper, scissor, stapler, cautery tool, linear cutter, or needle holder.

[0006] To perform surgical procedures, the surgeon passes working tools through cannula sleeves to an internal surgical site and manipulates them from outside the abdomen. The surgeon views the procedure from a monitor that displays an image of the surgical site taken from the endoscope. Similar endoscopic techniques are employed in, for example, arthroscopy, retroperitoneoscopy, pelviscopy, nephroscopy, cystoscopy, cisternoscopy, sinoscopy, hysteroscopy, urethroscopy, and the like.

[0007] Minimally invasive telesurgical robotic systems increase a surgeon's

dexterity when working on an internal surgical site, as well as allow a surgeon to operate on a patient from a remote location (outside the sterile field). In a telesurgery system, the surgeon is often provided with an image of the surgical site at a control console. While viewing a three dimensional image of the surgical site on a suitable viewer or display, the surgeon performs the surgical procedures on the patient by manipulating master input or control devices of the control console, which in turn control motion of the servo-mechanically operated slave instruments.

[0008] The servomechanism used for telesurgery will often accept input from two master controllers (one for each of the surgeon's hands) and may include two or more robotic arms. A surgical instrument is mounted on each of the robotic arms. Operative communication between master controllers and associated robotic arm and instrument assemblies is typically achieved through a control system. The control system typically includes at least one processor that relays input commands from the master controllers to the associated robotic arm and instrument assemblies and back in the case of, for example, force feedback or the like. One example of a robotic surgical system is the DA VINCI™ system commercialized by Intuitive Surgical, Inc. of Sunnyvale, California.

[0009] A variety of structural arrangements have been used to support the surgical instrument at the surgical site during robotic surgery. The driven linkage or "slave" is often called a robotic surgical manipulator, and exemplary linkage arrangements for use as a robotic surgical manipulator during minimally invasive robotic surgery are described in U.S. Pat. Nos. 7,594,912, 6,758,843, 6,246,200, and 5,800,423, the full disclosures of which are incorporated herein by reference in their entirety for all purposes. These linkages often manipulate an instrument holder to which an instrument having a shaft is mounted. Such a manipulator

structure can include a parallelogram linkage portion that generates motion of the instrument holder that is limited to rotation about a pitch axis that intersects a remote center of manipulation located along the length of the instrument shaft. Such a manipulator structure can also include a yaw joint that generates motion of the instrument holder that is limited to rotation about a yaw axis that is perpendicular to the pitch axis and that also intersects the remote center of manipulation. By aligning the remote center of manipulation with the incision point to the internal surgical site (for example, with a trocar or cannula at an abdominal wall during laparoscopic surgery), an end effector of the surgical instrument can be positioned safely by moving the proximal end of the shaft using the manipulator linkage without imposing potentially hazardous forces against the abdominal wall. Alternative manipulator structures are described, for example, in U.S. Pat. Nos. 6,702,805, 6,676,669, 5,855,583, 5,808,665, 5,445,166, and 5,184,601, the full disclosures of which are incorporated herein by reference in their entirety for all purposes.

[0010] During a surgical procedure, the telesurgical system can provide mechanical actuation and control of a variety of surgical instruments or tools having end effectors that perform various functions for the surgeon, for example, holding or driving a needle, grasping a blood vessel, dissecting tissue, or the like, in response to manipulation of the master input devices. Manipulation and control of these end effectors is a particularly beneficial aspect of robotic surgical systems. For this reason, it is desirable to provide surgical tools that include mechanisms that provide two or three degrees of rotational movement of an end effector to mimic the natural action of a surgeon's wrist. Such mechanisms should be appropriately sized for use in a minimally invasive procedure and relatively simple

in design to reduce possible points of failure. In addition, such mechanisms should provide an adequate range of motion to allow the end effector to be manipulated in a wide variety of positions, especially when deployed into restrictive body cavities (e.g., through a cannula to inside the pelvis).

5 [0011] Surgical clamping and cutting instruments (e.g., non-robotic linear clamping, stapling, and cutting devices, also known as surgical staplers; and electrosurgical vessel sealing devices) have been employed in many different surgical procedures. For example, a surgical stapler can be used to resect a cancerous or anomalous tissue from a gastro-intestinal tract. Many known surgical
10 clamping and cutting devices, including known surgical staplers, have opposing jaws that clamp tissue and an articulated knife to cut the clamped tissue.

[0012] Many surgical clamping and cutting instruments include an instrument shaft supporting an end effector to which a replaceable stapler cartridge is mounted. An actuation mechanism articulates the stapler cartridge to deploy
15 staples from the stapler cartridge to staple tissue clamped between the stapler cartridge and an articulable jaw of the end effector.

[0013] The use of surgical clamping and cutting instruments to seal tissue may become difficult and present a variety of issues when a user must accommodate tissue of varying sizes, shapes, thicknesses, and toughness. If a
20 surgical clamping and cutting instrument is not suitable for the specific properties of the tissue being sealed, staple formation may be negatively impacted, generally resulting in a higher rate of negative complications. To address this problem, a user must often switch to a different instrument during the surgical procedure, or use complicated tissue gap-setting mechanisms.

25 [0014] Accordingly, further improvements to surgical instruments would be

desirable. In general, it would be desirable to have a surgical instrument that is able to provide for various tissue gaps to effectively accommodate tissue of varying size and thickness without having to use complicated gap-setting mechanisms. Additionally, it would be desirable to provide for a mechanism to secure different
5 reloads, each configured to provide for a unique tissue gap, within the stationary jaw of a singular surgical instrument.

SUMMARY

10 [0015] The following presents a simplified summary of the claimed subject matter in order to provide a basic understanding of some aspects of the claimed subject matter. This summary is not an extensive overview of the claimed subject matter. It is intended to neither identify key or critical elements of the claimed subject matter nor delineate the scope of the claimed subject matter. Its sole
15 purpose is to present some concepts of the claimed subject matter in a simplified form as a prelude to the more detailed description that is presented later.

[0016] In one aspect, the present disclosure relates to a surgical instrument having an elongate shaft and an end effector on a distal end portion of the shaft. The end effector includes a first jaw, and a coupling member configured to receive
20 either a first or second reload and to removably couple either the first or second reload to the end effector. The coupling member is configured to retain the first reload in a closed position relative to the first jaw such that the first jaw and first reload have a first gap therebetween. The coupling member is configured to retain the second reload in a closed position relative to the first jaw such that the first jaw
25 and the second reload have a second gap therebetween, the second gap being

greater than the first gap. The instrument is designed to accommodate reloads having different tissue gaps between the first jaw and the reload, thereby allowing an operator to treat tissue of varying sizes, shapes, thicknesses, and toughness with the same surgical instrument.

5 [0017] In certain embodiments, the first and second reloads include a movable jaw configured for coupling to the first jaw of the surgical instrument. In other embodiments, the first and second reloads include a staple cartridge housing a plurality of staples. In still another embodiment, the reloads include a removable jaw that includes a staple cartridge housed therein.

10 [0018] In embodiments, the coupling member may be a channel configured to receive a coupling element on the reload, such as a pin or other suitable coupling member such that the reload is coupled to the end effector when the pin is moved into the channel. In certain embodiments, the coupling member may be configured to receive an engagement structure of the first or second movable jaw.

15 [0019] In embodiments, the surgical instrument may further include an actuator coupled to the end effector. The actuator may be configured to translate the reload, which may be a movable jaw, movable between a first and second closed positions relative to the fixed jaw. The movable jaw may be substantially parallel to the fixed jaw in the first and second closed positions. This embodiment
20 allows the operator to, for example, translate the movable jaw into multiple parallel positions relative to the fixed jaw to provide a selected tissue gap for treating tissue. In certain embodiments, the movable jaw can be moved into the first closed position relatively close to, or in contact with, the fixed jaw for minimizing the instrument diameter as the instrument, for example, is passed through a cannula.

25 The movable jaw can then be moved into the second closed position with a

selected tissue gap between the jaws for clamping, stapling and/or sealing tissue between the fixed and movable jaws.

[0020] In certain embodiments, the actuator may be a drive member configured to translate distally through the end effector. In embodiments, the first
5 or second movable jaw includes a pin, and the drive member may include a camming surface configured to engage the pin as the drive member is translated through the end effector to move the first or second jaw from the first closed position to the second closed position.

[0021] In embodiments, the pin is pivotally coupled to the first or second
10 movable jaw to allow the first or second movable jaw to pivot relative to the pin and the fixed jaw between open and closed positions.

[0022] In embodiments, the surgical instrument may further include a locking mechanism coupled to either the shaft or the end effector and configured to lock the first or second jaw in the second closed position. This ensures that that
15 jaws are locked into the second closed position prior to clamping, stapling and/or sealing the tissue. In embodiments, the locking mechanism includes a latch having a first distal surface and a second proximal surface, wherein the first second proximal surface is disposed laterally away from the first distal surface.

[0023] In embodiments, the surgical instrument further includes an actuating
20 mechanism for translating the drive member distally through the end effector. The actuating mechanism may include a control device of a robotic surgical system.

[0024] In another aspect, the present disclosure relates to a surgical instrument including an elongate shaft and an end effector on a distal end portion of the shaft. The end effector includes a first jaw and a second jaw configured to
25 move relative to each other from an open position to a first closed position. The

first and second jaws are substantially parallel to each other in the closed position.

The first and second jaws are movable relative to each other between the first closed position, wherein the jaws define a first distance therebetween, and a

second closed or expanded closed position, wherein the jaws define a second

5 distance therebetween. The second distance is greater than the first distance and

the first and second jaws are substantially parallel to each other in the second

closed position. Moving the jaws between the first and second closed positions

allows the operator to both minimize the overall instrument profile when desired

(e.g., passing through a cannula) and to position the jaws in an optimal position

10 relative to each other to clamp, seal and/or staple tissue therebetween.

[0025] In certain embodiments, the second closed position may be

adjustable so that the operator can adjust the distance between the first and

second jaws, allowing the operator to select an optimal tissue gap for clamping,

sealing and/or stapling tissue. In other embodiments, the second closed position

15 is fixed for a particular staple cartridge. In these embodiments, the instrument may

be configured to receive other staple cartridges that provide different tissue gaps

in the second closed position.

[0026] In certain embodiments, the second jaw may be removably coupled

to the end effector.

20 [0027] In embodiments, the surgical instrument may further include a staple

cartridge coupled to the second jaw and housing a plurality of staples, and a drive

member configured to translate distally through the end effector. The drive member

may be configured to engage the staples upon distal translation of the drive

member through the staple cartridge and move the staples from an interior of the

25 staple cartridge to an exterior of the staple cartridge.

[0028] In embodiments, the end effector defines a longitudinal axis, and wherein the first and second jaws define a gap therebetween in the extended position, wherein the gap extends substantially along the longitudinal axis between the first and second jaws. In embodiments, the surgical instrument further includes

5 an actuator coupled to the end effector, the actuator being configured to move the jaws between the closed and extended positions. In embodiments, the actuator includes a drive member configured to translate distally through the end effector.

[0029] In embodiments, the second jaw may include a pin and the drive member may include a camming surface. The camming surface may engage the

10 pin as the drive member is translated through the end effector to move the second jaw from the closed position to the extended position.

[0030] In embodiments, the pin is pivotally coupled to the second jaw to allow the jaw to pivot relative to the pin and the first jaw between the open and closed positions.

15 [0031] In embodiments, the surgical instrument further includes a channel on the shaft or the end effector for receiving the pin. The channel may extend in a transverse direction to the longitudinal axis of the shaft, wherein the camming surface translates the pin through the channel to move the second jaw from the closed position to the extended position.

20 [0032] In embodiments, the surgical instrument may further include a locking mechanism coupled to the second jaw and configured to lock the second jaw in the extended position. In embodiments, the locking mechanism may be a latch having a first distal surface and a second proximal surface, wherein the first second proximal surface is disposed laterally away from the first distal surface.

25 [0033] In embodiments, the surgical instrument may further include an

actuation mechanism in contact with the drive member and configured to translate the drive member distally through the end effector, and an actuator operatively connected to the actuation mechanism. In embodiments, the actuator may be a control device of a robotic surgical system.

5 [0034] In another aspect, the present disclosure relates to a surgical instrument including an elongate shaft having an end effector, and a first drive member configured to translate distally through a portion of the end effector. The first drive member may include a first flange at a first end thereof and a first engagement structure at a second end thereof. The surgical instrument may further
10 include a reload removably coupled to the end effector and having a secondary drive member including a second flange at a first end thereof and a second engagement structure at a second end thereof. The second engagement structure may be configured to engage the first engagement structure such that the first drive member and the secondary drive member collectively establish a fixed distance
15 between the first flange of the first drive member and the second flange of the secondary drive member. It is advantageous for the first drive member to engage the secondary drive member as the fixed distance between the first flange of the first drive member and the second flange of the secondary drive member determines the tissue gap of the end effector having a given reload installed. In
20 other words, this allows a given surgical instrument to receive various reloads configured to provide for unique tissue gaps in operation.

[0035] In embodiments, the first engagement structure is slot and the second engagement structure is a tab configured to be received within the slot.

[0036] In embodiments, the end effector may be a first jaw and the reload
25 may be a second jaw, wherein the first flange is configured to translate through a

channel in the first jaw of the end effector, and the second flange is configured to translate through a channel in the second jaw. the first and second jaws are movable between an open position and a closed position to grasp tissue between the first and second jaws.

5 [0037] In embodiments, the drive member and the secondary drive member collectively form an I-beam upon engagement of the first engagement structure with the second engagement structure.

[0038] In embodiments, the surgical instrument may further include a spring on the stationary jaw, the spring configured to bias the reload towards the open
10 position. In embodiments, the reload includes a staple cartridge and the stationary jaw includes an anvil.

[0039] In embodiments, the drive member may further include a distal ramped surface configured to engage a surface of the reload to pivot the reload toward the closed position upon distal translation of the drive member.

15 [0040] In embodiments, the surgical instrument may be a manually activated surgical instrument, an electro-mechanically powered instrument, or a robotic surgical instrument.

[0041] In another aspect, the present disclosure relates to a surgical instrument including a stationary jaw configured to receive a reload having
20 proximal and distal pins. The stationary jaw includes a proximal slot for receiving the proximal pin and a distal slot for receiving the distal pin, wherein movement of the distal pin in the distal slot pivots the reload relative to the stationary jaw between an open position and a closed position. The surgical instrument may further include a latch movable to first retaining position and a second locking
25 position, the proximal pin being movably retained within the proximal slot when the

latch is in the first retaining position.

[0042] In embodiments, the latch is biased towards the second locking position. In embodiments, the end effector may further include a latch release configured for manual activation to move the latch from the second locked position
5 to a proximal position. In embodiments, the latch release may include a series of grooves on an exposed portion of the latch release. In embodiments, the latch abuts a portion of a drive member, the drive member preventing the latch from translating distally.

[0043] In embodiments, the reload may include a staple cartridge and the
10 stationary jaw includes an anvil.

[0044] In yet another aspect, the present disclosure relates to a kit including a first reload configured for removable coupling to a surgical instrument. The kit may further include first drive member configured to translate through the reload and having a body with a first height, and a second reload configured for removably
15 coupling to a surgical instrument and including a second drive member configured to translate through the reload and having body with a second height that is greater than the height of the body of the first drive member.

[0045] In embodiments, the first and second drive members each include an engagement structure configured for engaging an actuator on the surgical
20 instrument for translating the first and second drive members through the first and second reloads.

[0046] In embodiments, each reload includes a staple cartridge.

[0047] In embodiments, the first and second drive members may each include a shoe at a first end thereof, and an engagement structure at a second end
25 thereof, the body extending between the shoe and the engagement structure. A

height of the body may determine a tissue gap between the reload and a stationary jaw onto which the reload is installed.

[0048] In yet another aspect, the present disclosure relates to a method for treating tissue. The method includes installing a reload onto an end effector of a surgical instrument such that the reload is pivotally coupled to a first jaw on the end effector between open and closed positions, the reload and the first jaw may define a first distance therebetween in the closed position, and translating the reload in a substantially perpendicular direction relative to the first jaw to define a second distance therebetween.

10 [0049] In embodiments, the method may further include advancing a drive member in a distal direction through the end effector, the drive member causing the reload to move in the substantially perpendicular direction.

[0050] In embodiments, the method may further include engaging a pin on the reload with a camming surface of the drive member as the drive member is advanced distally through the end effector.

[0051] In embodiments, the method may further include locking the reload in position with the second distance between the reload and the first jaw.

[0052] In embodiments, the method may further include engaging a secondary drive member on the reload with the drive member to form an I-beam as the drive member is advanced distally through the end effector.

20 [0053] In embodiments, the method may further include installing a second reload onto the end effector of the surgical instrument and translating the second reload in the substantially perpendicular direction relative to the first jaw to define a third distance therefore, wherein the third distance is greater than the second distance.

25

[0054] In yet another aspect, the present disclosure relates to a kit including a surgical instrument having an elongate shaft and an end effector including a first jaw. A first staple cartridge may be removably couplable to the end effector and housing a plurality of staples, wherein the first staple cartridge is configured to move between open and closed positions relative to the first jaw. The first jaw and the first staple cartridge may be separated by a first distance in the closed position. The kit may further include a second staple cartridge removably couplable to the end effector and housing a plurality of staples, wherein the second staple cartridge is configured to move between open and closed positions relative to the first jaw. The first jaw and the second staple cartridge may be separated by a second distance in the closed position, the second distance being greater than the first distance.

[0055] In embodiments, the first and second staple cartridges are substantially parallel to the first jaw in the closed position.

BRIEF DESCRIPTION OF THE DRAWINGS

[0056] The above and other aspects, features, and advantages of the present surgical instruments will become more apparent in light of the following detailed description when taken in conjunction with the accompanying drawings in which:

[0057] Fig. 1 is a perspective view of an illustrative surgical instrument in accordance with the present disclosure;

[0058] Fig. 2 is a perspective view of a stationary jaw and a reload of an illustrative surgical instrument in accordance with the present disclosure;

[0059] Fig. 3 is a partial perspective view of a stationary jaw of an illustrative surgical instrument in accordance with the present disclosure;

[0060] Fig. 4 is a perspective view of a reload of an illustrative surgical instrument in accordance with the present disclosure;

5 [0061] Fig. 4A is an exploded view of a reload of an illustrative surgical instrument in accordance with the present disclosure;

[0062] Figs. 5-6 are cross-sectional views of a portion of the end effector of the surgical instrument of Fig. 1 each having a unique reload and tissue gap;

[0063] Fig. 7 is a partial perspective view of the end effector of the surgical instrument of Fig. 1 depicting an illustrative reload being installed;

[0064] Fig. 8 is a partial perspective view of the end effector of the surgical instrument of Fig. 1 depicting a pin engaging a latch during installation of a reload;

[0065] Fig. 9 is a partial perspective view of the end effector of the surgical instrument of Fig. 1 depicting an illustrative reload installed and secured;

15 [0066] Fig. 10A is a partial perspective view of the end effector of the surgical instrument of Fig. 1 being inserted through a cannula;

[0067] Fig. 10B is a partial perspective view the of end effector of the surgical instrument of Fig. 1 being inserted through a cannula;

[0068] Fig. 11A is a partial perspective view of the end effector of the surgical instrument of Fig. 5 being inserted through a cannula;

[0069] Fig. 11B is a partial perspective view of the end effector of a surgical instrument of Fig. 6 being inserted through a cannula;

[0070] Fig. 11C is a partial perspective view with parts removed of the end effector of the surgical instrument of Fig. 1 in a passively open position after
25 passing through a cannula;

[0071] Fig. 12 is a partial perspective view of the end effector of the surgical instrument of Fig. 1 depicting a drive member translating distally to begin closing the jaws;

[0072] Fig. 13A is a partial perspective view of the end effector of the surgical instrument of Fig. 1 in the closed and clamped position;

[0073] Fig. 13B is a partial perspective view of the end effector of the surgical instrument of Fig. 5 shown in a second closed position providing for a tissue gap;

[0074] Fig. 13C is a partial perspective view of the end effector of the surgical instrument of Fig. 6 shown in a second closed position providing for a tissue gap;

[0075] Fig. 14 is a partial perspective view of the end effector of the surgical instrument of Fig. 1 having a drive member that is translating distally to pick up a secondary drive member during actuation of the surgical instrument;

[0076] Fig. 15 is a partial perspective view of the end effector of the surgical instrument of Fig. 1 depicting a drive member and a secondary drive member moving distally together through the end effector to sever and staple tissue;

[0077] Fig. 16 is a partial perspective view of the end effector of the surgical instrument of Fig. 1 after the surgical instrument has been actuated with the drive members at the distal end of the end effector;

[0078] Fig. 17A is a partial perspective view of the end effector of the surgical instrument of Fig. 1 depicting a mechanism for releasing the reload;

[0079] Fig. 17B is a partial bottom view of the end effector of the surgical instrument of Fig. 1 depicting the mechanism for releasing the reload;

[0080] Fig. 18 illustrates a top view of an operating room employing a robotic

surgical system utilizing aspects of the present disclosure; and

[0081] Fig. 19 illustrates a simplified side view of a robotic arm assembly that is usable with various aspects of the present disclosure.

5

DETAILED DESCRIPTION

[0082] Particular embodiments of the present surgical instruments are described hereinbelow with reference to the accompanying drawings; however, it is to be understood that the disclosed embodiments are merely exemplary of the disclosure and that the present surgical instruments may be embodied in various forms. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a basis for the claims and as a representative basis for teaching one skilled in the art to variously employ the present disclosure in virtually any appropriately detailed structure. Well-known functions or constructions are not described in detail to avoid obscuring the present disclosure in any unnecessary detail.

15

[0083] While the following disclosure is presented with respect to a surgical instrument configured to staple tissue, it should be understood that certain features of the presently described surgical instruments may be readily adapted for use in any type of surgical clamping, cutting, or sealing instruments. For example, features of the present surgical instruments may be employed to set a tissue gap for treating tissue with electrosurgical energy (e.g., cutting, sealing, ablating, etc.) rather than stapling. The surgical clamping and cutting instrument may be a minimally invasive (e.g., laparoscopic) instrument or an instrument used for open surgery.

20

25 [0084] Additionally, the features of the presently described surgical stapling

instruments may be readily adapted for use in surgical instruments that are activated using any technique within the purview of those skilled in the art, such as, for example, manually activated surgical instruments, powered surgical instruments (e.g., electro-mechanically powered instruments), robotic surgical instruments, and the like.

[0085] Fig. 1 is a perspective view of an illustrative surgical instrument 100 in accordance with embodiments of the present disclosure having a handle assembly 102, and an end effector 110 mounted on an elongated shaft 106 of the surgical stapling instrument 100. End effector 110 includes a stationary jaw 111 and a removable second jaw 112, sometimes referred to herein as reload 112, that is movable relative to stationary jaw 111 from an open position toward a closed position to grasp tissue. In a fully closed position, jaws 111 and 112 are separated by a distance referred to herein as a tissue gap. In the present instruments, the tissue gap is determined by first and second drive members as will be described in detail below. The term "reload" as used in the present disclosure refers to a removable portion of end effector 110 of surgical instrument 100 that may be installed onto end effector 110, used during a procedure, and then removed from end effector 110. The reload may be exchanged with other reloads prior to, during, or after the surgical procedure. The term "reload" may refer to a removable jaw, a staple cartridge or a removable jaw that houses a staple cartridge. While certain embodiments described herein may include a reload 112 that is a removable jaw including a stapler cartridge for use with a surgical stapling instrument, it should be understood that reloads in accordance with this disclosure may be a variety of removable jaws configured for use with various surgical instruments in which varying the tissue gap is desirable, such as, for example, a surgical sealing

instrument configured to treat tissue with electrosurgical energy (e.g., cutting, sealing, ablating, etc.).

[0086] Handle assembly 102 includes a stationary handle 102a and a moveable handle 102b which serves as an actuator for surgical instrument 100. In certain embodiments, handle assembly 102 may include input couplers (not shown) instead of, or in addition to, the stationary and movable handles. The input couplers provide a mechanical coupling between the drive tendons or cables of the instrument and motorized axes of the mechanical interface of a drive system. The input couplers may interface with, and be driven by, corresponding output couplers (not shown) of a telesurgical surgery system, such as the system disclosed in U.S. Pub. No. 2014/0183244A1, the entire disclosure of which is incorporated by reference herein for all purposes. The input couplers are drivingly coupled with one or more input members (not shown) that are disposed within the instrument shaft 106 and end effector 110. Suitable input couplers can be adapted to mate with various types of motor packs (not shown), such as the stapler-specific motor packs disclosed in U.S. Pat. No. 8,912,746, or the universal motor packs disclosed in U.S. Pat. No. 8,529,582, the disclosures of both of which are incorporated by reference herein in their entirety for all purposes. Further details of known input couplers and surgical systems are described, for example, in U.S. Pat. No. 8,597,280, U.S. Pat. No. 7,048,745, and U.S. Pat. No. 10,016,244. Each of these patents is hereby incorporated by reference in its entirety for all purposes.

[0087] Actuation mechanisms of surgical instrument 100 may employ drive cables that are used in conjunction with a system of motors and pulleys. Powered surgical systems, including robotic surgical systems that utilize drive cables connected to a system of motors and pulleys for various functions including

opening and closing of jaws, as well as for movement and actuation of end effectors are well known. Further details of known drive cable surgical systems are described, for example, in U.S. Pat. No. 7,666,191 and U.S. Pat No. 9,050,119 both of which are hereby incorporated by reference in their entireties for all
5 purposes. While described herein with respect to an instrument configured for use with a robotic surgical system, it should be understood that the wrist assemblies described herein may be incorporated into manually actuated instruments, electro-mechanical powered instruments, or instruments actuated in any other way.

[0088] Fig. 2 is a perspective view of the jaws of surgical instrument 100
10 including stationary jaw 111, removable jaw 112 and a clevis 140 for mounting jaws 111, 112 to instrument 100. Stationary jaw 111 is configured to receive removable jaw 112. Once removable jaw 112 is received by and secured to jaw 111, tissue may be grasped between tissue contacting surfaces 117 of jaw 111 and tissue contacting surfaces 118 of removable jaw 112 as it moves and pivots towards
15 stationary jaw 111.

[0089] Fig. 3 is a perspective view of a proximal portion of stationary jaw 111 which includes an anvil 114, a drive member 150, an anvil spring 165, a latch 170, a latch spring 175, a proximal slot 180, and a distal slot 190. As those skilled in the art will appreciate, stationary jaw 111 is symmetrical having corresponding
20 structure on either side thereof.

[0090] Stationary jaw 111 may include coupling members for receiving removable jaw 112. In embodiments, proximal slots 180 and distal slots 190 of stationary jaw 111 are configured to receive pins of removable jaw 112 such that removable jaw 112 may be installed on end effector 110 of surgical instrument 100.

The design of stationary jaw 111 of surgical instrument 100 is such that stationary jaw 111 may receive and support various reloads 112 each configured to provide a particular tissue gap between stationary and removable jaws 111, 112 for surgical instrument 100 upon installation. Anvil spring 165 has one end secured to anvil 114, and another end that is free to contract upon contact with a cartridge during installation of a fresh reload. This will allow for stationary jaw 111 and movable jaw 112 to remain in a passively open position except when the bias over spring 165 is overcome during closing of the jaws 111,112 for actuation or translation through a cannula. The details of the opening and closing of jaws 111,112 will be further described below.

[0091] As best shown in Figs. 5 and 6, drive member 150 contains a flange (sometimes referred to hereinafter as a shoe) 155 that travels within a channel 157 in stationary jaw 111. A center bore 159 of drive member 150 is configured to receive an actuation mechanism such as a drive rod 130 that is operably connected to moveable handle 102b such that movement of movable handle 102b towards stationary handle 102a causes drive member 150 to translate distally through end effector 110 and movement of movable handle 102b away from stationary handle 102a causes drive member 150 to retract proximally through end effector 110. In embodiments, the actuation mechanism may include a series of cables or other actuators as discussed previously in connection with Fig. 1. Body 158 connects shoe 155 and bore 159. Lower portion of drive member 150 contains a slot 153 (see Fig. 14) and a number of cam surfaces for engaging portions of jaw 112. Slot 153 functions as an engagement structure and is configured to engage a secondary engagement structure on jaw 112 (e.g., proximal tab 178 of secondary drive member 179), as will be shown below in connection with Fig. 14.

[0092] Fig. 4 is a perspective view of an illustrative removable jaw 112 including a staple cartridge 122, secondary drive member 179, channel 115, pivot pins 143a,b and hard stop pins 144a,b. Removable jaw 112 is configured to be received by stationary jaw 111 such that upon installation, removable jaw 112 provides a movable jaw pivotable from an open position to a closed position relative to stationary jaw 111 to grasp tissue. Stapling cartridge 122 is contained in channel 115 of removable jaw 112. As removable jaw 112 pivots from an open position, stationary jaw 111 and removable jaw 112 cooperate to clamp tissue such that cartridge 122 and anvil 114 are in close cooperative alignment.

[0093] Fig. 4a shows that cartridge 122 may include a plurality of staples 124 supported on corresponding staple drivers 126 provided within respective staple apertures 127 formed in cartridge 122. Cartridge 122 also may include a shuttle 123 having an inclined distal portion 125 that, upon distal movement, sequentially acts on staple drivers 126, camming them upwardly thereby moving staples 124 into deforming contact with anvil 114. A knife (not shown) may be configured to translate distally through end effector 110 to sever clamped, stapled tissue. The knife may be a sharpened edge formed on drive member 150. Cartridge 122 may be removably received within removable jaw 112 or, in single use embodiments, may be permanently secured within removable jaw 112.

[0094] Reload 112 also includes secondary drive member 179. As best seen in Figs. 5 and 6, secondary drive member 179 includes a flange (sometimes referred to hereinafter as a shoe) 187 that travels in a channel 131 in jaw 112 and a body 188 extending from shoe 187 and terminating in a proximal tab 178 (see Fig. 14) which functions as an engagement structure and is configured to engage

a slot 153 of drive member 150. Since the height of drive member 150 (which is not part of the replaceable reload) is constant, choosing a reload with a secondary drive member 179 having a body 188 of a particular height (which may be different in different reloads) may be used to adjust the size of the tissue gap between jaws 111, 112 when the jaws are in the extended closed position relative to each other (as discussed below).

[0095] A plurality of reloads 112 may be provided in a kit, with different reloads including secondary drive members 179 having bodies 188 of different sizes (compare Figs. 5 and 6) to define different tissue gaps between the removable jaw 112 and anvil 114 of stationary jaw 111. The tissue gap of surgical instrument 100 is determined by the height of secondary drive member 179. In embodiments, when engaged together, drive member 150 and secondary drive member 179 collectively form an I-beam or E-beam, as will be further described below. Although slot 153 and proximal tab 178 are shown as the engagement structure to connect drive member 150 and secondary drive member 179, it should be understood that other suitable engagement structures (e.g., other interlocking structures) may be employed. For example, the drive member may include a tab and the secondary drive member may include a slot. Those skilled in the art reading this disclosure will readily envision other structural configurations suitable for the engagement structures.

[0096] Figs. 5 and 6 show cross-sectional views of a portion of the end effector of surgical instrument 100 including stationary jaw 111, removable jaw 112, drive member 150, cartridge 122, and secondary drive member 179.

[0097] In Fig. 5, surgical instrument 100 is in an extended closed position in which drive member 150 has begun to translate distally to engage and pick up

secondary drive member 179, but has not yet fired staples or severed tissue. As previously noted, choosing a reload with a secondary drive member 179 of a particular overall height may be used to set the desired tissue gap. Removable jaw 112 of surgical instrument 100 contains a secondary drive member 179a, having a height configured to set a tissue gap "A". Prior to actuating and firing, as best seen in Fig 10A below, the removable jaw 112 may be compressed towards stationary jaw 111 to permit the instrument to travel through a cannula. Once the end effector extends out of the cannula, the removable jaw 112 moves away from the stationary jaw 111, ensuring that upon translation of drive member 150 distally, the engagement structure (e.g., slot 153) of the drive member 150 is properly aligned with the engagement structure (e.g., proximal tab 178) of the secondary drive member 179. The amount of movement of the removable jaw 112 away from the stationary jaw 111 to align the engagement structures of the drive member 150 and secondary drive member 179 may vary based on the height of secondary drive member 179.

[0098] Fig. 6 shows surgical instrument 100 having a removable jaw 112 including a cartridge 122, and a secondary drive member 179b having a shorter overall height in the extended closed position than secondary drive member 179a shown in Fig. 5. The shorter height of drive member 179b provides for tissue gap "B". One of ordinary skill will appreciate that the tissue gap for surgical instrument 100 in Fig. 6 is thinner than the tissue gap in Fig. 5 as a result of the height of the secondary drive member 179 contained in removable jaw 112.

[0099] Figs. 7-9 depict the installation of a removable jaw 112 into stationary jaw 111 of surgical instrument 100.

[00100] Figs. 7-9 illustrate the installation of removable jaw 112 onto

stationary jaw 111. Removable jaw 112 may be installed manually. As shown in Fig. 7, a user initially guides a pivot pin 143a,b and hard stop pins 144a,b into proximal slot 180a,b and distal slot 190a,b respectively. Proximal pin 143 engages distal ramped surface 181 of proximal slot 180 until reaching and riding through a central portion 182 of proximal slot 180. Simultaneously distal pin 144 engages a distal ramped surface 191 of distal slot 190 to urge distal pin 144 proximally towards closing portion 193 of slot 190, where distal pin 144 can no longer move proximally because it is stopped by edge 192 of distal slot 190.

[00101] As shown, latch 170 is biased by latch spring 175 (see Fig. 3) towards a distal position designed to retain proximal pin 143 within proximal slot 180, thereby retaining removable jaw 112 in the installed position within stationary jaw 111. Latch spring 175 is received within a bore 197 formed on latch 170. When latch 170 is in the spring-biased distal position, a distal face 171 of latch 170 is substantially aligned with central portion 182 of proximal slot 180 such that distal face 171 obstructs proximal pin 143 after it has traveled through central portion 182 of proximal slot 180.

[00102] Referring now to Fig. 8, removable jaw 112 has been pushed further in the proximal direction as it is being installed into stationary jaw 111. Proximal pin 143 has traveled through central portion 182 of proximal slot 180 and is now engaging distal ramped surface 171 of latch 170. As the bias of latch spring 175 is overcome by the manual force applied by a user upon installation, proximal pin 143 slides along distal ramped surface 171 of latch 170, ultimately pushing latch 170 proximally and allowing proximal pin 143 to ride underneath latch 170. At this point, proximal pin 143 may ride below lower surface 172 of latch 170 into a proximal portion 184 of proximal slot 180.

[00103] In Fig. 9, proximal pin 143 has cleared lower surface 172 of latch 170. This causes spring 175 to force latch 170 distally to a first retaining position, trapping proximal pin 143 between lower face 172 of latch 170 and an edge 183 of proximal slot 180. The distance between lower surface 172 of latch 170 and edge 183 of proximal slot 180 is less than the diameter of proximal pin 143. In this position, removable jaw 112 is secured to stationary jaw 111, as proximal pin 143 cannot escape the proximal portion 184 of proximal slot 180. Thus, latch 170 is movable to a first retaining position to keep pin 143 movably retained within the proximal slot within proximal slot 180.

[00104] Once removable jaw 112 is installed and secured, surgical instrument 100 may be inserted through a cannula towards a surgical site. In embodiments, the height of secondary drive member 179 in a given removable jaw or reload 112 will determine the distance proximal pin 143 moves within proximal portion 184 of proximal slot 180, for example, as the removable jaw 112 is compressed towards anvil 114 in preparation for traveling through a cannula towards a surgical site.

[00105] Figs. 10A and 10B depict surgical instrument 100 with two different reloads or removable jaws both in a first closed position that minimizes the diameter of instrument 100. The first closed position may be suitable, for example, when the instrument travels through a cannula or other percutaneous penetration into a patient. Fig. 10A depicts surgical instrument 100 having a removable jaw 112 configured to provide a relatively thick tissue gap between jaws 111, 112 when the instrument is in a second or "extended" closed position suitable for clamping, sealing and/or stapling tissue (the extended closed position is discussed below and shown in FIGS. 13B and 13C). Fig. 10B depicts surgical instrument 100 having a

removable jaw 112 configured to provide for a relatively thin tissue gap in the second or extended closed position. To insert surgical instrument 100 through a cannula once a reload is installed, a user manually overcomes the bias of anvil spring 165 by pushing removable jaw 112 towards the anvil and then inserting the instrument into a cannula while the jaws are at least somewhat closed. Once inserted, the cannula forces surgical instrument 100 to conform to the diameter of the cannula. It should be noted that while in the cannula, the unique tissue gap of removable jaw 112 is not yet activated, as secondary drive member 179 is not engaged with drive member 150 and thus jaw 112 is able to move towards and away from anvil 114. This allows anvil spring 165 to be compressed enough to conform to the smaller diameter of a cannula regardless of the size of the tissue gap removable jaw 112 is configured to provide. One of ordinary skill will appreciate that while within the cannula, proximal pin 143 and distal pin 144 will translate upwards or downwards within their respective slots depending on the amount of compression of removable jaw 112 that is necessary to conform surgical instrument 100 to the diameter of the cannula. This is depicted in Figs. 11A and 11B respectively.

[00106] Fig. 11A depicts the end effector and removable jaw of the embodiment shown in Fig. 5, configured to provide for a first tissue gap, passing through a cannula. Fig. 11B depicts the end effector and removable jaw of the embodiment shown in Fig. 6, configured to provide for a second tissue gap different from the first tissue gap, passing through a cannula. As shown, proximal and distal pins 143, 144 of the two different reloads are in different vertical positions within slots 180, 190 while in the first closed position. This means that pins 143, 144 will travel different distances vertically downward through slots 180, 190 when the

reloads are moved into the second or extended closed positions (Figs. 13B and 13C). Thus, the reloads will be moved away from fixed jaw 111 by different distances when moving them into the second closed positions, creating different tissues gaps therebetween.

5 [00107] Fig. 11C depicts surgical instrument 100 that has been passively opened by anvil spring 165 after passing through a cannula towards a surgical site. In Fig. 11C, removable jaw 112 remains securely installed within stationary jaw 111, as latch 170 is still trapping proximal pin 143. However, once passing through a cannula, anvil spring 165 continues to bias the jaws of surgical instrument 100
10 towards the open position. This causes removable jaw 112 to pivot away from stationary jaw 111, ultimately resting in a passively open position.

[00108] Figs. 12 and 13 depict the closing of the jaws of surgical instrument 100 to clamp tissue.

[00109] In Fig. 12, upon an input command being given to a robotic surgical
15 system to grasp tissue, or upon manual activation of a trigger or handle as are known by those of skill in the art, drive member 150 travels distally, causing a lower distal ramped surface 151 of drive member 150 to engage ramped surface 113 on channel 115 of removable jaw 112, forcing removable jaw 112 to move towards anvil 114, thereby urging the jaws towards a closed position. Simultaneously,
20 proximal ramped surface 152 of drive member 150 pushes proximal pin 143 downwards as drive member 150 translates distally.

[00110] In Fig. 13A, the jaws of surgical instrument 100 are fully closed, tissue is clamped, and instrument 100 is prepared for actuation to staple and sever clamped tissue. In this position, drive member 150 has continued to travel distally
25 and has caused the jaws 111,112 to pivot to the second closed position providing

for a tissue gap between jaws 111, 112. The second closed positions are best illustrated and described below in connection with Figs. 13B and 13C. In Fig. 13A, drive member 150 has also pushed proximal pin 143 further downwards within proximal slot 180, causing removable jaw 112 to translate downwards in relation to stationary jaw 111. In this position, secondary drive member 179 has been consequently translated downwards into proper alignment with drive member 150 as shown in Fig. 14 below. Once pin 143 has cleared proximal ramped surface 152 of drive member 150, the bias of latch spring 175 forces latch 170 to translate distally, causing a distal locking edge 177 of latch 170 to trap proximal pin 143 in a predetermined, second locked position in which it is substantially unable to move. Distal locking edge 177 of latch 170 is unable to trap proximal pin 143 in the second locked position before drive member 150 has translated far enough distally to drive proximal pin 143 towards the bottom of proximal slot 180, because an edge 156 of drive member 150 interferes with and abuts distal locking edge 177 of latch 170. Once drive member 150 begins to translate distally, spring 175 will force latch 170 to also translate distally until a lower distal surface 174 of latch 170 engages and abuts a proximal surface 142 of clevis protrusion 141 such that latch 170 remains in the proper position to trap proximal pin 143. In this configuration, the tissue gap of surgical instrument 100, as determined by the height of secondary drive member 179 is provided for. One of ordinary skill will appreciate that proximal pin 143 will ultimately be trapped in the second locked position in which it is substantially unable to move regardless of the height of secondary drive member 179 and the size of the tissue gap provided for in a given removable jaw 112 secured within stationary jaw 111 of surgical instrument 100.

[00111] Figs. 13B depicts the end effector and removable jaw of the

embodiment shown in Fig. 5 in the second closed position providing for a first tissue gap. Fig. 13C depicts the end effector and removable jaw shown in Fig. 6 in a second closed position providing for a second tissue gap that is thinner than the first tissue gap shown in Fig. 13B. As described above, proximal pin 143 remains stationary in the predetermined second locked position in both embodiments despite removable jaw 112 being of a different size and configured to provide for a unique tissue gap in each embodiment. Surgical instrument 100 is now prepared for actuation to grasp, sever, and staple grasped tissue.

[00112] In an alternative embodiment, surgical instrument 100 is configured to adjust the position of the removable jaw or reload 112 in the second or extended closed position such that an individual reload may be moved into different extended closed positions relative to jaw 111, thereby creating different tissue gaps with the same reload 112. In this embodiment, it may not be necessary to install a second reload onto surgical instrument 100 in order to change the size of the tissue gap between jaws 111, 112. In certain embodiments, latch 170 may include one or more camming surfaces (not shown) configured to move pin 143 of jaw 112 into multiple vertical positions within proximal slot 180. For example, latch 170 may be configured to translate distally a first distance, thereby camming pin 143 vertically downwards a first distance that provides a first tissue gap between jaws 111, 112. Latch 170 may then be configured to translate distally a second distance greater than the first distance, thereby camming pin 143 vertically downwards a second distance to provide a larger tissue gap between jaws 111, 112.

[00113] Figs. 14-16 depict actuation of surgical instrument 100 to staple and sever clamped tissue.

[00114] Fig. 14 shows drive member 150 being driven distally upon actuation

of surgical instrument 100. Known actuation mechanisms and backend mechanisms, such as those previously referenced above, cause drive member 150 to travel distally through the end effector. As shown in Fig. 15, as drive member 150 continues to translate distally, it picks up secondary drive member 179 as proximal tab 178 of secondary drive member 179 passes into a slot 153 of drive member 150. As drive member 150 continues translating distally, lower distal surface 154 of drive member 150 will engage proximal tab 178 on secondary drive member 179. In embodiments, drive member 150 may be an upper portion of an I-beam, and secondary drive member 179 may be an I-beam footer that is “picked up” upon distal translation of drive member 150 forming an I-Beam.

[00115] In Fig. 16, drive member 150 and secondary drive member 179 have translated to the distal end of surgical instrument 100, stapling and severing tissue through interaction with the components of cartridge 122 as described above. Upon completion of a firing stroke, the surgical instrument 100 may be removed from the surgical site and the drive member 150 may be retracted by the actuation mechanism (not expressly shown) so that surgical instrument 100 returns to the passively open position shown in Fig. 11. However, removable jaw 112 remains secured to surgical instrument 100 until released by a user.

[00116] Figs. 17A and 17B illustrate a mechanism for releasing removable jaw 112 from surgical instrument 100.

[00117] In Fig. 17A, latch 170 includes a latch release 195 on bottom face 176 of latch member 170. Bottom face 176 of latch release 195 protrudes out of a window 199 on the bottom of movable jaw 112 such that a user may manually activate latch release 195 to release a reloadable portion 112 after firing. As shown in Fig. 17B, bottom face 176 of latch 170 may have grooves 196 to facilitate manual

activation of latch release 195, however, bottom face 176 of latch 170 may include other features to facilitate use such as a protrusion, a recess, or any other design to facilitate manually activating latch release 195. When bottom face 176 is manually pulled in the proximal direction shown by Arrow "A" overcoming the bias
5 of latch spring 175, latch 170 translates proximally, freeing proximal pin 143 and allowing for removal of removable jaw 112.

[00118] The present surgical instrument may be used in a robotic surgical system. FIG. 18 illustrates, as an example, a top view of an operating room employing a robotic surgical system. The robotic surgical system in this case is a
10 robotic surgical system 300 including a console ("C") utilized by a surgeon ("S") while performing a minimally invasive diagnostic or surgical procedure, usually with assistance from one or more assistants ("A"), on a patient ("P") who is lying down on an operating table ("O").

[00119] The console includes a monitor 304 for displaying an image of a
15 surgical site to the Surgeon, left and right manipulatable control devices 308 and 309, a foot pedal 305, and a processor 302. The control devices 308 and 309 may include any one or more of a variety of input devices such as joysticks, gloves, trigger-guns, hand-operated controllers, or the like. The processor 302 may be a dedicated computer that may be integrated into the Console or
20 positioned next to it.

[00120] The surgeon performs a minimally invasive surgical procedure by manipulating the control devices 308 and 309 (also referred to herein as "master manipulators") so that the processor 302 causes their respectively associated robotic arm assemblies, 328 and 329, (also referred to herein as "slave
25 manipulators") to manipulate their respective removably coupled surgical

instruments 338 and 339 (also referred to herein as “tools”) accordingly, while the Surgeon views the surgical site in 3-D on the Console monitor 304 as it is captured by a stereoscopic endoscope 340.

[00121] Each of the tools 338 and 339, as well as the endoscope 340, may
5 be inserted through a cannula or other tool guide (not shown) into the Patient so as to extend down to the surgical site through a corresponding minimally invasive incision such as incision 366. Each of the robotic arms is conventionally formed of links, such as link 362, which are coupled together and manipulated through motor controlled or active joints, such as joint 363.

10 [00122] The number of surgical tools used at one time and consequently, the number of robotic arms being used in the system 300 will generally depend on the diagnostic or surgical procedure and the space constraints within the operating room, among other factors. If it is necessary to change one or more of the tools being used during a procedure, the Assistant may remove the tool no
15 longer being used from its robotic arm, and replace it with another tool 331 from a Tray (“T”) in the operating room.

[00123] The monitor 304 may be positioned near the Surgeon's hands so that it will display a projected image that is oriented so that the Surgeon feels that he or she is actually looking directly down onto the operating site. To that end,
20 images of the tools 338 and 339 may appear to be located substantially where the Surgeon's hands are located.

[00124] The processor 302 performs various functions in the system 300. One important function that it performs is to translate and transfer the mechanical motion of control devices 308 and 309 to their respective robotic arms 328 and
25 329 through control signals over bus 310 so that the Surgeon can effectively

manipulate their respective tools 338 and 339. Another important function is to implement various control system processes as described herein.

[00125] Although described as a processor, it is to be appreciated that the processor 302 may be implemented in practice by any combination of hardware, software and firmware. Also, its functions as described herein may be performed by one unit, or divided up among different components, each of which may be implemented in turn by any combination of hardware, software and firmware.

[00126] For additional details on robotic surgical systems, see, e.g., U.S. Pat. Nos. 6,493,608 and 6,671,581, the entire contents of which are incorporated herein by this reference.

[00127] FIG. 19 illustrates, as an example, a side view of a simplified (not necessarily in proportion or complete) illustrative robotic arm assembly 400 (which is representative of robotic arm assemblies 328 and 329) holding a surgical instrument 450 (which is representative of tools 338 and 339) for performing a surgical procedure. The surgical instrument 450 is removably held in tool holder 440. The arm assembly 400 is mechanically supported by a base 401, which may be part of a patient-side movable cart or affixed to the operating table or ceiling. It includes links 402 and 403 which are coupled together and to the base 401 through setup joints 404 and 405.

[00128] The setup joints 404 and 405 in this example are passive joints that allow manual positioning of the arm 400 when their brakes are released. For example, setup joint 404 allows link 402 to be manually rotated about axis 406, and setup joint 405 allows link 403 to be manually rotated about axis 407.

[00129] Although only two links and two setup joints are shown in this example, more or less of each may be used as appropriate in this and other

robotic arm assemblies in conjunction with the present disclosure. For example, although setup joints 404 and 405 are useful for horizontal positioning of the arm 400, additional setup joints may be included and useful for limited vertical and angular positioning of the arm 400. For major vertical positioning of the arm 400, however, the arm 400 may also be slidably moved along the vertical axis of the base 401 and locked in position.

[00130] The robotic arm assembly 400 also includes three active joints driven by motors. A yaw joint 410 allows arm section 430 to rotate around an axis 461, and a pitch joint 420 allows arm section 430 to rotate about an axis perpendicular to that of axis 461 and orthogonal to the plane of the drawing. The arm section 430 is configured so that sections 431 and 432 are always parallel to each other as the pitch joint 420 is rotated by its motor. As a consequence, the instrument 450 may be controllably moved by driving the yaw and pitch motors so as to pivot about the pivot point 462, which is generally located through manual positioning of the setup joints 404 and 405 so as to be at the point of incision into the patient. In addition, an insertion gear 445 may be coupled to a linear drive mechanism (not shown) to extend or retract the instrument 450 along its axis 463.

[00131] Although each of the yaw, pitch and insertion joints or gears, 410, 420 and 445, is controlled by an individual joint or gear controller, the three controllers are controlled by a common master/slave control system so that the robotic arm assembly 400 (also referred to herein as a "slave manipulator") may be controlled through user (e.g., surgeon) manipulation of its associated master manipulator.

[00132] While several embodiments have been shown in the drawings, it is

not intended that the disclosure be limited thereto, as it is intended that the disclosure be as broad in scope as the art will allow and that the specification be read likewise. Therefore, the above description should not be construed as limiting, but merely as exemplifications of presently disclosed embodiments. Thus,
5 the scope of the embodiments should be determined by the appended claims and their legal equivalents, rather than by the examples given.

[00133] Persons skilled in the art will understand that the devices and methods specifically described herein and illustrated in the accompanying drawings are non-limiting exemplary embodiments. The features illustrated or
10 described in connection with one exemplary embodiment may be combined with the features of other embodiments. Various alternatives and modifications can be devised by those skilled in the art without departing from the disclosure. Accordingly, the present disclosure is intended to embrace all such alternatives, modifications and variances. As well, one skilled in the art will appreciate further
15 features and advantages of the present disclosure based on the above-described embodiments. Accordingly, the present disclosure is not to be limited by what has been particularly shown and described, except as indicated by the appended claims.

CLAIMS

1. A surgical instrument comprising:

an elongate shaft;

an end effector on a distal end portion of the shaft and comprising a first
5 jaw;

a coupling member on the end effector configured to receive either a first
or second reload and to removably couple either the first or second reload to the
end effector;

wherein the coupling member is configured to retain the first reload in a
10 closed position relative to the first jaw such that the first jaw and first reload have
a first gap therebetween; and

wherein the coupling member is configured to retain the second reload in a
closed position relative to the first jaw such that the first jaw and second reload
have a second gap therebetween, the second gap being greater than the first
15 gap.

2. The surgical instrument of claim 1, wherein the first and second reloads
each comprise a movable jaw.

20 3. The surgical instrument of claim 1, wherein the first and second reloads
each comprise a staple cartridge housing a plurality of staples.

4. The surgical instrument of claim 1, wherein the coupling member is a
channel extending transversely to a longitudinal axis of the elongate shaft.

25

5. The surgical instrument of claim 2, wherein the coupling member is configured to receive an engagement structure of the first or second movable jaw.

5 6. The surgical instrument of claim 5, wherein the engagement structure of the first or second movable jaw is a pin.

7. The surgical instrument of claim 1, further comprising an actuator coupled to the end effector, the actuator being configured to move the first jaw and the
10 first or second movable jaw between an open position and a closed position.

8. The surgical instrument of claim 5, further comprising an actuator coupled to the end
effector, the actuator being configured to move the first or second movable jaw
15 between first and second closed positions relative to the first jaw, wherein the first or second movable jaw is substantially parallel to the first jaw in the first and second closed positions.

9. The surgical instrument of claim 8, wherein the actuator comprises a drive
20 member
configured to translate distally through the end effector.

10. The surgical instrument of claim 9, wherein the first or second movable jaw comprises a pin and the drive member comprises a camming surface, wherein the
25 camming surface engages the pin as the drive member is translated through the

end effector to move the first or second jaw from the first closed position to the second closed position.

11. The surgical instrument of claim 10, wherein the pin is pivotally coupled to the first or second movable jaw to allow the first or second movable jaw to pivot relative to the pin and the first jaw between the open and closed positions.

12. The surgical instrument of claim 8, further comprising a locking mechanism coupled to elongate shaft and configured to lock the first or second jaw in the second closed position.

13. The surgical instrument of claim 12, wherein the locking mechanism comprises a latch having a first distal surface and a second proximal surface, wherein the first second proximal surface is disposed laterally away from the first distal surface.

14. The surgical instrument of claim 9 further comprising an actuating mechanism for translating the drive member distally through the end effector, wherein the actuating mechanism includes a control device of a robotic surgical system.

15. A surgical instrument comprising:
an elongate shaft;
an end effector on a distal end portion of the shaft and comprising a first jaw and a second jaw configured to move relative to each other from an open position

to a closed position, the first and second jaws being substantially parallel to each other in the closed position; and

wherein the first and second jaws are movable relative to each other between the closed position, wherein the jaws define a first distance therebetween, and an expanded position, wherein the jaws define a second distance therebetween, the second distance being greater than the first distance, wherein the first and second jaws are substantially parallel to each other in the expanded position.

16. The surgical instrument of claim 15, wherein the second jaw is removably coupled to the end effector.

17. The surgical instrument of claim 15, further comprising:

a staple cartridge coupled to the second jaw and housing a plurality of staples; and

a drive member configured to translate distally through the end effector, the drive member being configured to engage the staples upon distal translation of the drive member through the staple cartridge and move the staples from an interior of the staple cartridge to an exterior of the staple cartridge.

18. The surgical instrument of claim 15, wherein the end effector defines a longitudinal axis, and wherein the first and second jaws define a gap therebetween in the extended position, wherein the gap extends substantially along the longitudinal axis between the first and second jaws.

19. The surgical instrument of claim 15, wherein the first and second jaws contact each other in the closed position.

20. The surgical instrument of claim 15, further comprising an actuator
5 configured to move the jaws between the closed and extended positions.

21. The surgical instrument of claim 20, wherein the actuator comprises a drive member configured to translate distally through the end effector.

10 22. The surgical instrument of claim 21, wherein the second jaw comprises a pin and the drive member comprises a camming surface, wherein the camming surface engages the pin as the drive member is translated through the end effector to move the second jaw from the closed position to the extended position.

15 23. The surgical instrument of claim 22, wherein the pin is pivotally coupled to the second jaw to allow the jaw to pivot relative to the pin and the first jaw between the open and closed positions.

24. The surgical instrument of claim 23, further comprising a channel on the
20 shaft or the end effector for receiving the pin, the channel extending in a transverse direction to the longitudinal axis of the shaft, wherein the camming surface translates the pin through the channel to move the second jaw from the closed position to the extended position.

25 25. The surgical instrument of claim 24, further comprising a locking mechanism

coupled to the second jaw and configured to lock the second jaw in the extended position.

26. The surgical instrument of claim 25, wherein the locking mechanism
5 comprises a latch having a first distal surface and a second proximal surface, wherein the first second proximal surface is disposed laterally away from the first distal surface.

27. The surgical instrument of claim 20, further comprising:
10 an actuation mechanism in contact with the drive member and configured to translate the drive member distally through the end effector; and the actuator operatively connected to the actuation mechanism.

28. The surgical instrument of claim 27, wherein the actuator includes a control
15 device of a robotic surgical system.

29. A surgical instrument comprising:
an elongate shaft having an end effector;
a first drive member configured to translate distally through a portion of
20 the end effector, the first drive member including a first flange at a first end thereof and a first engagement structure at a second end thereof; and
a reload removably coupled to the end effector and having a secondary drive member including a second flange at a first end thereof and a second engagement structure at a second end thereof, the second engagement structure
25 being configured to engage the first engagement structure such that the first drive

member and the secondary drive member collectively establish a fixed distance between the first flange of the first drive member and the second flange of the secondary drive member.

5

30. The surgical instrument of claim 29, wherein the first engagement structure is a slot and the second engagement structure is a tab configured to be received within the slot.

10 31. The surgical instrument of claim 29, wherein the end effector comprises a first jaw and the reload comprises a second jaw, wherein the first flange is configured to translate through a channel in the first jaw of the end effector, and the second flange is configured to translate through a channel in the second jaw.

15 32. The surgical instrument of claim 31, wherein the first and second jaws are movable between an open position and a closed position to grasp tissue between the first and second jaws.

20 33. The surgical instrument of claim 29, wherein the drive member and the secondary drive member collectively form an I-beam upon engagement of the first engagement structure with the second engagement structure.

34. The surgical instrument of claim 29, further comprising a spring on the stationary jaw, the spring configured to bias the reload towards the open position.

25

35. The surgical instrument of claim 29, wherein the reload includes a staple cartridge and the stationary jaw includes an anvil.

36. The surgical instrument of claim 32, wherein the drive member further
5 includes a distal ramped surface configured to engage a surface of the reload to pivot the reload toward the closed position upon distal translation of the drive member.

37. The surgical instrument of claim 29, wherein the surgical instrument is one
10 of a manually activated surgical instrument, an electro-mechanically powered instrument, or a robotic surgical instrument.

38. A surgical instrument comprising:

a first jaw configured to receive a reload having proximal and distal pins,
15 the first jaw comprising a proximal slot for receiving the proximal pin and a distal slot for receiving the distal pin, wherein movement of the distal pin in the distal slot pivots the reload relative to the first jaw between an open position and a closed position; and

a latch movable between a first retaining position and a second locking
20 position, the proximal pin being movably retained within the proximal slot when the latch is in the first retaining position.

39. The end effector of claim 38, wherein the latch is biased towards the second locking position.

40. The end effector of claim 38, further comprising a latch release configured for manual activation to move the latch from the second locked position to a proximal position.

5 41. The end effector of claim 40, wherein the latch release includes a series of grooves on an exposed portion of the latch release.

42. The end effector of claim 38, wherein the latch abuts a portion of a drive member, the drive member preventing the latch from translating distally.

10

43. The end effector of claim 38, wherein the reload includes a staple cartridge and the stationary jaw includes an anvil.

44. A kit comprising:

15 a first reload configured for removable coupling to a surgical instrument and comprising a first drive member configured to translate through the reload and having a body with a first height; and

a second reload configured for removably coupling to a surgical instrument and comprising a second drive member configured to translate through the reload
20 and having a body with a second height that is greater than the height of the body of the first drive member.

45. The kit of claim 44, wherein the first and second drive members each comprise an engagement structure configured for engaging an actuator on the

surgical instrument for translating the first and second drive members through the first and second reloads.

46. The kit of claim 44, wherein each reload includes a staple cartridge.

5

47. The kit of claim 44, wherein the first and second drive members each comprise a shoe at a first end thereof, an engagement structure at a second end thereof, the body extending between the shoe and the engagement structure, wherein a height of the body determines a tissue gap between the reload

10 and a stationary jaw onto which the reload is installed.

48. A method for treating tissue, the method comprising:

installing a reload onto an end effector of a surgical instrument such that the reload is pivotally coupled to a first jaw on the end effector between open and closed positions, the reload and the first jaw defining a first distance therebetween in the closed position; and

15

translating the reload in a substantially perpendicular direction relative to the first jaw to define a second distance therebetween.

20

49. The method of claim 48, further comprising advancing a drive member in a distal direction through the end effector, the drive member causing the reload to move in the substantially perpendicular direction.

50. The method of claim 49, further comprising engaging a pin on the reload with a camming surface of the drive member as the drive member is advanced distally through the end effector.

5 51. The method of claim 50, further comprising locking the reload in position with the second distance between the reload and the first jaw.

52. The method of claim 51, further comprising engaging a secondary drive member on the reload with the drive member to form an I-beam as the drive member is advanced distally through the end effector.

10

53. The method of claim 52, further comprising installing a second reload onto the end effector of the surgical instrument and translating the second reload in the substantially perpendicular direction relative to the first jaw to define a third distance therefore, wherein the third distance is greater than the second distance.

15

54. A kit comprising:

a surgical instrument having an elongate shaft and an end effector comprising a first jaw;

20 a first staple cartridge removably couplable to the end effector and housing a plurality of staples, wherein the first staple cartridge is configured to move between open and closed positions relative to the first jaw, the first jaw and the first staple cartridge being separated by a first distance in the closed position; and

a second staple cartridge removably couplable to the end effector and housing a plurality of staples, wherein the second staple cartridge is configured to

25

move between open and closed positions relative to the first jaw, the first jaw and the second staple cartridge being separated by a second distance in the closed position, the second distance being greater than the first distance.

- 5 55. The kit of claim 54, wherein the first and second staple cartridges are substantially parallel to the first jaw in the closed position.

1/22

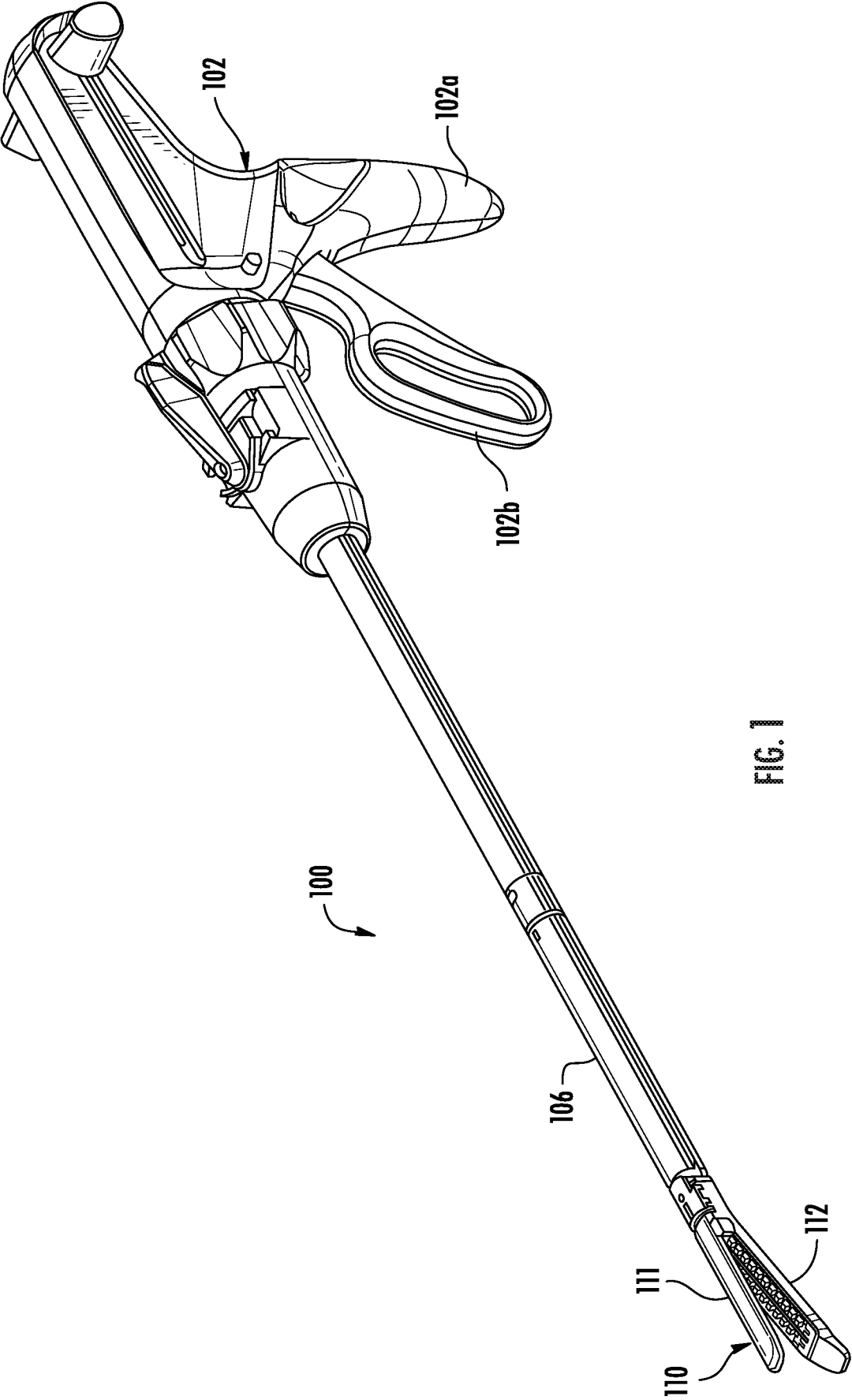
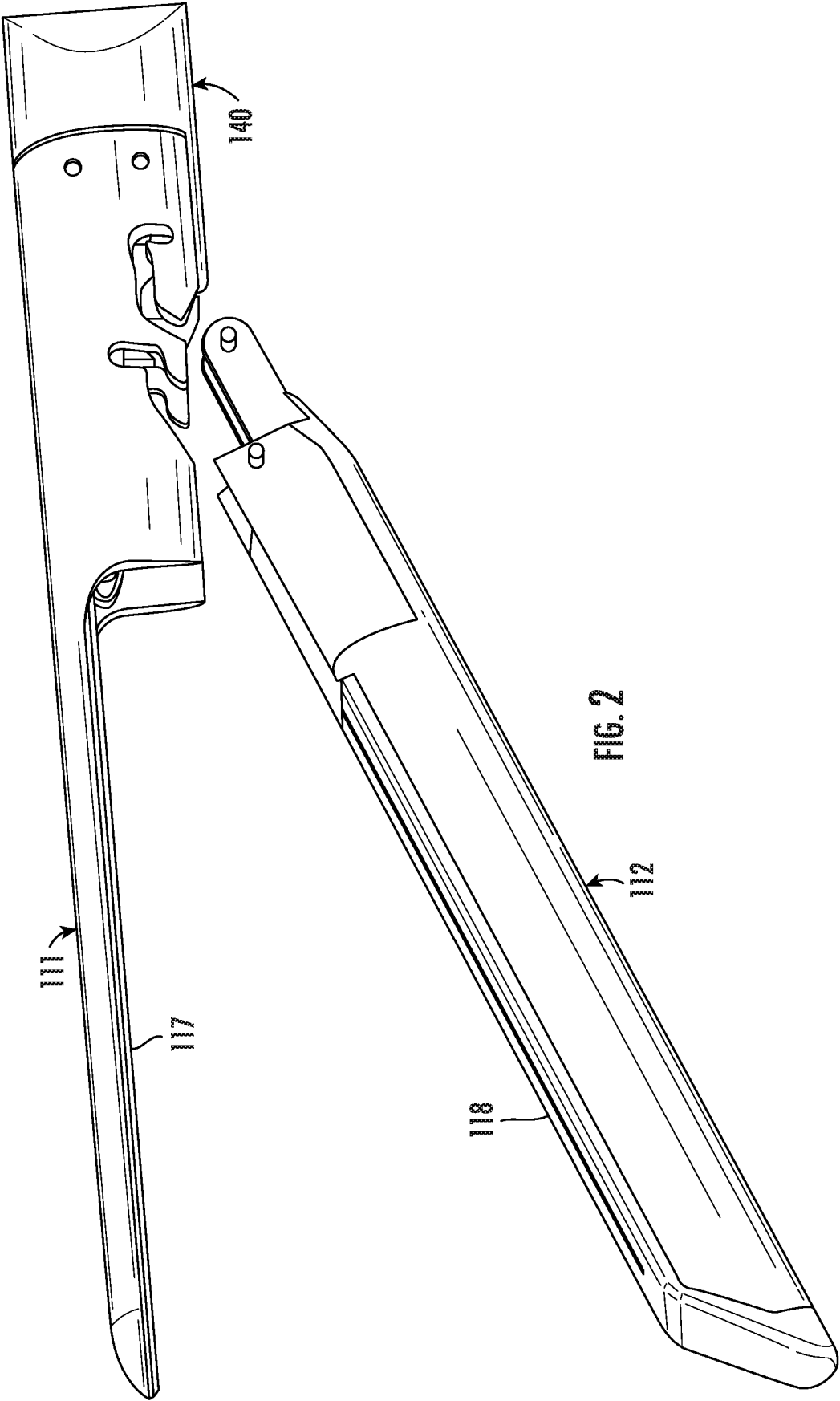


Fig. 1

2/22



3/22

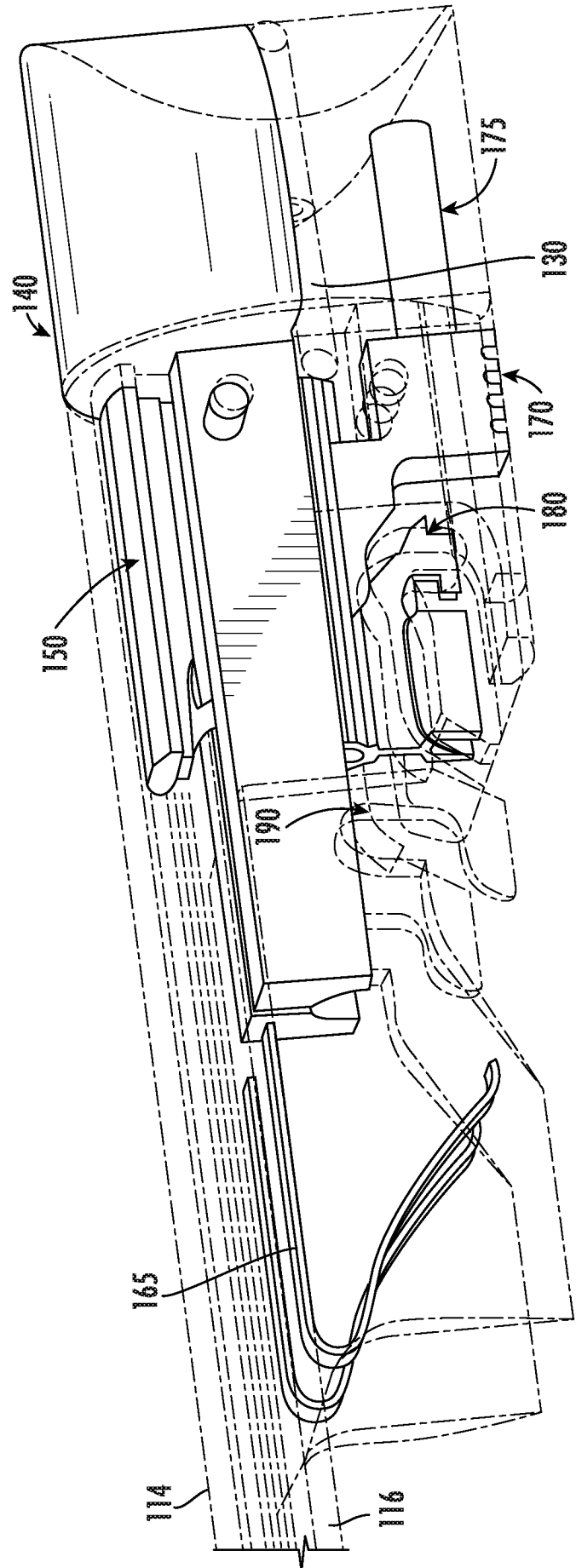


FIG. 3

4/22

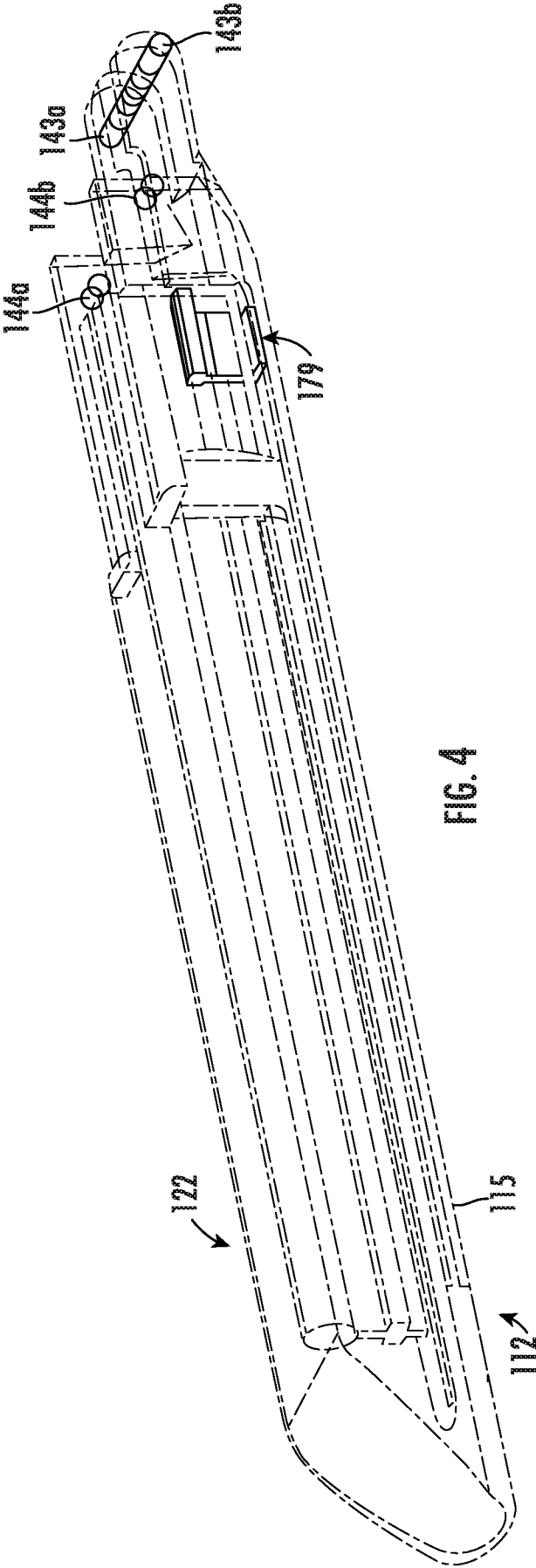
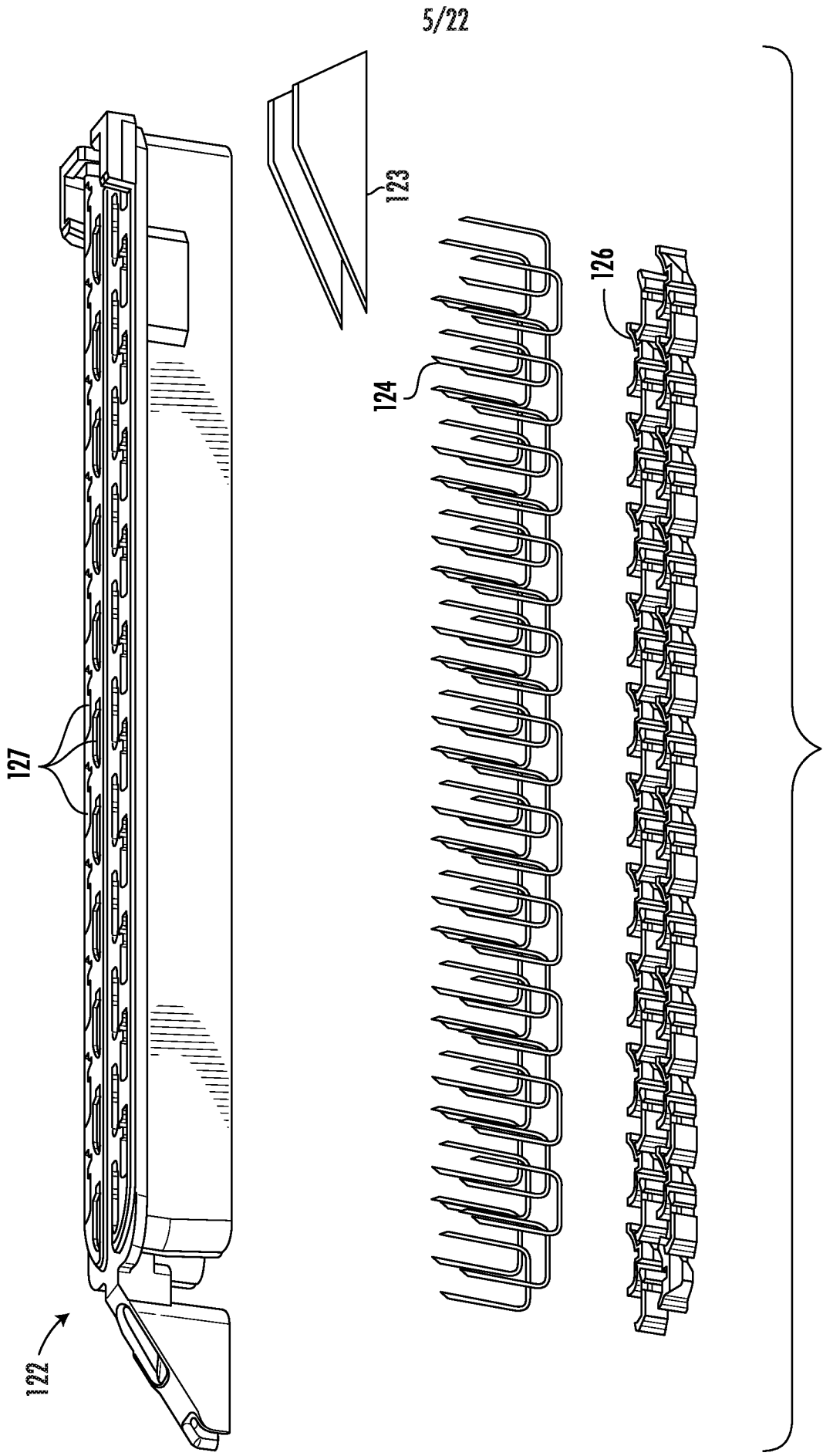


FIG. 4



6/22

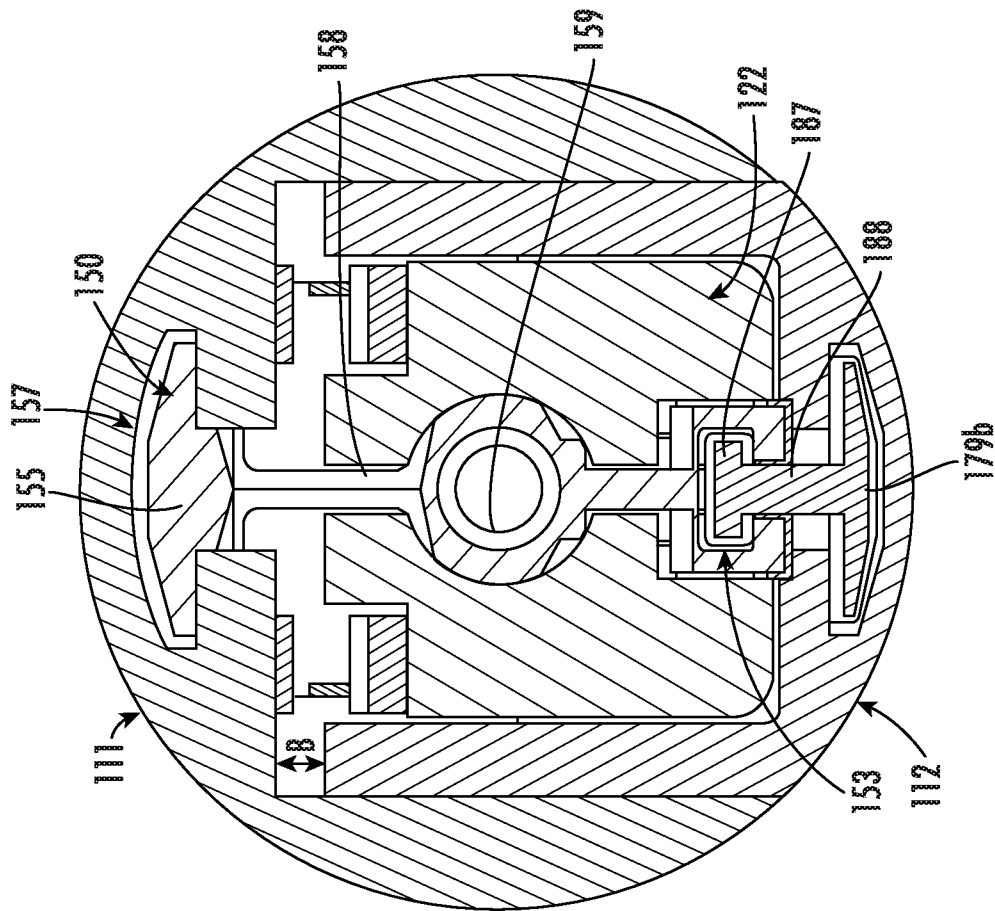


FIG. 6

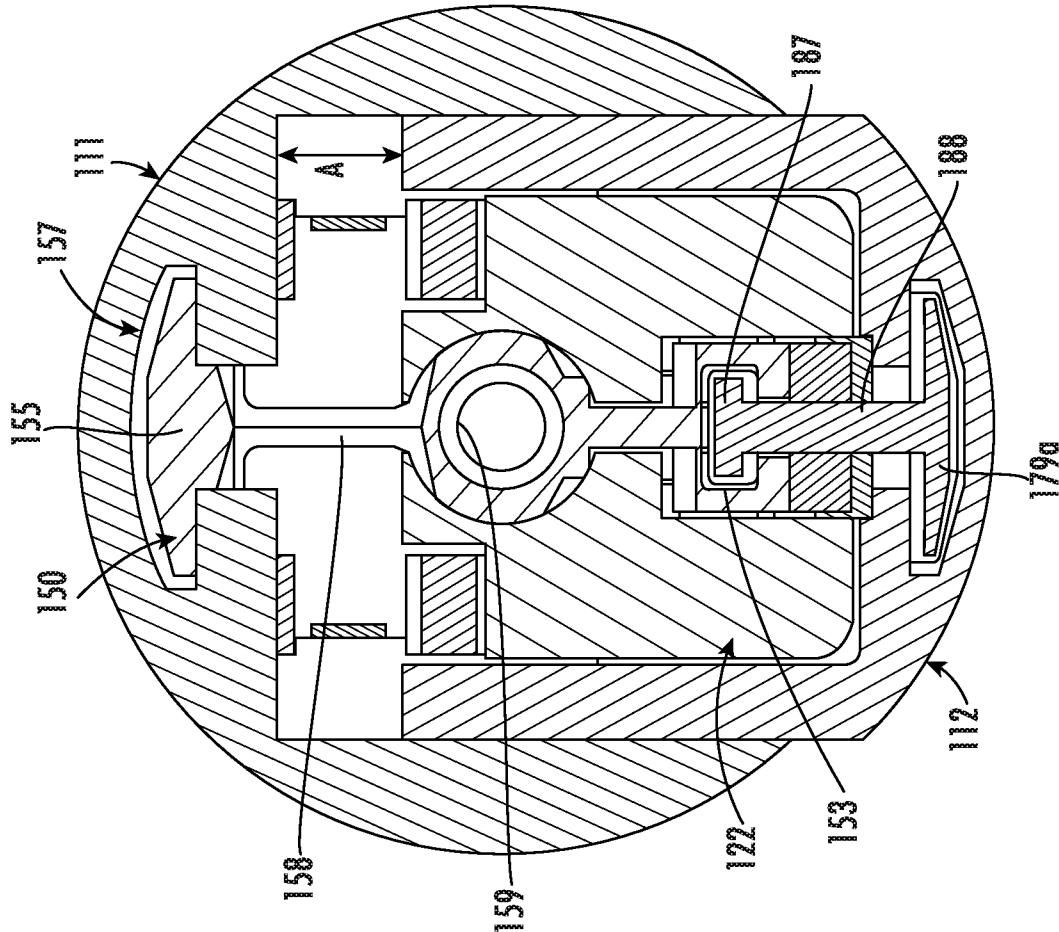
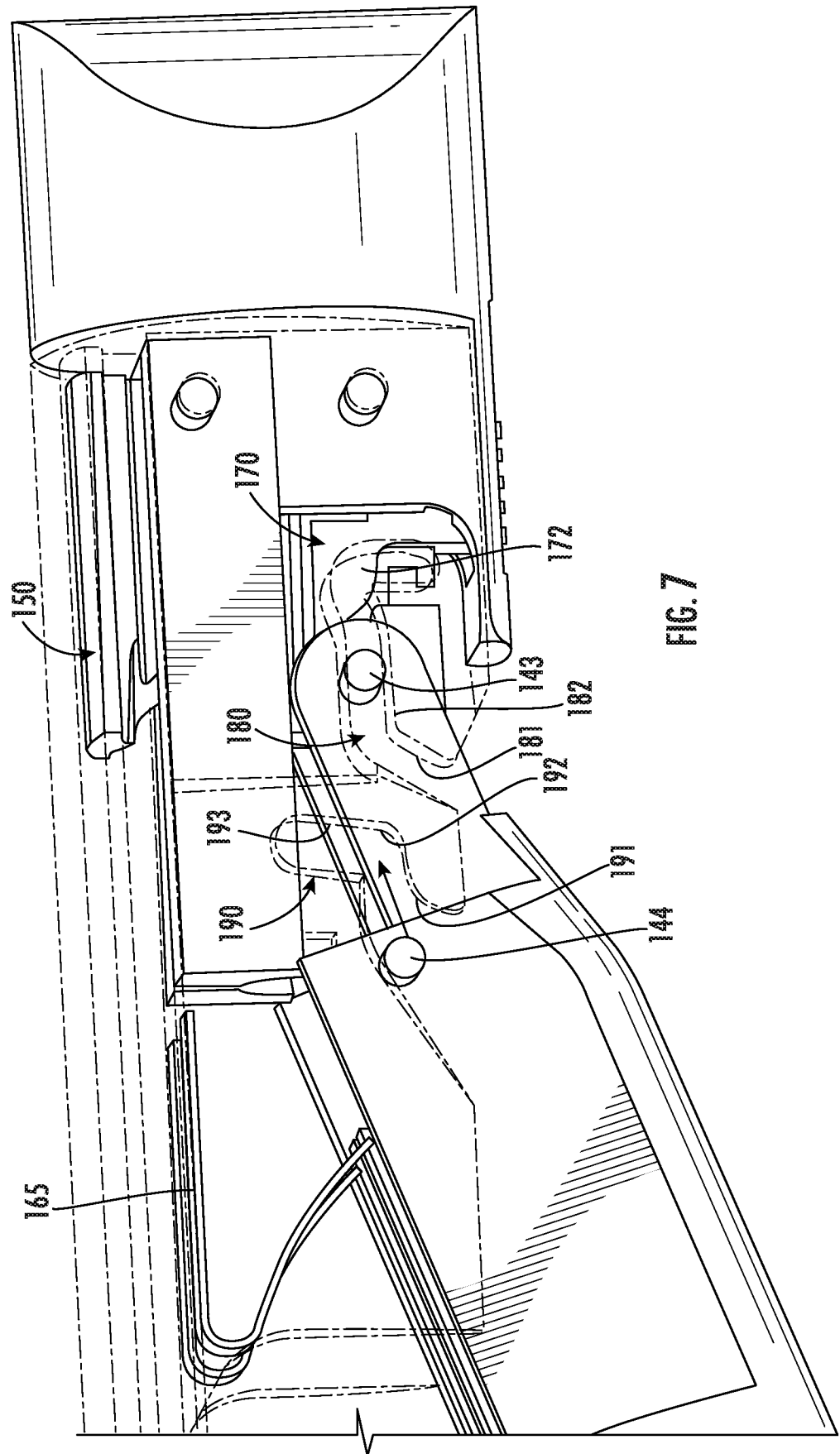


FIG. 5

7/22



8/22

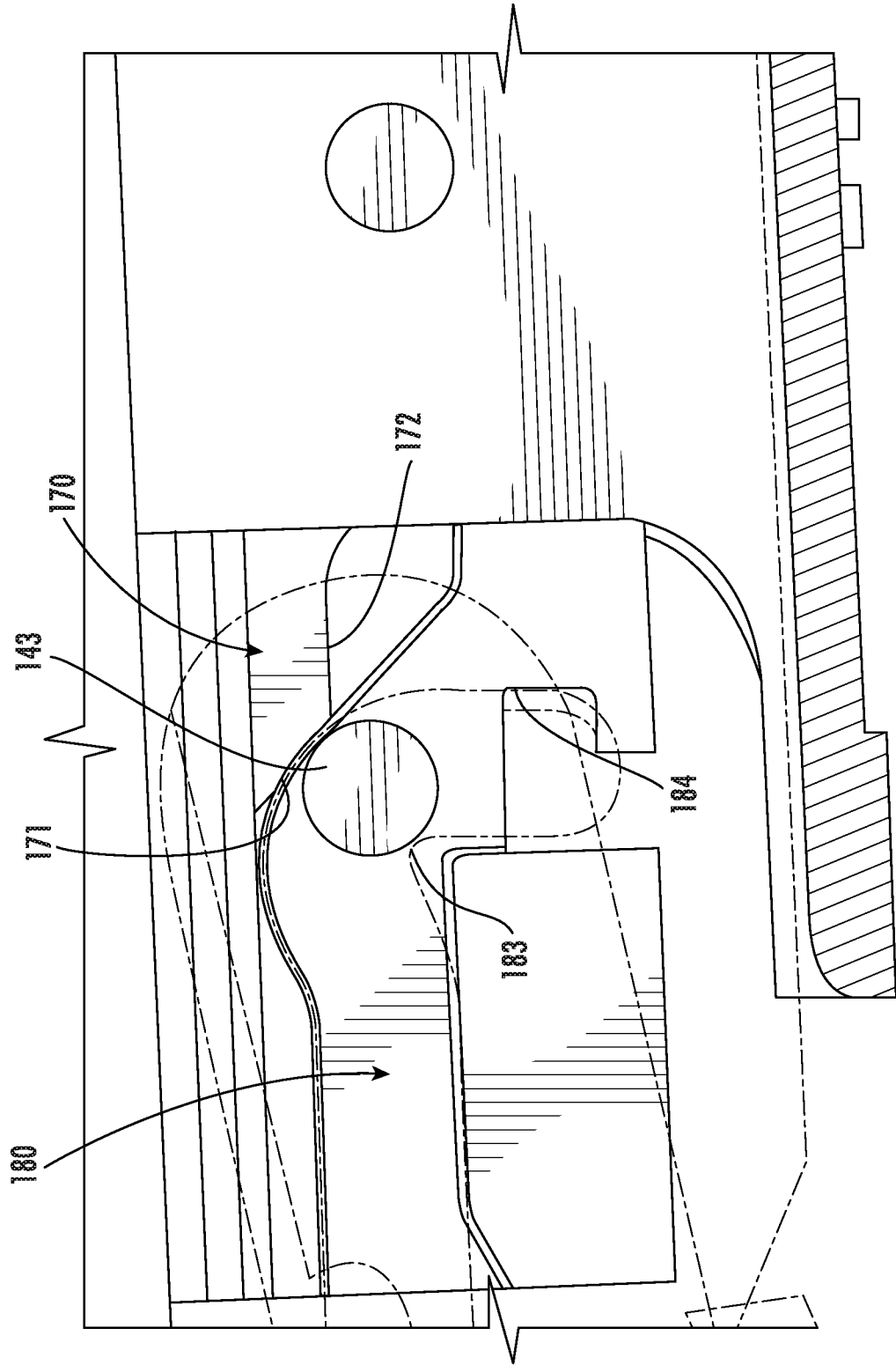


FIG. 8

9/22

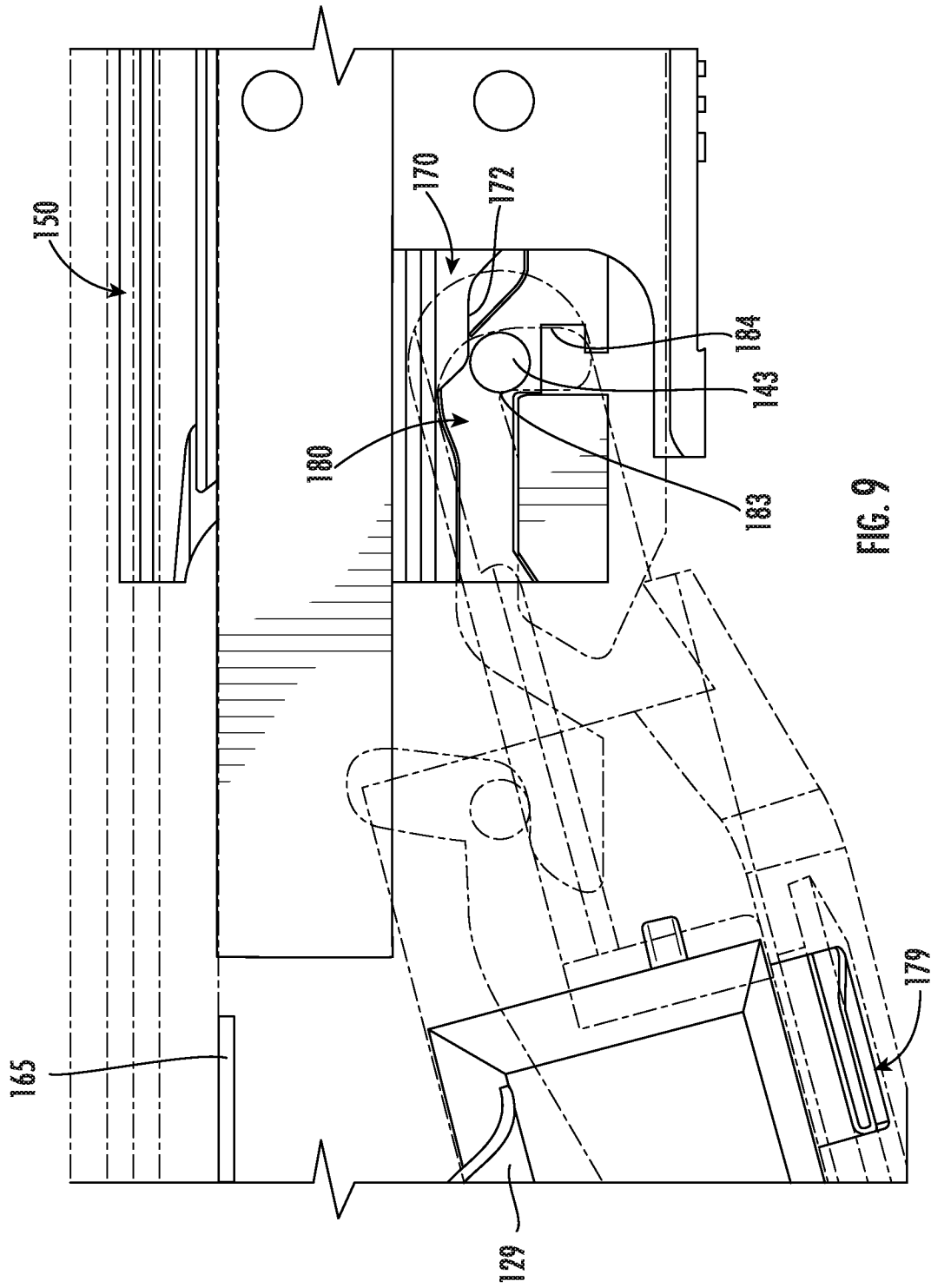
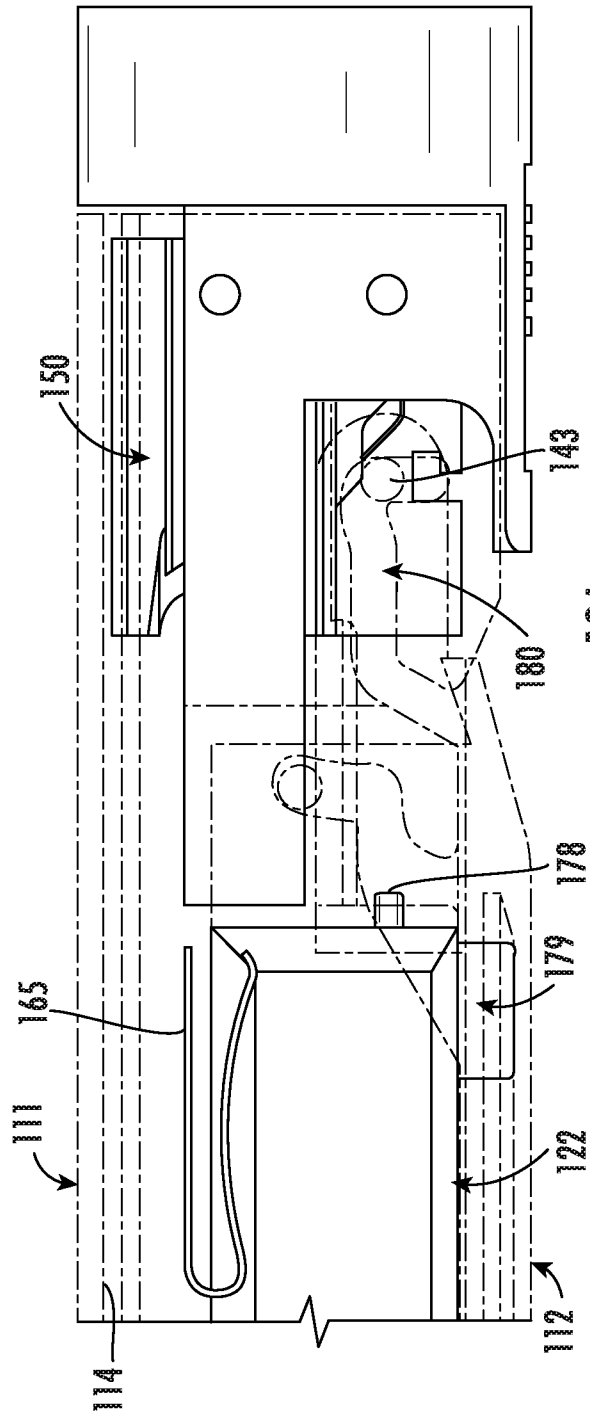
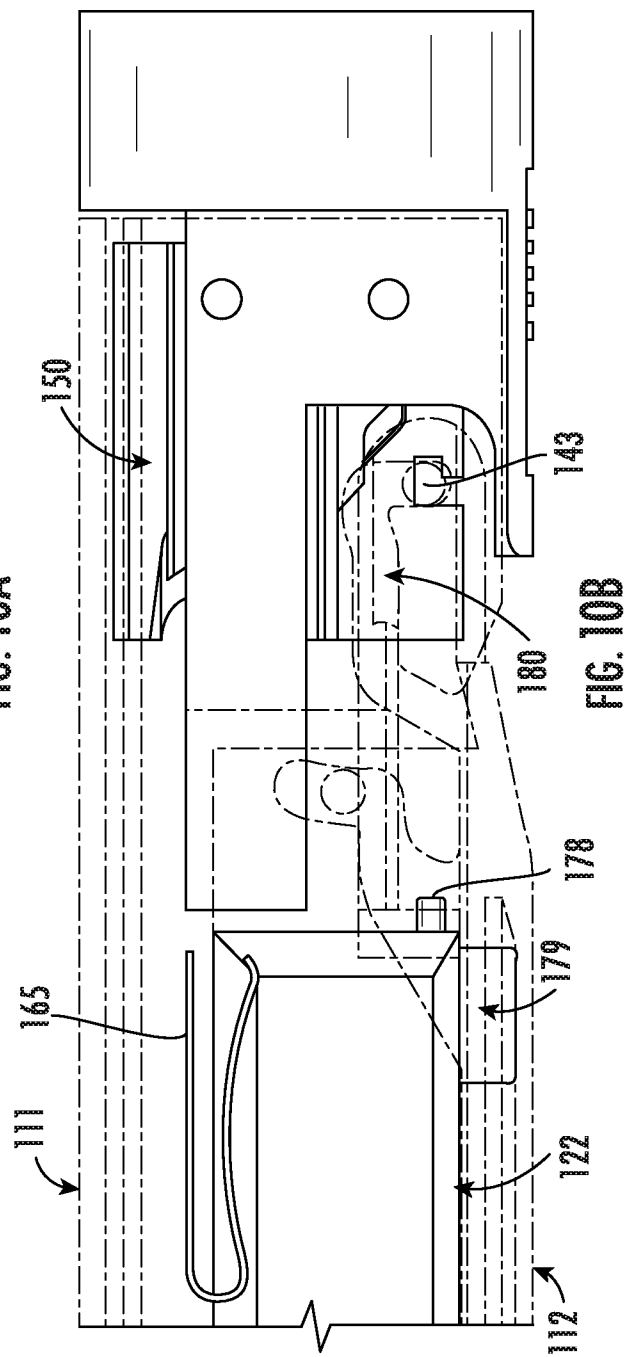


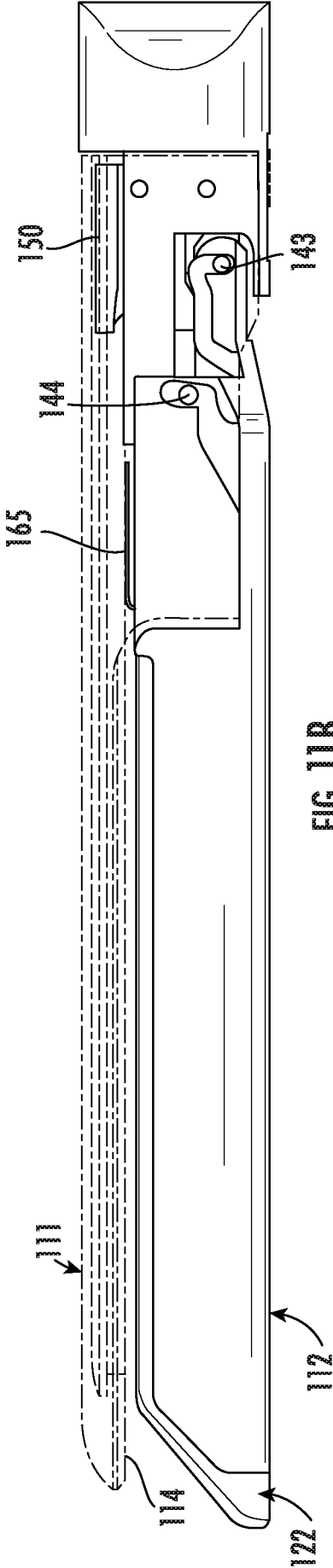
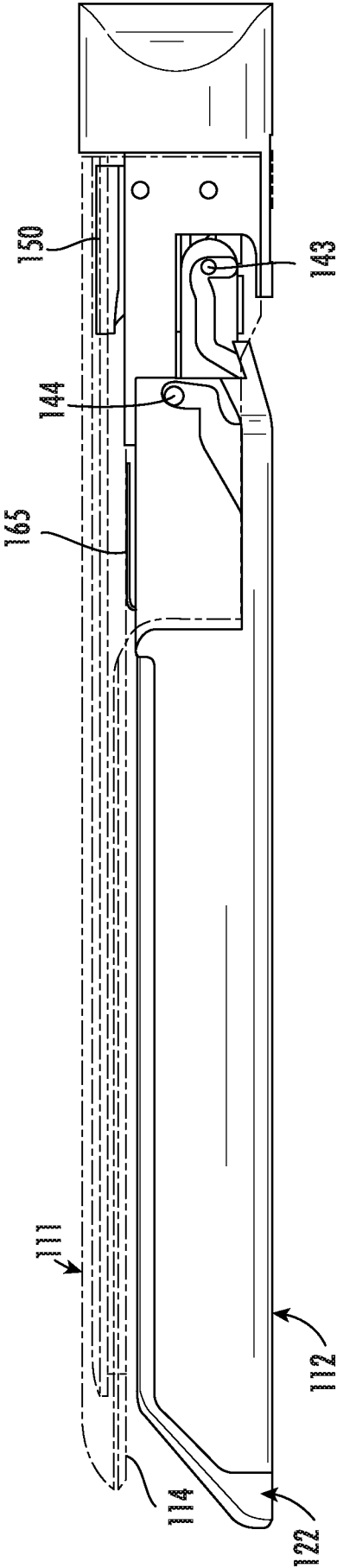
FIG. 9

10/22



40
G^o
L





12/22

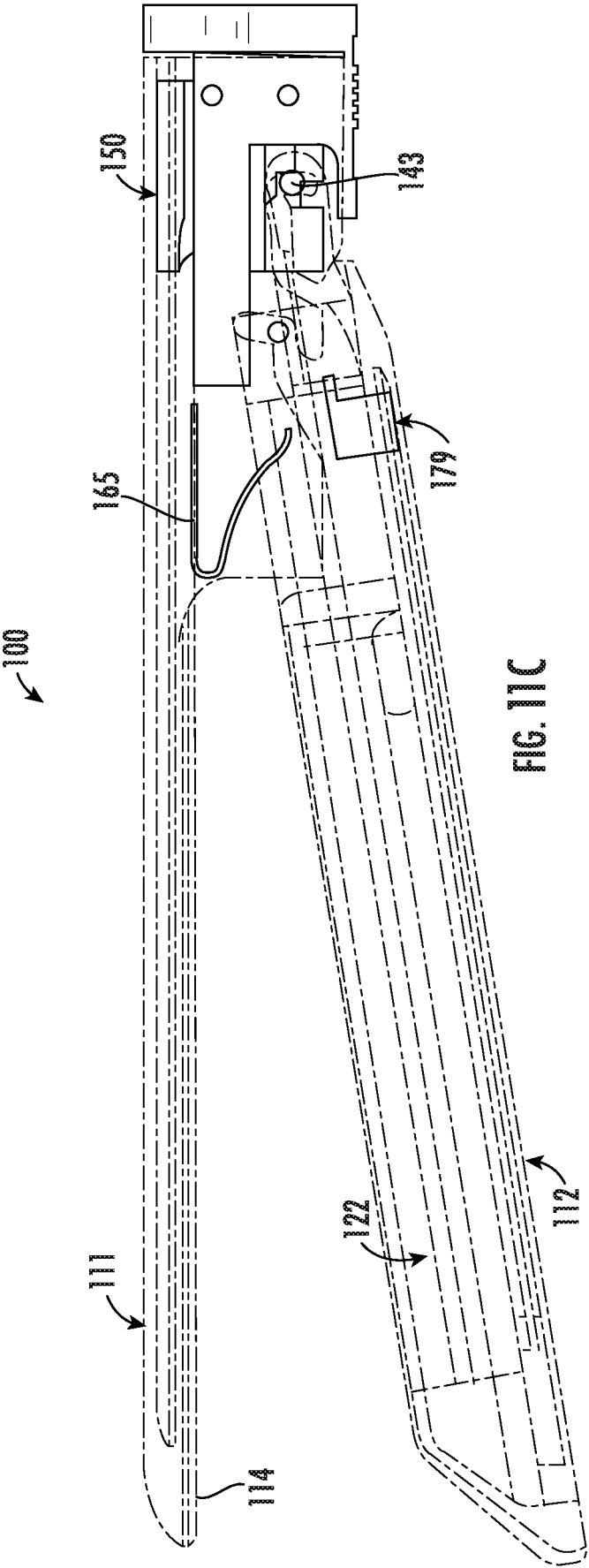
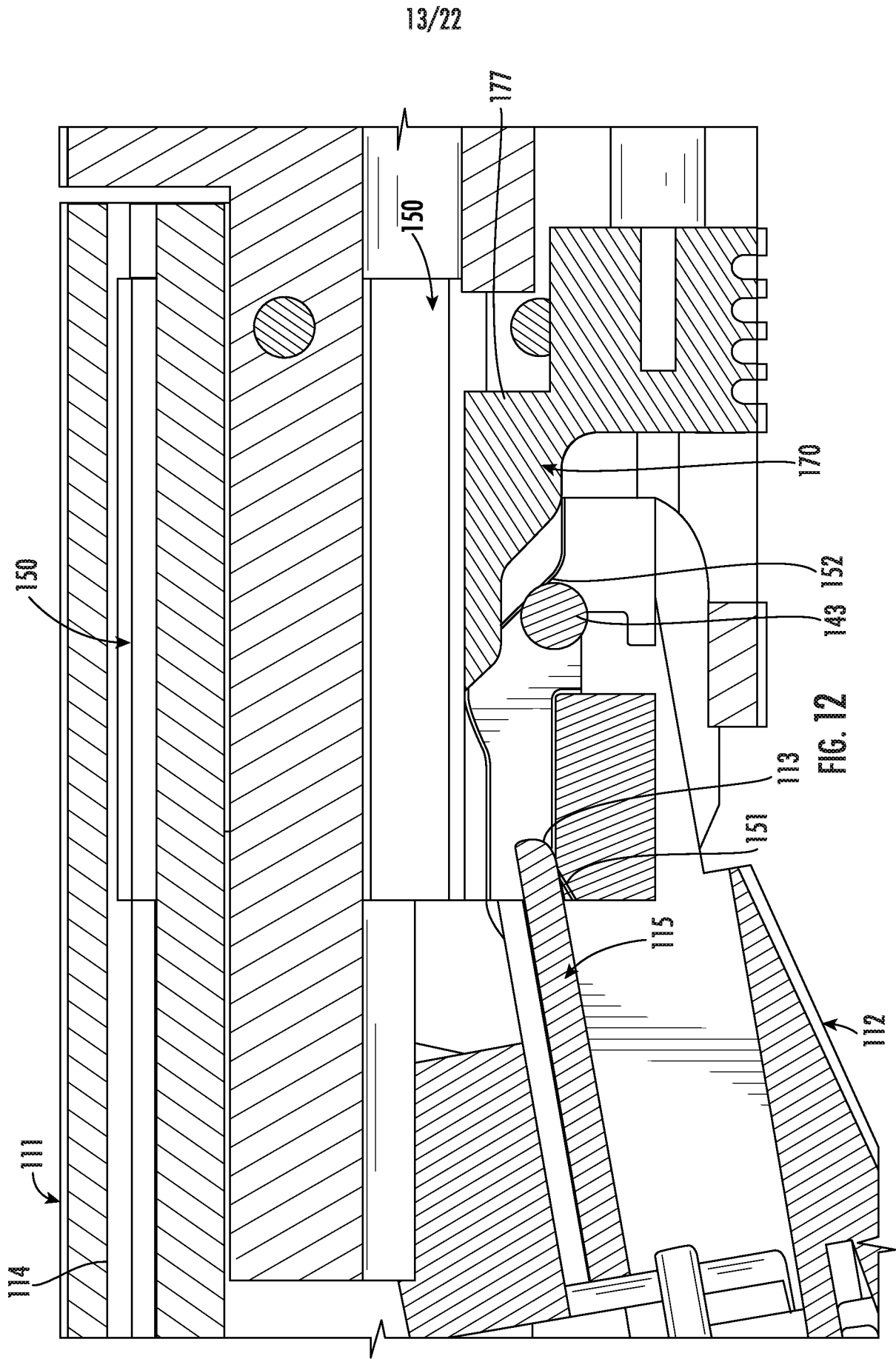
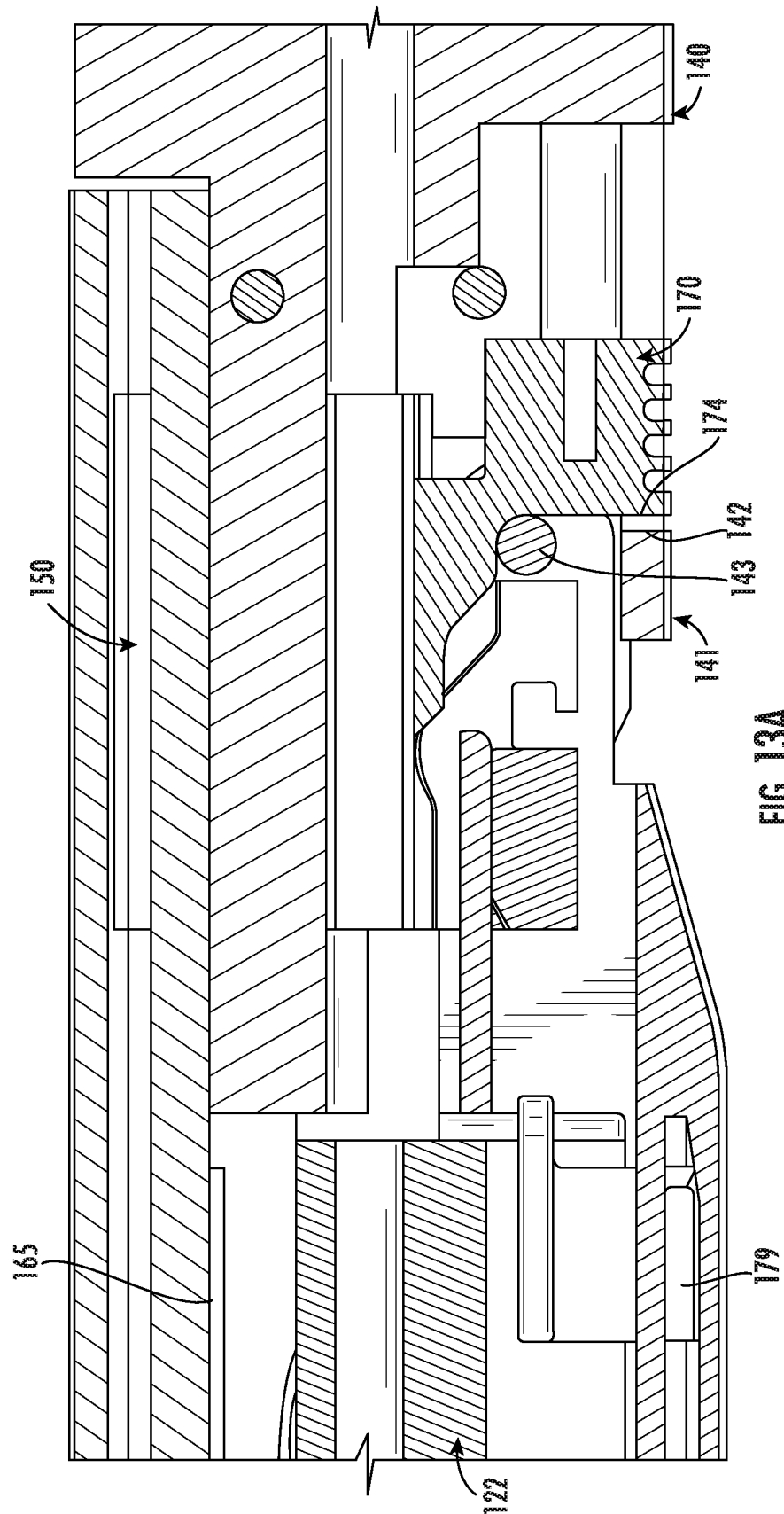


FIG. 11C



14/22



343E*

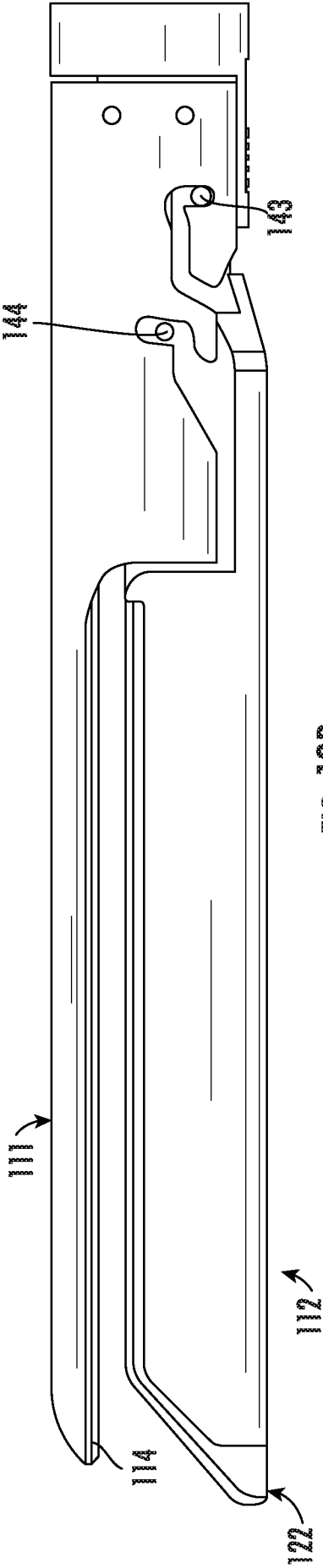


FIG. 13B

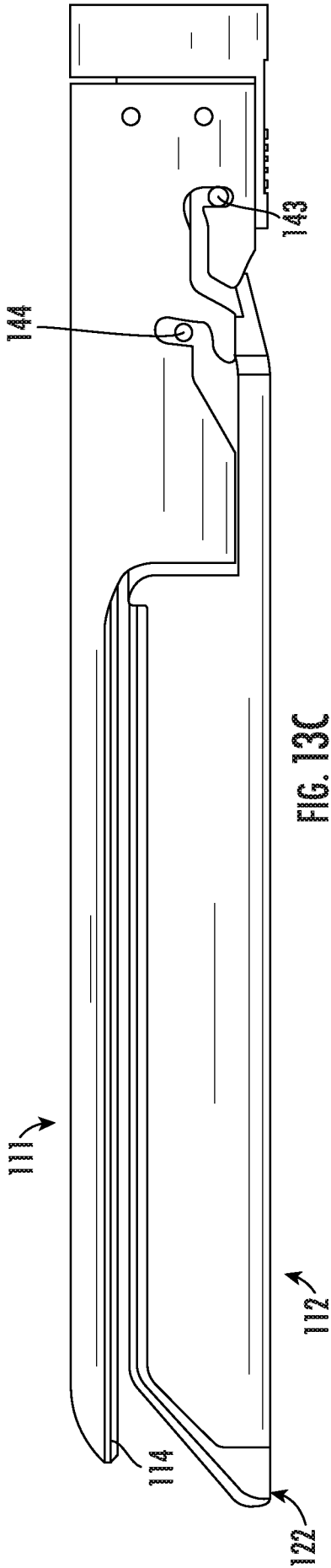


FIG. 13C

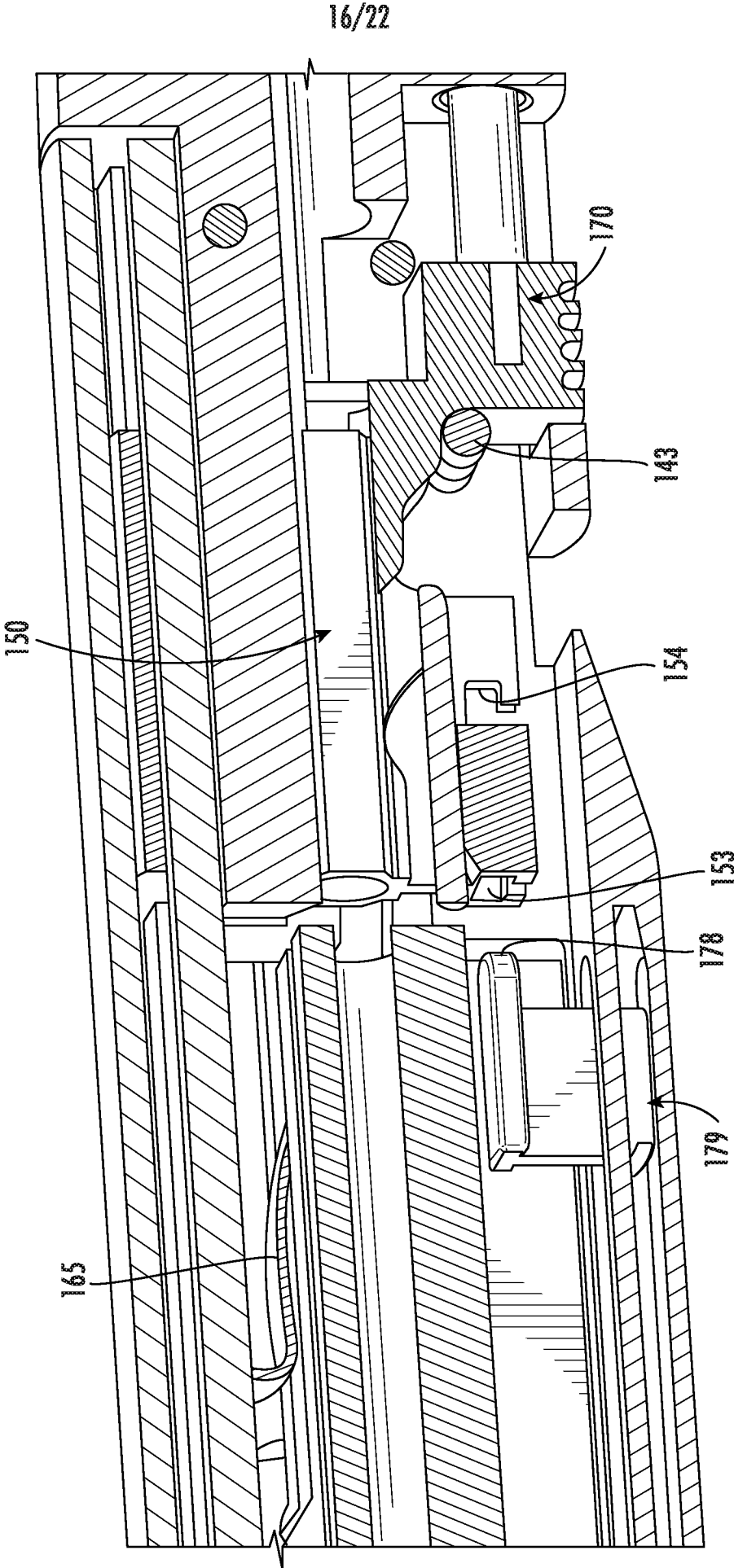
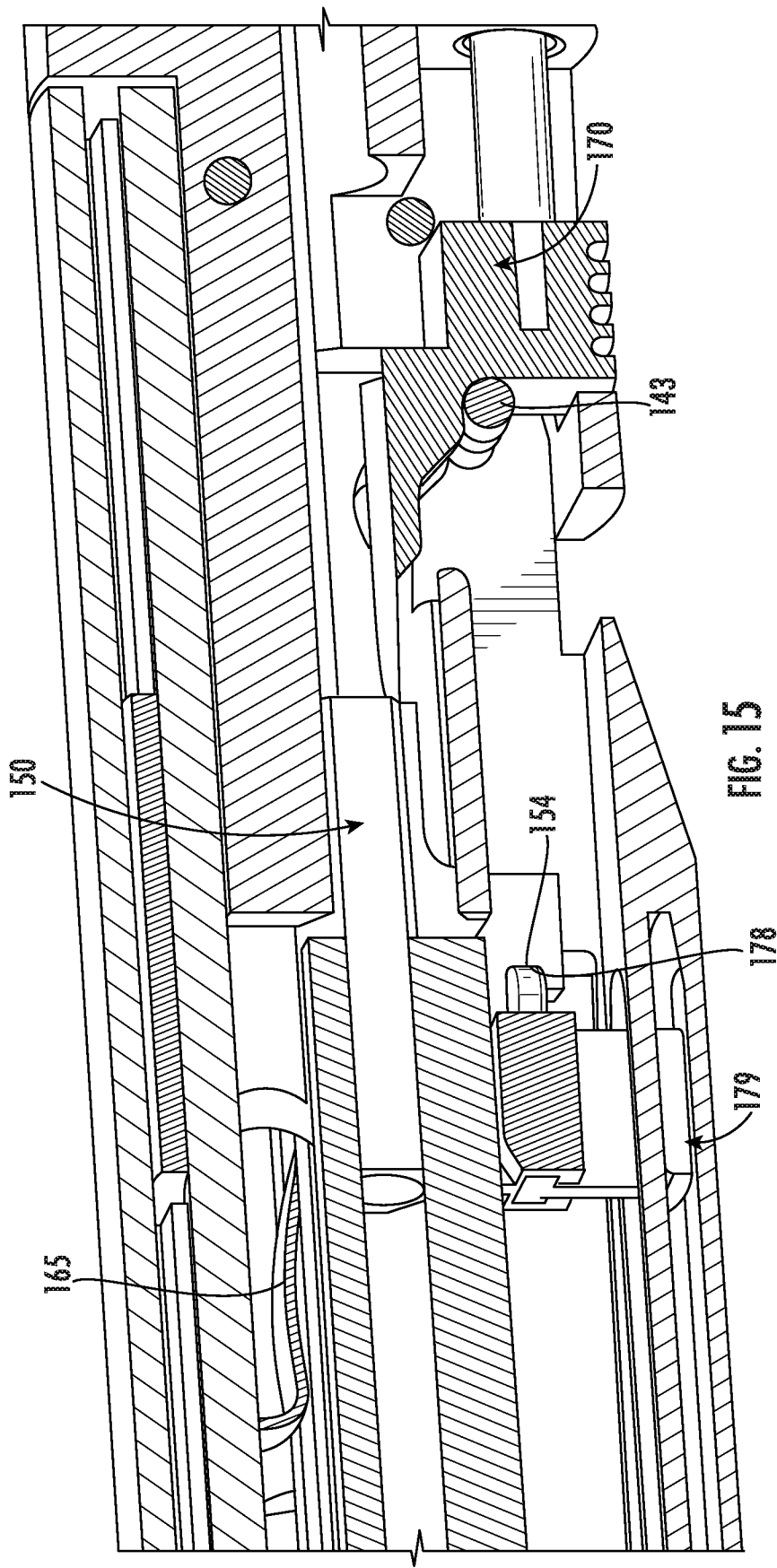


FIG. 14

17/22



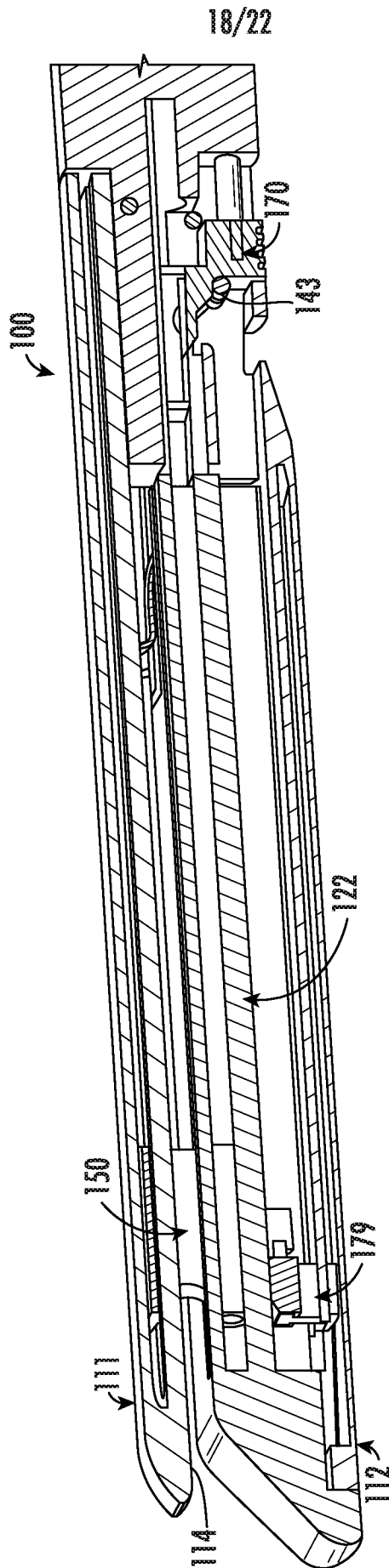


FIG. 16

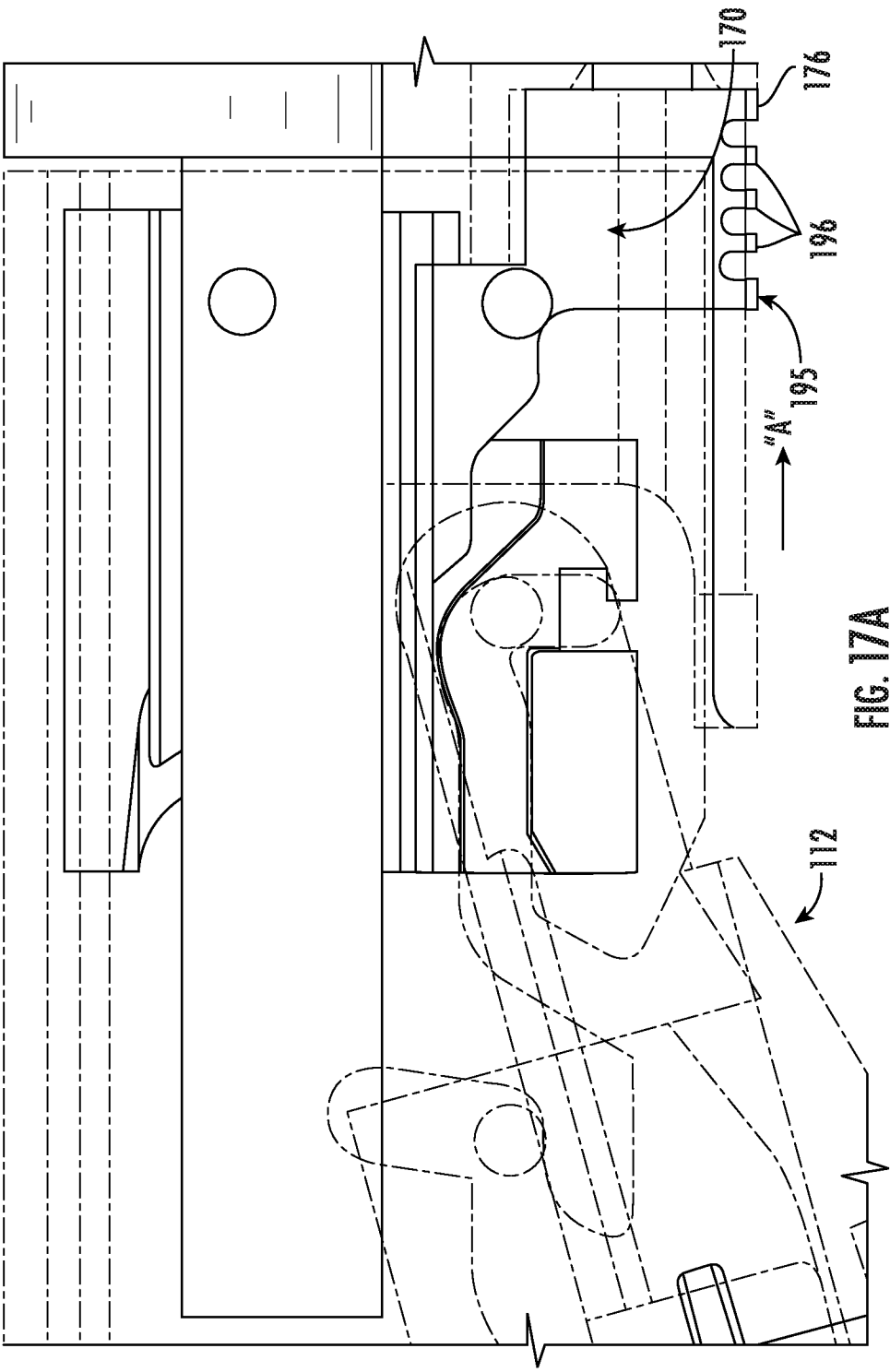
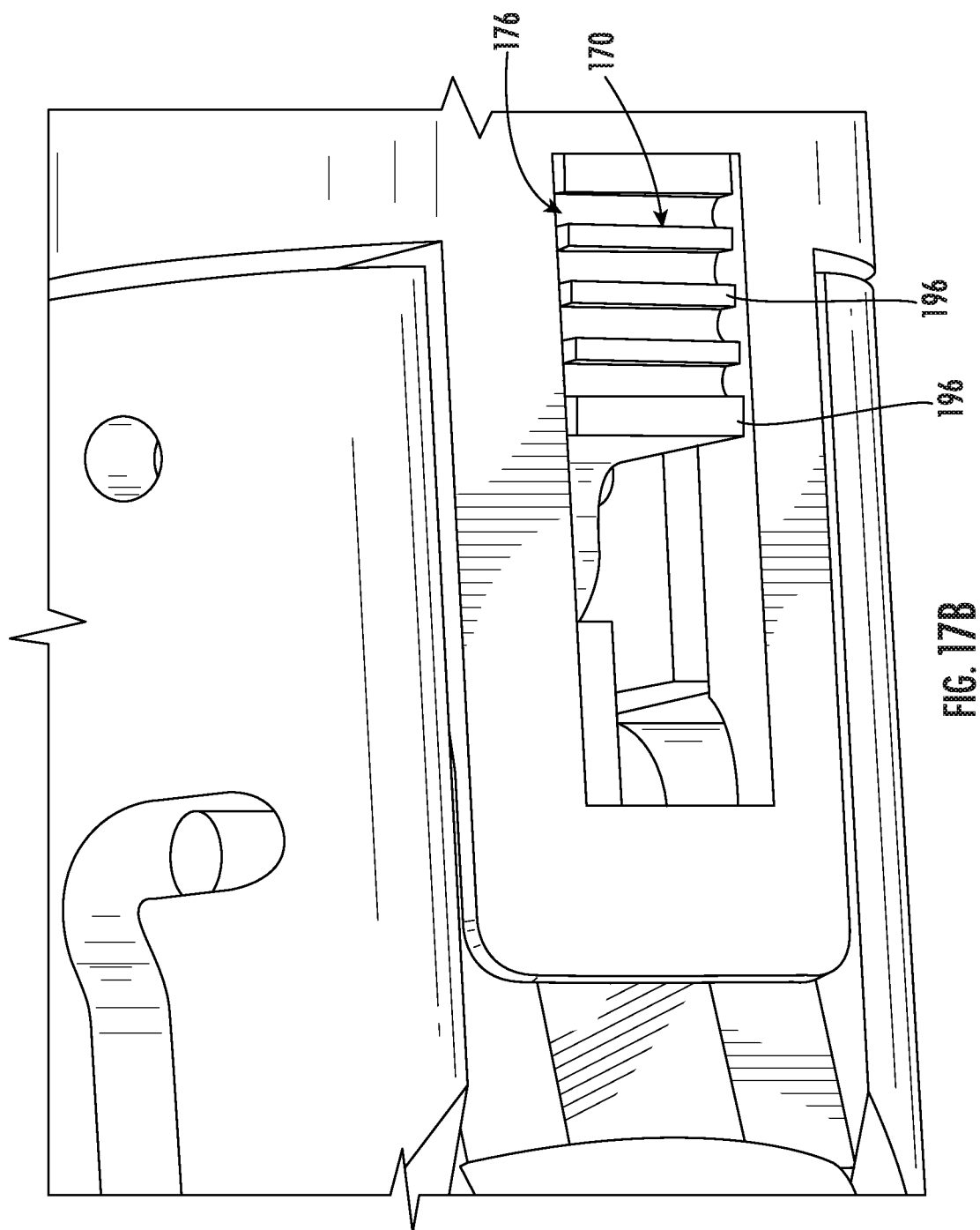
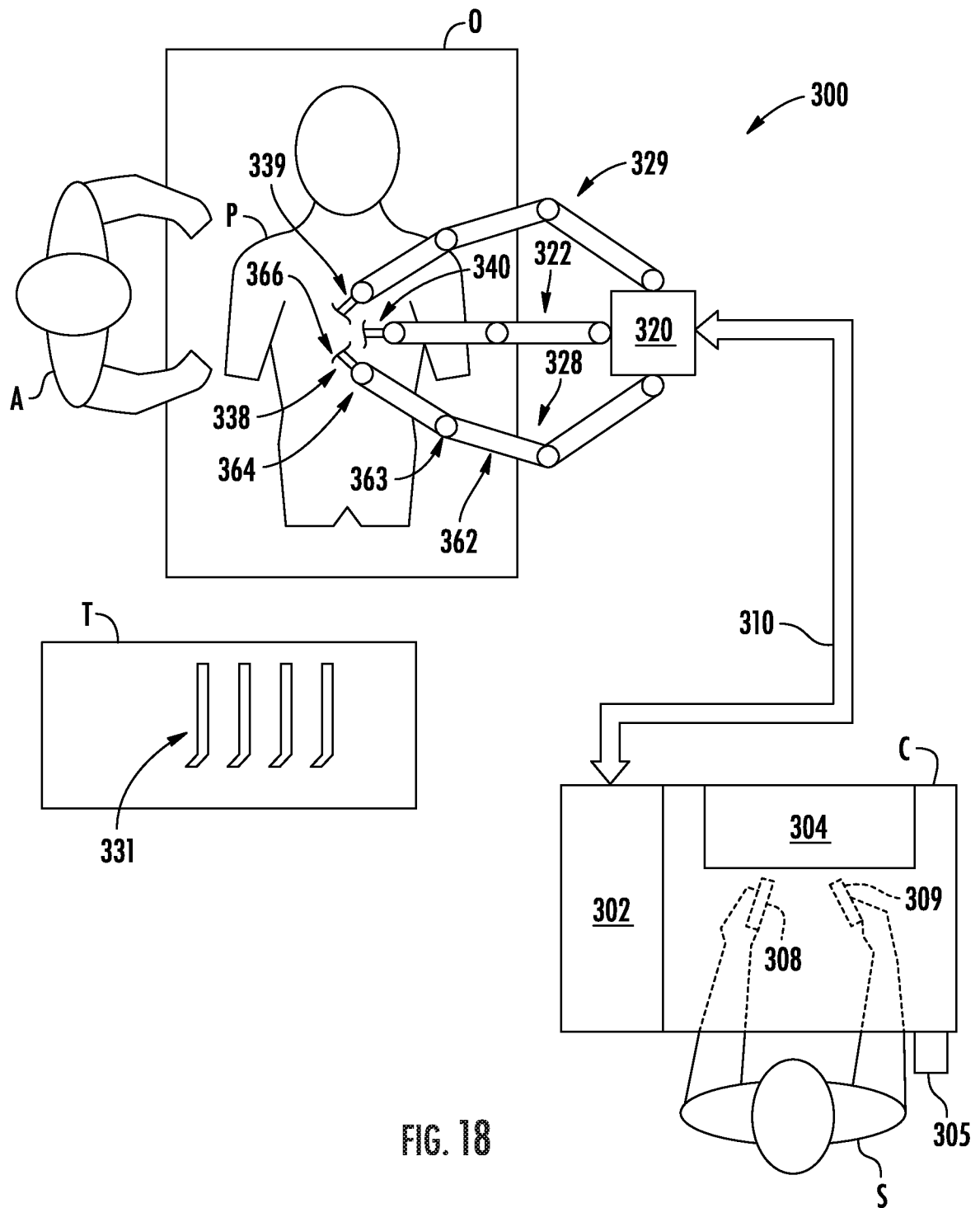


FIG. 17A

20/22





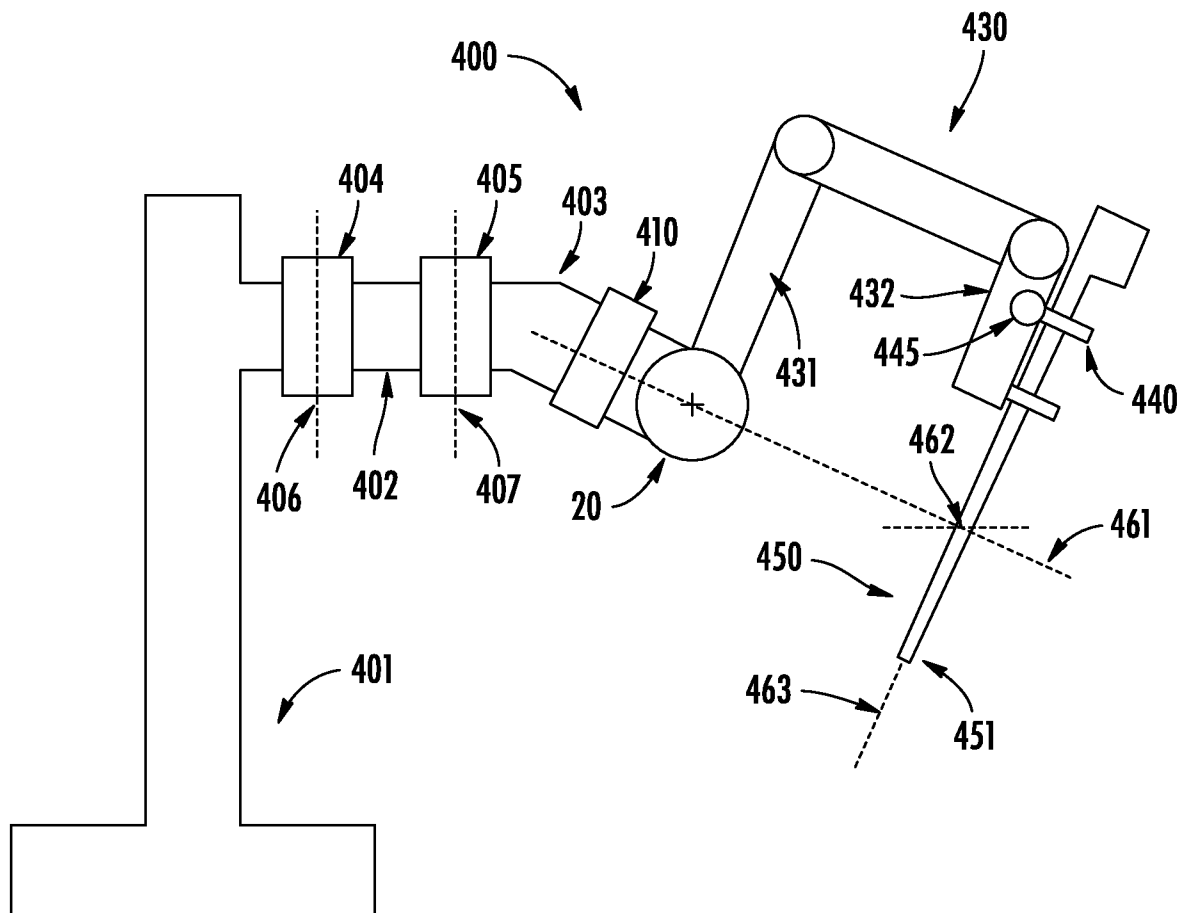


FIG. 19

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2020/025655**A. CLASSIFICATION OF SUBJECT MATTER****A61B 17/072(2006.01)i, A61B 17/115(2006.01)i, A61B 34/30(2016.01)i**

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 17/072; A61B 17/04; A61B 17/06; A61B 17/068; A61B 17/29; A61B 18/14; A61B 17/115; A61B 34/30

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & keywords: reload, removable, translate, tissue, thickness, surgical instrument

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2015-0209037 A1 (COVIDEN LP) 30 July 2015 paragraphs [0013]-[0094]; claim 1; figures 1A-28	1-55
A	EP 3173029 A1 (COVIDEN LP) 31 May 2017 whole document	1-55
A	JP 2016-513570 A (CETERIX ORTHOPAEDICS INC.) 16 May 2016 whole document	1-55
A	US 2016-0038227 A1 (COVIDIEN LP) 11 February 2016 whole document	1-55
A	WO 2018-118402 A1 (ETHICON LLC) 28 June 2018 whole document	1-55



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

"D" document cited by the applicant in the international application

"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

22 July 2020 (22.07.2020)

Date of mailing of the international search report

22 July 2020 (22.07.2020)

Name and mailing address of the ISA/KR

International Application Division

Korean Intellectual Property Office

189 Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea



Facsimile No. +82-42-481-8578

Authorized officer

KANG MIN JEONG

Telephone No. +82-42-481-8131



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2020/025655

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2015-0209037 A1	30/07/2015	AU 2014-259548 A1 AU 2014-259548 B2 AU 2019-204241 A1 CA 2868736 A1 CN 104799899 A CN 104799899 B EP 2898839 A1 EP 2898839 B1 JP 2015-139703 A JP 2019-088799 A JP 6497931 B2 US 2017-0189029 A1 US 9629627 B2	13/08/2015 28/03/2019 04/07/2019 28/07/2015 29/07/2015 26/03/2019 29/07/2015 13/03/2019 03/08/2015 13/06/2019 10/04/2019 06/07/2017 25/04/2017
EP 3173029 A1	31/05/2017	AU 2014-259515 A1 AU 2014-259515 B2 CA 2869044 A1 CN 104799900 A CN 104799900 B EP 3173029 B1 ES 2608390 T3 JP 2015-139704 A JP 2019-069188 A JP 6480179 B2 US 10582927 B2 US 2015-0209030 A1 US 2017-0281156 A1 US 9700312 B2	13/08/2015 11/07/2019 28/07/2015 29/07/2015 02/04/2019 29/04/2020 10/04/2017 03/08/2015 09/05/2019 06/03/2019 10/03/2020 30/07/2015 05/10/2017 11/07/2017
JP 2016-513570 A	16/05/2016	AU 2012-253852 A1 AU 2012-253852 B2 AU 2012-253853 A1 AU 2012-253853 B2 BR 112013025760 A2 BR 112013028339 A2 CN 102846345 A CN 102846345 B EP 2211725 A1 EP 2211725 A4 EP 2929841 A1 EP 2929841 B1 JP 2014-519872 A JP 6524431 B2 KR 10-1947349 B1 KR 10-1947616 B1 KR 10-2014-0024424 A KR 10-2014-0029483 A US 2012-0265221 A1 US 2014-0236192 A1	05/09/2013 08/09/2016 12/09/2013 29/10/2015 20/12/2016 24/01/2017 02/01/2013 07/09/2016 04/08/2010 01/04/2015 14/10/2015 15/11/2017 21/08/2014 05/06/2019 12/02/2019 14/02/2019 28/02/2014 10/03/2014 18/10/2012 21/08/2014

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2020/025655

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		US 8449533 B2	28/05/2013
		US 9011454 B2	21/04/2015
		WO 2009-061504 A1	14/05/2009
		WO 2011-057245 A2	12/05/2011
		WO 2011-057245 A3	22/09/2011
		WO 2012-154581 A1	15/11/2012
US 2016-0038227 A1	11/02/2016	US 10085795 B2	02/10/2018
		US 2012-0303025 A1	29/11/2012
		US 2019-0021787 A1	24/01/2019
		US 9161807 B2	20/10/2015
WO 2018-118402 A1	28/06/2018	BR 112019012459 A2	14/04/2020
		CN 110114007 A	09/08/2019
		EP 3338662 A1	27/06/2018
		EP 3338664 A2	27/06/2018
		EP 3338664 A3	05/09/2018
		EP 3338667 A1	27/06/2018
		JP 2020-501751 A	23/01/2020
		MX 2019007299 A	15/10/2019
		US 10675025 B2	09/06/2020
		US 2018-0168589 A1	21/06/2018
		US 2018-0168590 A1	21/06/2018
		US 2018-0168591 A1	21/06/2018
		US 2018-0168593 A1	21/06/2018
		WO 2018-118308 A1	28/06/2018
		WO 2018-118309 A1	28/06/2018
		WO 2018-118400 A1	28/06/2018
		WO 2018-118401 A1	28/06/2018
		WO 2018-118499 A1	28/06/2018