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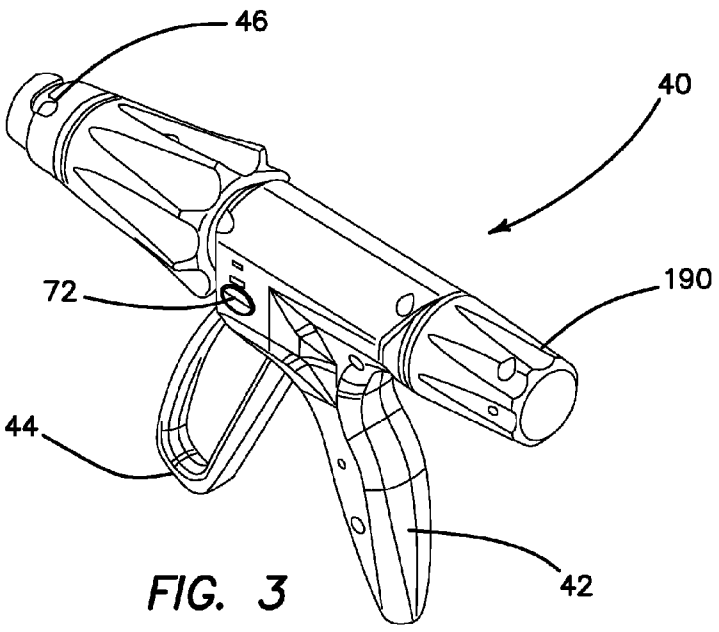


FIG. 3

(57) Abstract: A handle assembly for a surgical stapler can comprise a rotatable actuation shaft. The actuation shaft can have a first rotational orientation in which it can actuate a jaw assembly in a repeatable open and close mode, a second rotational orientation in which it can actuate a jaw assembly in a staple firing mode, and a third rotational orientation in which it can actuate a jaw assembly in a reversing mode. The handle assembly can include an articulation mechanism including a ball screw to selectively articulate the jaw assembly relative to an elongate shaft.

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SURGICAL STAPLER HAVING ARTICULATION MECHANISM

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of U.S. Provisional Patent Application Serial No. 62/321,643, entitled "SURGICAL STAPLER HAVING ARTICULATION MECHANISM," filed April 12, 2016, currently pending. The above-referenced application is incorporated by reference herein in its entirety.

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0002] The present application relates generally to surgical occlusion instruments and, more particularly, to surgical staplers.

DESCRIPTION OF THE RELATED ART

[0003] Surgical staplers are used to approximate or clamp tissue and to staple the clamped tissue together. As such, surgical staplers have mechanisms to ensure that tissue is properly positioned and captured and to drive staples through the tissue. As a result, this has produced, for example, multiple triggers and handles in conjunction with complex mechanisms to provide proper stapling of the clamped tissue. With these complex mechanisms, surgical staplers can have increased manufacturing burdens, as well as potential sources for device failure and confusion for the user. Thus, reliable stapling of clamped tissue without complex mechanisms is desired.

SUMMARY OF THE INVENTION

[0004] In certain embodiments, a surgical stapler is provided herein. The surgical stapler comprises an elongate shaft, a jaw assembly, and a handle assembly. The elongate shaft has a proximal end and a distal end. The elongate shaft defines a longitudinal axis between the proximal end and the distal end. The jaw assembly is positioned at the distal end of the elongate shaft. The jaw assembly comprises a first jaw, a second jaw, and a plurality of staples. The jaw assembly is selectively positionable in one of a closed configuration, an open configuration, and a firing configuration. The handle assembly is positioned at the proximal end of the elongate shaft. The handle assembly comprises a stationary handle, a movable trigger pivotably coupled to the stationary handle, and an actuation shaft. The actuation shaft is longitudinally slideable within the handle assembly with respect to the longitudinal axis of the actuation shaft and rotatable within the handle assembly with respect to the longitudinal axis.

[0005] In certain embodiments, the handle assembly further comprises an articulation mechanism. The articulation mechanism comprises a ball screw having a thread formed therein. The articulation mechanism further comprises at least one ball bearing engageable with the thread. The articulation mechanism comprises a linkage coupled to an articulation adapter. In operation, rotation of the ball screw can translate the articulation adapter. In some embodiments, the articulation mechanism can comprise a release mechanism. The release mechanism can disengage the ball

bearings from the ball screw and be biased to return the articulation mechanism to a longitudinally centered position. The articulation adapter can be coupled to an articulation member in the shaft to selectively articulate the jaw assembly relative to the longitudinal axis of the elongate shaft.

[0006] In certain embodiments, a handle assembly for a surgical stapler is provided. The handle assembly comprises a handle body, an actuation shaft, and an articulation mechanism. The handle body comprises a stationary handle and a movable handle pivotably coupled to the handle body. The actuation shaft is mechanically coupled to the movable handle for manual actuation thereof. The actuation shaft is slidable within the handle body along a longitudinal axis. The articulation mechanism comprises a manually actuated articulation knob and an articulation adapter. The manually actuated articulation knob is positioned at a proximal end of the handle body and rotatable about the longitudinal axis. The articulation adapter is positioned at the distal end of the handle body. The articulation adapter is operatively coupled to the articulation knob such that rotation of the articulation knob about the longitudinal axis longitudinally slides the articulation adapter.

[0007] In certain embodiments, a handle assembly for a surgical stapler is provided. The handle assembly comprises a handle body, an actuation shaft, and an articulation mechanism. The handle body comprises a stationary handle and a movable handle pivotably coupled to the handle body. The actuation shaft is mechanically coupled to the movable handle for manual actuation thereof. The actuation shaft is slidable within the handle body along a longitudinal axis. The articulation mechanism

comprises a manually actuated articulation knob and a ball screw. The manually actuated articulation knob is positioned at a proximal end of the handle body. The manually actuated articulation knob is rotatable about the longitudinal axis. The ball screw is operatively coupled to the articulation knob and longitudinally movable by rotation of the articulation knob.

[0008] In certain embodiments, a handle assembly for a surgical stapler is provided. The handle assembly comprises a handle body, an actuation mechanism, and an articulation mechanism. The handle body comprises a stationary handle and a movable handle pivotably coupled to the handle body. The handle body has a proximal end and a distal end and defines a central longitudinal axis between the proximal end and the distal end. The actuation mechanism is positioned within the handle body. The articulation mechanism comprises a manually actuated articulation knob, an articulation adapter, and a first articulation link. The manually actuated articulation knob is positioned at a proximal end of the handle body and rotatable about the longitudinal axis. The articulation adapter is positioned at the distal end of the handle body. The articulation adapter is operatively coupled to the articulation knob such that rotation of the articulation knob about the longitudinal axis longitudinally slides the articulation adapter. The first articulation link operatively couples the actuation knob to the articulation adaptor. The first articulation link extends longitudinally within the handle body laterally offset from the actuation mechanism.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Figure 1 is a perspective view of an embodiment of surgical stapling device with the jaws in an open configuration;

[0010] Figure 2 is a perspective view of an embodiment of a reload shaft for the surgical stapling device of Figure 1 with the jaws in a closed configuration;

[0011] Figure 3 is a perspective view of an embodiment of handle assembly having an articulation mechanism for a surgical stapling device;

[0012] Figure 4 is a perspective view of the handle assembly of Figure 3 with a movable handle in a closed configuration;

[0013] Figure 5 is a top view of the handle assembly of Figure 3 with a selector in a first configuration;

[0014] Figure 6 is a top view of the handle assembly of Figure 3 with a selector in a second configuration;

[0015] Figure 7A is a side view of the handle assembly of Figure 3;

[0016] Figure 7B is a cross-sectional side view of the handle assembly of Figure 3;

[0017] Figure 8A is a cross-sectional side view of the handle assembly of Figure 1 in an initial configuration;

[0018] Figure 8B is a cross-sectional perspective view of the handle assembly of Figure 8A;

[0019] Figure 9A is a cross-sectional side view of the handle assembly of Figure 1 actuated to a closed configuration;

[0020] Figure 9B is a cross-sectional perspective view of the handle assembly of Figure 9A;

[0021] Figure 10A is a cross-sectional side view of the handle assembly of Figure 1 in a forward drive configuration;

[0022] Figure 10B is a cross-sectional perspective view of the handle assembly of Figure 10A;

[0023] Figure 11A is a cross-sectional side view of the handle assembly of Figure 1 in the forward drive configuration;

[0024] Figure 11B is a cross-sectional perspective view of the handle assembly of Figure 11A;

[0025] Figure 12A is a cross-sectional side view of handle assembly of Figure 1 in a fully driven forward configuration;

[0026] Figure 12B is a cross-sectional perspective view of the handle assembly of Figure 12A;

[0027] Figure 13A is a cross-sectional side view of the handle assembly of Figure 1 in a reverse drive configuration;

[0028] Figure 13B is a cross-sectional perspective view of the handle assembly of Figure 13A;

[0029] Figure 14A is a cross-sectional side view of the handle assembly of Figure 1 in a fully driven reverse configuration;

[0030] Figure 14B is a cross-sectional perspective view of the handle assembly of Figure 14A;

[0031] Figure 15 is a cut-away side view of an embodiment of articulation mechanism of the handle assembly of Figure 3;

[0032] Figure 16 is a perspective view of the articulation mechanism of Figure 15 in an articulated position;

[0033] Figure 17A is a cut-away side view of the articulation mechanism of Figure 15;

[0034] Figure 17B is a cut-away side view of the articulation mechanism of Figure 15 with a release button depressed;

[0035] Figure 17C is a cut-away side view of the articulation mechanism of Figure 15 with the release button depressed and partially returned to a centered position;

[0036] Figure 17D is a cut-away side view of the articulation mechanism of Figure 15 with the release button depressed and returned to a centered position;

[0037] Figure 17E is a cut-away side view of the articulation mechanism of Figure 15 in the centered position with the release button partially released; and

[0038] Figure 17F is a cut-away side view of the articulation mechanism of Figure 15 in the centered position.

DETAILED DESCRIPTION OF THE INVENTION

[0039] With reference to Figures 1-2, an embodiment of surgical stapling device is illustrated. The illustrated embodiment of surgical stapler 10 comprises an elongate shaft 20, a jaw assembly 30, and a handle assembly 40. Figure 1 illustrates the surgical stapler 10 with the jaw assembly 30 in an open configuration. Figure 2 illustrates a removable reload shaft assembly comprising the elongate shaft 20 and jaw assembly 30 of the surgical stapler 10 with the jaw assembly 30 in a closed configuration.

[0040] With continued reference to Figures 1 and 2, the illustrated embodiment of surgical stapler 10 can be sized and configured for use in laparoscopic surgical procedures. For example, the elongate shaft 20 and jaw assembly 30 can be sized and configured to be introduced into a surgical field through an access port or trocar cannula. In some embodiments, the elongate shaft 20 and jaw assembly 30 can be sized and configured to be inserted through a trocar cannula having a relatively small working channel diameter, such as, for example, less than 8 mm. In other

embodiments, elongate shaft 20 and jaw assembly 30 can be sized and configured to be inserted through a trocar cannula having a larger working channel diameter, such as, for example, 10 mm, 11 mm, 12 mm, or 15 mm. In other embodiments, it is contemplated that certain aspects of the surgical staplers described herein can be incorporated into a surgical stapling device for use in open surgical procedures.

[0041] With continued reference to Figures 1 and 2, as illustrated, the elongate shaft 20 comprises a generally tubular member. The elongate shaft 20 extends from a proximal end 22 to a distal end 24. The elongate shaft 20 defines a central longitudinal axis, L. of the surgical stapler 10 extending between the proximal end 22 and the distal end 24.

[0042] With continued reference to Figures 1 and 2, in the illustrated embodiment, the jaw assembly 30 is coupled to the elongate shaft 20 at the distal end 24 of the elongate shaft 20. The jaw assembly 30 comprises a first jaw 32 and a second jaw 34 pivotally coupled to the first jaw 32. In the illustrated embodiment of Figure 3 and 15-17, the jaw assembly 30 is articulable with respect to the elongate shaft 20 responsive to an articulation mechanism in the handle. Figure 1 and Figures 8-14 illustrate a handle assembly that are configured to fire a centrally-fixed jaw assembly to further illustrate an actuation mechanism of the handle assembly in a staple firing sequence. In an initial configuration, the first jaw 32 includes a plurality of staples 36 disposed therein.

[0043] With continued reference to Figures 1 and 2, in the illustrated embodiment, the jaw assembly 30 can be actuated from an open configuration (Figure 1) to a closed configuration (Figure 2) to a stapling configuration by an actuation member or beam that is longitudinally slideable within the elongate shaft. In an initial position, the beam can be positioned at the distal end 24 of the elongate shaft 20. With the beam in the initial position, the second jaw 34 is pivoted away from the first jaw 32 such that the jaw assembly 30 is in the open configuration. The actuation beam engages the second jaw 34 upon translation of the actuation member or beam distally along the longitudinal axis L. Translation of the actuation beam distally from the initial position a first distance can actuate the jaw assembly from the open configuration to the closed configuration. With the jaw assembly 30 in the closed configuration, the actuation beam can be returned proximally the first distance to return the jaw assembly 30 to the open configuration. A distal end of the actuation beam can advance a staple slider configured to deploy staples from the first jaw 32 such that further translation of the actuation beam distally past the first distance deploys the plurality of staples 36 from the first jaw 32.

[0044] With continued reference to Figures 1 and 2, in the illustrated embodiment, the handle assembly is coupled to the elongate shaft 20 at the proximal end 22 of the elongate shaft 20. As illustrated, the handle assembly 40 has a pistol grip configuration with a housing defining a stationary handle 42 and a movable handle 44 or trigger pivotably coupled to the stationary handle 42. It is contemplated that in other embodiments, surgical stapler devices including aspects described herein can have

handle assemblies with other configurations such as, for example, scissors-grip configurations, or in-line configurations. As further described in greater detail below, the handle assembly 40 houses an actuation mechanism configured to selectively advance an actuation shaft responsive to movement of the movable handle 44.

[0045] In some embodiments, the surgical stapler 10 can include the plurality of staples 36 positioned in a disposable cartridge while the handle assembly 40 is configured to be reused with multiple staple cartridges. In the illustrated embodiment, the elongate shaft 20 and jaw assembly 30 define a disposable cartridge that is removably couplable to the handle assembly 40. Accordingly, in the illustrated embodiment the handle assembly 40 includes a coupler 46 at the distal end thereof. The coupler 46 is adapted to engage the elongate shaft 20 of the surgical stapler 10 The coupler 46 can have a bayonet connection having an outer connector that can removably couple the handle assembly 40 to the elongate shaft 20, and an inner connector that can removably couple the actuation shaft of the handle assembly 42 to the actuation member of the elongate shaft 20. Accordingly, the surgical stapler 10 can be configured such that the handle assembly 40 can be reused with multiple disposable cartridges during a surgical procedure. It is contemplated that in other embodiments, the handle assembly and some portion of the elongate shaft can be reusable while a remainder of the elongate shaft and the jaw assembly define a disposable cartridge. In certain other embodiments, the handle assembly and the elongate shaft can be reusable while the jaw assembly defines a disposable cartridge. In still other

embodiments, a jaw insert housing a plurality of staples can define a disposable cartridge while the remainder of the surgical stapler is reusable.

[0046] Figures 3-7 illustrate various views of an embodiment of handle assembly 40 having an articulation mechanism for a surgical stapler 10. The articulation mechanism can be positioned at the proximal end of the handle assembly 40 and have an articulation knob 190 for articulation of the jaw assembly. In Figure 3, a perspective view of the handle assembly 40 as illustrated with the movable handle 44 in an open position spaced apart from the stationary handle 42. The illustrated handle assembly 40 further comprises a selector 72 operably coupled to the actuation mechanism housed within the handle assembly 40 as further discussed herein. As illustrated in Figure 3, the selector 72 is in a first position.

[0047] With reference to Figure 4, another perspective view of the handle assembly 40 of Figure 3 is illustrated. As illustrated, the movable handle 44 is in the open position positioned adjacent the stationary handle 42, and the selector 72 is in a second position. Figures 5 and 6 illustrate a top view of the handle assembly of Figure 3 with the selector 72, such as a slider 74, in the first position (Figure 5), and in the second position (Figure 6). Figure 7A illustrates a side view of the handle assembly 40 of Figure 3, and Figure 7B illustrates a cross-sectional side view of the handle assembly 40 of Figure 3.

[0048] Figures 8A and 8B illustrate cross-sectional views of the handle assembly 40 in an initial configuration, revealing operation of the actuation mechanism

50. In the illustrated embodiment, the actuation mechanism 50 is configured to selectively translate the actuation shaft 60 from a first position corresponding to the jaw assembly 30 being in the open configuration to a second position corresponding to the jaw assembly 30 being in the closed configuration and from the second position to a third position to position the jaw assembly 30 in a stapling configuration and deploy the plurality of staples 36. In the initial configuration illustrated in Figures 8A and 8B, actuation mechanism 50 can repeatedly translate the actuation shaft 60 between the first position and the second position responsive to movement of the movable handle 44 or trigger without deploying the staples to provide an open and close functionality. This open and close functionality allows a user to position, clamp tissue, and reposition the stapler 10 to find a desirable staple placement location before deploying the staples.

[0049] With reference to Figures 8-14, in the illustrated embodiment, the actuation mechanism comprises an advancing or forward driver 52, a reverse driver 54, an opening driver 58, an advancing surface 62, a reversing surface 64, and an opening surface 66. The forward driver 52 can be operably coupled to the movable handle 44 such that movement of the movable handle 44 from the open position to the closed position advances the forward driver 52 in a first direction such as for example distally within the handle assembly 40. The forward driver 52 can comprise a pawl or tooth configured to engage a recess or slot.

[0050] The reverse driver 54 can be operably coupled to movable handle 44 such that movement of the movable handle 44 from the open position to the closed position advances the reverse driver 54 in a second direction opposite the first direction

such as, for example proximally within the handle assembly 40. In some embodiments, the movable handle 44 can be operably coupled with the reverse driver 54 with a geared connection including an idler gear 56. The reverse driver 54 can comprise a pawl or tooth configured to engage a recess or slot.

[0051] The opening driver 58 can be operably coupled to the movable handle 44 such that movement of the movable handle 44 from the open position to the closed position advances the opening driver 58 in a first direction such as for example distally within the handle assembly 40. In the illustrated embodiment, the opening driver 58 is coupled to the idler 56 with a pin and slot connection to operably couple the opening driver 58 to the movable handle 44. The opening driver 58 can comprise a pawl or tooth configured to engage a recess or slot.

[0052] The actuation shaft 60 includes advancing surface 62, reversing surface 64, and opening surface 66 formed thereon. In the illustrated embodiment, the advancing surface 62 comprises a rack, or plurality of spaced recesses or teeth formed longitudinally along the actuation shaft 60. As illustrated, reversing surface 64 comprises a rack or plurality of space recesses or teeth formed longitudinally along the actuation shaft 60 and angularly offset from the advancing surface 62. In the illustrated embodiment, the opening surface 66 comprises a recess formed in the actuation shaft 60.

[0053] In certain embodiments, the actuation shaft 60 is rotatable within the handle assembly 40 about the longitudinal axis of the stapler 10. The handle assembly

40 can comprise a rotation mechanism 70 to provide selective rotation of the actuation shaft 60 within the handle assembly 40. The actuation shaft 60 can be rotatable between a first orientation in which the forward driver 52 is engageable with the advancing surface 62 and a second orientation in which the reverse driver 54 is engageable with the reversing surface 64. With the angular offset of the advancing surface 52 from the reversing surface 54 with respect to the actuation shaft 60, with the actuation shaft in the first orientation, the reverse driver 54 is disengaged from the reversing surface 64, and with the actuation shaft in the second orientation, the forward driver 52 is disengaged from the advancing surface 62.

[0054] With continued reference to Figures 8-14, in certain embodiments, the rotation mechanism 70 comprises a selector 72, such as a slider. The slider can extend transversely through the housing of the handle assembly 40. The slider can be operably coupled to the actuation shaft 60 such that positioning the slider in the first position extending from one side of the handle assembly 40 positions the actuation shaft 60 in the first orientation, and positioning the slider in the second position extending from an opposite side of the handle assembly 40 rotates the actuation shaft 60 to the second orientation. In the illustrated embodiment, the slider is coupled to a rack 76 in meshing engagement with a gear 78 that is rotatably fixed to the actuation shaft 60 and longitudinally slidable along the actuation shaft 60 (such as, for example, with a keyed connection). Desirably, the illustrated rotation mechanism 70 including a slider discretely positions the actuation shaft 60 in a desired orientation, reducing the incidence of the mismeshed gearing within the actuation mechanism 50. In some

embodiments the slider can include visual indicators, such as arrows, to indicate the orientation of the actuation shaft 60, and thus, the actuation mode of the stapler to a user. In other embodiments, the rotation mechanism 70" (Figure 1) can include another mechanism such as a rotatable knob directly rotationally coupled to the actuation shaft, rather than the slider selector 72.

[0055] In the illustrated embodiment, the advancing surface 62 and the reverse surface 64 are angularly offset by approximately 90 degrees about the actuation shaft. Thus, the rotation mechanism 70 is configured to rotate the actuation shaft approximately 90 degrees between the first orientation and the second orientation. In other embodiments, the actuation surface 62 and the reverse surface 64 can have a different angular offset, such as, for example 120 degrees, and the rotation mechanism 70 can be configured to rotate the actuation shaft 60 correspondingly. Moreover, as described in further detail herein with respect to an open/close mode of the handle assembly 40 operation, in the illustrated embodiment, the opening driver 58 engages with the actuation shaft in the second orientation, in other embodiments, the actuation shaft can be rotatable to a third orientation in which the opening driver 58 engages with the actuation shaft.

[0056] With reference to Figures 8-14, a typical operation sequence of the actuation mechanism 50 of the handle assembly 40 is illustrated. Figures 8A-8B and 9A-9B illustrate operation of the handle assembly 40 in an initial configuration providing an open/close functionality to the jaw assembly 30. In Figure 8A, the movable trigger 44 is at an open position, and the actuation shaft 60 is at a first position, corresponding

to the first position of the actuation beam at the distal end of the elongate shaft 20. In the initial position, the actuation shaft 60 is positioned at the second orientation such that the reverse driver 54 is angularly aligned with the reversing surface 64. With actuation shaft 60 in the second orientation, the opening driver 58 is positioned within the opening surface 66 or recess. Movement of the movable handle 44 from the open position (Figure 8A-8B) to the closed position (Figure 9A-9B), advances the forward driver 52 distally along the actuation shaft 60 to engage an advancing recess 63 formed in the actuation shaft 60 and drive the actuation shaft 60 distally in the handle assembly 40 to a second position. The second position of the actuation shaft 60 within the handle assembly 40 corresponds to the second position of the actuation beam, which positions the jaw assembly 30 in a closed configuration.

[0057] The movable handle 44 can be biased to the open position by a biasing member, such as a coil spring 68 (Figure 11A). Thus, releasing the movable handle 44 from the closed position illustrated in Figure 9A-9B would return it to the open position of Figures 8A-8B. Operable coupling of the movable handle 44 to the opening driver 58 would likewise translate the opening driver 58 proximally within the handle assembly 40 as the movable handle 44 returns to the open position. In the second orientation of the actuation shaft 60, the opening driver 58 engages opening surface 66 such that the proximal movement of the opening driver 58 returns the actuation shaft 60 from the second position to the first position, returning the jaw assembly 30 to the open configuration.

[0058] A user can seek a desired stapling position within a surgical field by repeatedly opening and closing the jaws to clamp tissue in various locations. Once a desired stapling position has been selected, the actuation mechanism 50 can be configured in a stapling or firing mode by rotating the actuation shaft 60 to the first orientation. With the jaw assembly a closed configuration at a desired stapling position (as illustrated in Figures 9A-9B), a user can reposition the selector 72 by sliding the slider to the first position, corresponding to the first orientation of the actuation shaft 60 (as illustrated in Figures 10A-10B). In the first orientation of the actuation shaft 60, the forward driver 52 is engageable with the advancing surface 62, the reversing driver 54 is angularly misaligned with the reversing surface 64, and the opening driver 58 angularly misaligned with the opening surface 66. With the actuation shaft 60 in the first orientation, the movable handle 44 can be released into the open position (Figure 11A-11B), engaging the forward driver 52 with the advancing surface 62.

[0059] With reference to Figures 11A-11B and 12A-12B, with the actuation shaft 60 in the first orientation, and the forward driver 52 engaging the advancing surface 62, the actuation mechanism 50 is in a stapling or firing mode. Several cycles of movable handle 44 movement from the open position to the closed position and back to the open position advance the actuation shaft 60 from the second position (Figures 11A-11B), to a third position in which the actuation shaft 60 is moved to its distal-most limit with respect to the handle assembly 40 (Figures 12A-12B). In some embodiments, the actuation mechanism can include a stop to interfere with distal travel of the actuation shaft 60 at the third position. The second position of the actuation shaft

corresponds to the second position of the actuation beam in the jaw assembly 30. The third position of the actuation shaft corresponds to the third position of the actuation beam in the jaw assembly 30 in which the plurality of staples have been deployed from the first jaw. With movement of the movable handle 44 or trigger in the firing mode to advance the actuation shaft from the second position to the third position, the forward driver 52 is sequentially advanced over the adjacent teeth or grooves of the actuating surface 62 in a ratchet-like advancement.

[0060] With reference to Figures 13A-13B, once the actuation shaft 60 has been advanced to the third position and the staples have been fired from the jaw assembly, the actuation mechanism 50 can be configured in a reverse mode. Accordingly, the rotation mechanism 70 can rotate the actuation shaft 60 to the second orientation to position the reversing surface 64 in angular alignment with the reverse driver 54. The slider can be slid to the second position to rotate the actuation shaft from the first orientation (Figures 12A-12B) to the second orientation (Figures 13A-13B). With the actuation shaft 60 in the second orientation, repeated cycles of the movable handle 44 from the open position to the closed position and back to the open position engage the reverse driver 54 with the reversing surface 64 in a ratchet-like advancement while retracting the actuation shaft 60 proximally in the handle assembly 40. Once the reverse driver 54 has driven the actuation shaft 60 proximally to the second position (illustrated in Figures 14A-14B), the opening driver 58 engages the opening surface 66. The opening driver 58 returns the actuation shaft 60 to the first position when the movable handle 44 is released to the open position. (Returning the

handle assembly to the configuration illustrated in Figures 8A-8B). With the actuation shaft 60 in the first position, the cartridge, emptied of staples, can be decoupled from the handle assembly 40 and a new cartridge can be coupled to the handle assembly to begin another stapling operation.

[0061] With reference to Figures 15, 16, and 17A-17F, an embodiment of articulation mechanism for the handle assembly 40 is illustrated. In the illustrated embodiment, the handle can articulate the jaw assembly at the distal end of the shaft up to 45° in a fully articulated position in either direction relative to a longitudinally centered position. In some embodiments, the handle assembly uses a manual articulation mechanism including a series of components coupled to the manually actuated articulation knob 190 at the proximal end of the handle. It is contemplated that in other embodiments, the articulation knob and certain components of the articulation mechanism can be disposed at other locations on the handle assembly such as, for example, the distal end, an upper surface thereof, or on the stationary handle.

[0062] With reference to Figures 15 and 16, the articulation mechanism is coupled to an articulation member 206 extending longitudinally within the reload shaft when the reload shaft is coupled to the handle. Actuation of the articulation mechanism longitudinally translates the articulation member 206 proximally or distally relative to the shaft to articulate the jaw assembly at the distal end of the shaft.

[0063] With reference to Figure 15, the articulation mechanism comprises a ball screw 192 having at least one helical groove or thread 195 in which one or more

ball bearing 194 can ride. In the illustrated embodiment, the articulation mechanism comprises two ball bearings 194 that are engageable in two threads 195. The ball bearings 194 are positioned in ball bearing apertures 189 in a ball sleeve 191 positioned radially outwardly of the ball screw 192. The ball bearings 194 are maintained in the threads 195 by a release sleeve 196 positioned radially outward of the ball bearings 194. Rotation of the articulation knob 190, which is coupled to the ball sleeve 191 such as by connecting pins 193, rotates the ball sleeve 191 about an axis of rotation, causing the ball bearings 194 to travel within the threads 195 and correspondingly longitudinally translate the ball screw 192. Articulation of the jaw assembly is accomplished by rotating the articulation knob 190 to correspondingly rotate the ball sleeve 191 and the ball bearings 194 about the axis of rotation while their longitudinal position is fixed along the axis of rotation. The ball bearings 194, which are engaged in the threads 195 of the ball screw 192 will then translate the ball screw 192 forward and reverse along the axis of rotation. In the illustrated embodiment, the ball sleeve 191 is generally tubular, having a cavity formed therein, and a portion of the ball screw 192 is positioned within the cavity and translates longitudinally within the cavity. While the illustrated embodiment of articulation mechanism includes two ball bearings engageable threads in a ball screw, it is contemplated that in other embodiments, the articulation mechanism can have fewer or more than two ball bearings such as, for example, a single ball bearing positioned in a single helical screw or three or more ball bearings in a corresponding number of helical threads.

[0064] With reference to Figures 15 and 16, the ball screw 192 extends to a distal end 200 coupled to a pair of articulation links 202. The articulation links 202 are spaced apart from one another, which desirably allows them to be positioned radially outwardly of the actuation mechanism and actuation shaft within the handle. As illustrated in Figure 16, the articulation links 202 can comprise a mating feature such as a slot formed therein to allow them to be keyed into a corresponding mating feature such as a post extending radially inwardly from the handle body. The slots can stabilize the articulation links relative to the handle and interaction of the handle posts with ends of the slots can define a range of articulation for the articulation mechanism. The distal ends of the articulation links 202 can be rotatably coupled to the articulation adapter 204, which can be positioned coaxially radially outwardly of the actuation adapter at the distal end of the handle. This rotational coupling can include an articulation bearing 205 having relatively low friction properties. This articulation bearing 205 can facilitate rotation of a coupled reload shaft relative to the handle assembly and longitudinal movement of the articulation adapter 204 during operation of the articulation mechanism. While the illustrated embodiment of articulation mechanism includes two articulation links laterally offset from the actuation mechanism within the handle, it is contemplated that in other embodiments, the articulation mechanism can have fewer or more than two articulation links such as, for example, an articulation link or three or more articulation links.

[0065] With continued reference to Figure 16, the articulation adapter 204 can be connected to the articulation member 206 in the shaft by a bayonet connection when

the shaft is coupled to the handle. The articulation member 206 extends distally within the shaft and is coupled to an end effector or jaw assembly articulably coupled to the shaft. The threads 195 can be configured such that moving the ball screw proximally will articulate the jaw assembly to the left when viewed from the handle relative to a longitudinally centered position and moving the ball screw 192 distally will articulate the jaw assembly to the right when viewed from the handle relative to the centered position.

[0066] Advantageously, since the helical threads 195 of the ball screw 192 are continuous, the articulation mechanism can allow the jaw assembly to be articulated to virtually infinite angular positions between a desired operational range. In some embodiments, the articulation mechanism can be configured to provide an articulation operational range from -45° to +45° of the jaw assembly relative to a longitudinally centered position defined by the longitudinal axis of the shaft. In other embodiments, the articulation mechanism can be configured to provide other operative articulation ranges including ranges providing more than +/-45° of articulation or those providing less than +/-45° of articulation. In some embodiments, the articulation mechanism can be configured to provide articulation in a single direction relative to a longitudinally centered position.

[0067] In some embodiments, the pitch of the threads 195 on the ball screw 192 is variable. For example, the threads 195 can include a relatively low pitch towards an end of the threads to advantageously provide a larger mechanical advantage when the jaw assembly can require more force to articulate. The threads 195 can include a relatively higher pitch towards a center of the threads to allow rapid movement with a

relatively lower mechanical advantage where the jaw assembly can require a lower force to articulate. In other embodiments, the threads 195 include a constant pitch such that rotation of the articulation knob results in a proportional amount of articulation of a jaw assembly of the stapler that does not vary over the articulation range of the articulation mechanism. Desirably, such a constant pitch thread ball screw can result in an easily predictable response during operation of the actuation mechanism.

[0068] With reference to Figures 17A-17F, the articulation mechanism can comprise a release mechanism that allows the articulation mechanism to advantageously be reset to the longitudinally centered position from any articulated position. The release mechanism is operated by user pressing a release button 198. In the illustrated embodiment, the release button 198 is positioned radially nested within the articulation knob 190.

[0069] With reference to Figure 17B, operation of the release button 198 will distally advance the release sleeve 196. A radially inner surface of the release sleeve 196 is stepped to include an engagement surface 186 having a relatively small inner diameter and a release surface 188 having a relatively larger inner diameter with a smooth ramp between the engagement surface and the release surface. In operation, the engagement surface of the release sleeve maintains the ball bearings 194 in the threads 195 of the ball screw 192. Once the release button 198 is pushed, the engagement surface is distally advanced, allowing the ball bearings 194 to disengage from the threads 195 and advance radially outward through the ball bearing apertures 189 in the ball sleeve 191 (Figure 15) against the release surface.

[0070] With reference to Figures 17C and 17D, with the ball bearings 194 disengaged from the threads 195, the articulation mechanism can be biased to a centered position. In some embodiments, the ball screw 192 is biased to a centered position by a biasing member such as two springs 197 and spring force from the shaft. The ball bearings 194 positioned in the centered position (Figure 17D) along the threads 195 corresponds to a longitudinally centered position of the jaw assembly.

[0071] With reference to Figures 17E-17F, once the release button 198 is allowed to return to an undisturbed configuration, release sleeve 196 is retracted proximally (indicated by arrows 199) by a spring. Proximal movement of the release spring 196 forces the ball bearings 194 into engagement with the threads 195 of the ball screw. Thus, the articulation mechanism can then be used to articulate the jaw assembly from the longitudinally centered position, or the stapler can be used with the jaw assembly in the longitudinally centered position.

[0072] Although this application discloses certain preferred embodiments and examples, it will be understood by those skilled in the art that the present inventions extend beyond the specifically disclosed embodiments to other alternative embodiments and/or uses of the invention and obvious modifications and equivalents thereof. Further, the various features of these inventions can be used alone, or in combination with other features of these inventions other than as expressly described above. Thus, it is intended that the scope of the present inventions herein disclosed should not be limited by the particular disclosed embodiments described above, but should be determined only by a fair reading of the claims.

What is claimed is:

1. A handle assembly for a surgical stapler, the handle assembly comprising:

a handle body comprising a stationary handle and a movable handle pivotably coupled to the handle body;

an actuation shaft mechanically coupled to the movable handle for manual actuation thereof, the actuation shaft slidable within the handle body along a longitudinal axis; and

an articulation mechanism comprising:

a manually actuated articulation knob positioned at a proximal end of the handle body and rotatable about the longitudinal axis; and

an articulation adapter positioned at the distal end of the handle body, the articulation adapter operatively coupled to the articulation knob such that rotation of the articulation knob about the longitudinal axis longitudinally slides the articulation adapter.

2. The handle assembly of claim 1, wherein the articulation mechanism further comprises:

a ball screw having a helical thread formed therein;

a ball sleeve positioned radially outwardly of the ball screw, and having an aperture formed therein; and

a ball bearing positioned in the aperture of the ball sleeve and engaged in the helical thread of the ball screw.

3. The handle assembly of claim 2, wherein the ball screw is longitudinally movable relative to the handle body, and wherein movement of the ball bearing within the helical thread longitudinally moves the ball screw.

4. The handle assembly of claim 2, wherein the ball screw has a distal end, and further comprising an articulation link coupled to the distal end of the ball screw and extending distally within the handle body to the articulation adapter.

5. The handle assembly of claim 2, wherein the ball sleeve is rotationally coupled to the articulation knob.

6. A handle assembly for a surgical stapler, the handle assembly comprising:

a handle body comprising a stationary handle and a movable handle pivotably coupled to the handle body;

an actuation shaft mechanically coupled to the movable handle for manual actuation thereof, the actuation shaft slidable within the handle body along a longitudinal axis; and

an articulation mechanism comprising:

a manually actuated articulation knob positioned at a proximal end of the handle body and rotatable about the longitudinal axis; and

a ball screw operatively coupled to the articulation knob and longitudinally movable by rotation of the articulation knob.

7. The handle assembly of claim 6, wherein the ball screw comprises a helical thread formed therein and the articulation mechanism further comprises a ball bearing engageable in the helical thread to transfer rotational motion of the articulation knob to longitudinal motion of the ball screw.

8. The handle assembly of claim 6, wherein the articulation mechanism further comprises a release mechanism configured to reset the ball screw to a longitudinally centered position.

9. The handle assembly of claim 8, wherein the release mechanism comprises a release button operatively engaged with a release sleeve such that actuation of the release button operatively disengages the articulation knob from the ball screw.

10. The handle assembly of claim 9, wherein the ball screw comprises a helical thread formed therein and the articulation mechanism further comprises a ball bearing engageable in the helical thread to transfer rotational motion of the articulation knob to longitudinal motion of the ball screw, and wherein actuation of the release mechanism disengages the ball bearing from the helical thread.

11. The handle assembly of claim 10, wherein the release sleeve has an inner surface comprising an engagement surface having a first inner diameter and a release surface having a second inner diameter larger than the first inner diameter.

12. The handle assembly of claim 11, wherein actuation of the release button positions the release surface adjacent the ball bearing to disengage the ball bearing from the helical thread.

13. The handle assembly of claim 8, wherein the release mechanism further comprises a biasing member biasing the ball screw to a longitudinally centered position when the release mechanism is actuated.

14. A handle assembly for a surgical stapler, the handle assembly comprising:

a handle body comprising a stationary handle and a movable handle pivotably coupled to the handle body, the handle body having a proximal end and a distal end and defining a central longitudinal axis between the proximal end and the distal end;

an actuation mechanism within the handle body; and

an articulation mechanism comprising:

a manually actuated articulation knob positioned at a proximal end of the handle body and rotatable about the longitudinal axis;

an articulation adapter positioned at the distal end of the handle body, the articulation adapter operatively coupled to the articulation knob such that rotation of the articulation knob about the longitudinal axis longitudinally slides the articulation adapter; and

a first articulation link operatively coupling the actuation knob to the articulation adaptor and extending longitudinally within the handle body laterally offset from the actuation mechanism.

15. The handle assembly of claim 14, whether the articulation mechanism comprises an articulation bearing rotationally coupling the first articulation link to the articulation adapter.

16. The handle assembly of claim 14, wherein the articulation mechanism further comprises a second articulation link operatively coupling the articulation knob to the articulation adapter and extending longitudinally within the handle body laterally offset from the actuation mechanism opposite the first articulation link.

17. The handle assembly of claim 14, wherein the actuation mechanism comprises an actuation shaft mechanically coupled to the movable handle for manual actuation thereof, the actuation shaft slidable within the handle body along a longitudinal axis and rotatable with respect to the longitudinal axis.

18. The handle assembly of claim 14, wherein the articulation mechanism further comprises:

a ball sleeve having an aperture formed therein, the ball sleeve rotationally coupled to the articulation knob;

a ball bearing positioned in the aperture; and

a ball screw longitudinally slidable within the ball sleeve and having a helical thread formed therein,

wherein the ball bearing is engageable with the helical thread.

19. The handle assembly of claim 18, wherein the helical thread comprises a constant pitch.

20. The handle assembly of claim 14, wherein the articulation adapter comprises a bayonet coupler.

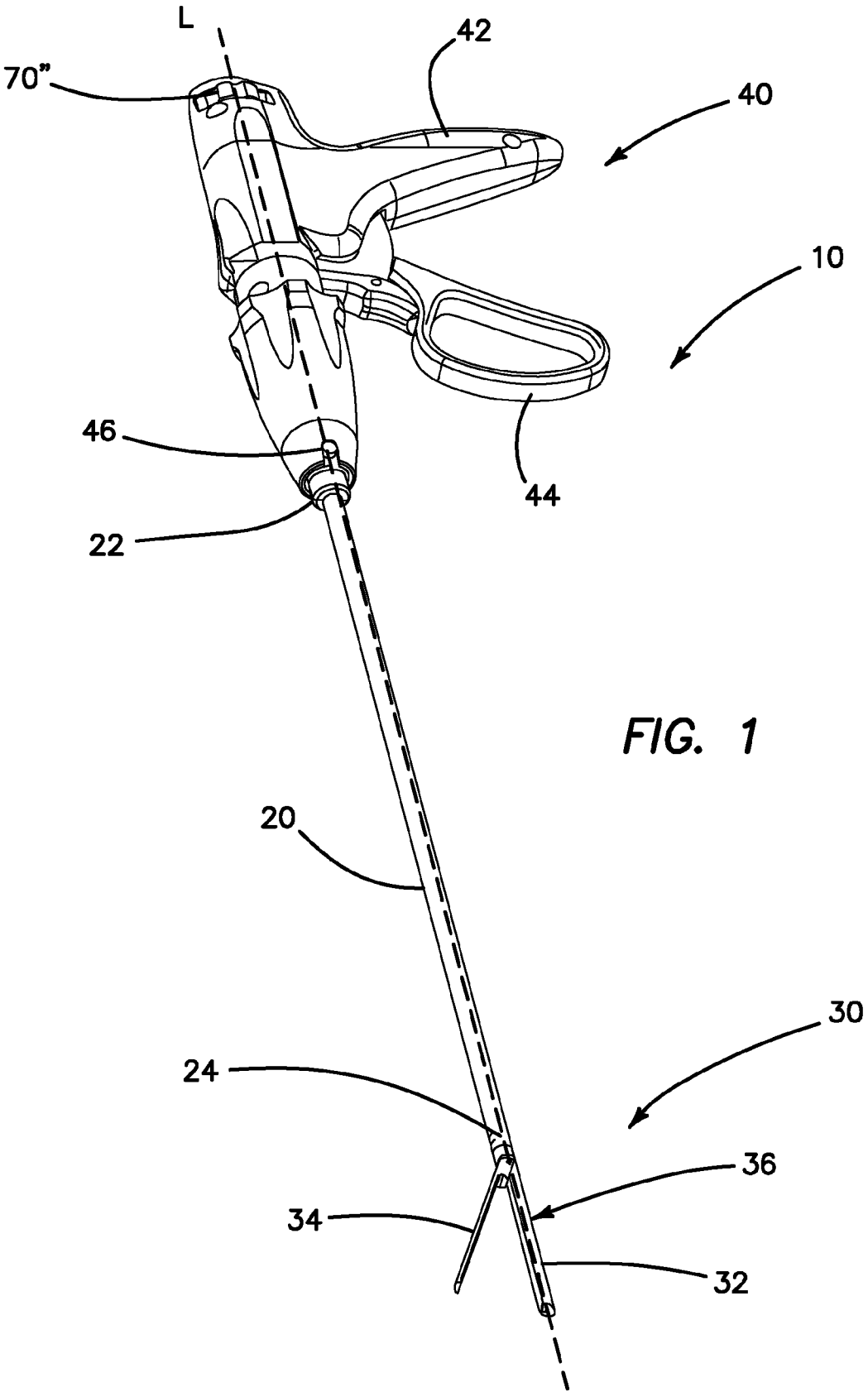


FIG. 1

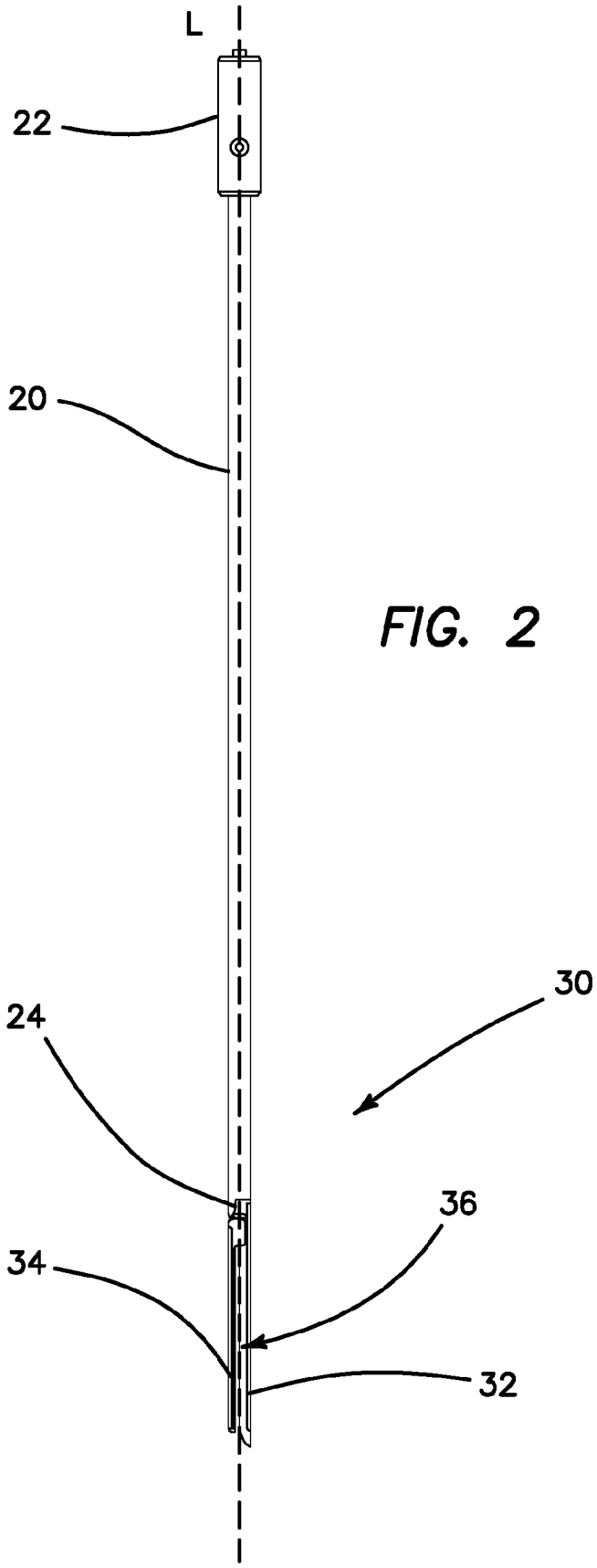


FIG. 2

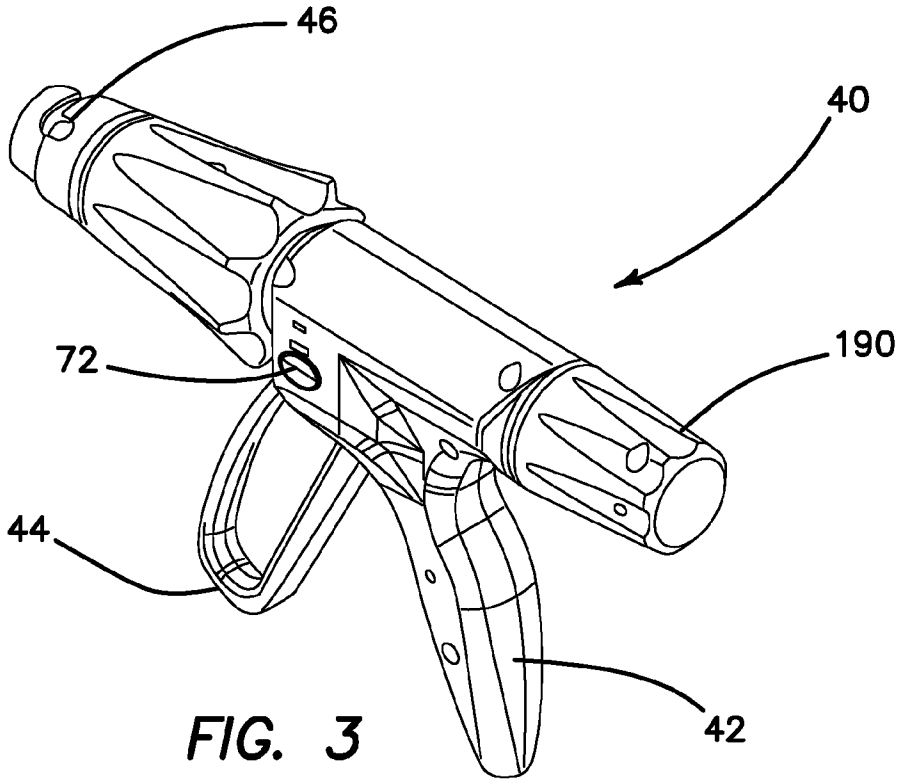


FIG. 3

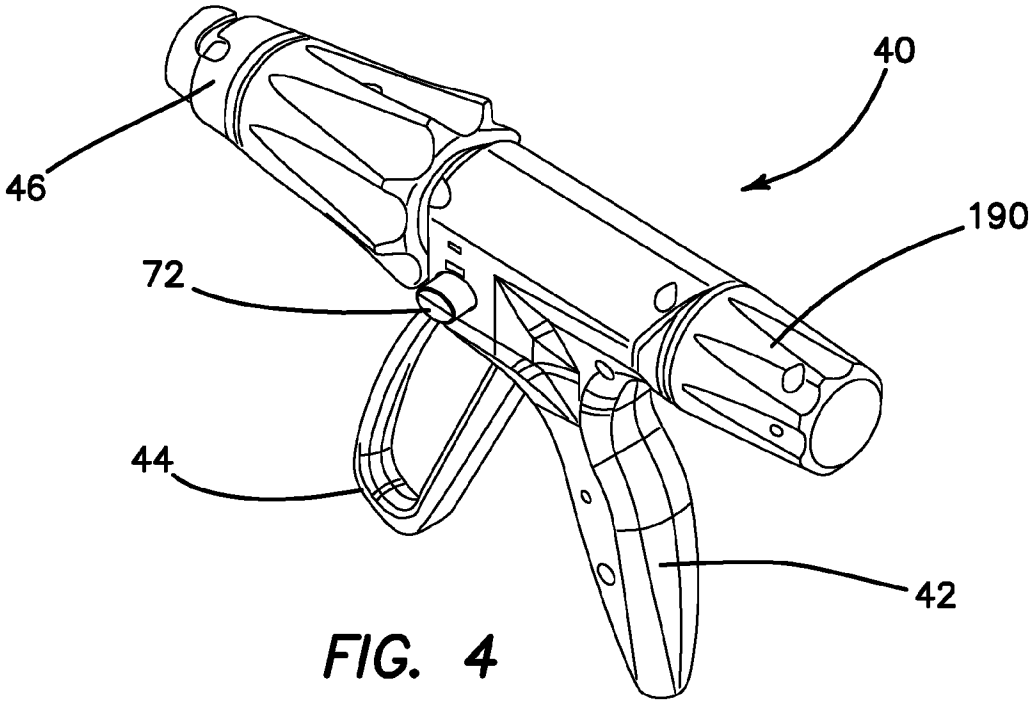


FIG. 4

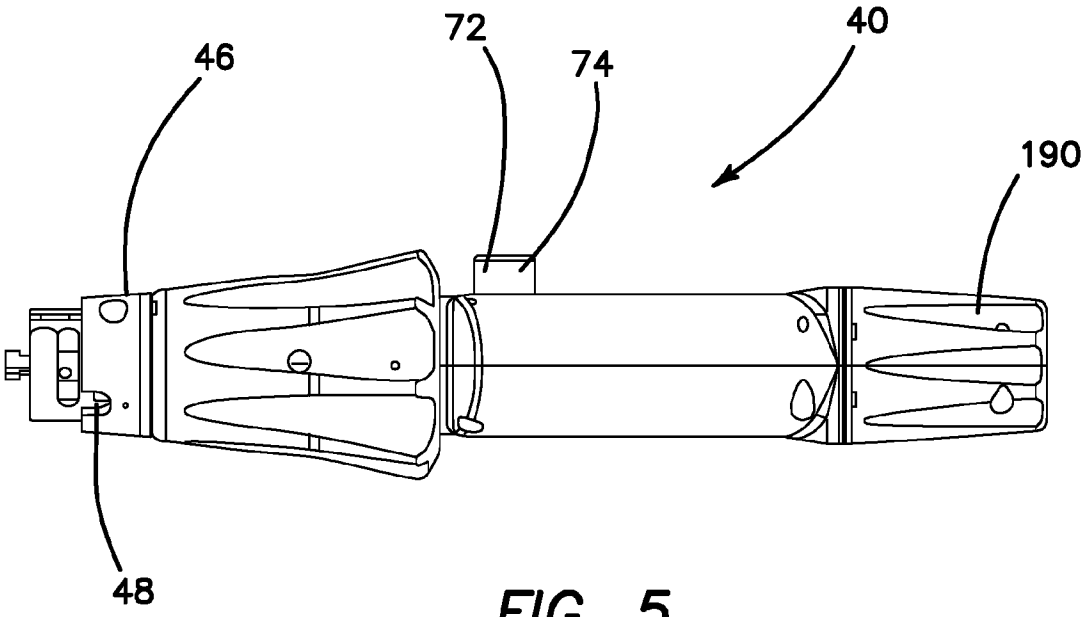


FIG. 5

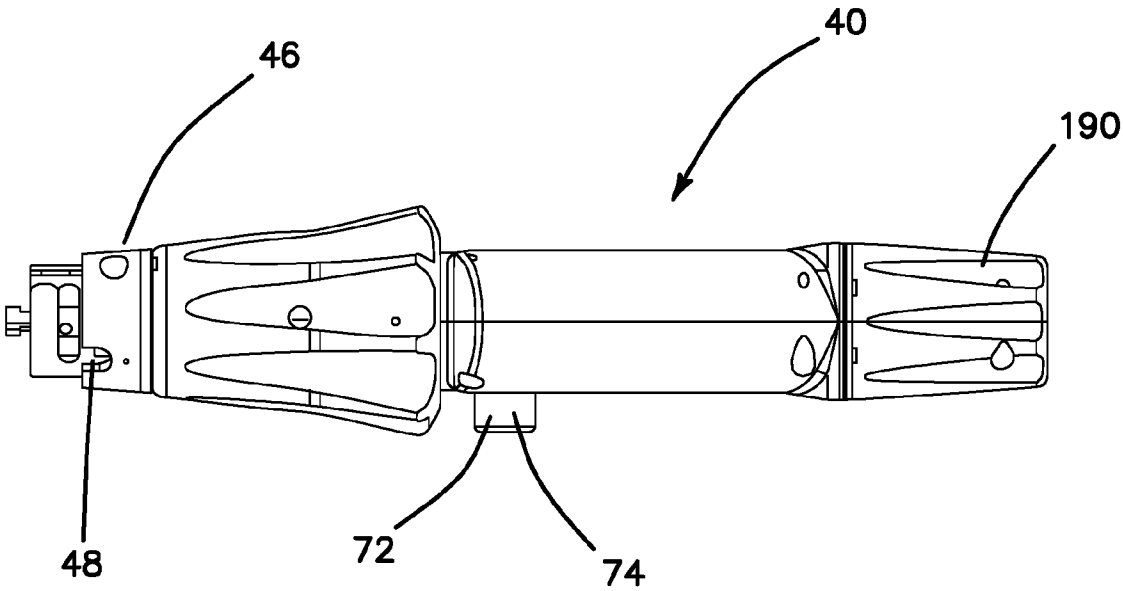


FIG. 6

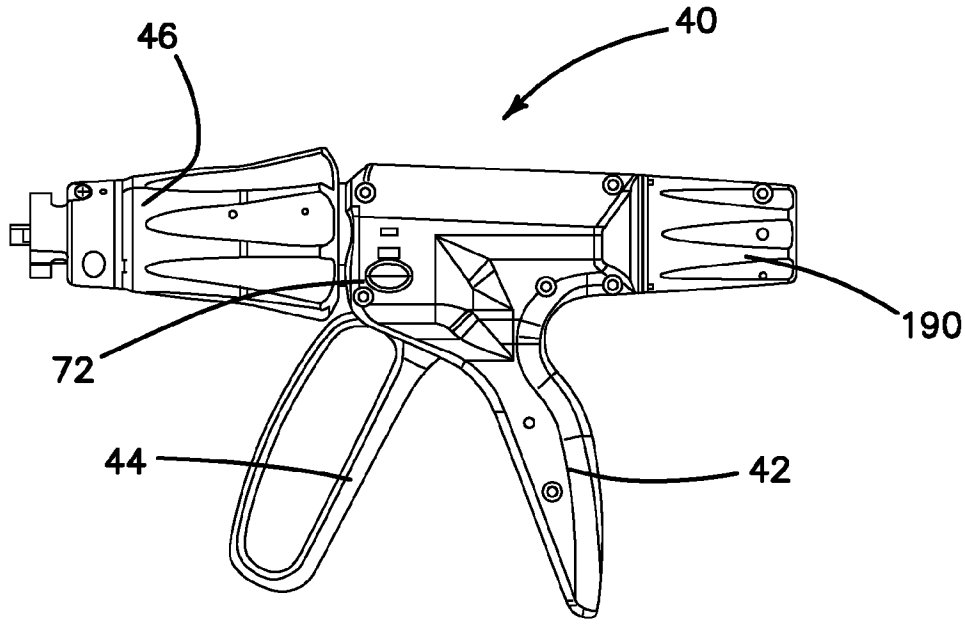


FIG. 7A

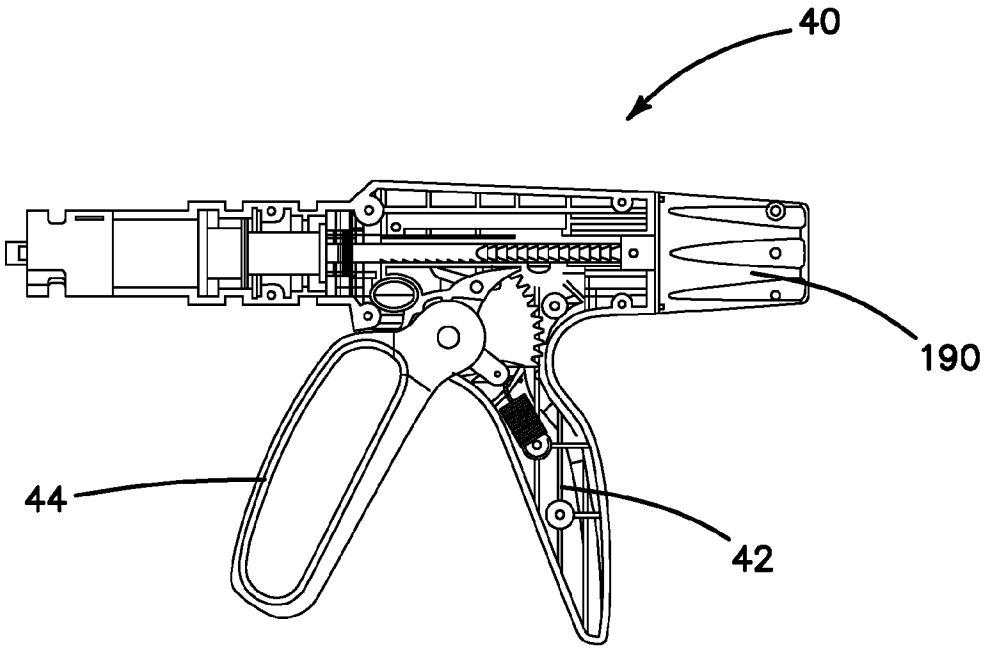


FIG. 7B

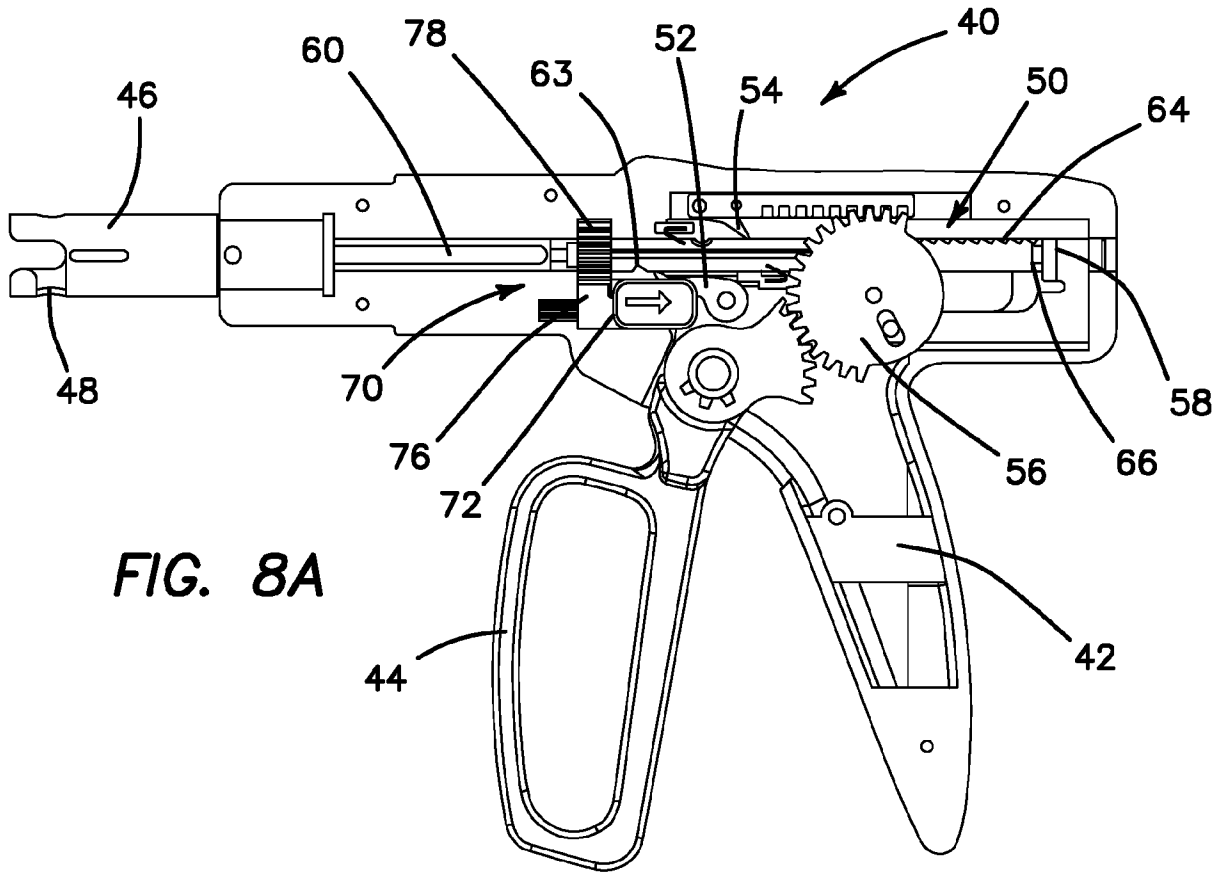

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FIG. 8A

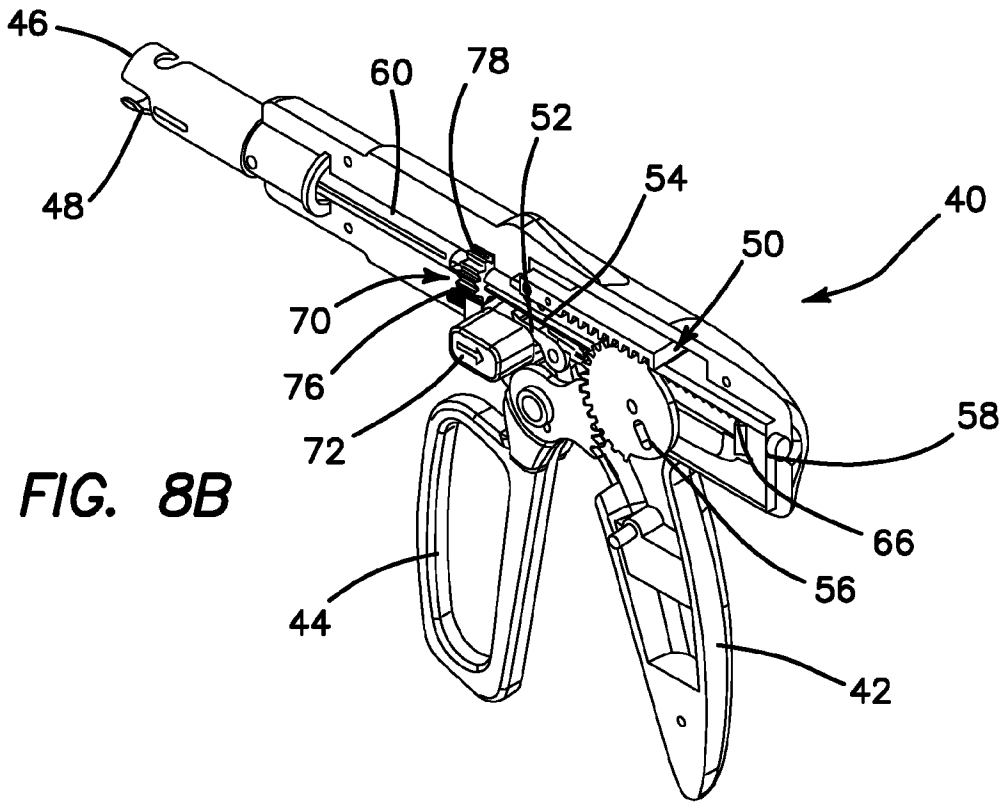

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FIG. 8B

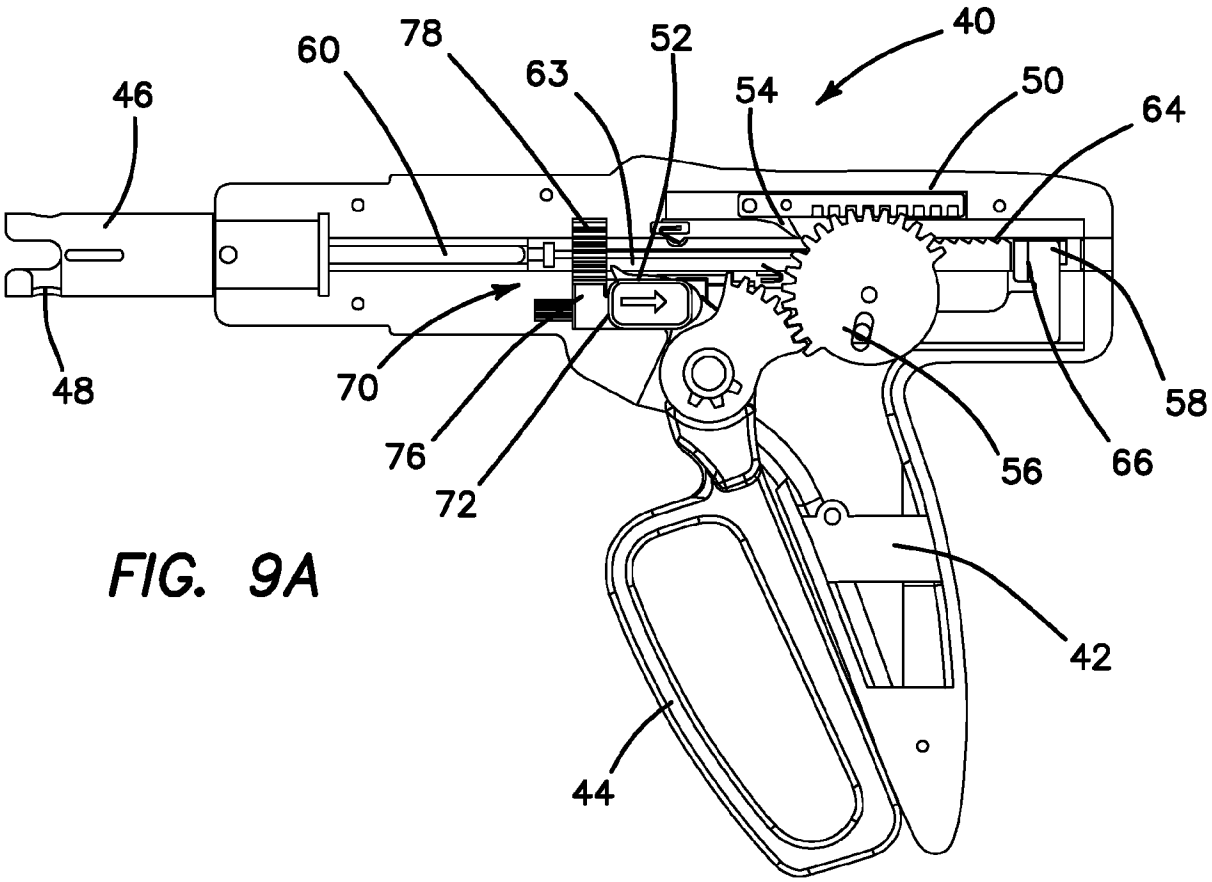

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FIG. 9A

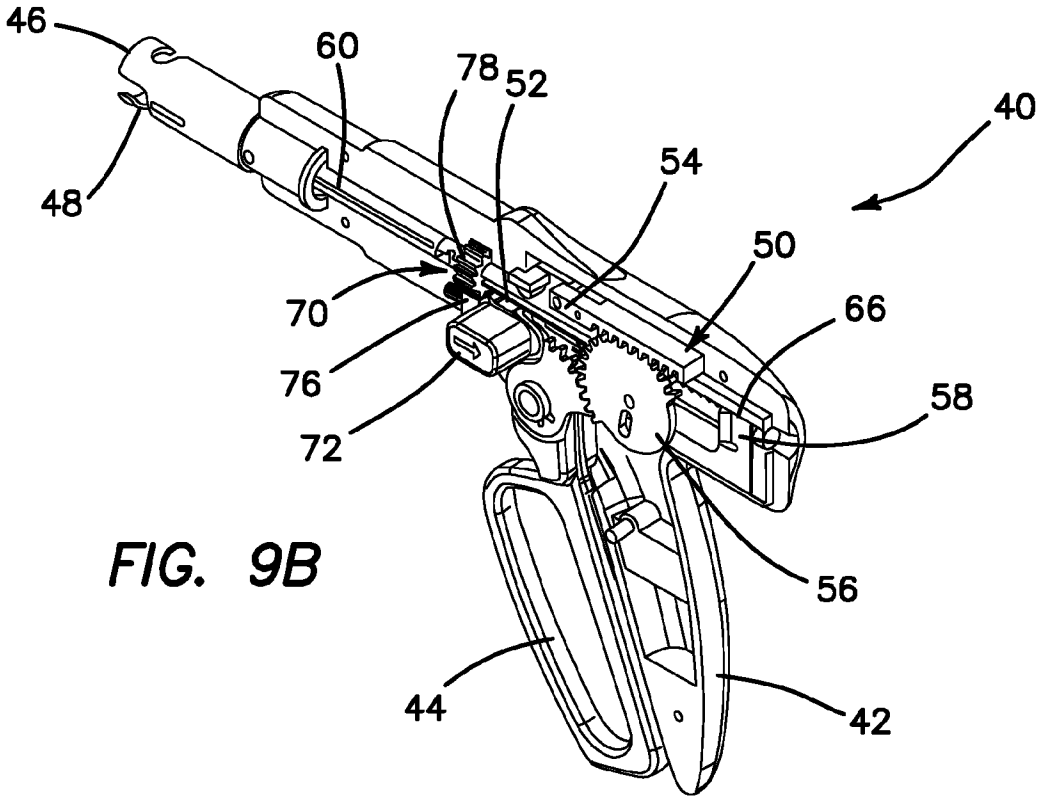

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FIG. 9B

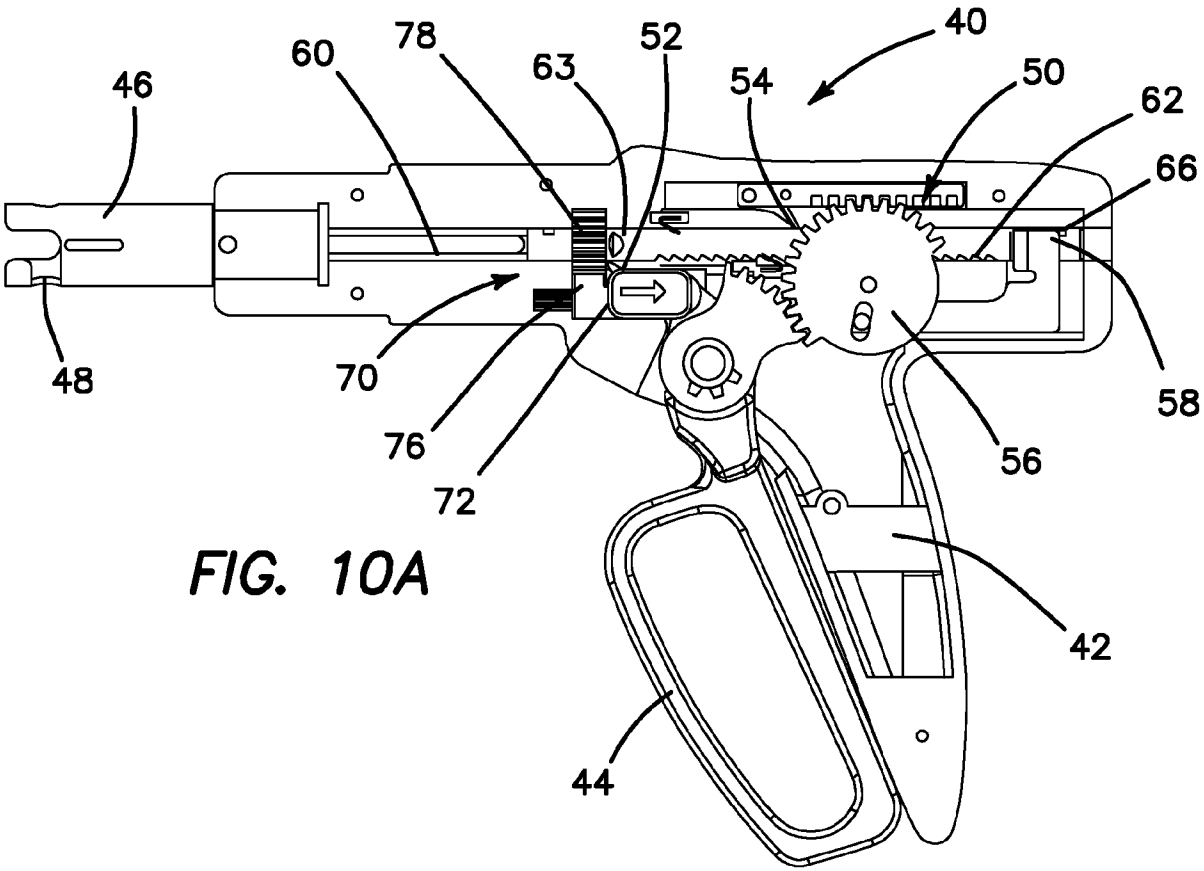


FIG. 10A

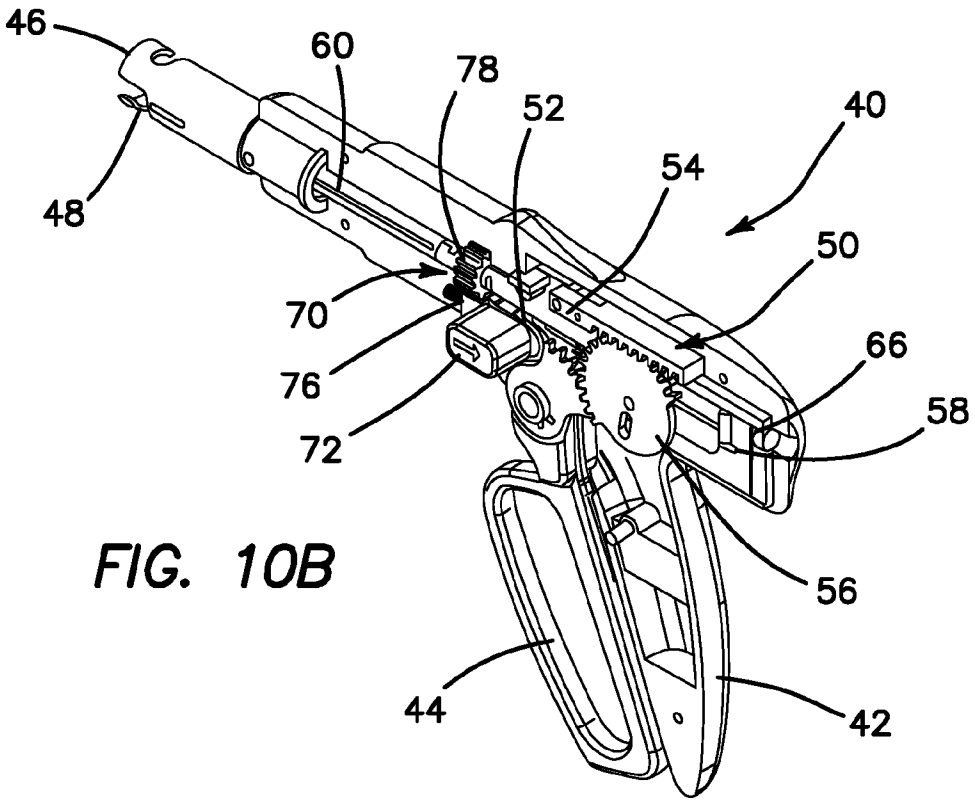


FIG. 10B

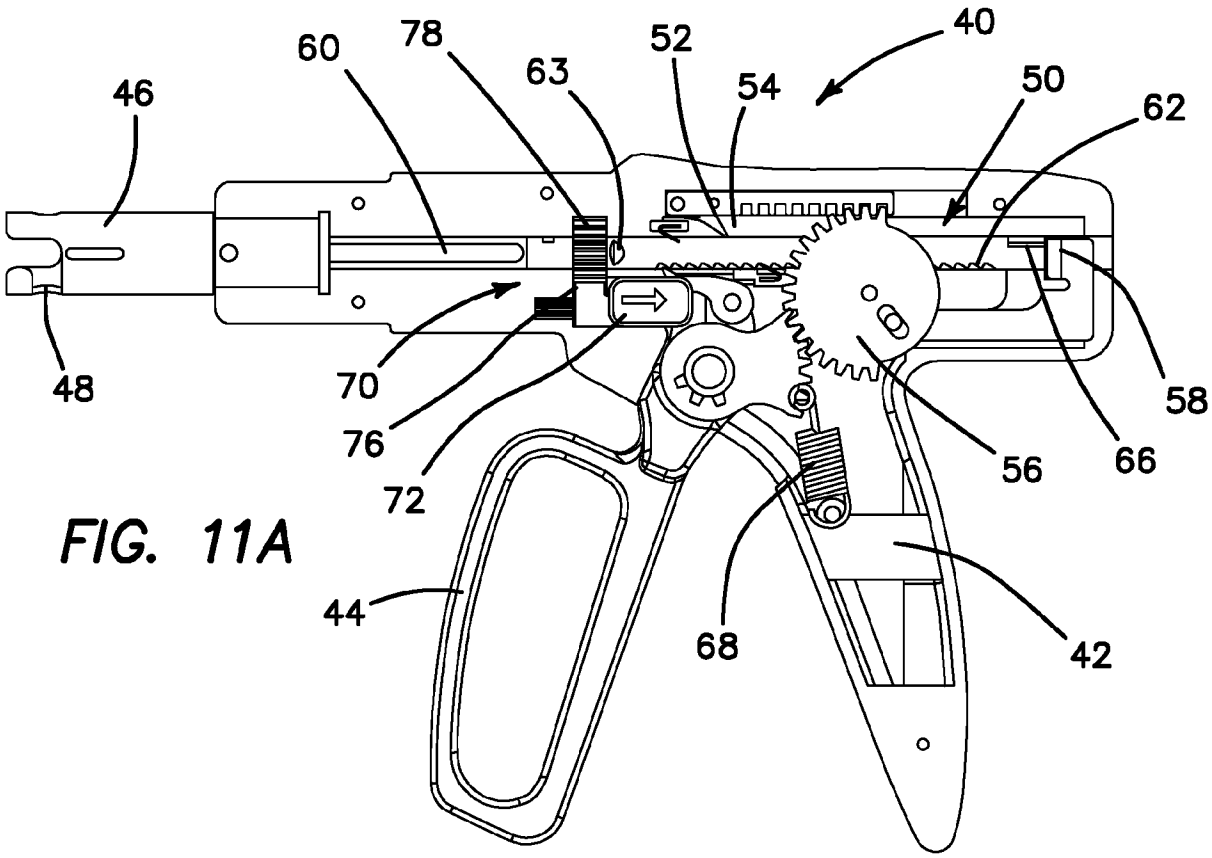


FIG. 11A

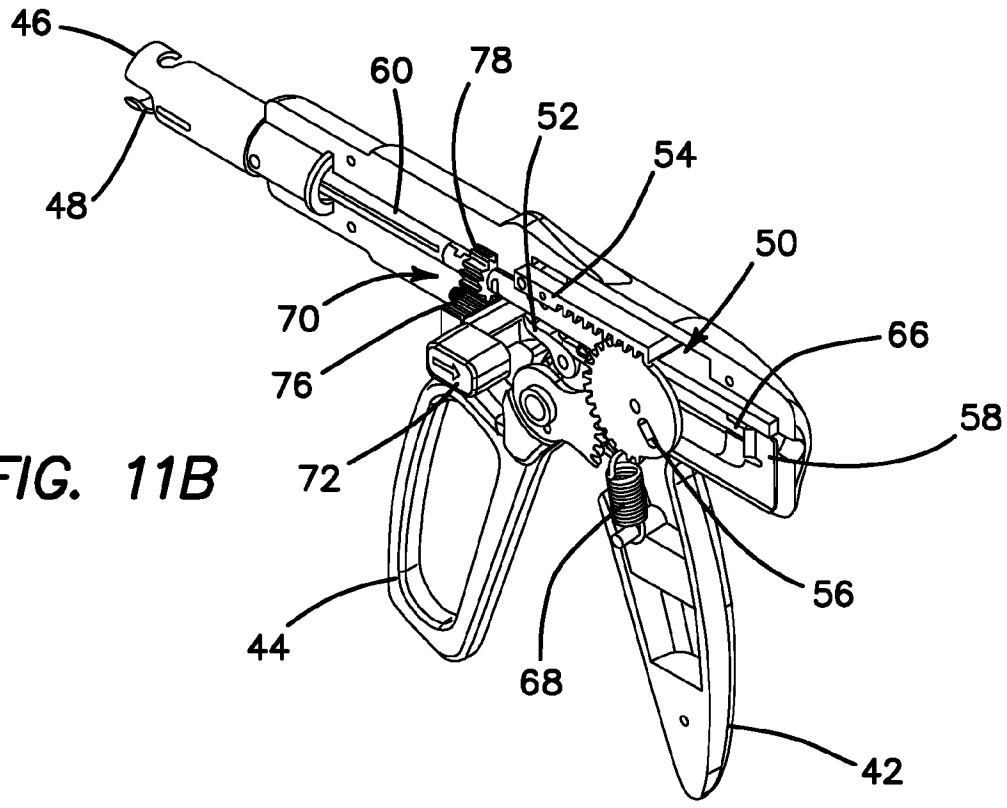


FIG. 11B

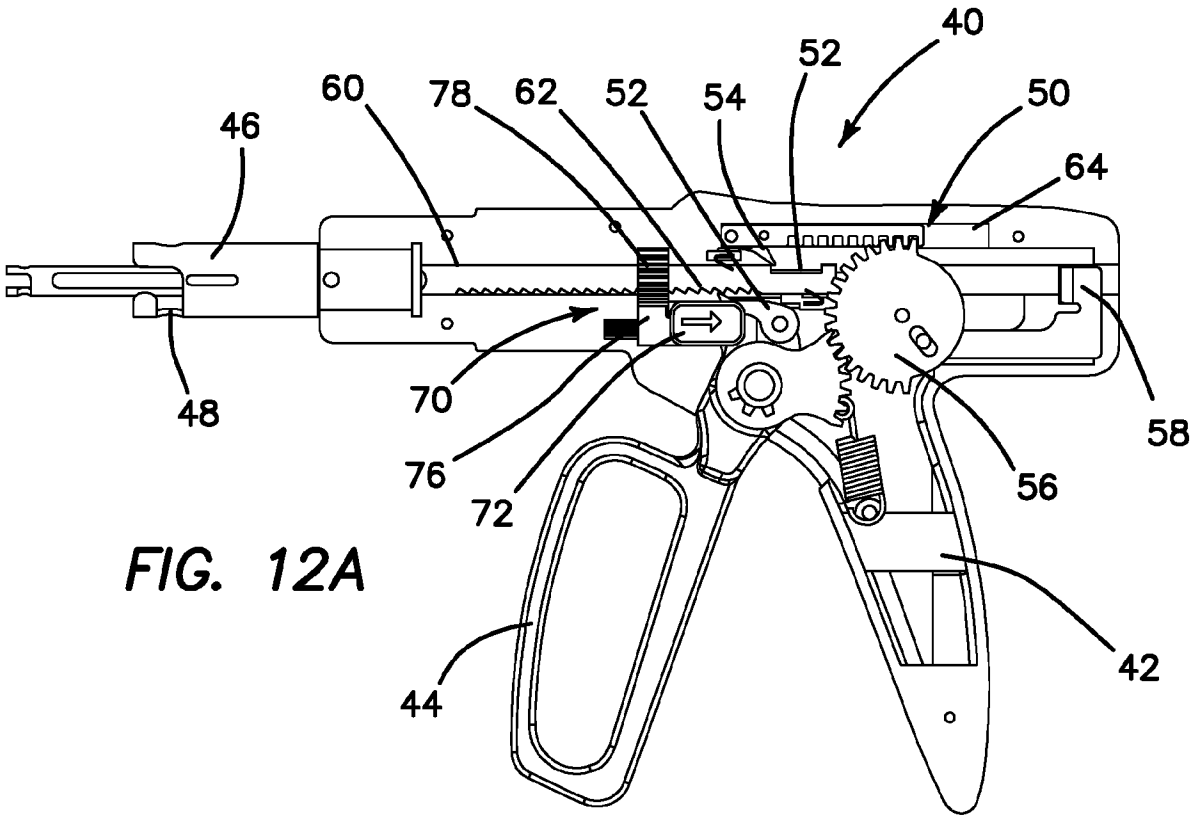


FIG. 12A

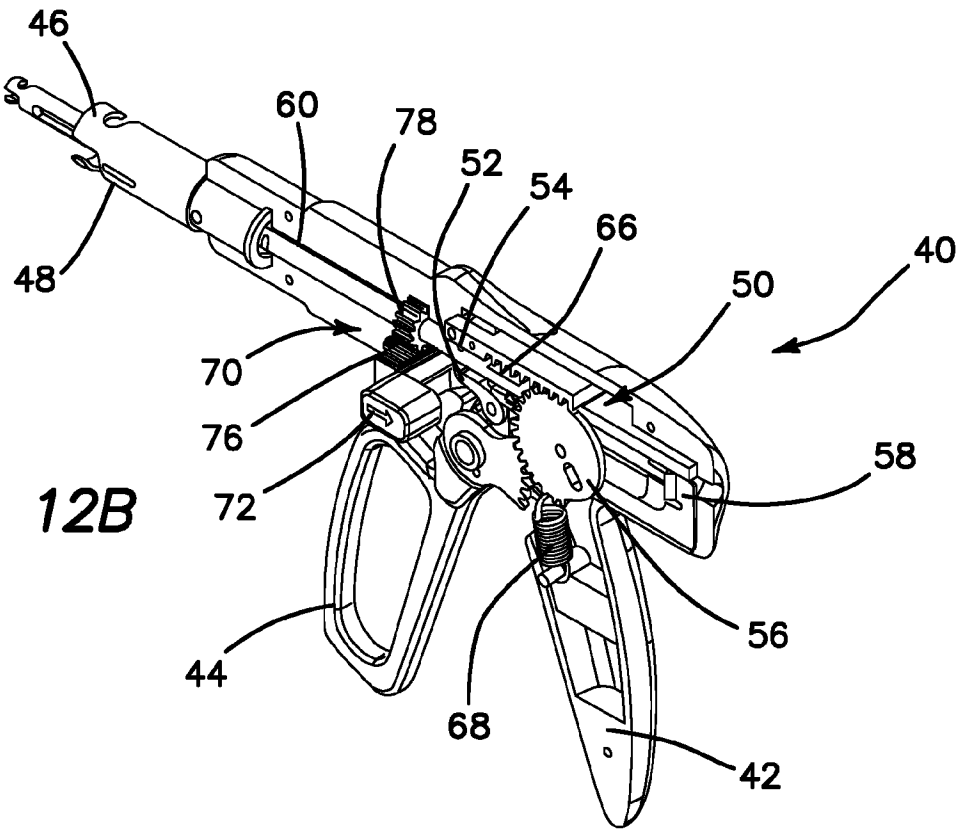


FIG. 12B

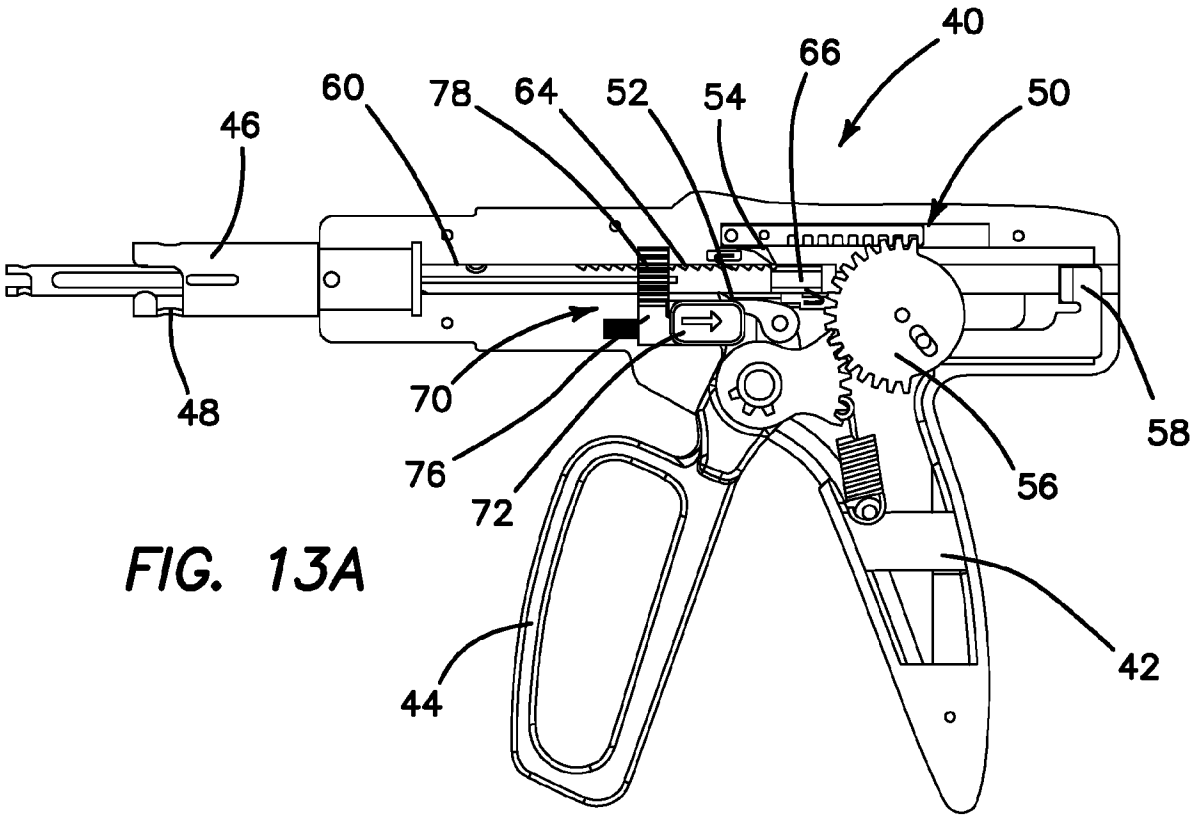


FIG. 13A

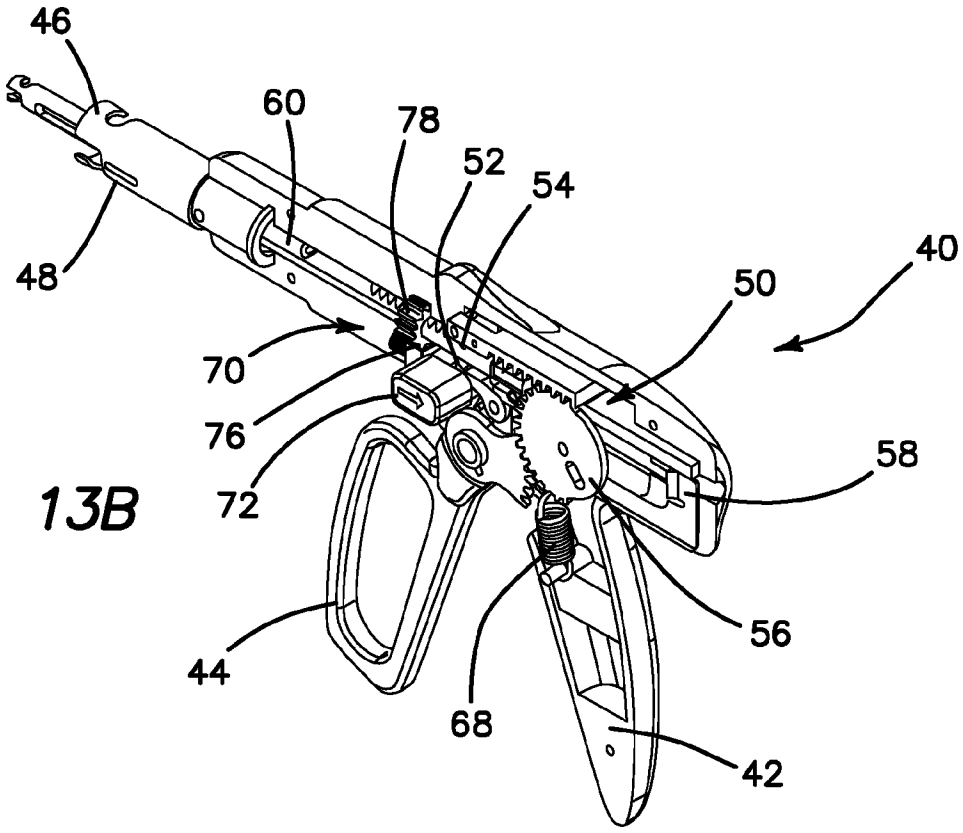


FIG. 13B

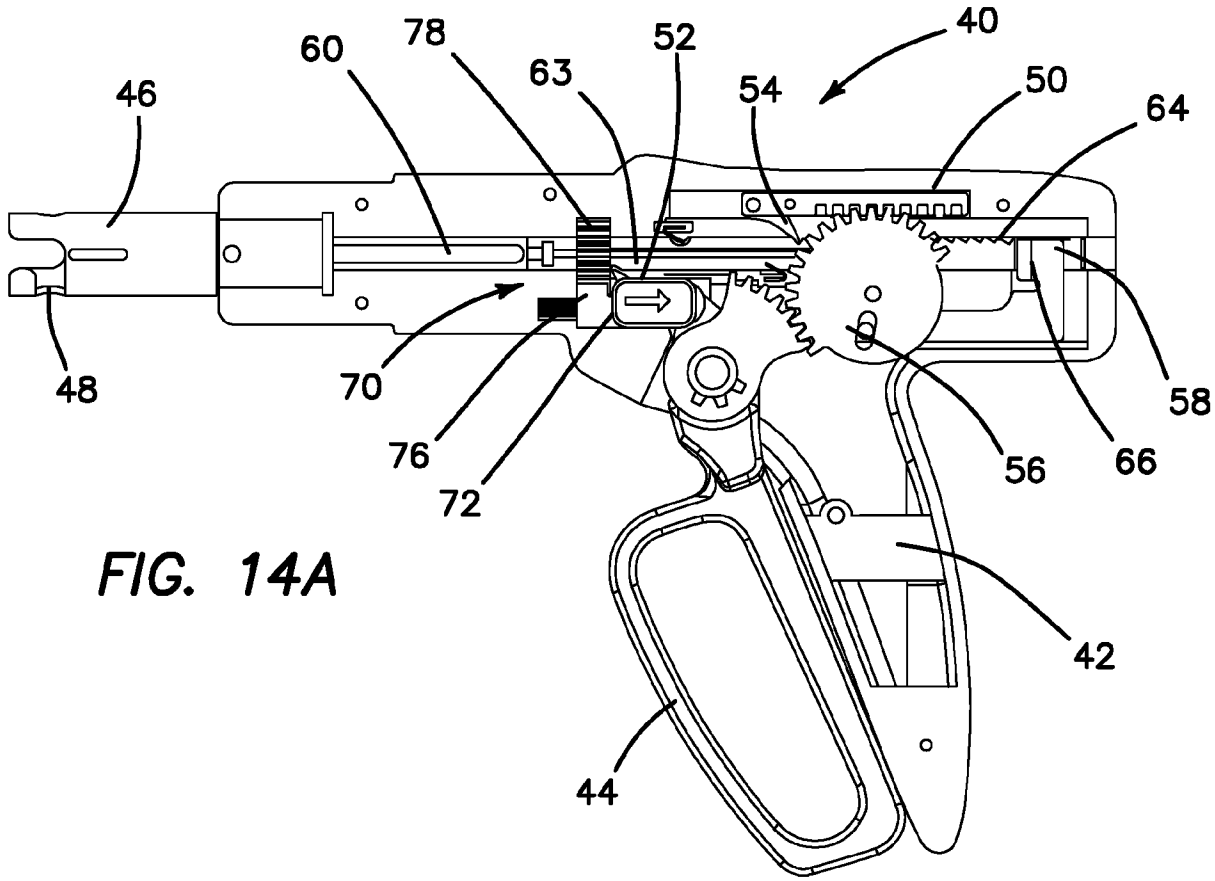


FIG. 14A

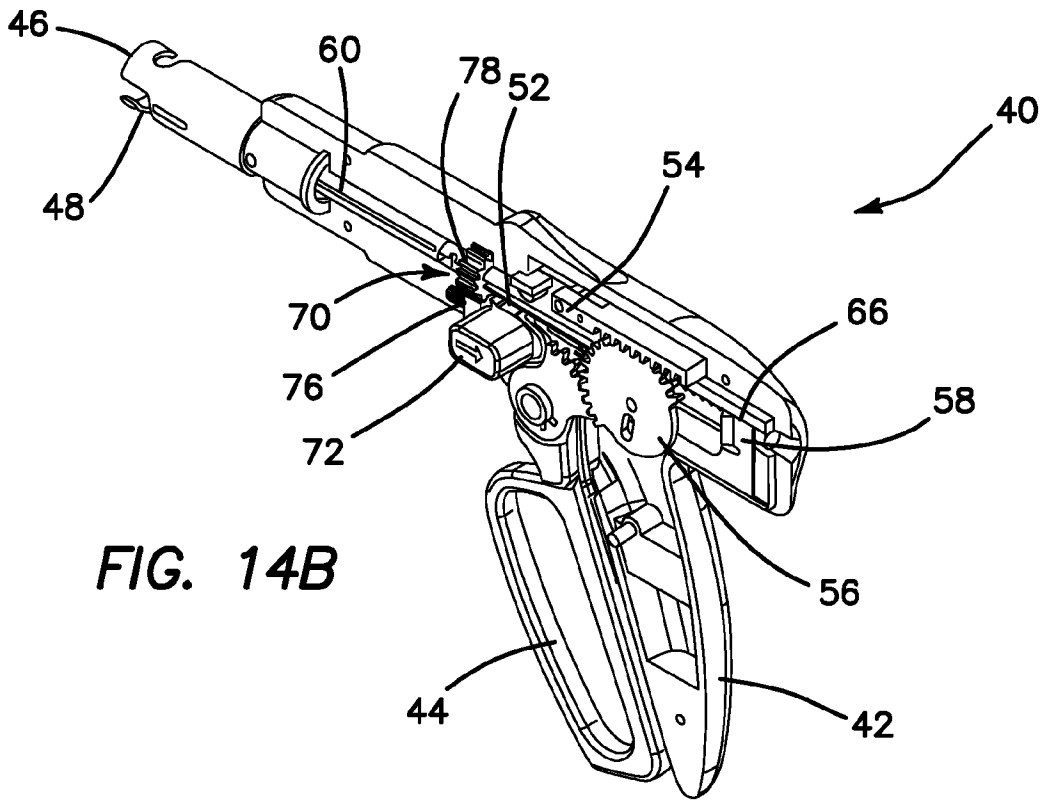


FIG. 14B

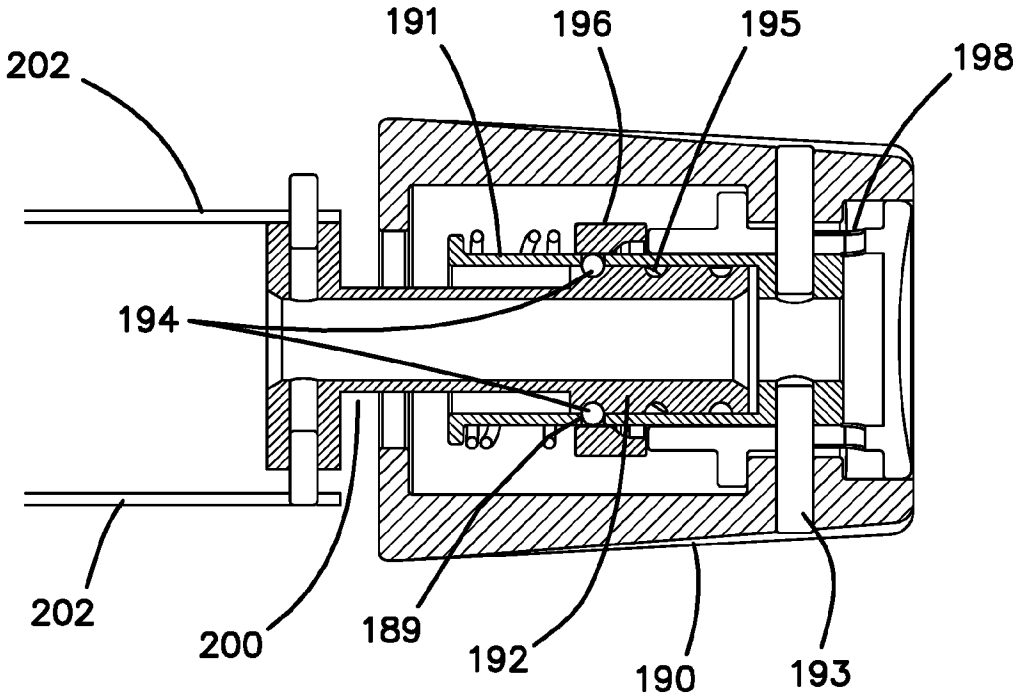

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FIG. 15

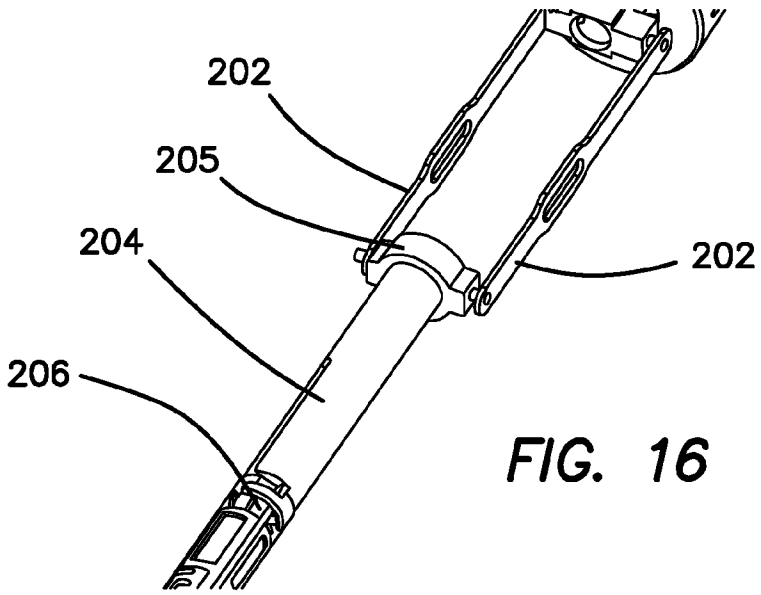

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FIG. 16

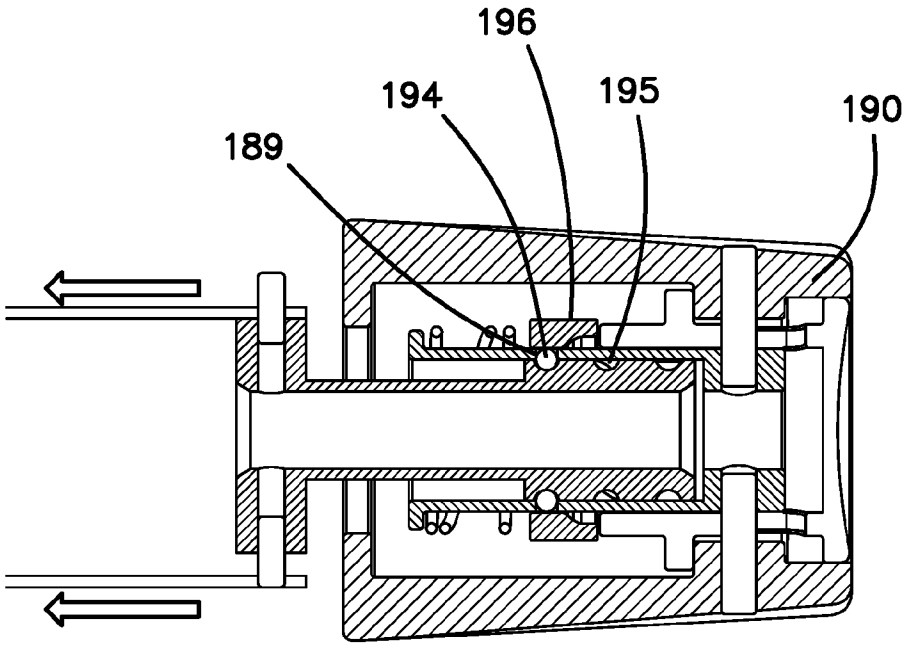


FIG. 17A

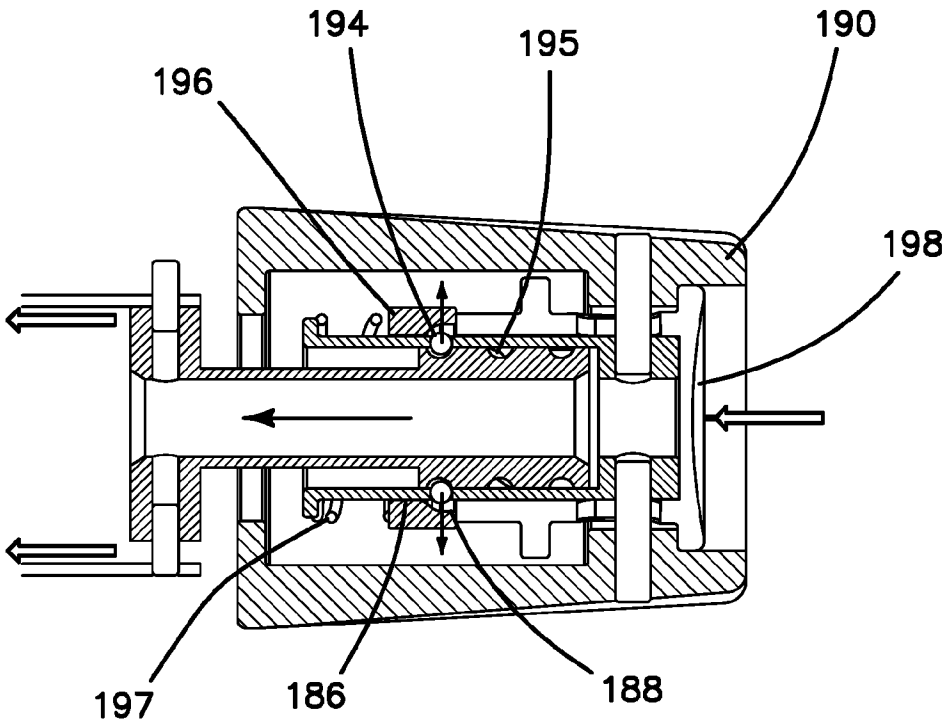


FIG. 17B

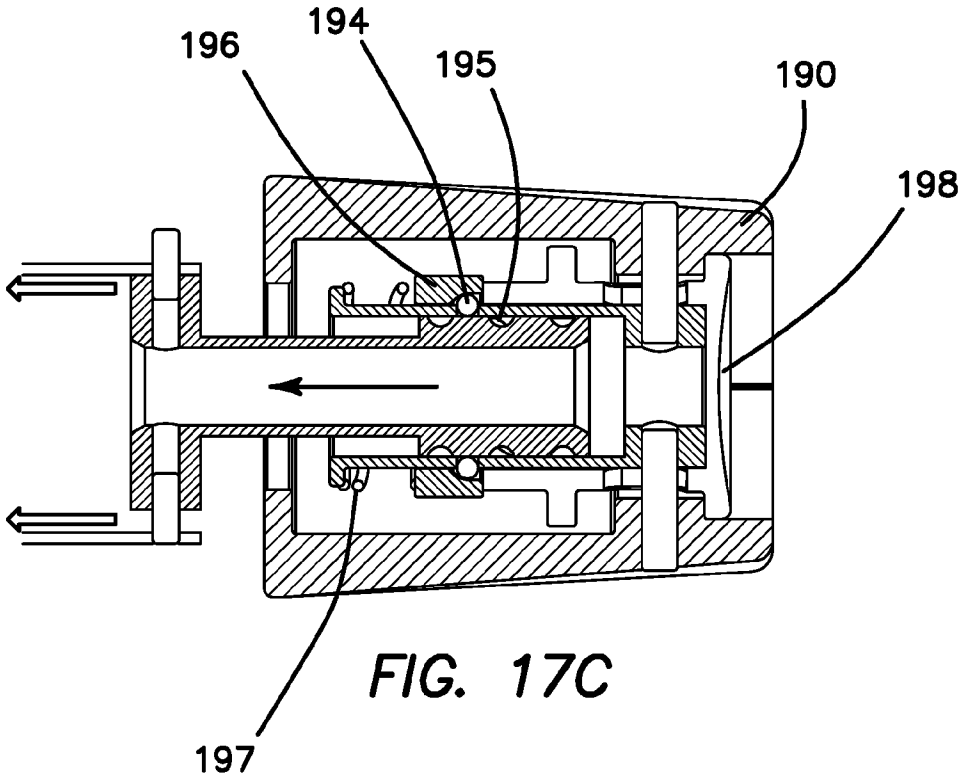


FIG. 17C

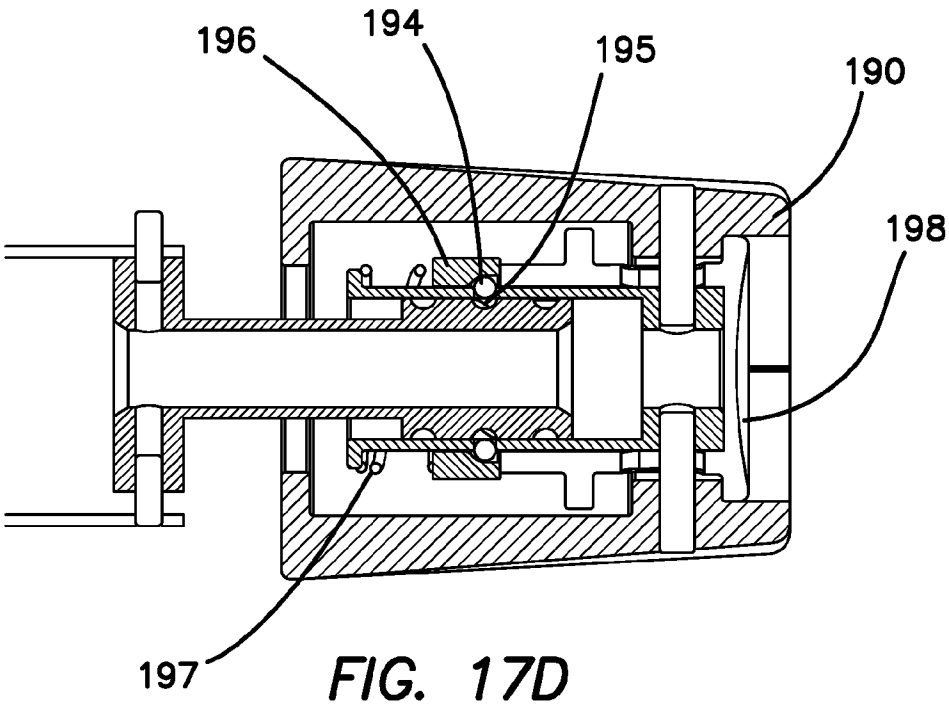


FIG. 17D

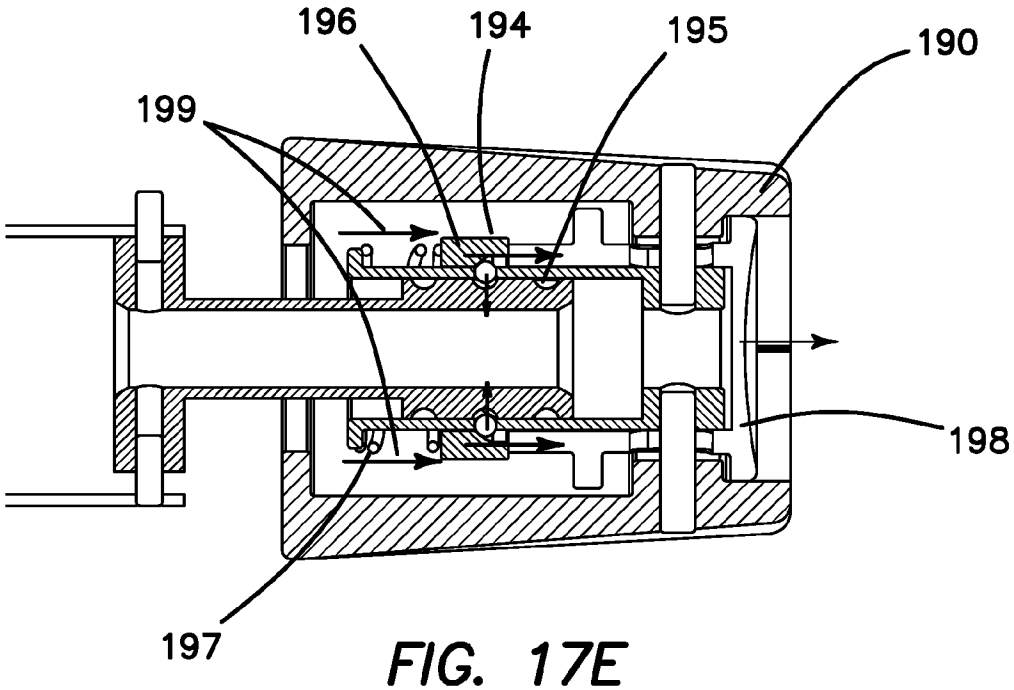


FIG. 17E

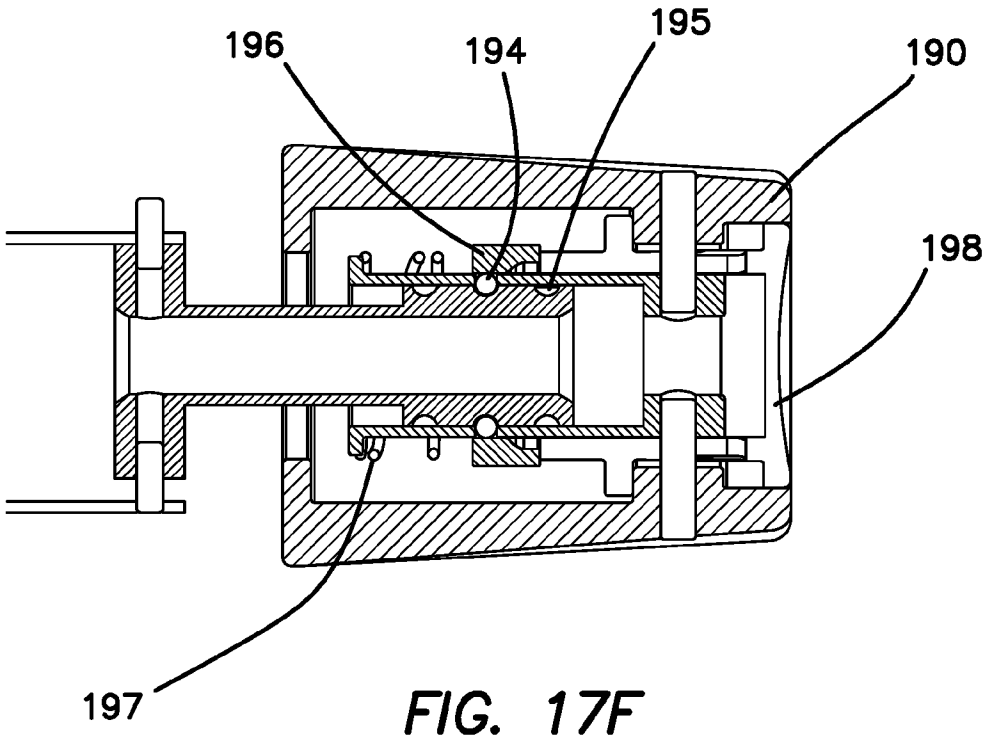


FIG. 17F

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2017/027142

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

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

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

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

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

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

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

see additional sheet

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

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

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

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

1-13(completely); 18, 19(partially)

Remark on Protest

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

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

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2017/027142

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B17/072
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61B

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 2012/078243 A1 (WORRELL BARRY C [US] ET AL) 29 March 2012 (2012-03-29) para. 97-107; figures 18-20 -----	1 2-7
A	EP 2 361 562 A1 (TYCO HEALTHCARE [US]) 31 August 2011 (2011-08-31) para. 92; figures 5, 7, 10-13 -----	1-7
A	EP 2 263 568 A2 (TYCO HEALTHCARE [US]) 22 December 2010 (2010-12-22) para. 113-116; figures 20-23 -----	1-7
	-/--	

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
26 June 2017	14/09/2017

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

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FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

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

1. claims: 1-13(completely); 18, 19(partially)

A handle assembly comprising:
a handle body;
an actuation shaft;
an articulation mechanism comprising:
a manually actuated articulation knob;
an articulation adapter;
and a ball screw.

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2. claims: 14-17, 20(completely); 18, 19(partially)

A handle assembly comprising:
a handle body;
an actuation mechanism;
an articulation mechanism comprising:
a manually actuated articulation knob;
an articulation adapter;
a first articulation link.
