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(54) **SURGICAL CUTTING AND STAPLING DEVICE WITH CLOSURE APPARATUS FOR LIMITING MAXIMUM TISSUE COMPRESSION FORCE**

CHIRURGISCHES SCHNEIDE- UND KLAMMERGERÄT MIT EINEM VERSCHLUSSAPPARAT ZUR BEGRENZUNG DER MAXIMAL AUF DAS GEWEBE EINWIRKENDEN KOMPRESSIONSKRAFT

DISPOSITIF DE DÉCOUPE ET D'AGRAFAGE CHIRURGICAL AVEC APPAREIL DE FERMETURE POUR LIMITER LA FORCE DE COMPRESSION MAXIMALE DU TISSU

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Description

FIELD OF THE INVENTION

[0001] The present invention generally relates to endoscopic and open surgical instrumentation, and more particularly, to surgical staples, surgical staplers and cutters including, but not limited to, open surgical stapling devices, laparoscopic surgical stapling devices, endoscopic and intralumenal surgical stapling devices.

BACKGROUND

[0002] Endoscopic and laparoscopic surgical instruments are often preferred over traditional open surgical devices since a smaller incision tends to reduce the post-operative recovery time and complications. The use of laparoscopic and endoscopic surgical procedures has been relatively popular and has provided additional incentive to develop the procedures further. In laparoscopic procedures, surgery is performed in the interior of the abdomen through a small incision. Similarly, in endoscopic procedures, surgery is performed in any hollow viscus of the body through narrow endoscopic tubes inserted through small entrance wounds in the skin.

[0003] Laparoscopic and endoscopic procedures generally require that the surgical region be insufflated. Accordingly, any instrumentation inserted into the body must be sealed to ensure that gases do not enter or exit the body through the incision. Moreover, laparoscopic and endoscopic procedures often require the surgeon to act on organs, tissues and/or vessels far removed from the incision. Thus, instruments used in such procedures are typically long and narrow while being functionally controllable from a proximal end of the instrument.

[0004] Significant development has gone into a range of endoscopic surgical instruments that are suitable for precise placement of a distal end effector at a desired surgical site through a cannula of a trocar. These distal end effectors engage the tissue in a number of ways to achieve a diagnostic or therapeutic effect (e.g., endocutter, grasper, cutter, staplers, clip applier, access device, drug/gene therapy delivery device, and energy device using ultrasound, RF, laser, etc.).

[0005] Known surgical staplers include an end effector that simultaneously makes a longitudinal incision in tissue and applies lines of staples on opposing sides of the incision. The end effector includes a pair of cooperating jaw members that, if the instrument is intended for endoscopic or laparoscopic applications, are capable of passing through a cannula passageway. One of the jaw members receives a staple cartridge having at least two laterally spaced rows of staples. The other jaw member defines an anvil having staple-forming pockets aligned with the rows of staples in the cartridge. The instrument includes a plurality of reciprocating wedges which, when driven distally, pass through openings in the staple cartridge and engage drivers supporting the staples to effect the firing of the staples toward the anvil.

[0006] Recently, an improved "E-beam" firing bar was described for a surgical stapling and severing instrument that advantageously included a top pin that slides within an internal slot formed in the upper jaw (anvil) and has a middle pin and bottom foot that slides on opposite sides of a lower jaw of an end effector, or more particularly a staple applying assembly. Distal to the middle pin, a contacting surface actuates a staple cartridge held within an elongate staple channel that forms the lower jaw. Between the contacting surface and the top pin, a cutting surface, or knife, severs tissue clamped between the anvil and the staple cartridge of the lower jaw. Since both jaws are thus engaged by the E-beam, the E-beam maintains a desired spacing between the jaws to ensure proper staple formation. Thus, if a lesser amount of tissue is clamped, the E-beam holds up the anvil to ensure sufficient spacing for the staples to properly form against an undersurface of the anvil. In addition, if a greater amount of tissue is clamped, the E-beam draws down the anvil to ensure that the spacing does not exceed the length of the staple such that ends of each staple are not sufficiently bent to achieve a desired degree of retention. Such an E-beam firing bar is described in U.S. Pat. Appln. No. 10/443,617, entitled "Surgical Stapling Instrument Incorporating an E-Beam Firing Mechanism", filed on May 20, 2003, now U.S. Patent No. 6,978,921, issued December 27, 2005.

[0007] While an E-beam firing bar has many advantages for a surgical stapling and severing instrument, often it is desirable to sever and staple tissue of various thicknesses. A thin layer of tissue may result in staples that only form loosely, perhaps requiring the need for bolstering material. A thick layer of tissue may result in formed staples that exert a strong compressive force on the captured tissue, perhaps resulting in necrosis, bleeding or poor staple formation/retention. Rather than limiting the range of tissue thicknesses that are appropriate for a given surgical stapling and severing instrument, it would be desirable to accommodate a wider range of tissue thickness with the same surgical stapling and severing instrument.

[0008] Consequently, a significant need exists for an improved surgical stapling and severing instrument that incorporates a staple applying assembly (end effector) that adjusts to the amount of tissue that is clamped.

[0009] In addition, the staple drivers that are commonly employed in existing staple applying assemblies are traditionally made as stiff as possible to assure proper "B" form staple height. Because of this stiff construction, these drivers do not provide any flexibility for adjusting the formed height of the staple to a particular thickness of tissue clamped within the assembly.

[0010] Thus, another significant need exists for staple drivers that are able to facilitate the adjustment of the formed height of the staples in response to variations in tissue thickness.

[0011] In various types of encocutter arrangements,

the anvil is opened and closed by axially actuating a closure tube assembly that serves to interface with closure features on the proximal end of the anvil. The anvil is commonly formed with trunnions that are received in somewhat elongated slots in the proximal end of the channel. The trunnions serve to pivotally support the staple cartridge and permit the anvil to move into axial alignment while pivoting to a closed position. Unfortunately, however, this arrangement lacks means for limiting or adjusting the amount of clamping forces applied to the anvil during the clamping process. Thus, the same amount of clamping forces generated by the closure tube assembly are applied to the anvil regardless of the thickness of the tissue to be clamped therein. Such arrangement can result in thinner tissues being over clamped which could lead to excessive bleeding and possibly damage or even destroy the tissue.

[0012] Thus, there is another need for a closure system that includes means for limiting or adjusting the amount of closure forces applied to the anvil based on the thickness of the tissue to be clamped between the anvil and the staple cartridge.

[0013] In certain types of surgical procedures the use of surgical staples has become the preferred method of joining tissue, and, specially configured surgical staplers have been developed for these applications. For example, intra-luminal or circular staplers have been developed for use in a surgical procedure known as an anastomosis. Circular staplers useful to perform an anastomosis are disclosed, for example, in U.S. Pat. No. 5,104,025 and U.S. Patent No. 5,309,927.

[0014] An anastomosis is a surgical procedure wherein sections of intestine are joined together after a connecting section has been excised. The procedure requires joining the ends of two tubular sections together to form a continuous tubular pathway. Previously, this surgical procedure was a laborious and time consuming operation. The surgeon had to precisely cut and align the ends of the intestine and maintain the alignment while joining the ends with numerous suture stitches. The development of circular staplers has greatly simplified the anastomosis procedure and also decreased the time required to perform an anastomosis.

[0015] In general, a conventional circular stapler typically consists of an elongated shaft having a proximal actuating mechanism and a distal stapling mechanism mounted to the shaft. The distal stapling mechanism typically consists of a fixed stapling cartridge containing a plurality of staples configured in a concentric circular array. A round cutting knife is concentrically mounted in the cartridge interior to the staples. The knife is moveable in an axial, distal direction. Extending axially from the center of the cartridge is a trocar shaft. The trocar shaft is moveable, axially, with respect to the cartridge and elongated shaft. An anvil member is mounted to the trocar shaft. The anvil member has a conventional staple anvil mounted to it for forming the ends of the staples. The distance between the distal face of the staple cartridge and the staple anvil is controlled by an adjustment mechanism mounted to the proximal end of the stapler shaft. Tissue contained between the staple cartridge and the staple anvil is simultaneously stapled and cut when the actuating mechanism is engaged by the surgeon.

[0016] When performing an anastomosis using a circular stapler, typically, the intestine is stapled using a conventional surgical stapler with double rows of staples being emplaced on either side of a target section (i.e., specimen) of intestine. The target section is typically simultaneously cut as the section is stapled. Next, after removing the specimen, the surgeon typically inserts the anvil into the proximal end of the lumen, proximal of the staple line. This is done by inserting the anvil head into an entry port cut into the proximal lumen by the surgeon. On occasion, the anvil can be placed transanally, by placing the anvil head on the distal end of the stapler and inserting the instrument through the rectum. Typically the distal end of the stapler is inserted transanally. The surgeon then ties the proximal end of the intestine to the anvil shaft using a suture or other conventional tying device. Next, the surgeon cuts excess tissue adjacent to the tie and the surgeon attaches the anvil to the trocar shaft of the stapler. The surgeon then closes the gap between the anvil and cartridge, thereby engaging the proximal and distal ends of the intestine in the gap. The surgeon next actuates the stapler causing several rows of staples to be driven through both ends of the intestine and formed, thereby joining the ends and forming a tubular pathway. Simultaneously, as the staples are driven and formed, a concentric circular blade is driven through the intestinal tissue ends, cutting the ends adjacent to the inner row of staples. The surgeon then withdraws the stapler from the intestine and the anastomosis is complete.

[0017] During the stapling process, however, the surgeon must be careful not to over compress the material that is being stapled to avoid killing or detrimentally damaging that tissue. While some prior staplers are fitted with an indicator mechanism for providing the surgeon with some indication of the spacing between the anvil and the staple cartridge, it is desirable for the stapler to include a mechanism that provides a means for avoiding over compression of the tissue.

[0018] International application no. WO95/29639 relates to a laparoscopic stapler with overload sensor and interlock.

[0019] US patent no. 4,415,112 relates to a surgical stapling assembly having resiliently mounted anvil.

[0020] US patent no. 5,653,721 relates to an override mechanism for an actuator on a surgical instrument.

BRIEF SUMMARY

[0021] The invention overcomes the above-noted and other deficiencies of the prior art by providing a surgical instrument, as described in claim 1, that incorporates a cartridge supporting assembly that is configured to op-

erably support a staple cartridge therein. An anvil is operably coupled to the cartridge supporting assembly and is selectively movable between open and closed positions. A closure member interfaces with the anvil to selectively apply a closing force thereto in response to a closing motion applied to the closure member. The closure member may also be configured to apply an opening force to the anvil in response to an opening motion applied to the closure member. At least one force limiting member interacts with the closure member to limit an amount of the closing force applied to the anvil by the closure member in response to a resistive force experienced by the anvil when clamping tissue between the anvil and the staple cartridge supported in the cartridge supporting assembly.

[0022] In another aspect of the disclosure, a surgical instrument has a handle assembly and an elongate spine that is coupled to the handle assembly. An elongate channel is distally coupled to the elongate spine and is configured to support a staple cartridge therein. An anvil is operably coupled to the elongate channel and is selectively movable between open and closed positions. A closure tube assembly is movably received on the elongate spine and has a distal end portion that is oriented to selectively interact with the anvil to cause the anvil to move between the open and closed positions. A closure drive is operably supported within the handle assembly and movably supports a proximal end portion of the closure tube assembly therein. The closure drive is operable to selectively apply opening and closing motions to the closure tube assembly such that upon application of the closure motion to the closure tube assembly, the closure tube assembly applies a closing force to the anvil. At least one force limiting member interacts with the closure tube assembly to limit an amount of the closing force applied to the anvil by the closure tube assembly in response to a resistive force experienced by the anvil when clamping tissue between the anvil and the elongate channel.

[0023] These and other objects and advantages of the present invention shall be made apparent from the accompanying drawings and the description thereof.

BRIEF DESCRIPTION OF THE FIGURES

[0024]

FIG. 1 is a perspective view of a surgical cutting and staple instrument.

FIG. 2 is a left side view of a closed end effector (staple applying assembly) with a retracted force adjusted height firing bar consistent with the present invention.

FIG. 3 is a left isometric view of the force adjusted (compliant) height firing bar of FIG. 2.

FIG. 4 is an exploded assembly view of an end effector and elongate shaft assembly.

FIG. 5 is an exploded assembly view of a handle assembly and closure shuttle arrangements, with the firing system components omitted for clarity.

FIG. 6 is a cross-sectional side view of the handle assembly depicted in FIG. 5 with the closure trigger thereof in a locked position.

FIG. 7 is a partially enlarged view of a closure tube and anvil arrangement of an embodiment of the present invention with the anvil in a partially closed position.

FIG. 8 is another partially enlarged view of the closure tube and anvil arrangement of FIG. 7 with the anvil in a fully closed position.

DETAILED DESCRIPTION

[0025] Turning to the Drawings, wherein like numerals denote like components throughout the several views, FIGS. 1-8 illustrate a surgical stapling and severing instrument 1000 in accordance with the present invention. As can be seen in FIG. 1, the instrument 1000 includes a handle assembly 1020 that is manipulated to position an implement portion 1014 including a fastening end effector, depicted as a staple applying assembly 1016, distally attached to an elongate shaft assembly 1100. The implement portion 1014 is sized for insertion through a cannula of a trocar (not shown) for an endoscopic or laparoscopic surgical procedure with an upper jaw (anvil) 1050 and a lower jaw 1018 of the staple applying assembly 1016 closed by depression of a closure trigger 1040 toward a pistol grip 1034 of the handle assembly 1020, which advances an outer closure tube assembly 1130 of the elongate shaft assembly 1100 to pivot the anvil 1050 to a closed position as will be discussed in further detail below.

[0026] Once inserted into an insufflated body cavity or lumen, the closure trigger 1040 may be released, opening the anvil 1050 so that tissue may be grasped and positioned. Once satisfied with the tissue held in the staple applying assembly 1016, the surgeon depresses the closure trigger 1040 until locked against the pistol grip 1034, clamping tissue inside of the staple applying assembly 1016. Then a firing trigger 1046 is drawn toward the closure trigger 1040 and pistol grip 1034, thereby applying a firing force or motion thereto to distally advance a firing member supported with in the implement 1014 from an unfired position. As the firing member advances through the implement or end effector 1014 in a known manner, it severs the tissue clamped within the end effector 1014 and fires or drives the staples contained with the staple cartridge 42 supported therein.

[0027] One example of a surgical instrument in accordance with the present invention may employ a firing bar 36 and E-Beam 50 arrangement as shown in FIGS. 2 and 3. In FIGS. 2 and 3, a firing bar 36 has a proximal portion 48 that is attached to a distal E-beam 50 that translates within the staple applying assembly 16. As depicted with the firing bar 36 retracted, a vertical portion 52 of the E-beam 50 resides essentially aft of the staple cartridge 42, as after a new staple cartridge 42 has been

inserted into the elongate staple channel 40. An upper pin 54 that extends laterally from an upper portion of the vertical portion 52 of the E-beam 50 initially resides within an anvil pocket 56 recessed near a proximal pivoting end of the anvil 20. As the E-beam 50 is distally advanced during the staple firing motion, the vertical portion 52 passes through a narrow longitudinal anvil slot 58 formed in a staple forming undersurface 60 of the anvil 20, a proximally open vertical slot 62 formed in cartridge 42 and an underlying longitudinal channel slot 64 formed in the elongate staple channel 40.

[0028] In FIG. 2 the narrow longitudinal anvil slot 58 communicates upwardly to a laterally widened longitudinal anvil channel 66 sized to slidingly receive the upper pin 54. The longitudinal channel slot 64 communicates downwardly to a laterally widened longitudinal channel track 68 that receives a lower foot 70, which is sized to slide therein and is attached at a bottom of the vertical portion 52 of the E-beam 50. A laterally widened middle pin 72 extending from the vertical portion 52 of the E-beam 50 is positioned to slide along a top surface of a bottom tray 74 of the staple cartridge 42, which in turn rests upon the elongate staple channel 40. A longitudinal firing recess 75 formed in the staple cartridge 42 above the bottom tray 74 is sized to allow the middle pin 72 to translate through the staple cartridge 42.

[0029] A distal driving surface 76 of the vertical portion 52 of the E-beam 50 is positioned to translate through the proximally open vertical slot 62 of the staple cartridge 42 and distally drive a wedge sled 78 proximally positioned in the staple cartridge 42. The vertical portion 52 of the E-beam 50 includes a cutting surface 80 along a distal edge above the distal driving surface 76 and below the upper pin 54 that severs the clamped tissue 46 simultaneously with this stapling.

[0030] In other alternative examples, the E-Beam arrangements described in U.S. Patent Application Serial No. 11/231,456, filed September 21, 2005 and entitled "Surgical Stapling Instrument Having Force Controlled Spacing End Effector", may also be employed. In addition, as the present Detailed Description proceeds, those of ordinary skill in the art will appreciate that the advantages provided by these examples may be effectively attained when used in connection with other known non-E beam firing bar configurations. Thus, these examples should not be limited solely to use in connection with E-beam type firing and cutting arrangements.

[0031] FIG. 4 depicts the firing bar 36 as including a proximal firing rod 34, that is supported within a "frame ground" or spine assembly 1110 that connects the handle assembly 1020 to the staple applying assembly 1016. During the staple firing motion, the firing bar 36 engages an elongate staple channel 1060 and actuates a staple cartridge 42 contained therein, both forming the lower jaw 1018 in the various manners described above.

[0032] A variety of different firing arrangements for applying an actuation force to the firing bar 36 to cause the firing bar to linearly advance and retract through the staple applying assembly 1016 are known. Such firing motions may be manually generated such as through use of the various firing system arrangements disclosed in U.S. Patent Application Serial No. 11/475,412, filed June 27, 2006, entitled "Manually Driven Surgical Cutting and Fastening Instrument" to Frederick E. Shelton, IV, et al. Still other actuation systems, such as the pneumatically powered actuation systems disclosed in U.S. Patent Application Serial No. 11/497,868, filed August 2, 2006, entitled "Pneumatically Powered Surgical Cutting and Fastening Instrument With a Variable Control of the Actuating Rate of Firing With Mechanical Power Assist" to Frederick E. Shelton, IV et al. may be successfully employed. Other examples may include, for example, the electrical motor driven actuation systems disclosed in U.S. Patent Application Serial No. 11/343,562, filed January 31, 2006, entitled "Motor-Driven Surgical Cutting and Fastening Instrument With Articulatable End Effector" to Frederick E. Shelton, IV et al.. Still other examples may include other known mechanically, electrically, hydraulically and/or pneumatically powered firing systems.

[0033] In various examples, the elongate shaft assembly 1100 consists of a closure tube assembly 1130 that is received on the spine assembly 1110. See FIG. 4. The spine assembly 1110 may comprise a single member or it may comprise multiple segments with an articulation joint (not shown) mounted therein. Such articulation joints are known in the art and may, for example, be mechanically, electrically, hydraulically or pneumatically controlled. In the example depicted in FIGS. 4 and 5, the spine assembly 1110 includes a proximal portion 1112 (FIG. 3) and a distal portion 1116 (FIG. 2). As will be discussed below, the proximal portion 1112 is attached to the handle assembly 1020 such that the closure tube assembly 1130 may be axially moved thereon to cause the anvil 1050 to pivot between open and closed positions. As can be seen in FIG. 2, the elongate channel 1060 has proximally placed attachment cavities 1062 that each receive a corresponding channel anchoring member 1118 formed on the distal end of the distal spine portion 1116. The elongate channel 1060 also has elongated anvil cam slots 1064 that movably receive a corresponding anvil trunnion 1052 on the anvil 1050 as will be discussed in further detail below.

[0034] The closure tube assembly 1130 may comprise a distal closure tube portion 1140 and a proximal closure tube portion 1150. The distal closure tube portion 1140 and the proximal closure tube portion 1150 may be fabricated from a polymer or other suitable material. The distal closure tube portion 1140 and the proximal closure tube portion 1150 are each hollow for receiving a corresponding portion of the spine assembly 1110 therein. The closure tube assembly 1130 is depicted as comprising two separate portions 1140 and 1150 for ease of assembly of the entire elongate shaft assembly 1100. Those portions 1140 and 1150 may be attached together after assembly by adhesive or other suitable fastening means. It is conceivable, however, that the closure tube assem-

bly 1130 may be fabricated as one piece. In addition, as was mentioned above, the spine assembly of various examples may have an articulation joint mounted therein. For those examples, a double pivot closure joint (not shown) may be employed in the closure tube assembly 1130. Examples of such double pivot closure arrangements are disclosed in U.S. Patent Application Serial No. 11/497,868.

[0035] In use, the closure tube assembly 1130 is translated distally to close the anvil 1050, for example, in response to the actuation of the closure trigger 1040. The anvil 1050 is closed by distally translating the closure tube assembly 1130 on the spine assembly 1110, causing the back of a horseshoe aperture 1142 in the distal closure tube portion 1140 to strike a closure feature 1053 in the form of an open/closing tab 1052 on the anvil 1050 and cause it to pivot to the closed position. See FIG. 4. To open the anvil 1050, the closure tube assembly 1130 is axially moved in the proximal direction on the spine assembly 1110 causing a tab 1144 on the distal closure tube portion 1140 to contact and push against the open/closing tab 1054 on the anvil 1050 to pivot the anvil 1050 to the opened position.

[0036] FIG. 5 illustrates an exploded assembly view of a non-limiting handle assembly 1020 wherein the various firing system components have been omitted for clarity. In the example depicted in FIG. 3, the handle assembly 1020 has a "pistol grip" configuration and is formed from a right hand case member 1022 and a left handed case member 1028 that are molded or otherwise fabricated from a polymer or other suitable material and are designed to mate together. Such case members 1022 and 1028 may be attached together by snap features, pegs and sockets molded or otherwise formed therein and/or by adhesive, screws, bolts, clips, etc. The upper portion 1024 of the right hand case member 1022 mates with a corresponding upper portion 1030 of the left hand case member 1028 to form a primary housing portion designated as 1031. Similarly, the lower grip portion 1025 of the right hand case member 1022 mates with the lower grip portion 1032 of the left hand case member 1028 to form a grip portion generally designated as 1034. See FIG. 1. Those of ordinary skill in the art will readily appreciate, however, that the handle assembly 1020 may be provided in a variety of different shapes and sizes.

[0037] For the purposes of clarity, FIG. 5 only illustrates the components employed to control the axial movement of the closure tube assembly 1130 which ultimately controls the opening and closing of the anvil 1050. As can be seen in that Figure, a closure shuttle 1160 that is coupled to the closure trigger 1040 by a linkage assembly 1180 is supported within the primary housing portion 1031. Closure shuttle 1160 may also be fabricated in two pieces 1162, 1164 that are molded or otherwise fabricated from a polymer or other suitable material and are designed to mate together. For example, as illustrated in FIG. 3, the right hand portion 1162 may be provided with fastener posts 1163 that are designed to be received within corresponding sockets 1167 in the left hand portion 1164. The right and left hand portions 1162, 1164 may be otherwise retained together by snap members and/or adhesive and/or bolts, screws, clips, etc. As can be seen in those Figures, a retention groove 1152 is provided in the proximal end 1151 of the proximal closure tube portion 1150. The right hand portion 1162 of the closure shuttle 1160 has a right retention flange 1165 that is adapted to cooperate with a left hand portion 1164 of the closure shuttle 1160 such that the retention flange 1165 extends into the retention groove 1151 in the proximal closure tube portion 1150. The retention flange 1165 serves to affix the closure tube assembly 1130 to the closure shuttle 1160 while facilitating its limited axial movement relative thereto as will be discussed in further detail below.

[0038] As can also be seen in FIG. 5, a right spine assembly retention peg 1027 protrudes inward from the right hand case member 1024. Such peg 1027 protrudes into an elongated slot or window 1166 in the right hand portion 1162 of the closure shuttle 1160. A similar closure shuttle retention peg (not shown) protrudes inward from the left hand case member 1164 to be received in another window or slot 1168 provided in the left hand side portion 1164 of the closure shuttle 1160. The retention pegs are configured to extend into a hole 1115 in the proximal end 1114 of the proximal spine portion 1110 to non-movably affix the spine portion 1110 to the handle assembly 1020 while permitting the closure shuttle 1160 to move axially relative thereto. See FIG. 3. The retention pegs may be mechanically attached to the proximal end 1114 of the proximal spine portion 1112 by, for example, bolts, screws, adhesive, snap features, etc. In addition, the closure shuttle 1160 is provided with laterally extending guide rails 1170, 1172. Rail 1170 is configured to be slidably received within rail guide 1026 in the right hand case member 1024 and rail 1172 is configured to be slidably received within a rail guide (not shown) in left hand case member 1028. See FIG. 5.

[0039] Axial movement of the closure shuttle 1160 and closure tube assembly 1130 in the distal direction (arrow "A") is created by moving the closure trigger 1040 toward the grip portion 1034 of the handle assembly 1020 and axial movement of the closure shuttle 1160 in the proximal direction (arrow "B") is created by moving the closure trigger 1040 away from the grip portion 1034. In various examples, the closure shuttle 1160 is provided with a connector tab 1174 that facilitates the attachment of the closure linkage assembly 1180 thereto. See FIGS. 5 and 6. The closure linkage assembly 1180 includes a yoke portion 1182 that is pivotally pinned to the connector tab 1174 by a pin 1184. The closure linkage assembly 1180 further has a closure arm 1186 that is pivotally pinned to a yoke assembly 1043 formed on the closure trigger 1042 by a closure pin 1188 as illustrated in FIG. 5. The closure trigger 1140 is pivotally mounted within the handle assembly 1020 by a pivot pin 11890 that extends between the right hand case member 1024 and the left hand case

member 1028.

[0040] When the clinician desires to close the anvil 1050 to clamp tissue within the end effector 1014, the clinician draws the closure trigger 1040 toward the pistol grip portion 1034. As the clinician draws the closure trigger 1040 toward the pistol grip portion 1034, the closure linkage assembly 1180 moves the closure shuttle 1160 in the distal "A" direction until the closure linkage assembly 1180 moves into the locked position illustrated in FIG. 6. When in that position, the closure linkage assembly 1180 will tend to retain the closure shuttle 1160 in that locked position.

[0041] In various examples, to further retain the closure shuttle 1160 in the closed position, the closure trigger 1040 may be provided with a releasable locking mechanism 1190 that is adapted to engage the pistol grip portion 1034 and releasably retain the closure trigger 1040 in the locked position. Other locking devices may also be used to releasably retain the closure shuttle 1160 in the locked position.

[0042] In the example depicted in FIG. 6, the closure trigger 1040 includes a flexible longitudinal arm 1192 that includes a lateral pin 1194 extending therefrom. The arm 1192 and pin 1194 may be made from molded plastic, for example. The pistol grip portion 1034 of the handle assembly 1020 includes an opening 1036 with a laterally extending wedge 1037 disposed therein. When the closure trigger 1040 is retracted, the pin 1194 engages the wedge 1037, and the pin 1194 is forced downward (i.e., the arm 1192 is rotated clockwise) by the lower surface of the wedge 1037. When the pin 1194 fully passes the lower surface, the clockwise force on the arm 1192 is removed, and the pin 1194 is rotated counterclockwise such that the pin 1194 comes to rest in a notch 1038 behind the wedge 1037 thereby locking the closure trigger 1040. The pin 1194 is further held in place in the locked position by a flexible stop 1039 extending from the wedge 1037.

[0043] To unlock the closure trigger 1040, the operator may further squeeze the closure trigger 1040, causing the pin 1194 to engage a sloped back wall 1041 of the opening 1036, forcing the pin 1194 upward past the flexible stop 1039. The pin 1194 is then free to travel out of the opening 1036 such that the closure trigger 1040 is no longer locked to the pistol grip portion 1034. Further details of such arrangement may be found in U.S. Patent Application Serial No.11/344,020, filed January 31, 2006 and entitled "Surgical Instrument Having A Removable Battery to Shelton, IV et al.,". Other releasable locking arrangements could also be employed.

[0044] As the closure shuttle 1160 is moved to the locked position, the closure tube assembly 1130 is moved distally on the spine assembly 1110 causing the closure/opening tab 1054 on the anvil 1050 to be contacted by the proximal end of the horseshoe aperture 1142 in the distal closure tube portion 1140 to thereby pivot the anvil 1050 to the closed (clamped) position. Thus, the clamping forces attained by the anvil 1050 during the clamping process are ultimately dependant upon the closure forces generated by the closure tube assembly as it contacts the tab 1054 on the anvil 1050. As was discussed above, prior closure tube arrangements lack means for limiting the amount of actuation force applied to the closure/opening tab 1054 of the anvil 1050.

[0045] The present invention addresses such shortcomings of prior closure tube arrangements by including a force limiting member for limiting the amount of closure force or load applied by the closure tube assembly to the closure/opening tab 1054 of the anvil.

[0046] FIGS. 7 and 8 illustrate an embodiment of the present invention that may be employed to limit closure forces applied to the anvil 1050 by the closure tube assembly 1130. As can be seen in those Figures, this embodiment employs an anvil 1050d that has a stepped ramp 1070 that is configured to be engaged by the distal end 1141 of the distal closure tube portion 1140. In particular, the anvil 1050d depicted in those Figures has a series of steps 1074d, 1076d, 1078d, 1080d formed therein. As the closure tube assembly 1130 is moved distally, the distal end 1141 starts to ride up the smooth portion 1072d of the ramp 1070 until it contacts the first step 1074d. The closure tube assembly 1130 will not advance further up the ramp 1070d to apply a higher amount of closure force to the anvil until the actuation force applied to the closure tube assembly 1130 attains a sufficient magnitude to cause the distal end 1141 to bump up over the first step 1074d and proceed to engage the next step 1076d. The closure tube assembly 1130 will not advance further up the ramp 1070d until the actuation force attains a sufficient magnitude to cause the distal end 1141 to bump up over the second step 1076d at which time it will engage the next step 1078d and so on. Thus, the stepped anvil 1050d cooperates with the closure tube assembly 1130 to provide a means for relating the amount of clamping forces ultimately applied to the tissue between the anvil 1050d and the staple cartridge 42 based on the amount of resistive forces generated thereby and encountered by the closure tube assembly 1130 during clamping. While four such steps have been disclosed, other numbers of steps may be employed. For example, only one such step may be used or 2, 3, or more than 4 steps could conceivably be employed.

[0047] While various manually operated surgical instruments have been depicted for clarity, it should be appreciated that such devices may also be robotically manipulated. In addition, those skilled in the art will appreciate that the examples, features and improvements disclosed herein may be readily employed in connection with a variety of other known surgical cutter/staplers, staplers, etc. that may have application in open, laparoscopic, endoscopic and/or intralumenal surgical procedures. In particular, such unique and novel features may be practiced in connection with linear staplers, cutters, contour cutters, etc. Thus, the scope and protection afforded to the various examples disclosed herein should not be limited solely to endocutter-type surgical staplers.

[0048] It will be apparent, that various modifications, alterations and adaptations to those examples may occur to persons skilled in the art with the attainment of some or all of the advantages. For example, according to various examples, a single component may be replaced by multiple components, and multiple components may be replaced by a single component, to perform a given function or functions. This application is therefore intended to cover all such modifications, alterations and adaptations without departing from the scope of the disclosed invention as defined by the appended claims.

[0049] The devices disclosed herein can be designed to be disposed of after a single use, or they can be designed to be used multiple times. In either case, however, the device can be reconditioned for reuse after at least one use. Reconditioning can include an combination of the steps of disassembly of the device, followed by cleaning or replacement of particular pieces, and subsequent reassembly. In particular, the device can be disassembled, and any number of particular pieces or parts of the device can be selectively replaced or removed in any combination. Upon cleaning and/or replacement of particular parts, the device can be reassembled for subsequent use either at a reconditioning facility, or by a surgical team immediately prior to a surgical procedure. Those of ordinary skill in the art will appreciate that the reconditioning of a device can utilize a variety of different techniques for disassembly, cleaning/replacement, and reassembly. Use of such techniques, and the resulting reconditioned device, are all within the scope of the present application.

[0050] Preferably, the invention described herein will be processed before surgery. First a new or used instrument is obtained and, if necessary, cleaned. The instrument can then be sterilized. In one sterilization technique, the instrument is placed in a closed and sealed container, such as a plastic or TYVEK® bag. The container and instrument are then placed in a field of radiation that can penetrate the container, such as gamma radiation, x-rays, or higher energy electrons. The radiation kills bacteria on the instrument and in the container. The sterilized instrument can then be stored in the sterile container. The sealed container keeps the instrument sterile until it is opened in the medical facility.

[0051] As used herein, the term "fluidically coupled" means that the elements are coupled together with an appropriate line or other means to permit the passage of pressurized gas therebetween. As used herein, the term "line" as used in "supply line" or "return line" refers to an appropriate passage formed from rigid or flexible conduit, pipe, tubing, *etc.* for transporting fluid from one component to another.

[0052] The invention which is intended to be protected is not to be construed as limited to the particular embodiments disclosed. The embodiments are therefore to be regarded as illustrative rather than restrictive. Variations and changes may be made by others without departing from the scope of the present invention. Accordingly, it is expressly intended that all such variations and changes which fall within the scope of the present invention as defined in the claims be embraced thereby.

Claims

1. A surgical instrument (1000) comprising:

a cartridge supporting assembly configured to operably support a staple cartridge (42) therein;
an anvil (1050) operably coupled to said cartridge supporting assembly and being selectively movable between open and closed positions;
a closure member (1130) interfacing with said anvil (1050) to selectively apply a closing force thereto in response to a closing motion applied to said closure member (1130) and an opening force thereto in response to an opening motion applied to said closure member (1130); and
at least one force limiting member interacting with said closure member (1130) to limit an amount of the closing force applied to said anvil (1050) by said closure member (1130) in response to a resistive force experienced by said anvil (1050) when clamping tissue between said anvil (1050) and a staple cartridge (42) supported in said cartridge supporting assembly, **characterised in that** said anvil (1050) has a ramp portion (1070) formed on a proximal end (1151) thereof for selective contact by a distal end (1141) of said closure member (1130) and wherein said force limiting member comprises at least two steps (1074d, 1076d, 1078d, 1080d) formed in said ramp portion (1070) for selective engagement by said distal end (1141) of said closure member (1130).

2. The surgical instrument (1000) of claim 1 further comprising:

a handle assembly (1020) operably supporting said closure drive; and
a closure trigger (1040) operably supported by said handle assembly (1020) and interacting with said closure drive such that activation of said closure trigger (1040) in a closing direction causes closure drive to apply said closure motion to said closure member (1130) and activation of said closure trigger (1040) in an opening direction causes said closure drive to apply said opening motion to said closure member (1130).

3. The surgical instrument (1000) of claim 1 wherein said anvil (1050) is pivotally coupled to said cartridge supporting assembly.

4. The surgical instrument (1000) of claim 1 wherein a

magnitude of said resistive force is depenent upon a thickness of the tissue clamped between said anvil (1050) and the cartridge supported in said cartridge supporting assembly.

Patentansprüche

1. Chirurgisches Instrument (1000), umfassend:

eine Magazinstützanordnung, die dazu konfiguriert ist, ein Klammermagazin (42) betriebsmäßig darin zu stützen,
einen Amboss (1050), der an die Magazinstützanordnung wirkgekoppelt und gezielt zwischen einer offenen und einer geschlossenen Position beweglich ist,
ein Schließglied (1130), das eine Schnittstelle mit dem Amboss (1050) bildet, um diesen als Reaktion auf eine Schließbewegung, mit der das Schließglied (1130) beaufschlagt worden ist, gezielt mit einer Schließkraft und als Reaktion auf eine Öffnungsbewegung, mit der das Schließglied (1130) beaufschlagt worden ist, gezielt mit einer Öffnungskraft zu beaufschlagen, und
mindestens ein Kraftbegrenzungsglied, das mit dem Schließglied (1130) zusammenwirkt, um eine Höhe der durch das Schließglied (1130) auf den Amboss (1050) ausgeübten Schließkraft als Reaktion auf eine Widerstandskraft zu begrenzen, die auf den Amboss (1050) ausgeübt wird, wenn Gewebe zwischen dem Amboss (1050) und einem in der Magazinstützanordnung gestützten Klammermagazin (42) geklemmt ist, **dadurch gekennzeichnet, dass** der Amboss (1050) einen an einem proximalen Ende (1151) davon gebildeten Rampenabschnitt (1070) zum gezielten Kontakt durch ein distales Ende (1141) des Schließglieds (1130) hat, und wobei das Kraftbegrenzungsglied mindestens zwei Stufen (1074d, 1076d, 1078d, 1080d) umfasst, die in dem Rampenabschnitt (1070) für den gezielten Eingriff durch das distale Ende (1141) des Schließglieds (1130) gebildet sind.

2. Chirurgisches Instrument (1000) nach Anspruch 1, ferner umfassend:

eine Griffanordnung (1020), die den Schließantrieb betriebsmäßig stützt, und
einen Schließauslöser (1040), der von der Griffanordnung (1020) betriebsmäßig gestützt wird und mit dem Schließantrieb zusammenwirkt, so dass durch die Aktivierung des Schließauslösers (1040) in einer Schließrichtung veranlasst wird, dass der Schließantrieb das Schließglied (1130) mit der Schließbewegung beaufschlagt, und durch die Aktivierung des Schließauslösers (1040) in einer Öffnungsrichtung veranlasst wird, dass der Schließantrieb das Schließglied (1130) mit der Öffnungsbewegung beaufschlagt.

3. Chirurgisches Instrument (1000) nach Anspruch 1, wobei der Amboss (1050) schwenkbar an die Magazinstützanordnung gekoppelt ist.

4. Chirurgisches Instrument (1000) nach Anspruch 1, wobei eine Größe der Widerstandskraft von einer Dicke des zwischen den Amboss (1050) und das in der Magazinstützanordnung gestützte Magazin geklemmten Gewebes abhängig ist.

Revendications

1. Instrument (1000) chirurgical comportant :

un ensemble support de cartouche configuré pour supporter de manière fonctionnelle une cartouche (42) d'agrafes dans ce dernier ;
une enclume (1050) accouplée de manière fonctionnelle audit ensemble support de cartouche et mobile sélectivement entre des positions ouverte et fermée ;
un élément (1130) de fermeture faisant interface avec ladite enclume (1050) pour appliquer sélectivement une force de fermeture sur ce dernier en réponse à un mouvement de fermeture appliqué sur ledit élément (1130) de fermeture et une force d'ouverture sur ce dernier en réponse à un mouvement d'ouverture appliqué sur ledit élément (1130) de fermeture ; et
au moins un élément limiteur de force agissant réciproquement avec ledit élément (1130) de fermeture pour limiter une quantité de la force de fermeture appliquée sur ladite enclume (1050) par ledit élément (1130) de fermeture en réponse à une force résistive rencontrée par ladite enclume (1050) lorsque le tissu est pincé entre ladite enclume (1050) et une cartouche (42) d'agrafes supportée dans ledit ensemble support de cartouche, **caractérisé en ce que** ladite enclume (1050) présente une partie rampe (1070) formée sur une extrémité (1151) proximale de cette dernière destinée à venir en contact sélectivement avec une extrémité (1141) distale dudit élément (1130) de fermeture et ledit élément limiteur de force comportant au moins deux gradins (1074d, 1076d, 1078d, 1080d) formés dans ladite partie (1070) rampe destinés à être mis en prise sélectivement par ladite extrémité (1141) distale dudit élément (1130) de fermeture.

2. Instrument (1000) chirurgical selon la revendication 1 comportant en outre :

un ensemble (1020) poignée supportant de manière fonctionnelle ledit entraînement de fermeture ; et
une gâchette (1040) de fermeture supportée de manière fonctionnelle par ledit ensemble (1020) poignée et agissant réciproquement avec ledit entraînement de fermeture de telle sorte que l'actionnement de ladite gâchette (1040) de fermeture dans une direction de fermeture amène l'entraînement de fermeture à appliquer ledit mouvement de fermeture sur ledit élément (1130) de fermeture et l'actionnement de ladite gâchette (1040) de fermeture dans une direction d'ouverture amène ledit entraînement de fermeture à appliquer ledit mouvement d'ouverture sur ledit élément (1130) de fermeture.

3. Instrument (1000) chirurgical selon la revendication 1, ladite enclume (1050) étant accouplée pivotante audit ensemble support de cartouche.

4. Instrument (1000) chirurgical selon la revendication 1, l'ordre de grandeur de ladite force résistive étant dépendant d'une épaisseur du tissu pincé entre ladite enclume (1050) et la cartouche supportée dans ledit ensemble support de cartouche.

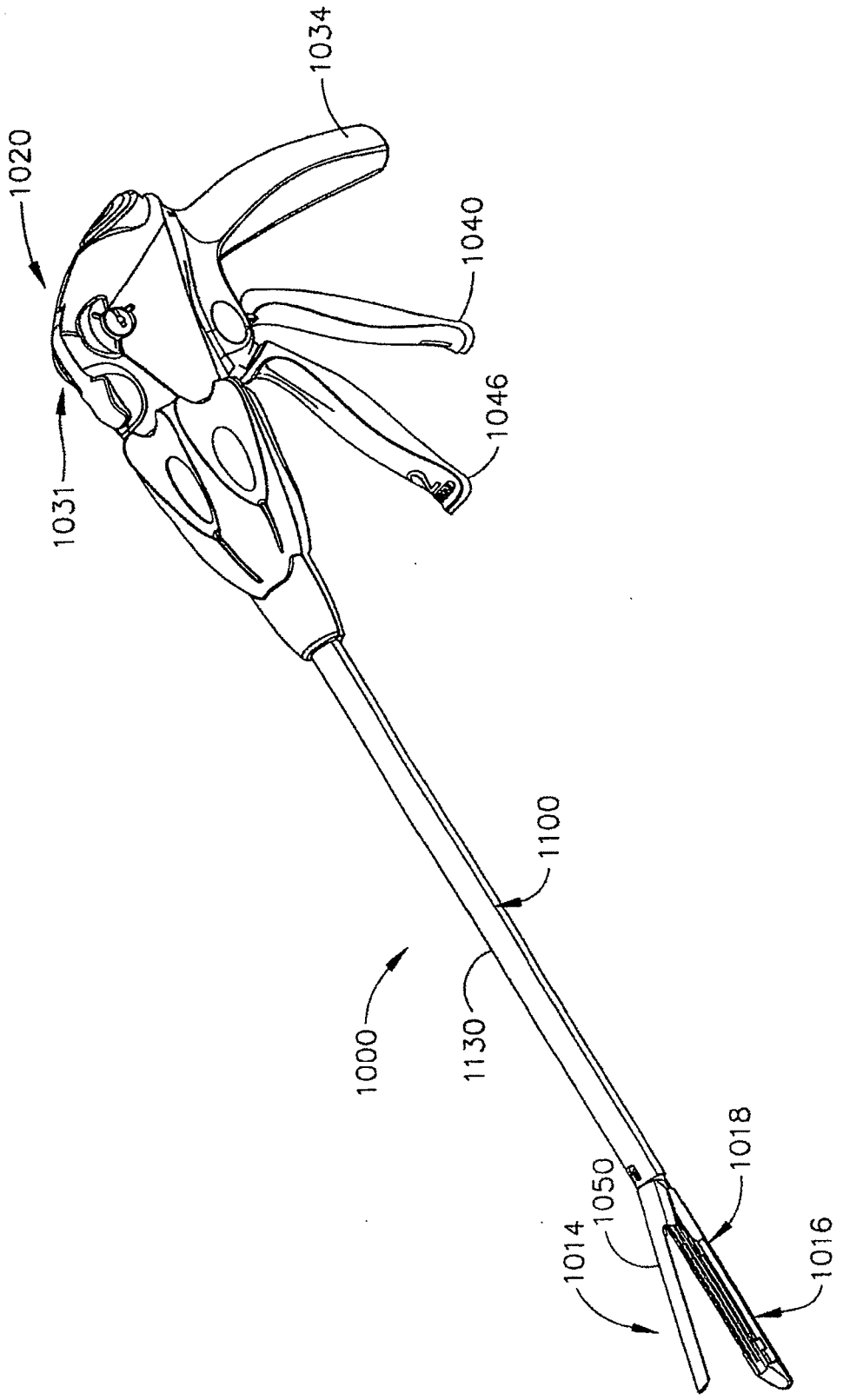
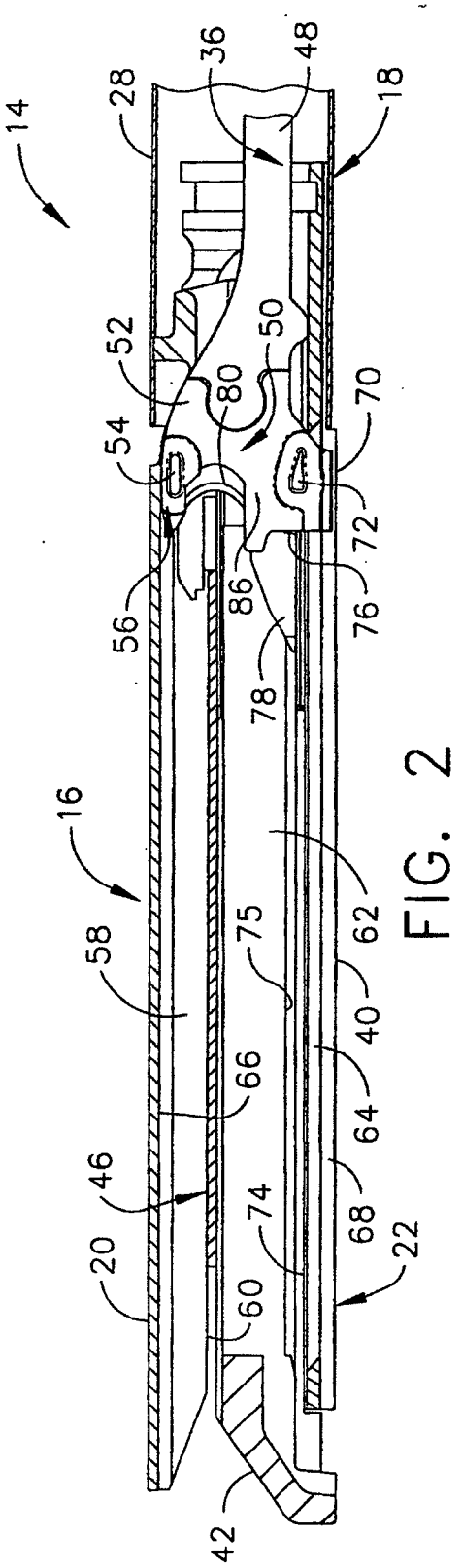


FIG. 1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42

FIG. 2

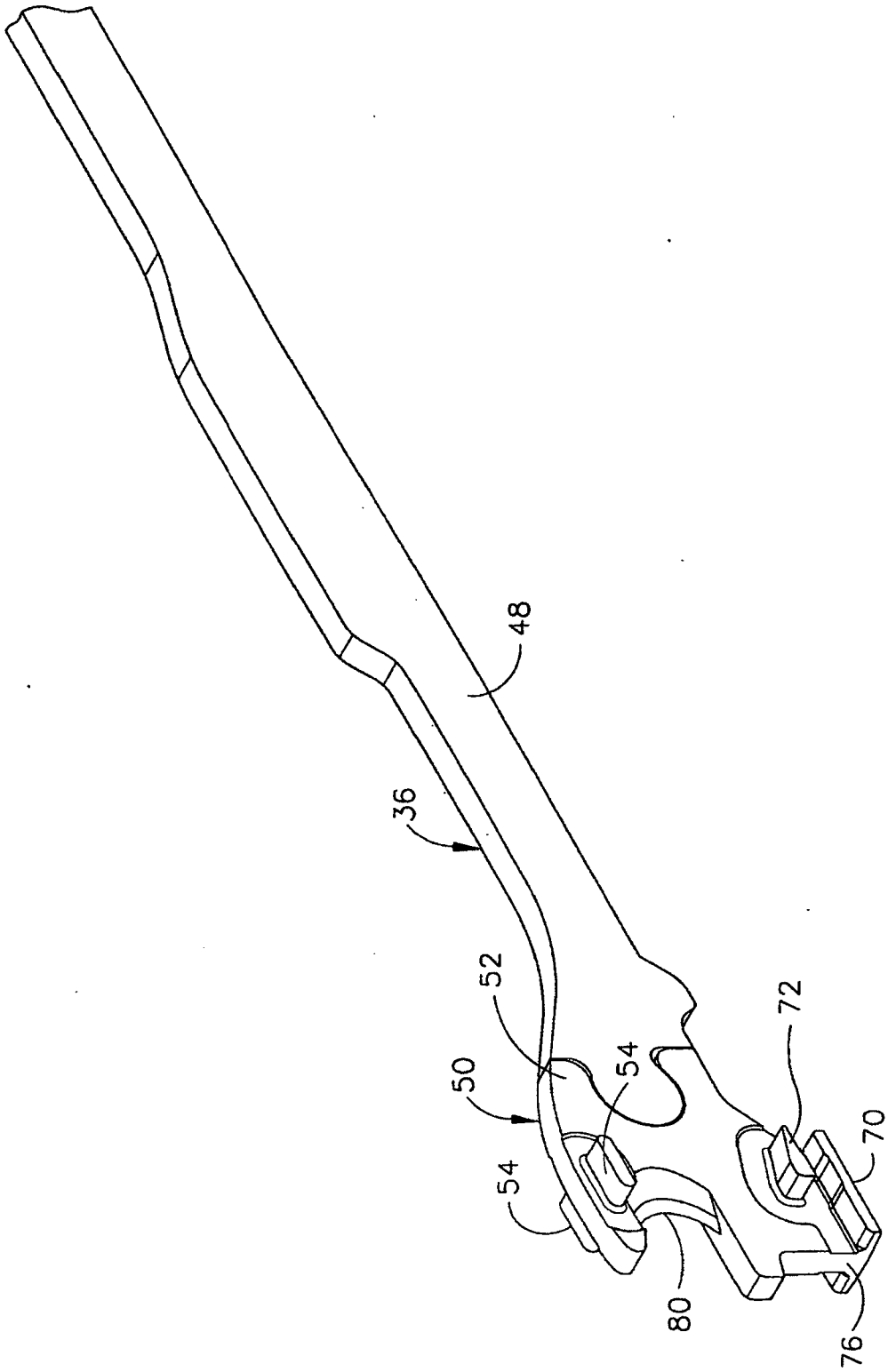
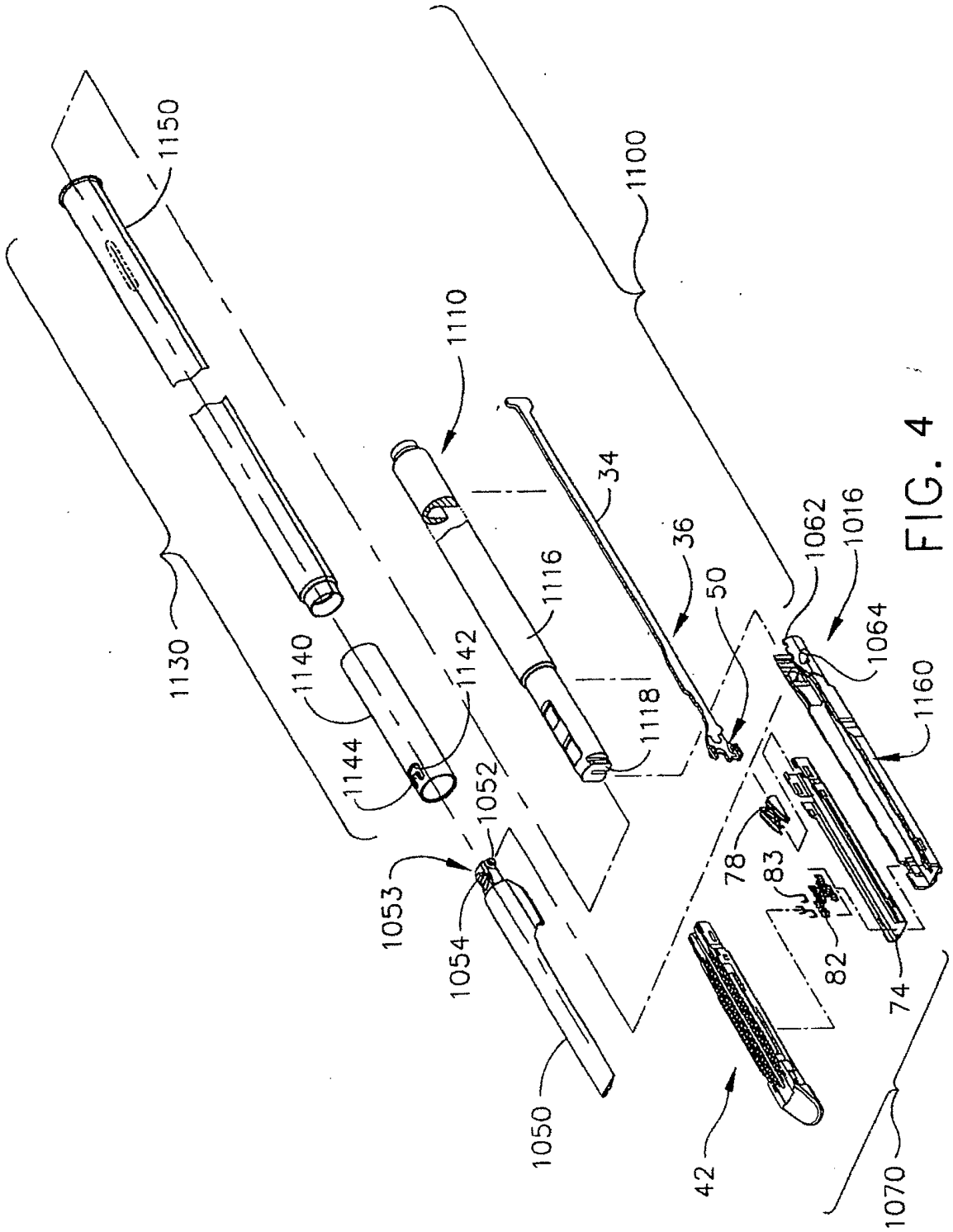


FIG. 3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1110
1130
1140
1142
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1116
34
36
50
1062
1016
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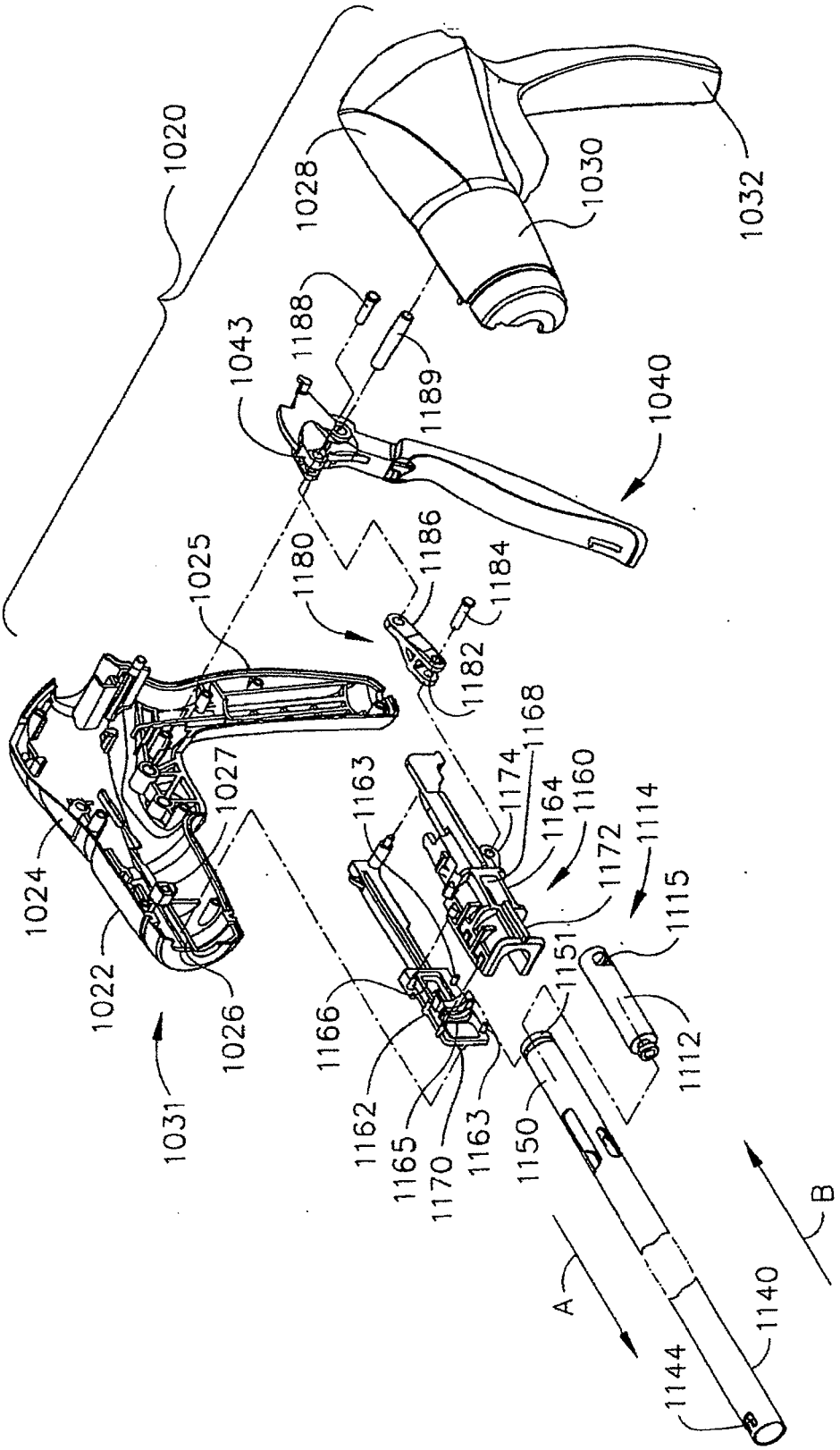
1160
1118
1052
1053
1054
78
83
82
74
1050
42
1070

FIG. 4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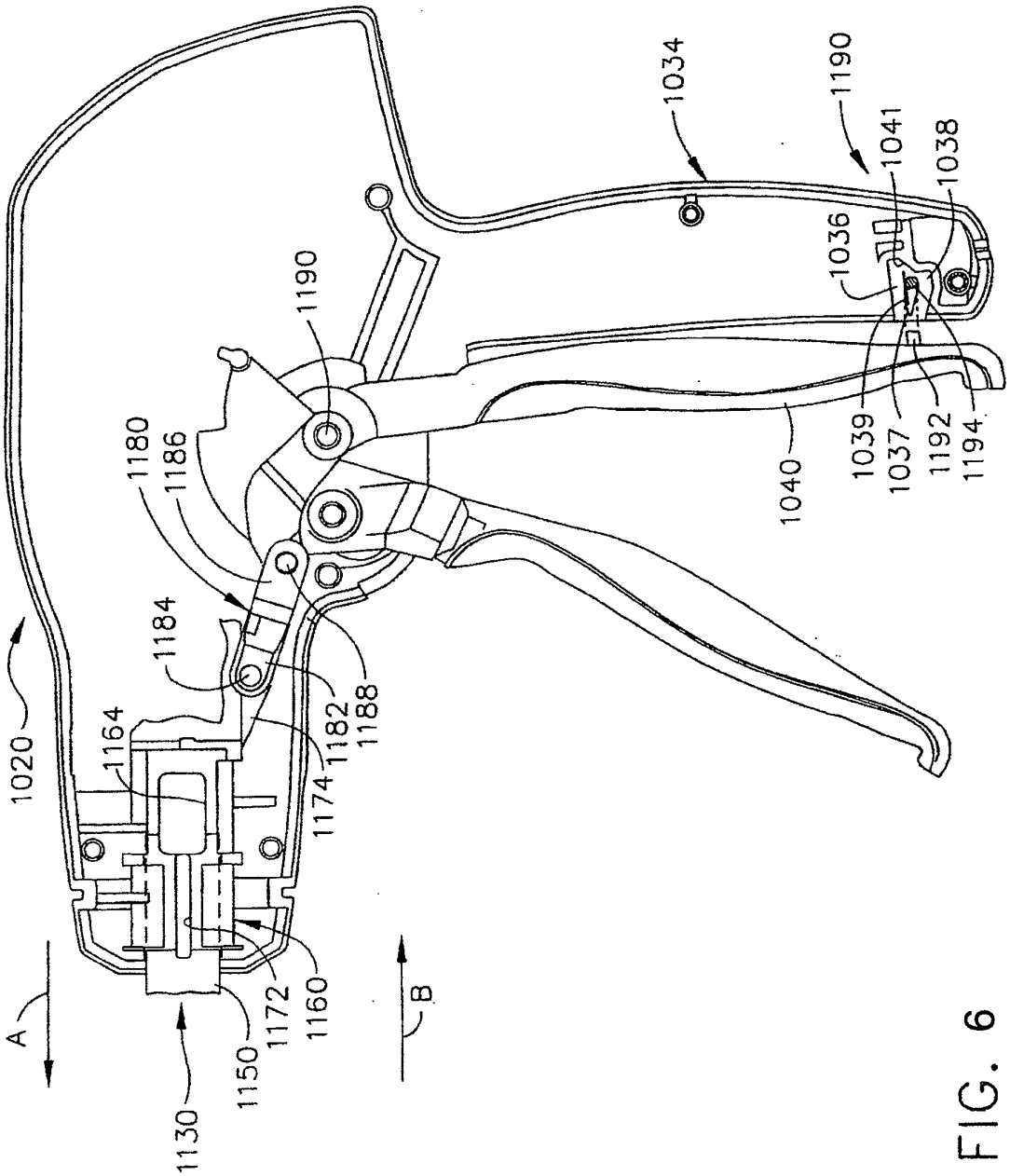
1164
1160
1114
1172
1115
1151
1027
1024
1022
1026
1031
1166
1162
1165
1170
1163
1150
1112
A
B
1140
1144

FIG. 5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1038
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1037
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1174
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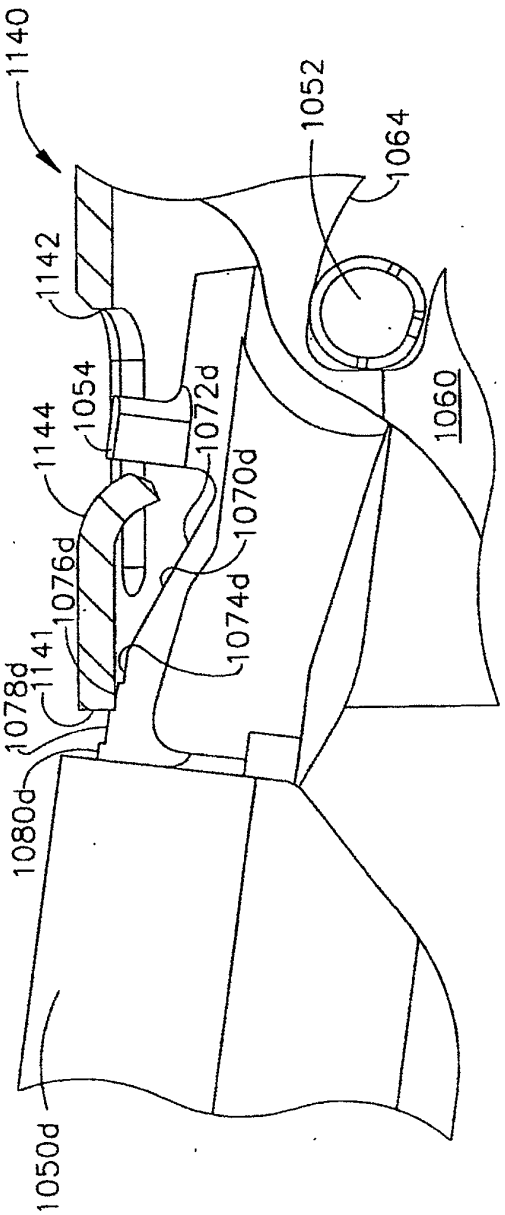
B
1172
1160
1150
1130

FIG. 6


1140
1052
1064
1142
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1072d
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1070d
1076d
1074d
1078d
1141
1080d
1050d

FIG. 7

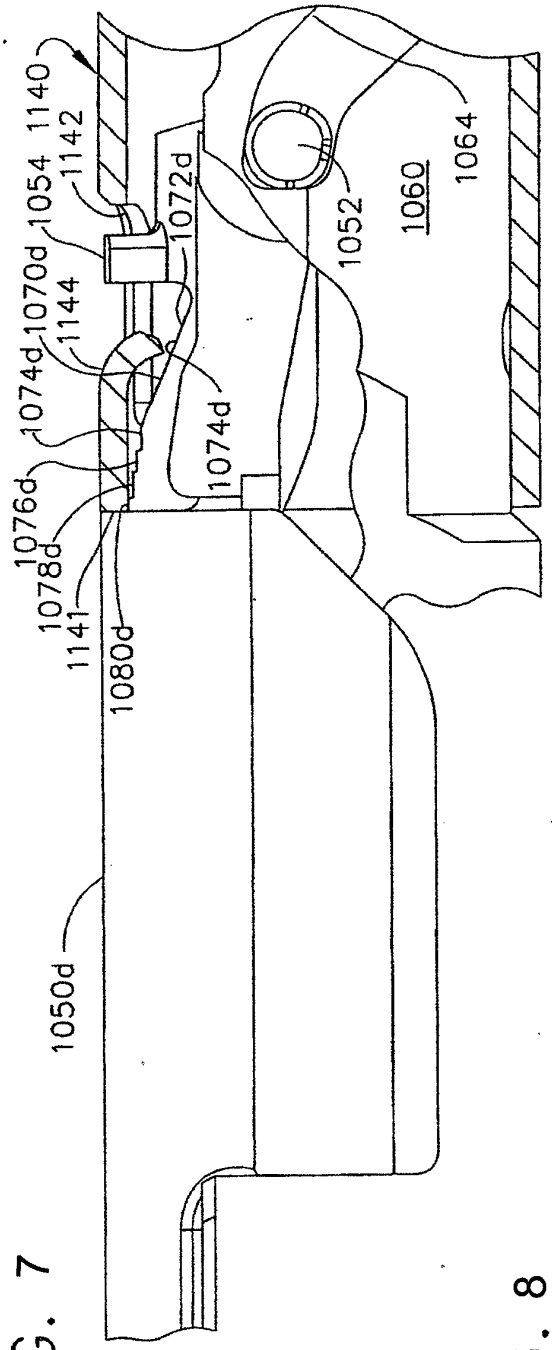
1140
1142
1054
1072d
1070d
1144
1074d
1076d
1078d
1141
1080d
1050d
1052
1060
1064

FIG. 8

REFERENCES CITED IN THE DESCRIPTION

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专利名称(译)	具有封闭装置的外科切割和缝合装置，用于限制最大组织压缩力		
公开(公告)号	EP2086424B1	公开(公告)日	2015-09-16
申请号	EP2007754179	申请日	2007-03-28
[标]申请(专利权)人(译)	伊西康内外科公司		
申请(专利权)人(译)	爱惜康内镜手术，INC.		
当前申请(专利权)人(译)	爱惜康内镜手术，INC.		
[标]发明人	SHELTON IV FREDERICK E SWAYZE JEFFREY S		
发明人	SHELTON IV, FREDERICK E. SWAYZE, JEFFREY S.		
IPC分类号	A61B17/072 A61B19/00		
CPC分类号	A61B17/064 A61B17/0644 A61B17/068 A61B17/072 A61B17/07207 A61B17/07292 A61B17/105 A61B17/11 A61B17/1114 A61B17/115 A61B17/1155 A61B17/34 A61B90/03 A61B2017/00004 A61B2017/00128 A61B2017/00539 A61B2017/00831 A61B2017/00862 A61B2017/0641 A61B2017/07228 A61B2017/07242 A61B2017/0725 A61B2017/07264 A61B2017/07271 A61B2017/07278 A61B2017/07285 A61B2017/2932 A61B2017/2943 A61B2017/320052 A61B2018/00666 A61B2019/302 A61B2019/306 A61B2019/4857 A61B2090/032 A61B2090/036 A61B2090/065 A61B2090/0811 A61B2017/07257		
优先权	11/541151 2006-09-29 US 11/529879 2006-09-29 US 11/529904 2006-09-29 US 11/529935 2006-09-29 US 11/541050 2006-09-29 US 11/541374 2006-09-29 US 11/541123 2006-09-29 US 11/541164 2006-09-29 US 11/541182 2006-09-29 US 11/541098 2006-09-29 US		
其他公开文献	EP2086424A1		
外部链接	Espacenet		

摘要(译)

用于内窥镜或腹腔镜插入手术部位以同时缝合和切断组织的手术器械包括细长通道，该细长通道构造成可操作地将钉仓支撑在其中。砧座（1050）可操作地连接到细长通道，并且可选择地在打开和关闭位置之间移动。闭合管组件（1130a）与砧座接合，以响应于施加到闭合管组件的闭合运动而选择性地向其施加闭合力。至少一个力限制构件（1212a）与闭合管组件相互作用，以限制闭合管组件施加到砧座上的闭合力的大小，以响应砧座在砧座和砧座之间夹紧组织时所经受的阻力。细长通道。力限制构件可包括闭合管组件中的一个或多个弹簧部分或闭合管组件的远端中的至少一个片簧。其他实施例可包括形成在砧座的斜坡部分中的台阶，用于接合闭合管组件的远端。

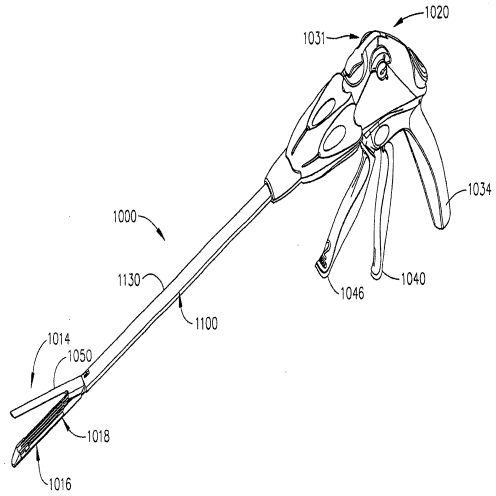

FIG. 1