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STAPLE CARTRIDGE FOR A SURGICAL INSTRUMENT

Abstract

The present disclosure provides a staple cartridge for a surgical instrument, such as a tissue sealing instrument. The staple cartridge includes a housing and one or more staple assemblies within the housing. The staple assemblies each include one or more staple pushers and associated staples. The staple pushers and housing include coupling elements configured to cooperate with each other to retain the staple assemblies to the housing prior to use in surgery. The coupling elements, along with other components of the cartridge and instrument, result in a smaller staple cartridge relative to conventional devices, allowing for a more compact and maneuverable surgical instrument.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS [0001] This application is a continuation application of U.S. application Ser. No. 18/600,702 filed 9 Mar. 2024, which is a continuation of U.S. application Ser. No. 17/603,252 filed 12 Oct. 2021-U.S. Pat. No. 11,944,302 issued 2 Apr. 2024, which is the National Stage of International Application No. PCT/US2020/020672 filed 2 Mar. 2020, which claims the benefit of U.S. Provisional Application Ser. No. 62/833,820, filed 15 Apr. 2019, the entire disclosure of which is incorporated herein by reference for all purposes.

BACKGROUND
[0002] The field of the present disclosure relates to medical instruments, and more particularly to tissue sealing instruments for use in surgeries. Even more particularly, the present disclosure relates to a surgical stapling instrument having a more compact staple cartridge for holding a staple.
[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 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 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 are being developed to increase a surgeon's

dexterity when working on an internal surgical site, as well as to 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 on each of which a surgical instrument is mounted. 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 from the instrument and arm assemblies to the associated master controllers 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. No. 7,594,912 (filed Sep. 30, 2004), U.S. Pat. No. 6,758,843 (filed Apr. 26, 2002), U.S. Pat. No. 6,246,200 (filed Aug. 3, 1999), and U.S. Pat. No. 5,800,423 (filed Jul. 20, 1995), 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. No. 6,702,805 (filed Nov. 9, 2000), U.S. Pat. No. 6,676,669 (filed Jan. 16, 2002), U.S. Pat. No. 5,855,583 (filed Nov. 22, 1996), U.S. Pat. No. 5,808,665 (filed Sep. 9, 1996), U.S. Pat. No. 5,445,166 (filed Apr. 6, 1994), and U.S. Pat. No. 5,184,601 (filed Aug. 5, 1991), the full disclosures of which are incorporated herein by reference in their entirety for all purposes.

[0010] During the 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 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.

[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 clamping and cutting devices, including known surgical staplers, have opposing jaws that clamp tissue and an articulated knife to cut the clamped tissue.
[0012] Surgical clamping and cutting instruments are often deployed into restrictive body cavities (e.g., through a cannula to inside the pelvis). Accordingly, it is desirable for the surgical clamping and cutting instrument to be both compact and maneuverable for best access to and visibility of the surgical site. Known surgical clamping and cutting instruments, however, may fail to be both compact and maneuverable. For example, known surgical staplers may lack maneuverability with respect to multiple degrees of freedom (e.g., Roll, Pitch, and Yaw) and associated desired ranges of motion.
[0013] Conventional surgical clamping and cutting instruments often include a staple cartridge designed to fit within the movable jaw of the end effector. The staple cartridge typically contains multiple rows of staple assemblies that each includes a staple and a staple pusher. The staple pusher holds the staple in place prior to use, and then drives the staple into tissue when the instrument is actuated. The requisite size and shape of the staple cartridge, however, limits the ability of the designer to reduce the size and shape of the overall surgical instrument.
[0014] One of the design features of conventional staple cartridges that limits its minimum size is that the staple pushers must be attached to the housing of the staple cartridge prior to use (i.e., during shipping, handling, etc.). At the same time, the staple pusher must be capable of forced movement relative to the staple cartridge during use to drive the staples into tissue. To meet these requirements, conventional staple cartridges often include an outer cover that extends around at least a portion of the cartridge housing to retain the staple pushers within the housing. The cover retains the staple pushers within the cartridge while allowing the requisite freedom of movement during use of the surgical instrument. One of the drawbacks with this outer cover, however, is that it adds material to the overall staple cartridge, thereby increasing the height and diameter of the cartridge and providing a downward limitation on the overall size of the cartridge and the surgical instrument.
[0015] Accordingly, while the new telesurgical systems and devices have proven highly effective and advantageous, still further improvements would be desirable. In general, it would be desirable to provide improved surgical instruments that are more compact and maneuverable to enhance the efficiency and ease of use of minimally invasive systems. More specifically, it would be beneficial to create smaller stapler cartridges that will, in turn, allow for the design of even more compact and maneuverable surgical instruments.
SUMMARY
[0016] 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 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.
[0017] The present disclosure provides a staple cartridge for a surgical instrument comprising a housing having a plurality of openings spaced from each other along the longitudinal axis of the housing. The staple cartridge further comprises one or more staple assemblies each having at least one staple pusher and a staple for driving the staple into a patient's tissue. The staple pushers each include a projection configured to cooperate with one of the openings in the housing to retain the staple assemblies to the housing. The cooperation of the staple pusher projections with the openings in the housing obviates the need for a staple cartridge cover designed to prevent the staple assemblies from disengaging from the housing before use (e.g., during shipping and handling). Eliminating this cover removes material thickness from the device, allowing for the design of taller

staples within a staple cartridge of a given size. Alternatively, this design may allow for staples with conventional heights in a more compact staple cartridge and thus a more compact and maneuverable surgical instrument.

[0018] In a preferred embodiment, the staple pusher projections comprise a retention boss having an inclined outer surface or ramp configured to extend through one of the openings of the housing. The boss is configured to retain the staple pushers within the housing. The ramp also preferably allows for forced movement of the staple pusher in only one direction relative to the housing such that, during use, a drive member of the surgical instrument can drive the staple pusher and staples substantially perpendicular to the longitudinal axis of the staple cartridge and into the patient's tissue.

[0019] In certain embodiments, the housing of the staple cartridge includes inner and outer walls sections each having a row of openings extending along the longitudinal axis of the housing. The staple cartridge further includes two rows of staple assemblies extending along the inner and outer wall sections of the housing. Each staple assembly comprises at least one staple pusher removably coupled to a staple. In certain embodiments, each stable assembly will include two or three staple pushers and their associated staples. The staple pushers have projections extending laterally therefrom that are aligned with the openings in the wall sections to thus engage the openings and retain the staple pushers to the cartridge.

[0020] In another embodiment, the housing is formed from two separate longitudinal sections coupled to each other. Each of the separate longitudinal sections comprises a row of openings for retaining the staple pushers. The longitudinal sections are preferably manufactured separately from each other to facilitate formation of the openings during, for example, an injection molding process. The longitudinal sections each include a coupling element, preferably formed on a distal portion of the sections. The respective coupling elements cooperate with each other to attach the two longitudinal sections together and form the cartridge. In an exemplary embodiment, the coupling sections including mating elements to align the sections to each other and coupling elements sized and configured to form an interference fit that locks the distal portion of the two longitudinal sections together.

[0021] In another aspect of the invention, a surgical instrument in accordance with this disclosure includes an end effector including a first fixed jaw and a second jaw. The second jaw is configured to move relative to the first jaw from an open to a closed position. The surgical instrument further comprises a staple cartridge coupled to one of the first or second jaws. The staple cartridge includes a housing having a plurality of openings spaced from each other along the longitudinal axis of the housing. The staple cartridge further comprises one or more staple assemblies each having at least one staple pusher and a staple for driving the staple into a patient's tissue. One or more of the staple pushers includes a projection configured to cooperate with one of the openings in the housing to retain the staple assemblies to the housing.

[0022] In a preferred embodiment, the surgical instrument further includes a drive member configured to translate distally and retract proximally through the end effector. The drive member has a central portion that translates through a channel in the fixed jaw. The central portion may be, for example, a cutting instrument, such as a knife, configured to cut tissue grasped between the first and second jaws when the jaws are in the closed position. The drive member further includes at least one outer portion spaced laterally from the central portion and having an inclined surface or ramp configured to engage the staple assemblies. As the drive member is translated distally, the drive member ramp forces the staple pushers and staples in a perpendicular direction to the longitudinal axis of the housing to drive the staples into tissue. In a particularly preferred embodiment, the central portion and the ramp are integrated into one single drive member that translates through channels formed in the staple cartridge.

[0023] In another aspect of the invention, the surgical instrument further includes an actuation mechanism in contact with the central portion of the drive member. The actuation mechanism is

configured to advance the drive member distally through the end effector and to retract the drive member proximally through the end effector. In an exemplary embodiment, the actuator includes a control device of a robotic telesurgical system that may, for example, allow for mechanical actuation and control of the surgical instrument to perform a variety of functions, such as grasping a blood vessel, dissecting tissue, or the like, in response to manipulation of master input devices located remotely from the surgical instrument.
[0024] In yet another aspect of the invention, a surgical instrument in accordance with this disclosure includes an end effector including a first fixed jaw and a second jaw. The second jaw is configured to move relative to the first jaw from an open to a closed position. The surgical instrument further comprises a staple cartridge coupled to one of the first or second jaws and a drive member configured to translate distally and retract proximally through the end effector. The staple cartridge comprises one or more staple assemblies each having at least one staple pusher removably coupled to a staple. The staple pusher comprises a coupling element configured to retain the staple pusher to the housing, while allowing the drive member to force the staple pusher to move relative to the housing in a direction substantially perpendicular to the longitudinal axis.
[0025] In another embodiment, a staple cartridge for a surgical instrument comprises first and second elongated sections each having one or more compartments sized for receiving a staple assembly and a wall extending substantially along a longitudinal axis. The elongated sections each further comprise a plurality of openings spaced from each other along the wall of each section and substantially aligned with the compartments. One or more coupling elements attach the elongated sections together to form the staple cartridge. Preferably, the sections are coupled together such that a first row of the openings resides on the outer section of the cartridge and a second row of the openings resides within the cartridge. This device, in particular, facilitates the formation of the second, inner, row of openings in a standard molding process (e.g., injection molding). After formation, the elongated sections are preferably coupled at their distal ends with one or more coupling elements that create an interference fit, such as a tapered dovetail, snap-fit, press-fit pin or the like.
[0026] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the disclosure. Additional features of the disclosure will be set forth in part in the description which follows or may be learned by practice of the disclosure.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0027] The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate several embodiments of the disclosure and together with the description serve to explain the principles of the disclosure.
[0028] FIG. **1** illustrates a perspective view of an illustrative surgical instrument having an end effector mounted to an elongated shaft;
[0029] FIG. **1**A is a perspective top view of the distal end portion of an illustrative surgical instrument with the jaws in the open position;
[0030] FIG. **1**B is a bottom perspective view with parts separated of a representative staple cartridge for an illustrative surgical instrument;
[0031] FIG. **1**C shows an enlarged view of the cooperative relationship between a portion of a drive member and a plurality of staple pushers and staples which form part of the staple cartridge of FIG. **1**B;
[0032] FIG. **1**D is a perspective bottom view of the distal end portion of the surgical instrument of FIG. **1**A;

[0033] FIG. **2** is a perspective bottom view of a staple cartridge according to certain embodiments of the present disclosure;

[0034] FIG. **3** is a perspective side view of a staple pusher according to certain embodiments of the present disclosure;

[0035] FIG. **4** is a semi-transparent view of one portion of a staple cartridge according to certain embodiments of the present disclosure;

[0036] FIG. **5**A is a perspective top view of two sections of a staple cartridge according to an embodiment of the present disclosure;

[0037] FIG. **5**B is a perspective view of a distal end portion of a staple cartridge according to an embodiment of the present disclosure;

[0038] FIG. **5**C is a perspective view of a distal end portion of a staple cartridge according to another embodiment of the present disclosure;

[0039] FIG. **6** is a perspective view of the distal end portion of an illustrative surgical instrument with parts removed;

[0040] FIG. **7**A is a front view of a drive member for the illustrative surgical instrument of FIG. **1**;

[0041] FIG. **7**B is a side view of the drive member of FIG. **7**A;

[0042] FIG. **8**A is a partial cross-sectional perspective view of the actuation mechanism for a drive member in accordance with the surgical instrument of FIG. **1**;

[0043] FIG. **8**B is a partial cross-sectional side view of the actuation mechanism for a drive member in accordance with the surgical instrument of FIG. **1**;

[0044] FIG. **9** is a cross-sectional side view of one portion of the illustrative surgical instrument of FIG. **1**;

[0045] FIG. **10** is a transverse cross-sectional view of a staple cartridge and drive member according to an embodiment of the present disclosure;

[0046] FIG. **11** illustrates a top view of an operating room employing a robotic surgical system utilizing aspects of the present invention; and

[0047] FIG. **12** illustrates a simplified side view of a robotic arm assembly that is usable with various aspects of the present invention.

DETAILED DESCRIPTION

[0048] This description and the accompanying drawings illustrate exemplary embodiments and should not be taken as limiting, with the claims defining the scope of the present disclosure, including equivalents. Various mechanical, compositional, structural, and operational changes may be made without departing from the scope of this description and the claims, including equivalents. In some instances, well-known structures and techniques have not been shown or described in detail so as not to obscure the disclosure. Like numbers in two or more figures represent the same or similar elements. Furthermore, elements and their associated aspects that are described in detail with reference to one embodiment may, whenever practical, be included in other embodiments in which they are not specifically shown or described. For example, if an element is described in detail with reference to one embodiment and is not described with reference to a second embodiment, the element may nevertheless be claimed as included in the second embodiment. Moreover, the depictions herein are for illustrative purposes only and do not necessarily reflect the actual shape, size, or dimensions of the system or illustrated components.

[0049] It is noted that, as used in this specification and the appended claims, the singular forms “a,” “an,” and “the,” and any singular use of any word, include plural referents unless expressly and unequivocally limited to one referent. As used herein, the term “include” and its grammatical variants are intended to be non-limiting, such that recitation of items in a list is not to the exclusion of other like items that can be substituted or added to the listed items.

[0050] While the following disclosure is presented with respect to a linear surgical stapler where staples are sequentially fired, it should be understood that the features of the presently described surgical instruments may be readily adapted for use in any type of surgical clamping, cutting, or sealing instruments, whether or not the surgical clamping and cutting instrument applies a fastener. For example, the presently described drive member and actuation mechanism may be employed in an electrosurgical instrument wherein the jaws include electrodes for applying energy to tissue to treat (e.g., cauterize, ablate, fuse, or cut) the tissue. The surgical clamping and cutting instrument may be a minimally invasive (e.g., laparoscopic) instrument or an instrument used for open surgery.

[0051] 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.

[0052] FIG. **1** is a perspective view of an illustrative surgical instrument **100** in accordance with certain 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 first jaw **111** and a second jaw **112**. Handle assembly **102** includes a stationary handle **102***a* and a moveable handle **102***b*, which serves as an actuator for surgical instrument **100**.

[0053] 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. 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. Further details of known input couplers and surgical systems are described, for example, in U.S. Pat. Nos. 8,597,280, 7,048,745, and 10,016,244. Each of these patents is hereby incorporated by reference in its entirety.

[0054] 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. Nos. 7,666,191 and 9,050,119 both of which are hereby incorporated by reference in their entireties. 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.

[0055] FIG. **1**A illustrates the distal end portion of surgical instrument **100**, including an end effector **110** having first and second jaws **111**, **112**, a clevis **140** for mounting jaws **111**, **112** to the instrument, and an articulation mechanism, such as a wrist **160**. First jaw **111** includes an anvil **115** having staple-forming pockets **116** (see FIG. **1**D). In certain embodiments, second jaw **112** is a movable jaw configured to move from an open position to a closed position relative to first jaw **111**. In other embodiments, first jaw **111** is a movable jaw configured to move between open and closed positions relative to second jaw **112**. In still other embodiments, both jaws **111**, **112** are movable relative to each other. In the open position, a fresh stapling cartridge **122** (sometimes referred to as a reload and shown more clearly in FIG. **1**B) can be loaded into movable jaw **112** and tissue may be positioned between the jaws **111**, **112**. In the closed position, jaws **111**, **112** cooperate to clamp tissue such that cartridge **122** and the anvil **115** are in close cooperative alignment.

[0056] Referring now to FIGS. **1**B and **1**C, a representative staple cartridge **122** may include a plurality of staples assemblies, each comprising one or more staples **124** supported on corresponding staple drivers or pushers **126** provided within respective staple apertures **127** formed in cartridge **122**. In certain embodiments, staple pusher(s) **126** include one or more supporting elements extending above their top surface for providing support to staples **124** when they are resting thereon. Of course, other suitable geometric designs of staple pusher **126** may be used to receive and hold staple **124** in accordance with the present invention. For example, pusher **126** may have a recess (not shown) for receiving staple **124**, as is described in commonly-assigned, co-pending provisional patent application Ser. No. 62/855,371, filed May 31, 2019. Alternatively, pusher **126** may have a flatter upper surface (i.e., without a recess or pocket) that allows the backspan of staple **124** to rest thereon, as is described in commonly-assigned, co-pending provisional patent application Ser. No. 62,783,460, the complete disclosures of both of these applications are hereby incorporated by reference in their entirety for all purposes.
[0057] In certain embodiments, cartridge **122** also may include a shuttle **123** having an inclined distal surface **125** that, upon distal movement, sequentially acts on staple pushers **126**, camming them upwardly, thereby moving staples **124** into deforming contact with anvil **115** (See FIG. **1**D). Shuttle **123** may be part of a drive member **150** (FIGS. **7**A and **7**B) described in more detail below. Cartridge **122** may be removably received within movable jaw **112** or, in single use embodiments, may be manufactured as part of movable jaw **112**.
[0058] FIG. **3** illustrates a preferred embodiment of a staple pusher **126** according to the present invention. As shown, pusher **126** has a projection or retention boss **230** extending laterally outward from pusher **126**. Boss **230** preferably has an inclined outer surface **232**, the purpose of which will be more fully described below. Pusher **126** further includes a recess or pocket **240** in the top surface of pusher **126** for receiving and holding at least the backspan of a staple **124** (shown in FIGS. **1**B and **1**C) such that the two legs of staple extend substantially vertically upwards from pusher **126**. It will be recognized by those skilled in the art that other suitable geometric designs of staple pusher **126** may be used to receive and hold staple **124**. For example, pusher **126** may have a flatter upper surface (i.e., without a recess or pocket) that allows the backspan of staple **124** to rest thereon, as is described in commonly-assigned, co-pending provisional patent application No. 62,783,460, the complete disclosure of which is hereby incorporated by reference in its entirety for all purposes.
[0059] Referring now to FIG. **2**, a preferred embodiment of staple cartridge **122** will now be described. As shown, cartridge **122** includes a housing **202** extending substantially along a longitudinal axis **204** and including a plurality of compartments **206** that form pockets within the housing to receive the staple assemblies. The staple assemblies each include at least one (preferably 2-4) staple pushers **126** removably coupled to at least one (preferably 2-4) staples **124**. The staple assemblies are preferably arranged within compartments **206** such that staple pusher **126** is situated near a bottom surface of housing **202** and staples **124** have their legs facing a top surface of housing **202**. For ease of reference, the top surface of housing faces fixed jaw **111** (see FIG. **1**). As discussed above, the entire staple cartridge **122** can be loaded into, or permanently affixed to, movable jaw **112** for use in surgery as described in more detail below.
[0060] In most conventional staple cartridge designs, the cartridge **122** would also include a sheet metal cover (not shown) surrounding at least a portion of cartridge **122**. The cover serves to prevent the staple assemblies from falling out of cartridge **122** prior to use in surgery, e.g., during shipping, handling, etc. The cover, however, adds material thickness to the vertical height and horizontal width of the cartridge. In the present invention, cartridge **122** does not include this cover and, therefore, may be designed with taller staples and/or a smaller overall profile (e.g., diameter) than conventional staple cartridges. In an exemplary embodiment, staple cartridge **122** of the present invention preferably has a diameter less than 12 mm, more preferably about 8 mm. This smaller diameter cartridge allows for the design of a smaller and more compact surgical instrument, which provides the surgeon with more maneuverability during a surgical procedure. In addition, the

smaller and more compact surgical instrument is less likely to contact and possibly damage collateral tissue in the surgical arena.

[0061] In one embodiment of the present invention, housing **202** of staple cartridge **122** includes a plurality of openings **214** spaced from each other and extending substantially in the direction of longitudinal axis **204**. As shown more clearly in FIG. **2**, each opening **214** is aligned with one of the staple pushers **126** such that retention boss **230** cooperates with and protrudes through opening **214** (see FIG. **4**). Retention boss **230** and opening **214** are sized and configured such that pusher **126** is retained to housing **206** when boss **230** extends through opening **214**. During use (described more fully below), inclined outer surface **232** of boss **230** allows pusher **126** to be driven vertically upwards (relative to FIG. **4**) by camming surface **232** along the edge of opening **214** as pusher **126** moves upward. Thus, retention boss **230** substantially inhibits movement of pusher **126** relative to housing **206**, while allowing for the forced or driven movement (see below) of pusher **126** in one direction only.

[0062] The present invention allows the staple assemblies to be retained to housing **202** of staple cartridge **122** without the presence of a conventional sheet metal cover. However, it should be noted that the present invention is not limited to the embodiment described herein and other coupling mechanisms may be used to retain the staple assemblies to the cartridge prior to use. For example, staple pusher **126** and housing **206** may include other cooperating or coupling elements that retain pusher **126** to housing **206** while still allowing it to be driven in one direction by drive member **150**, such as interference fits, snap-fit features, press-fit connectors, camming surfaces with various geometries and the like.

[0063] As shown in FIG. **2**, cartridge **122** preferably includes two rows of staple assemblies extending along longitudinal axis **204**. As such, cartridge **122** includes an inner row of openings **216** in an inner wall **220** and an outer row of openings **218** in an outer wall **222** aligned with the respective compartments **206** for staple assemblies **208**. To facilitate manufacture of this design (particularly inner row of openings **216**), cartridge **122** is formed from two longitudinally shaped sections **224**, **226** (shown in FIG. **5**A). Sections **224**, **226** preferably represent two halves of the overall staple cartridge **122**. However, it will be recognized that one of the sections may be larger than the other so long as each section contains one row of openings therein.

[0064] Referring now to FIGS. **5**B and **5**C, the distal portions of sections **224**, **226** of cartridge **122** are coupled to each other with coupling elements that hold the two halves of the cartridge together. FIGS. **5**B and **5**C illustrate preferred embodiments of the coupling elements. As shown in FIG. **5**B, section **224** includes male members **240** having a tapered dovetail shape. Section **226** includes the corresponding female members **242** of the tapered dovetail shape. As shown in FIG. **5**C, sections **224**, **226** may include one or more snap features **244** in addition to, or as an alternative to, male and female members **240**, **242**. In the preferred embodiment, cartridge **122** will include both features of FIGS. **5**B and **5**C. In this embodiment, male and female dovetail members **240**, **242** fit together to align sections **224**, **226** and snap features **244** form a press fit that locks the distal portions of sections **224**, **226** together. It should be noted that the present invention is not limited to the coupling elements shown in FIGS. **5**B and **5**C. For example, other coupled elements may be used with the present invention, such as press-fit connectors, such as solid or compliant press-fit pins and receptacles and other geometries of snap-fit features, such as annular cantilever, torsional, L-shaped, U-shaped and the like.

[0065] In certain embodiments, jaws **111**, **112** are attached to surgical instrument **100** via a suitable coupling device, such as a clevis **140**. Clevis **140** includes upper and lower portions that cooperate when assembled to form a protrusion **145** configured to engage tabs **113** (see FIG. **1**A) of jaw **111** to securely mount jaw **111** in a fixed position on instrument **100**. Clevis **140** further includes an opening for receiving a pivot pin **130** defining a pivot axis around which jaw **112** pivots as described in more detail below. A more complete description of a suitable clevis **140** for use with the present invention may be found in commonly-assigned, co-pending provisional patent application Nos. 62/783,444, filed Dec. 21, 2018; 62/783,481, filed Dec. 21, 2018; 62/783,460, filed Dec. 21, 2018; 62/747,912, filed Oct. 19, 2018; and 62/783,429, filed Dec. 21, 2018, the complete disclosures of which are hereby incorporated by reference in their entirety for all purposes. Of course, it will be recognized by those skilled in the art that other coupling mechanisms known by those skilled in the art may be used with the present invention to attach the jaws **11**, **112** to the proximal portion of surgical instrument **100**.

[0066] Referring now to FIG. **6**, end effector **110** may be articulated in multiple directions by an articulation mechanism. In certain embodiments, the articulation mechanism may be a wrist **160** as shown, although other articulation mechanisms are contemplated. As seen in FIG. **6**, a preferred embodiment of wrist **160** includes a plurality of articulation joints **162**, **164**, **166**, etc. that define a bore **167** through which an actuation mechanism (in certain embodiments, coil **120** and drive cable **171**, see FIG. **8**A) may pass. Upon exiting articulation wrist **160**, coil **120** enters and passes through an internal channel (not shown) of clevis **140**, ultimately engaging a proximal surface of upper shoe **152** of drive member **150** (see FIG. **8**A). Other articulation mechanisms known by those skilled in the art may substitute for wrist **160**. Other exemplary articulating mechanisms are shown for example in commonly-assigned, co-pending U.S. Publication. No. 2015/0250530 and International Application No. PCT/US19/62344, filed Nov. 20, 2019 the entire disclosures of which are hereby incorporated by reference in their entirety for all purposes.

[0067] As seen in FIGS. **7**A and **7**B, a preferred embodiment of drive member **150** may include a body, upper shoe **152**, lower shoe **154**, central portion **156** and lateral portions **159**. Lateral portions **159** are the fins that form shuttle **123** shown earlier. Lateral portions **159** of drive member **150** each comprise distal inclined surfaces or ramps **161** that engage with pushers **126** to drive pushers **126** (and the associated staples **124**) vertically or perpendicular to longitudinal axis **204** when drive member **150** is translated distally. In a preferred embodiment, shuttle fins **159** are integrated into lower shoe **154** of drive member **150**. In conventional designs, this is typically not possible because of the outer sheet metal cover used to retain staple assemblies **208** within housing **202** of staple cartridge **122**. Integrating shuttle fins **159** into drive member **150** provides more flexibility in the design of staple cartridge **122**. For example, this may allow for a reduction in the size of staple cartridge **122** and surgical instrument **100** and/or increasing the length of staples **124** for a given size of surgical instrument **100**.

[0068] As shown in FIGS. **8**A and **8**B, actuation assembly **190** includes a drive cable **171**, a coil **120**, a sheath **121** surrounding coil **120**, and a drive rod **175**. Drive cable **171** includes an enlarged distal end **173**. Upper shoe **152** of drive member **150** includes a bore **158** into which drive cables **171** are routed. When assembling illustrative surgical instrument **100**, coil **120** and protective sheath **121** are slipped over the free end of drive cable **171**. The free end of drive cable **171** is attached to drive rod **175** securing coil **120** and the protective sheath **121** between drive member **150** and drive rod **175** as best seen in FIG. **7**B). Sheath **121** may function to promote stability, smooth movement, and prevent buckling upon actuation of surgical instrument **100**. Sheath **121** may be made from polyimide, or any other suitable material having the requisite strength requirements such as various reinforced plastics, a nickel titanium alloy such as NITINOL™, poly para-phenyleneterphtalamide materials such as KEVLAR™ commercially available from DuPont. Those of skill in the art may envision other suitable materials.

[0069] Enlarged distal end **173** of drive cable **171** resides within an enlarged distal portion **159** of bore **158** in upper shoe **152** of drive member **150**, such that a proximal face **157** of enlarged distal end **173** may apply a retraction force on upper shoe **152** when the drive cable **171** is pulled proximally, i.e., in the direction of arrow "B" in FIG. **8**B. Drive rod **175** is operationally connected to an actuator (e.g., movable handle **102***b*), which allows distal translation and proximal retraction of actuation assembly **190**. Those skilled in the art will recognize that in a manually actuated instrument, the actuator may be a movable handle, such as moveable handle **102***b* shown in FIG. **1**; in a powered instrument the actuator may be a button (not shown) that causes a motor to act on the drive rod; and in a robotic system, the actuator may be a control device such as the control devices described below in connection with FIG. **12**. Any suitable backend actuation mechanism for driving the components of the surgical stapling instrument may be used. For additional details relating to exemplary actuation mechanisms using push/pull drive cables see, e.g., commonly assigned, co-pending International Application WO 2018/049217, the disclosure of which is hereby incorporated by reference in its entirety.

[0070] Referring now to FIG. **10**, upper shoe **152** of drive member **150** is substantially aligned with and translates through a channel **118** in fixed jaw **111**, while lower shoe **154** of drive member **150** is substantially aligned with and translates through a channel **119** and below jaw **112**. As shown in FIGS. **8**A and **8**B, bore **158** is formed through upper shoe **152** to receive drive cable **171** as will be described in more detail below. Proximal surface **153** of upper shoe **152** is configured to be engaged by a coil **120** of actuation assembly **190** such that coil **120** may apply force to upper shoe **152** to advance drive member **150** distally, i.e., in the direction of arrow “A” in FIG. **8**B. A knife **128** may be formed on drive member **150** along the distal edge between upper shoe **152** and central portion **156**.

[0071] During actuation of illustrative surgical instrument **100**, drive rod **175** applies force to coil **120**, thereby causing coil **120** to apply force to upper shoe **152** of drive member **150**, translating it distally (i.e., in the direction of arrow “A” in FIG. **7**B) initially closing jaws **111**,**112** and then ejecting staples **124** from cartridge **122** to staple tissue. After stapling is complete, drive rod **175** applies a force in the proximal direction to effect retraction of drive member. During retraction, enlarged distal end **173** of drive cable **171** is obstructed by wall **157** of enlarged portion **159** of bore **158**, causing drive cable **171** to apply force to upper shoe **152** of drive member **150**, thereby translating drive member **150** in the proximal direction. In certain embodiments, the surgical instrument may be designed such that the drive member **150** is not retracted in the proximal direction after the staples have been fired. One of ordinary skill in the art will appreciate that drive member **150**, drive cable **171**, and drive rod **175** all move in unison and remain in the same relative position to each other.

[0072] In use, in the open configuration, drive member **150** is positioned proximally of cam surface **114** formed on movable jaw **112**. As drive member **150** translates in the distal direction, movable jaw **112** will rotate towards the closed position around pivot **117**. Once drive member **150** has come into contact with cam surface **114** of movable jaw **112**, lower portion **154** of drive member **150** rides underneath cam surface **114**, drive member **150** pushes movable jaw **112**, causing it to pivot towards the closed position. In the closed position. drive member **150** has translated distally past cam surface **114**. In this position, tissue is clamped, and further advancement of the drive member will sever and staple tissue. Of course, it will be recognized by those skilled in the art that drive member **150** may be any structure capable of pushing at least one of a shuttle or a knife of a surgical stapling instrument with the necessary force to effectively sever or staple human tissue. Drive member **150** may be an I-beam, an E-beam, or any other type of drive member capable of performing similar functions. Drive member **150** is movably supported on the surgical stapling instrument **100** such that it may pass distally through a staple cartridge and upper fixed jaw **111** and lower jaw **112** when the surgical stapling instrument is fired (e.g., actuated).

[0073] FIG. **11** 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 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”).

[0074] The Console includes a monitor **304** for displaying an image of a 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 positioned next to it.

[0075] 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 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**.

[0076] Each of the tools **338** and **339**, as well as the endoscope **340**, may 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**.

[0077] 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 longer being used from its robotic arm, and replace it with another tool **331** from a Tray (“T”) in the operating room.

[0078] 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, images of the tools **338** and **339** may appear to be located substantially where the Surgeon's hands are located.

[0079] 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 **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.

[0080] 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. For additional details on robotic surgical systems, see, e.g., commonly owned U.S. Pat. No. 6,493,608 “Aspects of a Control System of a Minimally Invasive Surgical Apparatus,” and commonly owned U.S. Pat. No. 6,671,581 “Camera Referenced Control in a Minimally Invasive Surgical Apparatus,” which are hereby incorporated herein by reference in their entirety for all purposes.

[0081] FIG. **12** 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**.

[0082] 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**. 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 invention. 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.

[0083] 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**.

[0084] 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. A more complete description of illustrative robotic surgical systems for use with the present invention can be found in commonly-assigned U.S. Pat. Nos. 9,295,524, 9,339,344, 9,358,074, and 9,452,019, the complete disclosures of which are hereby incorporated by reference in their entirety for all purposes.

[0085] Hereby, all issued patents, published patent applications, and non-patent publications that are mentioned in this specification are herein incorporated by reference in their entirety for all purposes, to the same extent as if each individual issued patent, published patent application, or non-patent publication were specifically and individually indicated to be incorporated by reference.

[0086] While several embodiments of the disclosure 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 the scope of the embodiments should be determined by the appended claims and their legal equivalents, rather than by the examples given.

[0087] 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 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 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.

[0088] Other embodiments will be apparent to those skilled in the art from consideration of the specification and practice of the embodiment disclosed herein. It is intended that the specification and examples be considered as exemplary only, with a true scope and spirit of the embodiment being indicated by the following claims.

Claims

1. A surgical instrument comprising: an end effector comprising first and second jaws; a staple cartridge coupled to one of the first or second jaws, the staple cartridge comprising a housing having a longitudinal axis, a channel and a staple assembly comprising a staple pusher and a staple; and a drive member configured to translate distally through the end effector, the drive member comprising a central portion for translating through the channel and first and second outer portions each having an inclined surface for engaging the staple pusher upon distal translation of the drive member through the end effector, the drive member further comprising a lower portion configured to translate through the end effector exterior to the staple cartridge.

2. The surgical instrument of claim 1, wherein the first and second outer portions and the central portion are integrally formed as a single component.

3. The surgical instrument of claim 1, wherein the staple cartridge is coupled to the second jaw, wherein the second jaw has an inner surface facing the first jaw, wherein the lower portion of the drive member translates between the inner surface of the second jaw and staple cartridge.

4. The surgical instrument of claim 3, wherein the staple cartridge has an opening between the staple pusher and the inner surface of the second jaw.

5. The surgical instrument of claim 1, wherein the staple cartridge is devoid of an outer cover.

6. The surgical instrument of claim 1, wherein the housing comprises first and second longitudinal sections coupled to each other, wherein the first and second longitudinal sections cooperate to form the channel for receiving the central portion of the drive member.

7. The surgical instrument of claim 6, wherein each of the first and second longitudinal sections comprise a wall and a row of openings in the wall extending longitudinally along each section.

8. The surgical instrument of claim 7, wherein the first and second longitudinal sections each comprise a coupling member and wherein the coupling members of each of the first and second longitudinal sections are configured to cooperate with each other to form an interference fit that couples the first and second longitudinal sections to each other.

9. The surgical instrument of claim 1, wherein the cartridge comprises a sidewall with an opening and the staple pusher has a projection with an outer surface extending laterally outward through the opening in the housing.

10. A surgical instrument comprising: an end effector comprising first and second jaws, the second jaw having a cavity with an inner surface; a staple cartridge configured for positioning within the cavity of the second jaw, the staple cartridge comprising a housing having a longitudinal axis, a channel and a staple assembly comprising a staple pusher and a staple; a drive member configured to translate distally through the end effector, the drive member comprising a central portion for translating through the channel and a lower portion that translates through the cavity of the second jaw between the inner surface and the staple cartridge.

11. The surgical instrument of claim 10, wherein the staple cartridge has an opening between the staple pusher and the inner surface of the second jaw.

12. The surgical instrument of claim 10, wherein the staple cartridge is devoid of an outer cover.

13. The surgical instrument of claim, 10, wherein the drive member comprises first and second outer portions each having an inclined surface for engaging the staple pusher upon distal translation of the drive member through the end effector.

14. The surgical instrument of claim 10, wherein the cartridge comprises a sidewall with an opening and the staple pusher has a projection with an outer surface extending laterally outward through the opening in the housing.

15. A robotic control system comprising: a surgical instrument comprising an end effector comprising first and second jaws, a drive member configured to translate distally through the end effector and a staple cartridge coupled to one of the first or second jaws, the staple cartridge comprising: a housing comprising a longitudinal axis and a sidewall with an opening; and a staple assembly comprising a staple pusher and a staple, wherein the staple pusher has a projection with an outer inclined surface extending laterally outward through the opening in the housing; and an actuation mechanism in contact with the drive member and configured to translate the drive member distally through the end effector.

16. The robotic control system of claim 15, further comprising a robotic arm assembly coupled to the actuation mechanism and a control device coupled to the robotic arm assembly for remotely controlling the actuation mechanism.

17. The robotic control system of claim 15, wherein the drive member comprises a central portion for translating through the channel and first and second outer portions each having an inclined surface for engaging the staple pusher upon distal translation of the drive member through the end effector.

18. The robotic control system of claim 17, wherein the first and second outer portions and the central portion are integrally formed as a single component.

19. The robotic control system of claim 15, wherein the staple cartridge is configured for positioning with a cavity the second jaw, wherein the cavity has an inner surface facing the first jaw, wherein the drive member comprises a lower portion configured to translate between the inner surface of the second jaw and the staple cartridge.

20. The robotic control system of claim 15, wherein the outer inclined surface tapers inward in a direction transverse to the longitudinal axis and is configured to slide along an edge of the opening when the drive member is advanced distally through the end effector.