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**Bhowmick et al.**

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(54) **MEDICAL DEVICE HANDLE ASSEMBLIES  
AND METHODS OF USING THE SAME**

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18, 2020.

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**A61B 17/00** (2006.01)  
**A61M 25/01** (2006.01)

(52) **U.S. Cl.**  
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**2017/00323** (2013.01); **A61B 2017/00367**  
(2013.01); **A61M 25/0136** (2013.01)

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25/0136; A61M 25/0138; A61M 25/0141;  
A61M 25/0144; A61M 25/0147

USPC ..... 606/130  
See application file for complete search history.

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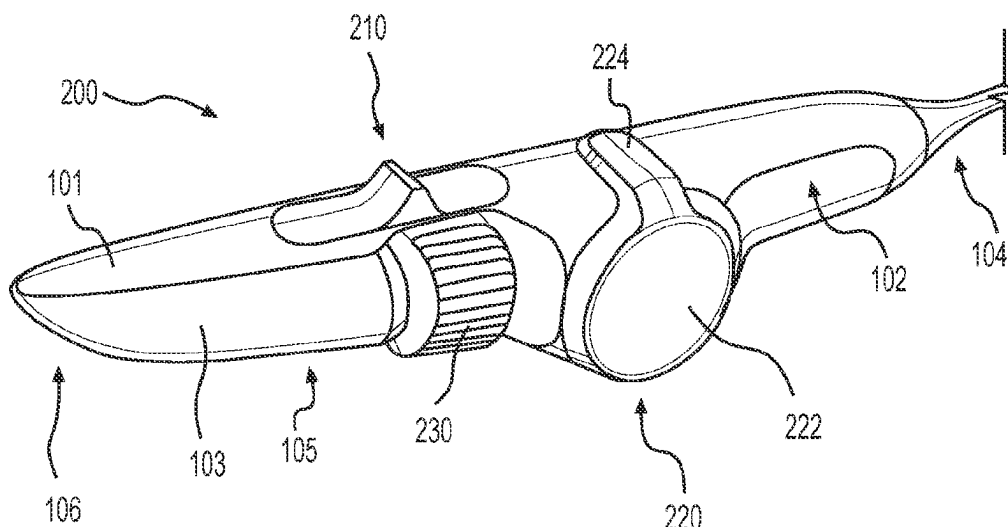
*Primary Examiner* — Aaron F Roane

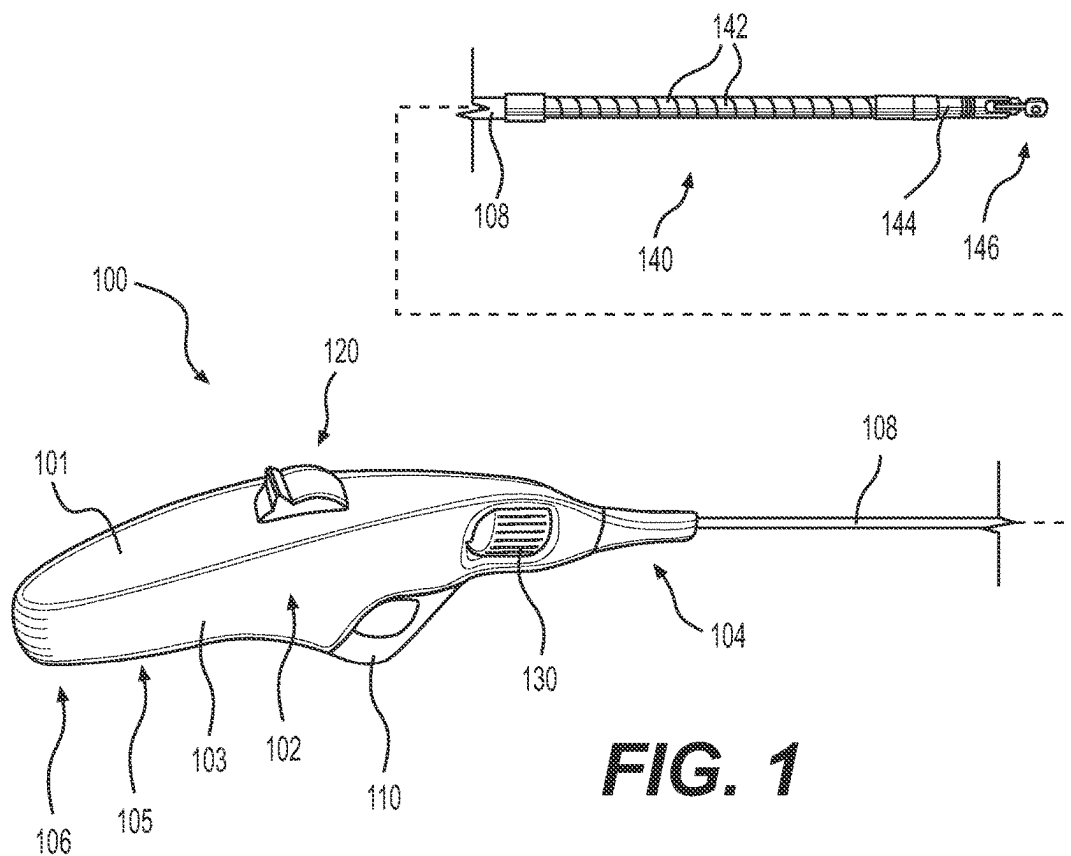
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PLLC

(57) **ABSTRACT**

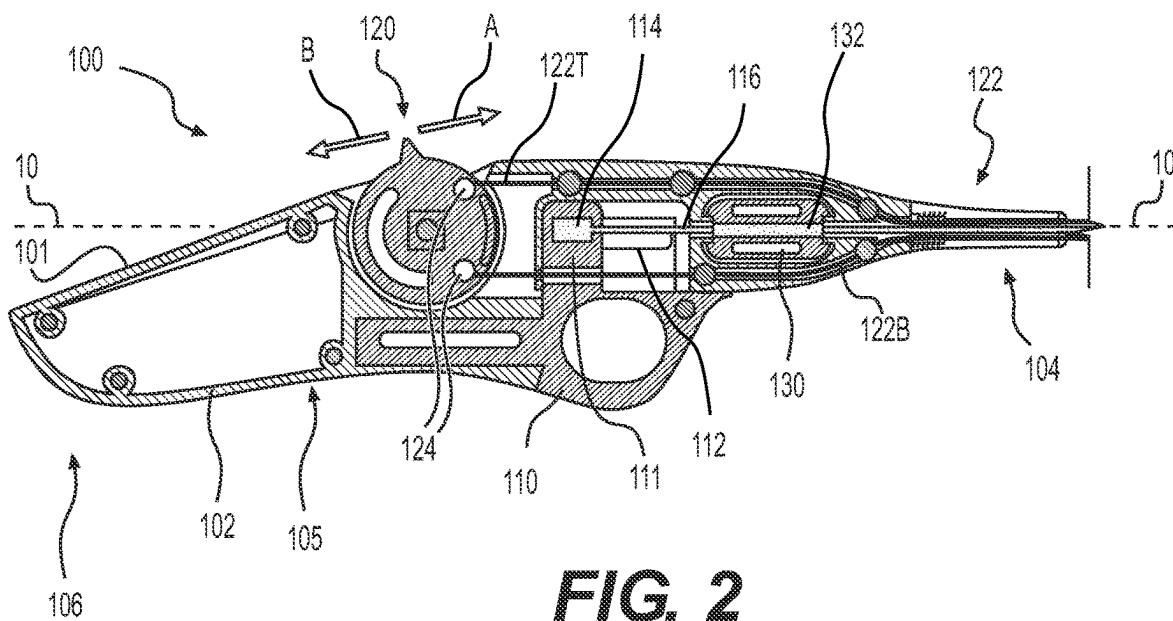
A medical device that includes a handle including a plurality of actuators. The handle defines a longitudinal axis extending through a distal end of the handle. The device includes a shaft extending from the handle and an end effector at a distal end of the shaft. A first actuator of the plurality of actuators is configured to actuate the end effector in response to translation of the first actuator relative to the handle along an axis parallel to the longitudinal axis. A second actuator of the plurality of actuators is configured to deflect the end effector relative to the shaft in response to pivoting the second actuator about an axis transverse to the longitudinal axis. A third actuator of the plurality of actuators is configured to rotate the end effector relative to the shaft in response to rotation of the third actuator relative to the handle about the longitudinal axis.

**20 Claims, 7 Drawing Sheets**

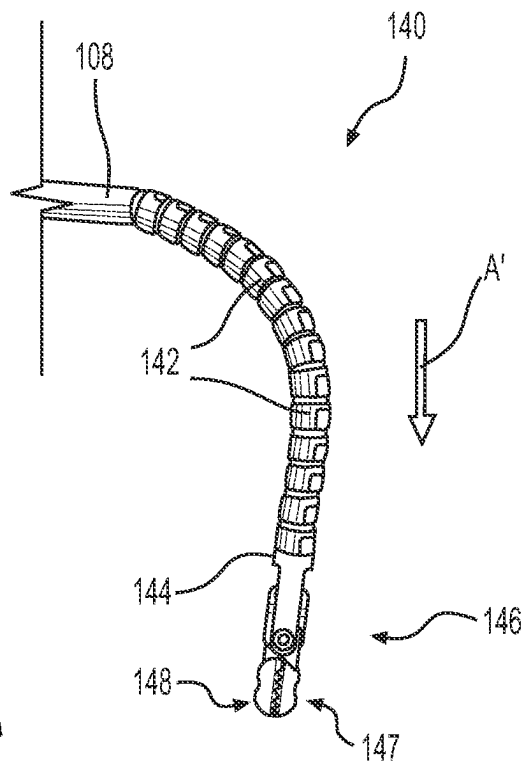




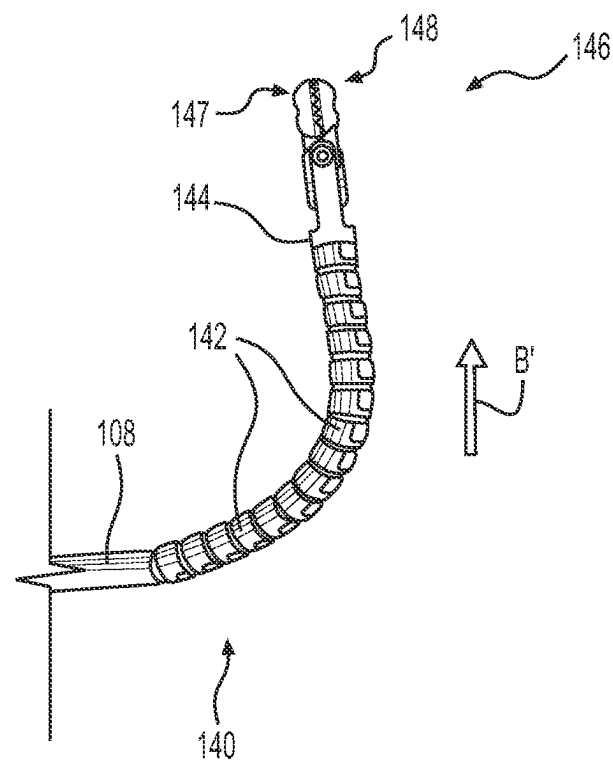
**FIG. 1**



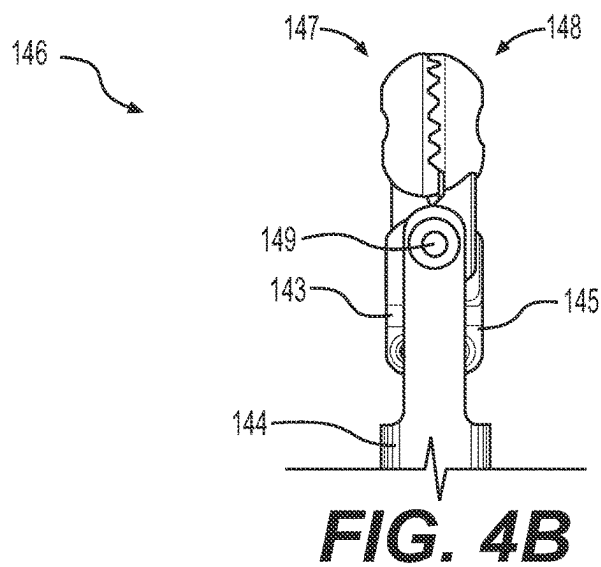
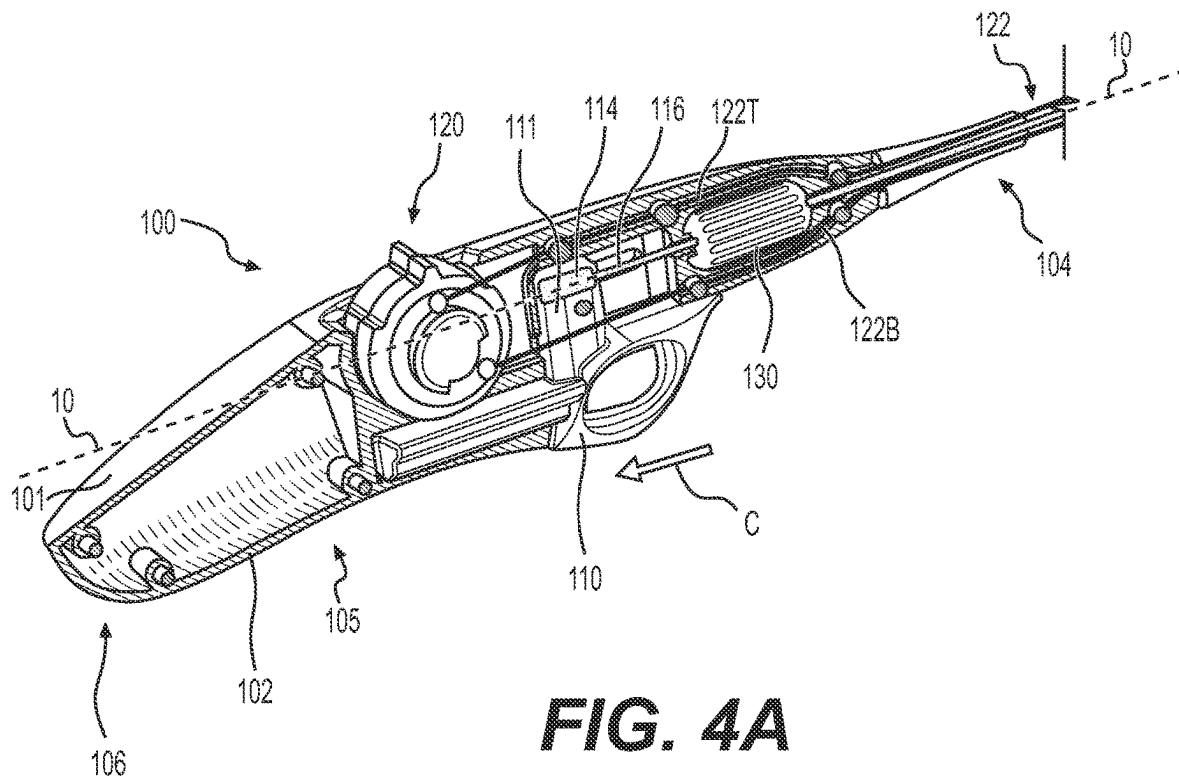
**FIG. 2**

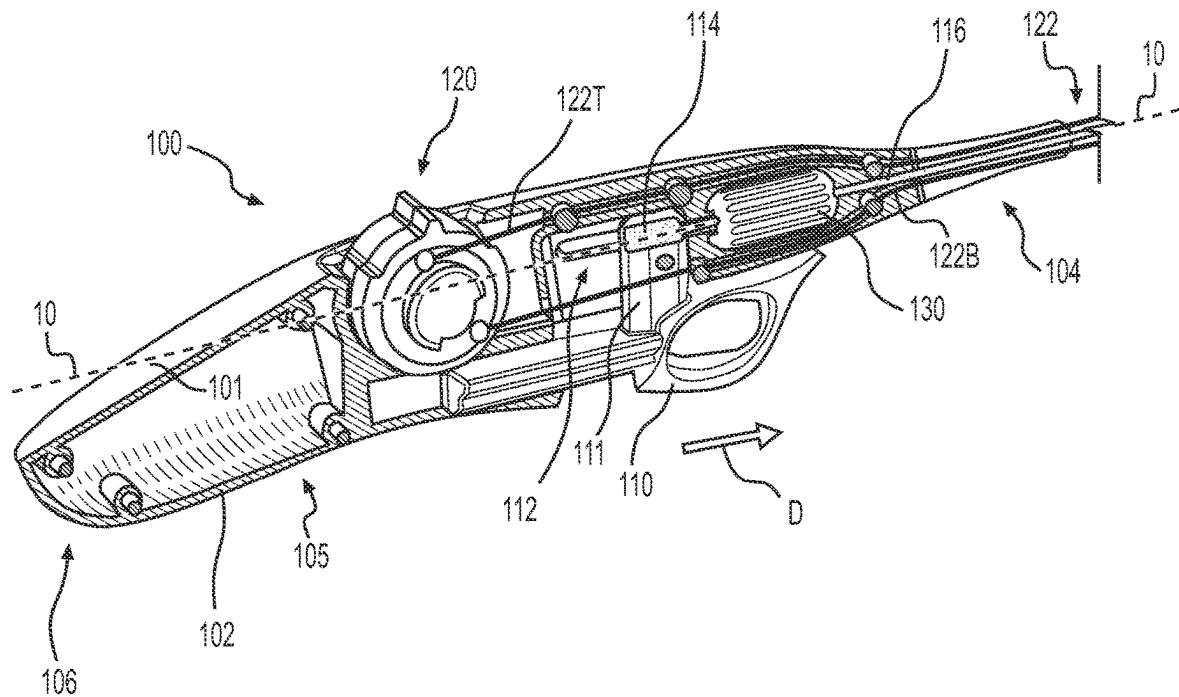


**FIG. 3A**

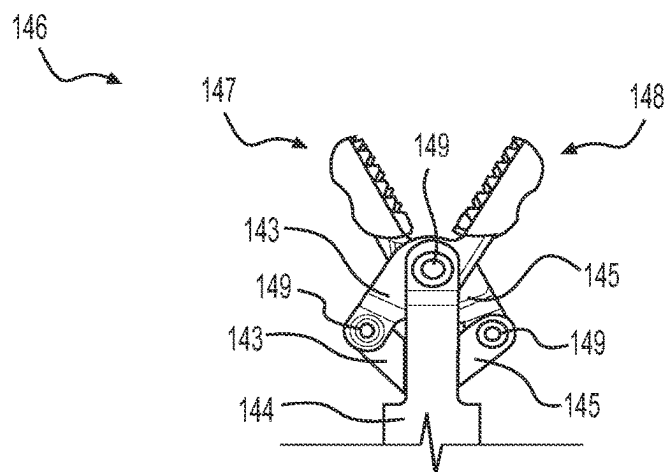


**FIG. 3B**

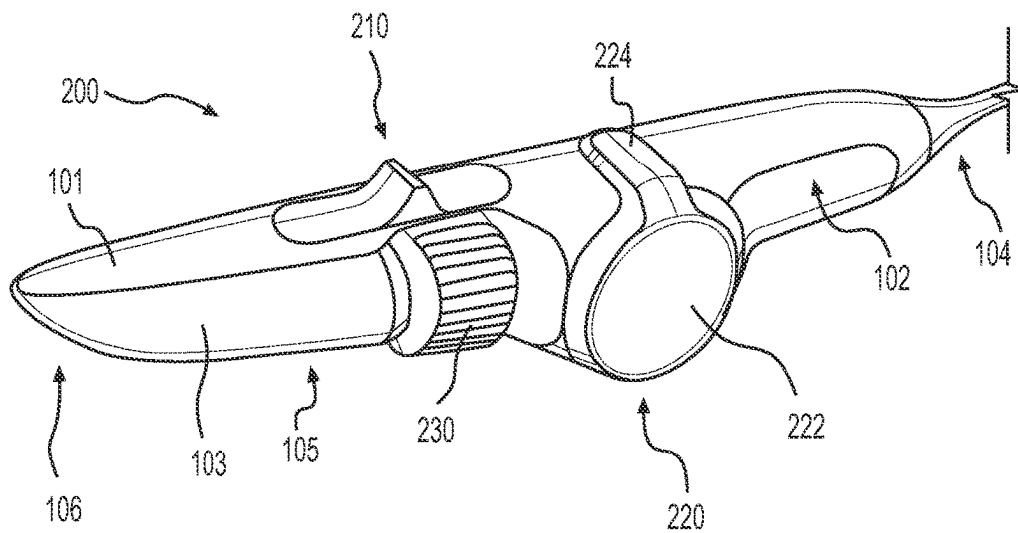




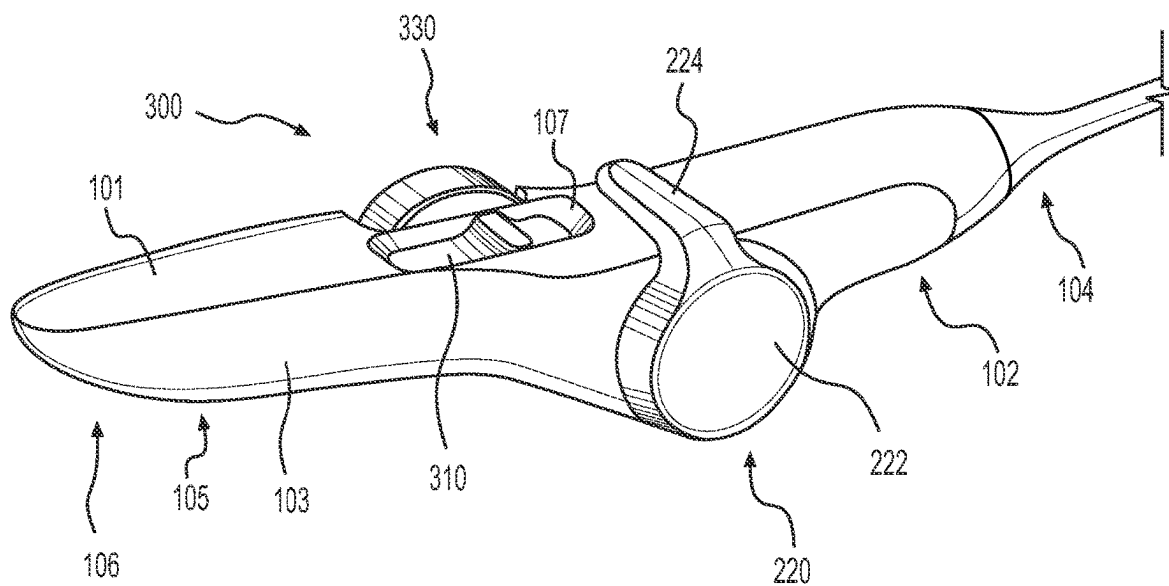
**FIG. 5A**



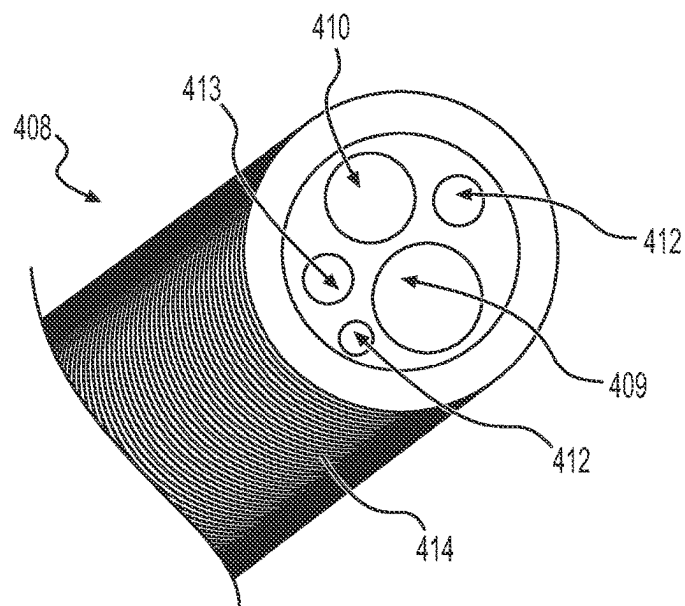
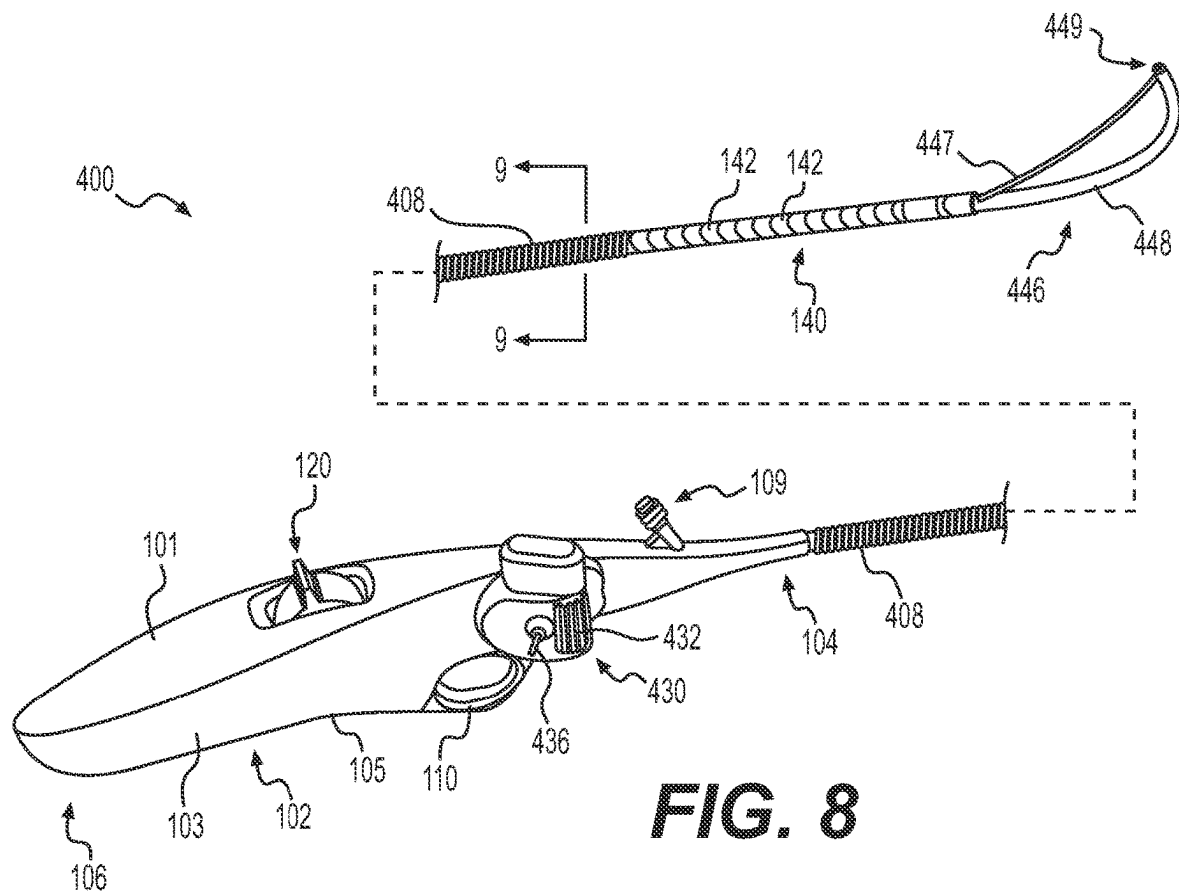
**FIG. 5B**



**FIG. 6**



**FIG. 7**



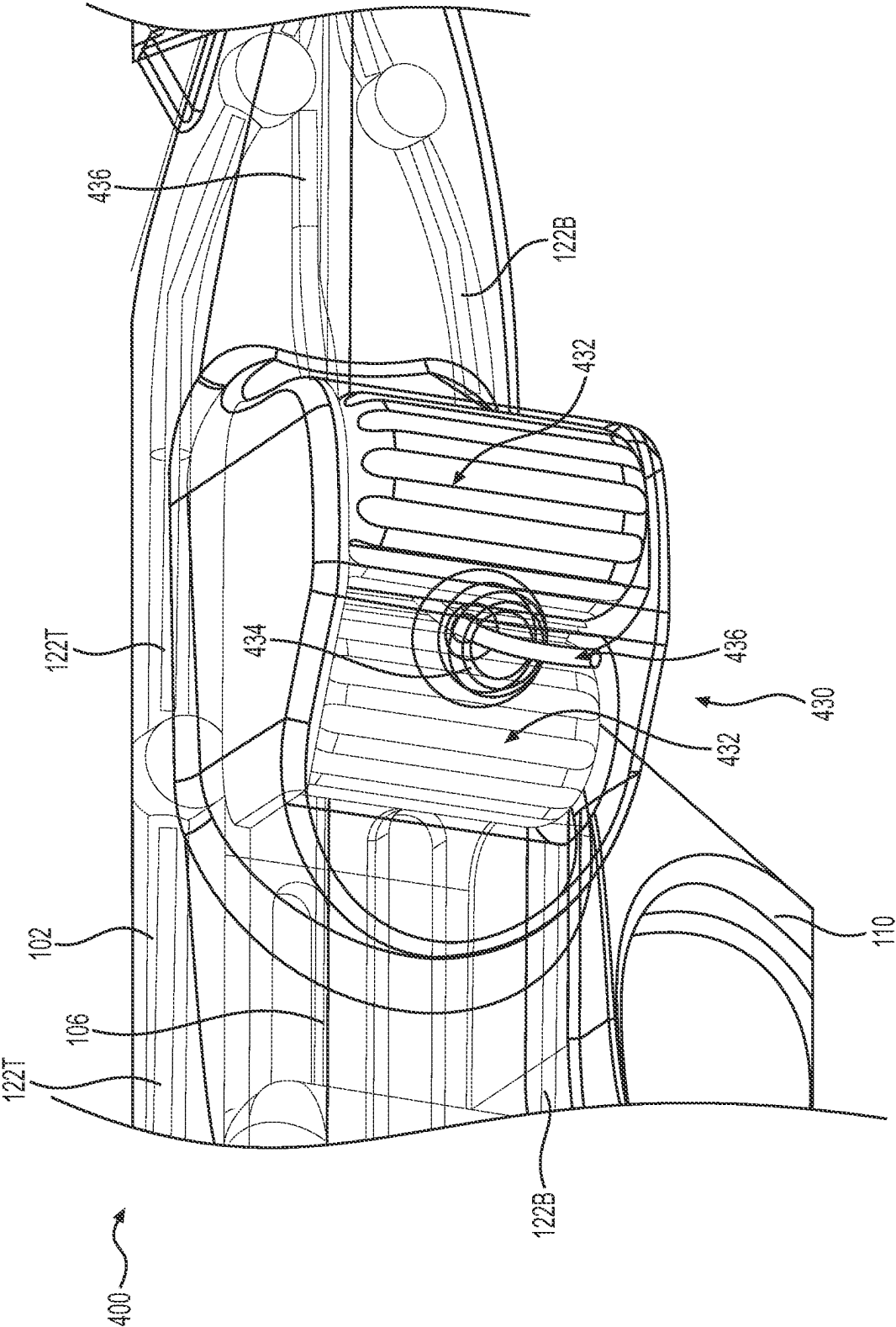


FIG. 10



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## MEDICAL DEVICE HANDLE ASSEMBLIES AND METHODS OF USING THE SAME

### CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. application Ser. No. 17/179,099, filed on Feb. 18, 2021, which claims the benefit of priority from U.S. Provisional Application No. 62/978,093, filed Feb. 18, 2020, each of which is incorporated by reference herein in its entirety.

### TECHNICAL FIELD

Various aspects of the disclosure relate generally to medical systems, devices, and related methods. More specifically, at least certain examples of the disclosure relate to systems, devices, and related methods for positioning and/or controlling one or more medical devices within a subject during a procedure via a handle assembly, among other aspects.

### BACKGROUND

Technological developments have given users of medical systems, devices, and methods, the ability to conduct increasingly complex procedures on subjects. One challenge in the field of minimally invasive surgeries such as endoscopy, laparoscopy, and thoracoscopy, among other surgical procedures, is associated with providing control of medical devices during a procedure. Placement of such medical devices within a subject (e.g., a patient) may be difficult. Additionally, actuating various medical systems that control a placement of such medical devices may be counterintuitive or complex to understand. The limitations on medical devices that facilitate access of other devices into a patient for placement may prolong the procedure, limit its effectiveness, and/or cause injury to the patient due to device failure or breakage. There is a need for devices and methods that address one or more of these difficulties or other related problems

### SUMMARY

Aspects of the disclosure relate to, among other things, systems, devices, and methods for accessing a target treatment site with a medical apparatus having intuitive handle assemblies that facilitate positioning of the apparatus, among other aspects. Each of the aspects disclosed herein may include one or more of the features described in connection with any of the other disclosed aspects.

According to an example, a medical device includes a handle including a plurality of actuators, wherein the handle defines a central longitudinal axis extending through a distal end of the handle. The medical device includes a shaft extending from the handle and an end effector at a distal end of the shaft. A first actuator of the plurality of actuators is configured to actuate the end effector in response to translation of the first actuator relative to the handle along an axis parallel to the central longitudinal axis. A second actuator of the plurality of actuators is configured to deflect the end effector relative to the shaft in response to pivoting the second actuator about an axis transverse to the central longitudinal axis. A third actuator of the plurality of actuators is configured to rotate the end effector relative to the shaft in response to rotation of the third actuator relative to the handle about the central longitudinal axis.

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Any of the medical devices described herein may have any of the following features. The first actuator of the plurality of actuators includes a trigger positioned along a bottom wall of the handle. The trigger is configured to translate along the bottom wall of the handle along the axis parallel to the central longitudinal axis of the handle. Further including an actuation wire coupled to and extending between the trigger and the end effector. At least a portion of the trigger is movably received within an inner slot of the handle and is coupled to the actuation wire. Actuating the trigger moves the trigger along the inner slot and the actuation wire along the shaft to actuate the end effector. The second actuator of the plurality of actuators includes a rocker with a protrusion positioned along a top wall of the handle. Further including a pair of drive wires coupled to and extending between the rocker and the distal end of the shaft. Actuating the rocker moves at least one of the pair of drive wires along the shaft to deflect the distal end of the shaft. The third actuator of the plurality of actuators includes a roller positioned along a sidewall of the handle. The handle includes one or more walls defining an exterior of the handle, wherein each of the first actuator, the second actuator, and the third actuator are positioned along different walls of the one or more walls of the handle. Further including an actuation wire coupled to and extending between the roller and the end effector, wherein actuating the roller rotates the actuation wire and the end effector relative to the shaft. The handle includes one or more walls defining an exterior of the handle, wherein the first actuator is positioned along a top wall of the handle, and the second actuator and the third actuator are positioned along a first sidewall of the handle. The second actuator extends at least partially over the top wall of the handle.

According to another example, a medical device includes a handle including an actuation wire and a drive wire, a shaft extending from the handle, and an end effector at a distal end of the shaft. The handle is configured to actuate the end effector in response to the actuation wire translating relative to and independent of the drive wire. The handle is configured to deflect the end effector relative to the shaft in response to the drive wire translating relative to and independent of the actuation wire. The handle is configured to rotate the end effector relative to the shaft in response to the actuation wire rotating relative to and independent of the drive wire.

Any of the medical devices described herein may have any of the following features. The handle includes a first actuator configured to actuate the end effector along a first plane, a second actuator configured to deflect the end effector along a second plane that is transverse to the first plane, and a third actuator configured to rotate the end effector and adjust the first plane relative to the second plane. The handle is configured to deflect the end effector in a downward direction relative to the shaft in response to a distal translation of the drive wire relative to the actuation wire. The handle is configured to deflect the end effector in an upward direction relative to the shaft in response to a proximal translation of the drive wire relative to the actuation wire. The handle includes an actuator that is configured to translate the actuation wire relative to the drive wire. The actuator transitions the end effector to an open configuration when translating the actuation wire in a first longitudinal direction, and transitions the end effector to a closed configuration when translating actuation wire in a second longitudinal direction that is opposite of the first longitudinal direction. The handle includes an actuator that is configured to translate the drive wire relative to the actuation wire. The

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actuator deflects the end effector upward relative to the shaft when translating the actuation wire in a first longitudinal direction, and deflects the end effector downward when translating actuation wire in a second longitudinal direction that is opposite of the first longitudinal direction.

According to another example, a medical device includes a shaft including a distal end and a proximal end, an end effector at the distal end of the shaft, and a handle at the proximal end of the shaft. The handle includes a first actuator that is movable in a first direction relative to the handle, wherein the first actuator is configured to actuate the end effector in response to moving the first actuator in the first direction. The handle includes a second actuator that is movable in a second direction relative to the handle, wherein the second actuator is configured to deflect the end effector relative to the shaft in response to moving the second actuator in the second direction. The handle includes a third actuator that is movable in a third direction relative to the handle, wherein the third actuator is configured to rotate the end effector relative to the shaft in response to moving the third actuator in the third direction. The first direction is parallel to a longitudinal axis of the handle, and the third direction is about the longitudinal axis of the handle.

It may be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the invention, as claimed.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate exemplary aspects of the disclosure and together with the description, serve to explain the principles of the disclosure.

FIG. 1 is a perspective view of an exemplary medical device having a handle assembly and an end effector, according to aspects of this disclosure;

FIG. 2 is a cross-sectional side view of the handle assembly of the medical device of FIG. 1, including an actuator, according to aspects of this disclosure;

FIG. 3A is a partial perspective view of the end effector of the medical device of FIG. 1 in a first articulated position, according to aspects of this disclosure;

FIG. 3B is a partial perspective view of the end effector of the medical device of FIG. 1 in a second articulated position, according to aspects of this disclosure;

FIG. 4A is a cross-sectional side view of the handle assembly of the medical device of FIG. 1, including an actuator in a first actuated state, according to aspects of this disclosure;

FIG. 4B is a partial side view of the end effector of the medical device of FIG. 1 in the first actuated state, according to aspects of this disclosure;

FIG. 5A is a cross-sectional side view of the handle assembly of the medical device of FIG. 1, with an actuator in a second actuated state, according to aspects of this disclosure;

FIG. 5B is a partial side view of the end effector of the medical device of FIG. 1 in the second actuated position, according to aspects of this disclosure;

FIG. 6 is a partial perspective view of another exemplary medical device including a handle assembly, according to aspects of this disclosure;

FIG. 7 is a partial perspective view of another exemplary medical device including a handle assembly, according to aspects of this disclosure;

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FIG. 8 is a perspective view of another exemplary medical device including a handle assembly and a coiled shaft, according to aspects of this disclosure;

FIG. 9 is a cross-sectional perspective view of the coiled shaft of FIG. 8, according to aspects of this disclosure; and

FIG. 10 is a partial perspective view of the handle assembly of FIG. 8 including an actuator with a guidewire disposed therein.

#### DETAILED DESCRIPTION

Examples of the disclosure include systems, devices, and methods for controlling multiple components of a medical device at a target site within the body, where the components generally require manipulation to access a target site, among other aspects. Reference will now be made in detail to aspects of the disclosure, examples of which are illustrated in the accompanying drawings. Wherever possible, the same or similar reference numbers will be used through the drawings to refer to the same or like parts. The term “distal” refers to a portion farthest away from a user when introducing a device into a patient. By contrast, the term “proximal” refers to a portion closest to the user when placing the device into the subject (e.g., patient). As used herein, the terms “comprises,” “comprising,” or any other variation thereof, are intended to cover a non-exclusive inclusion, such that a process, method, article, or apparatus that comprises a list of elements does not necessarily include only those elements, but may include other elements not expressly listed or inherent to such process, method, article, or apparatus. The term “exemplary” is used in the sense of “example,” rather than “ideal.” As used herein, the terms “about,” “substantially,” and “approximately,” indicate a range of values within  $\pm 10\%$  of a stated value.

Examples of the disclosure may be used to facilitate control and positioning of an end effector (tools/devices) of a medical device at a target treatment site by providing one or more mechanisms and/or assemblies for positioning said tools/devices at the target treatment site. Some examples combine a handle assembly on a medical device for selective control and/or manipulation of components of the medical device, such as, for example, an end effector. The medical device may include a plurality of actuators along the handle assembly that are independently movable relative to one another for controlling a position and/or orientation of the end effector. The handle assembly is configured such that actuation of the plurality of actuators of the handle assembly may provide a respective rotation, actuation, and/or deflection of the end effector relative to the handle assembly.

Examples of the disclosure may relate to devices and methods for performing various medical procedures and/or treating portions of the large intestine (colon), small intestine, cecum, esophagus, any other portion of the gastrointestinal tract, and/or any other suitable subject anatomy (collectively referred to herein as a “target treatment site”). The device and related methods may be used laparoscopically or endoscopically, or in any other open or minimally invasive procedure, including thoroscopic and ENT procedures. Reference will now be made in detail to examples of the present disclosure described above and illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

FIG. 1 shows a schematic depiction of an exemplary medical device 100 in accordance with an example of this disclosure. The medical device 100 may include a handle assembly 102 having a top wall 101, a pair of sidewalls 103,

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and a bottom wall **105**. In the example, the top wall **101**, the sidewalls **103**, and the bottom wall **105** of the handle assembly **102** extend between a distal end **104** and a proximal end **106** that define a longitudinal length of the handle assembly **102**. At least a portion of the longitudinal length of the handle assembly **102** (e.g., a distal portion proximate to the distal end **104**), as defined by the top wall **101**, the sidewalls **103**, and the bottom wall **105**, may define a central longitudinal axis **10** (FIG. 2) of the handle assembly **102**. In other embodiments, the handle assembly **102** may be defined by additional, fewer, and/or different walls than those shown and described herein, including, for example, a pair of curved sidewalls **103** that are coupled to one another. As described in further detail below, the handle assembly **102** may include one or more bends and/or angles formed along one or more of the top wall **101**, the sidewalls **103**, and the bottom wall **105** such that at least a portion of the longitudinal length of the handle assembly **102** (e.g., a proximal portion proximate to the proximal end **106**) may be transverse to the central longitudinal axis **10**.

In this instance, with at least a portion of the longitudinal length of the handle assembly **102** being transverse to the central longitudinal axis **10** of the handle assembly **102**, the top wall **101**, the sidewalls **103**, and the bottom wall **105** of the handle assembly **102** may be sized, shaped, and configured such that a hand of a user of the medical device **100** may form an ulnar deviation relative to a forearm of the user when manually grasping the handle assembly **102**. In other words, the handle assembly **102** includes a configuration with the top wall **101**, the sidewalls **103**, and the bottom wall **105** that positions a hand of a user of the medical device **100** at an angle relative to a forearm of the user when the handle assembly **102** is grasped by the hand of the user.

The medical device **100** may further include a shaft **108** extending distally from the distal end **104** of the handle assembly **102**, and an articulation joint **140** extending distally from a distal end of the shaft **108**. The shaft **108** of the medical device **100** may be flexibly deformable such that an orientation and/or a configuration of the shaft **108** may be adjustable. The shaft **108** may define a longitudinal axis extending between a proximal end of the shaft **108**, located adjacent to the handle assembly **102**, and a distal end of the shaft **108** located adjacent to the articulation joint **140** of the medical device **100**. In the example, the shaft **108** may be rotatably fixed relative to the handle assembly **102** and secured to, and/or coupled with, the articulation joint **140**. Accordingly, and as described in further detail herein, the shaft **108** of the medical device **100** is configured to move (e.g., rotate) the articulation joint **140** in response to rotation of the handle assembly **102**.

Still referring to FIG. 1, the medical device **100** may include one or more actuators **110**, **120**, **130** disposed along one or more exterior surfaces and/or walls of the handle assembly **102**. In the example, the medical device **100** includes a first (actuation) actuator **110** positioned along the bottom wall **105** of the handle assembly **102**, a second (articulation) actuator **120** positioned along the top wall **101** of the handle assembly **102**, and a third (rotation) actuator **130** positioned along one or more of the sidewalls **103** of the handle assembly **102**. The first (actuation) actuator **110** of the medical device **100** is configured to translate relative to the handle assembly **102**, such as, for example, in one or more directions (e.g., distally, proximally, etc.) parallel to the central longitudinal axis **10** of the handle assembly **102**. In the example, the first (actuation) actuator **110** is sized and shaped in the form of a trigger.

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The second (articulation) actuator **120** of the medical device **100** may be configured to pivot relative to the handle assembly **102**, such as, for example in one or more directions (e.g., distally, proximally, etc.) parallel to the central longitudinal axis **10** of the handle assembly **102**. In other words, the second (articulation) actuator **120** pivots about an axis (not shown) that is transverse (e.g., perpendicular) to the central longitudinal axis **10** of the handle assembly **102**. In the example, the second (articulation) actuator **120** may be a button/actuator that is sized and shaped in the form of a rocker, switch, a rotary slider, a knob and/or the like. For example, as shown in FIG. 1, the second (articulation) actuator **120** may comprise a rocker having a base wheel and one or more projections for secure placement of a user's thumb or fingers for actuation thereof. The second (articulation) actuator **120** may extend outwardly from the top wall **101** of the handle assembly **102** to facilitate access to the second (articulation) actuator **120** by a user of the medical device **100**. For example, the rocker of the second (articulation) actuator **120** may be at least partially rotatable and/or pivotable about an axis that is relatively transverse to the central longitudinal axis **10** (FIG. 2) of the handle assembly **102**. In the example, the projections of the second (articulation) actuator **120** may be movable in one or more directions that is at least relatively parallel to the central longitudinal axis **10**.

Still referring to FIG. 1, the third (rotation) actuator **130** may be configured to rotate (e.g., clockwise, counter-clockwise, etc.) relative to the handle assembly **102**, such as, for example, about an axis (not shown) that is collinear or parallel to the central longitudinal axis **10** of the handle assembly **102**. In the example, the third (rotation) actuator **130** is a button/actuator that is sized and shaped in the form of a roller, a drum, and/or the like. In some examples, the third (rotation) actuator **130** may extend laterally outward from at least one (or both) of the sidewalls **103** of the handle assembly **102** to facilitate access to the third (rotation) actuator **130** by a user of the medical device **100**. In other examples, the third (rotation) actuator **130** may be fully disposed within the handle assembly **102** and one or more of the sidewalls **103** of the handle assembly **102** may include a recess and/or opening that is sized, shaped, and aligned with a location of the third (rotation) actuator **130**. In this instance, the opening on the handle assembly **102** may be operable to facilitate access to the third (rotation) actuator **130** to a user of the medical device **100**.

It should be appreciated that additional and/or fewer actuators **110**, **120**, **130** may be included on various other walls **101**, **103**, **105** (and/or surfaces) of the handle assembly **102** without departing from the scope of this disclosure. It should further be understood that, in other examples, the actuators **110**, **120**, **130** may have various other configurations than those shown and described herein (see FIGS. 6-7). Additionally, the handle assembly **102** may include one or more actuators **110**, **120**, **130** that are any combination of an actuation, articulation, and/or rotation actuator. As described in further detail herein, the actuators **110**, **120**, **130** are configured and operable to actuate one or more components of the medical device **100**, such as, for example, an articulation joint **140** and/or an end effector **146**.

In embodiments, a position of the actuators **110**, **120**, **130** on the handle assembly **102** may be provided in an ergonomic manner such that the actuators **110**, **120**, **130** may be operable by a single hand of a user of the medical device **100**. For example, the actuators **110**, **120**, **130** may be positioned such that a first finger (e.g., an index finger) may operate the first (actuation) actuator **110**, a second finger

(e.g., a thumb) may operate the second (articulation) actuator **120**, and a third finger and/or at least one of the first or second fingers may operate the third (rotation) actuator **130**. In this instance, the medical device **100** may be operable to provide control of the handle assembly **102** with a single hand, thereby facilitating control of a second device (e.g., an endoscope, medical instrument, etc.) with another hand during a medical procedure.

Still referring to FIG. 1, the articulation joint **140** of the medical device **100** may include a plurality of articulation links **142** and a clevis **144**. The plurality of articulation links **142** may be sequentially aligned with one another and at least partially define a longitudinal length of the articulation joint **140**. In the example, the plurality of articulation links **142** are movably coupled to one another such that each of the plurality of articulation links **142** are configured to move (e.g., bend, pivot, deflect) relative to one another. In an unactuated state, a longitudinal length of the articulation joint **140**, defined by the plurality of articulation links **142**, may be substantially parallel to a longitudinal axis of the shaft **108**. As described above, a distal end of the shaft **108** may be positioned adjacent to and/or secured at a proximal end of the articulation joint **140**, such as, for example, a first (i.e., proximalmost) articulation link **142** of the plurality of articulation links **142**.

The clevis **144** may extend distally from and/or be coupled to a distal end of the articulation joint **140**, such as, for example, a last (i.e., distalmost) articulation link **142** of the plurality of articulation links **142**. The end effector **146** of the medical device **100** extends distally from a distal end of the clevis **144**. It should be appreciated that the end effector **146** of the medical device **100** may include various suitable components, including, but not limited to, one or more clamps, shears, forceps, suturing devices, lighting devices, imaging systems, grasper assemblies, and various other suitable tools and/or devices. Accordingly, the end effector **146** shown and described herein is merely provided for exemplary purposes and may include various other configurations without departing from the scope of this disclosure. With the end effector **146** and the clevis **144** of the medical device **100** positioned relatively distal of the articulation joint **140**, it should be understood that movement of the plurality of articulation links **142** may provide movement of the end effector **146** and the clevis **144** relative to at least a distal end of the shaft **108**.

Referring now to FIG. 2, the handle assembly **102** of the medical device **100** further includes a slot **112** formed within a cavity of the handle assembly **102**. Further, the first (actuation) actuator **110** may include a slider **111** that is sized, shaped, and configured to be slidably received within the slot **112** of the handle assembly **102**. The slider **111** may be configured and operable to translate relative to the handle assembly **102** along the slot **112** in response to translation of at least the portion of the first (actuation) actuator **110**. As described in greater detail herein, the slider **111** of the first (actuation) actuator **110** may include a cavity disposed therein that is sized and shaped to receive one or more components of the medical device **100** therein, such as, for example, at least a portion of an actuation wire **116**. The handle assembly **102** of the medical device **100** further includes a rotation joint **132** disposed along at least a portion of the third (rotation) actuator **130**. Accordingly, the rotation joint **132** is configured and operable to rotate relative to the handle assembly **102** in response to rotation of the third (rotation) actuator **130** within the handle assembly **102**. As described in further detail herein, the rotation joint **132** is

rotatably fixed relative to the third (rotation) actuator **130** and longitudinally translatable relative to the third (rotation) actuator **130**.

Still referring to FIG. 2, the third (rotation) actuator **130** may include a cavity that is sized and shaped in accordance with a configuration of the rotation joint **132** such that the rotation joint **132** may be received within the cavity of the third (rotation) actuator **130**. By way of illustrative example, the rotation joint **132** may include a rectangular (and/or cuboidal) shape and a cavity of the third (rotation) actuator **130** may be likewise rectangularly (and/or cuboidal) shaped, such that the corresponding configurations of the rotation joint **132** and the cavity of the third (rotation) actuator **130** may key and/or rotatably fix the rotation joint **132** to the third (rotation) actuator **130**, while permitting axial translation therebetween.

In this instance, the rotation joint **132** may be configured to translate through, along, and/or relative to the cavity of the third (rotation) actuator **130** and be inhibited from rotating independent of the third (rotation) actuator **130**. For example, due to the interaction between the edges, points, and/or contacts planes of the rotation joint **132** with one or more surfaces of the cavity of the third (rotation) actuator **130**, rotation of third (rotation) actuator **130** may result in likewise rotation of the rotation joint **132**. Additionally, due to the corresponding configurations of the rotation joint **132** and the cavity of the third (rotation) actuator **130**, axial advancement of the rotation joint **132** (e.g., as caused by actuation of first (actuation) actuator **110**) will not result in likewise advancement of third (rotation) actuator **130**. As described in detail herein, the rotation joint **132** may be monolithically formed with, and/or fixedly coupled to (e.g., immovable relative to), one or more components of the medical device **100**, such as, for example, an actuation wire **116**.

The medical device **100** may further include an actuation wire **116** and one or more drive wires **122** (e.g., top drive wire **122T**, bottom drive wire **122B**) disposed within the handle assembly **102**. In the example, the actuation wire **116** is secured and/or coupled to the slider **111** at a proximal end of the actuation wire **116**. For example, the actuation wire **116** includes a hub **114** at a proximal end of the actuation wire **116** that is sized and shaped in accordance with the cavity formed in the slider **111** of the first (actuation) actuator **110**, such that the hub **114** is received within the cavity of the slider **111**. It should be appreciated that the hub **114** may comprise an enlargement and/or protrusion positioned at a proximal end of the actuation wire **116**. In some examples, the hub **114** of the actuation wire **116** may be monolithically formed with, and/or fixedly coupled to (e.g., immovable relative to), the actuation wire **116**. Additionally, the hub **114** may be sized and shaped to be movable (e.g., rotatable) relative to the cavity of the slider **111** in which the hub **114** is disposed.

In other words, the slider **111** of the first (actuation) actuator **110** may include a cavity that is sized and shaped in accordance with a configuration of the hub **114** such that the hub **114** may be received within, and movable relative to, the cavity of the slider **111** of the first (actuation) actuator **110**. By way of illustrative example, the hub **114** may include a cylindrical shape and a cavity of the slider **111** may be cylindrically shaped such that movement (e.g., rotation) of the hub **114** relative to the cavity of the slider **111** is permitted.

The actuation wire **116** has a longitudinal length that extends through the handle assembly **102** and the shaft **108**. In the example, the actuation wire **116** extends through at

least a portion of the first (actuation) actuator 110 and the third (rotation) actuator 130. For example, the hub 114 of the actuation wire 116 is received in the slider 111 of the first (actuation) actuator 110 and through the rotation joint 132, which is disposed within the third (rotation) actuator 130. In this instance, the hub 114 is configured and operable to move (e.g., translate) the actuation wire 116 relative to the handle assembly 102 in response to, for example, translation of the first (actuation) actuator 110 and the slider 111 within the slot 112. Further, the rotation joint 132 is secured to and/or coupled with the actuation wire 116 such that the rotation joint 132 is configured and operable to move (e.g., rotate) the actuation wire 116 relative to the handle assembly 102 in response to, for example, rotation of the third (rotation) actuator 130 and the rotation joint 132.

Still referring to FIG. 2, with the hub 114 of the actuation wire 116 secured to and/or coupled with the slider 111, as described above, it should be understood that rotation of the rotation joint 132 may provide a simultaneous rotation of the hub 114 within the cavity of slider 111 of the first (actuation) actuator 110. Further, with at least a portion of the actuation wire 116 extending through and/or fixedly coupled to the rotation joint 132, as described above, it should be understood that translation of the slider 111, and the hub 114 disposed therein, may provide a simultaneous translation of the rotation joint 132 relative to the third (rotation) actuator 130. It should be appreciated that a longitudinal length of the rotation joint 132 is such that at least a portion of the rotation joint 132 may remain disposed within the third (rotation) actuator 130 during translation of the rotation joint 132 relative to the third (rotation) actuator 130. In this instance, rotation of the third (rotation) actuator 130 may provide rotation of the rotation joint 132 and the actuation wire 116 despite an extent of translation of the slider 111 relative to the slot 112.

Although not shown, it should be understood that the actuation wire 116 may extend through the shaft 108 of the medical device 100 and a second, distal end of the actuation wire 116 may be secured and/or coupled to the end effector 146 of the medical device 100. As described further herein, the actuation wire 116 is configured to actuate the end effector 146 of the medical device 100 in response to an actuation of the first (actuation) actuator 110. Additionally, the actuation wire 116 is further configured to rotate the end effector 146 relative to the shaft 108 and/or the articulation joint 140 in response to rotation of the third (rotation) actuator 130 relative to the handle assembly 102.

Still referring to FIG. 2, the handle assembly 102 includes a pair of drive wires 122 (e.g., top drive wire 122T, bottom drive wire 122B) secured and/or coupled to the second (articulation) actuator 120 within the handle assembly 102. In the example, a first, proximal end of each of the drive wires 122T, 122B is secured to the second (articulation) actuator 120 at respective connection points 124. The drive wires 122T, 122B have a longitudinal length that extend through the handle assembly 102. Although not shown, it should be understood that the drive wires 122T, 122B may extend through the shaft 108 of the medical device 100 and a second, distal end of each of the drive wires 122T, 122B may be secured and/or coupled to the articulation joint 140 of the medical device 100. For instance, a distal end of the drive wires 122T, 122B may be secured to a distalmost articulation link 142 of the plurality of articulation links 142, such as, for example, on opposing sides/portions of the distalmost articulation link 142. As described further herein, the pair of drive wires 122T, 122B are configured to articulate the articulation joint 140 of the medical device 100, such

as the plurality of articulation links 142, in response to actuation of the second (articulation) actuator 120.

Referring now to FIGS. 4B and 5B, in some embodiments, the end effector 146 of the medical device 100 includes a plurality of first links 143, a plurality of second links 145, a first jaw 147, and a second jaw 148. At least one of the plurality of first links 143 (i.e., a proximalmost first link 143) is movably coupled to the clevis 144 and at least one of the plurality of second links 145 (i.e., a proximalmost second link 145) is movably coupled to the clevis 144. At least one of the plurality of first links 143 (i.e., a distalmost first link 143) is movably coupled to a proximal end of the second jaw 148 and at least one of the plurality of second links 145 (i.e., a distalmost second link 145) is movably coupled to a proximal end of the first jaw 147. In other examples, the first links 143 and the second links 145 may be arranged such that at least one of the plurality of first links 143 (e.g., a distalmost first link 143) is movably coupled to a proximal end of the first jaw 147, and at least one of the plurality of second links 145 (e.g., a distalmost second link 145) is movably coupled to a proximal end of the second jaw 148.

As best seen in FIG. 5B, each of the plurality of first links 143 and each of the plurality of second links 145 may include a pivot joint 149 at opposing, terminal ends of the links 143, 145, respectively. Accordingly, each of the plurality of first links 143 may be movably (e.g., rotatably) coupled to one another at opposing ends of the first links 143 via respective pivot joints 149. Each of the plurality of second links 145 may be movably (e.g., rotatably) coupled to one another at opposing ends of the second links 145 via respective pivot joints 149. Further, the distalmost first link 143 is movably coupled to the second jaw 148 via the pivot point 149, and the distalmost second link 145 is movably coupled to the first jaw 147 via the pivot point 149.

In the example, the end effector 146 includes a pair of first links 143 and a pair of second links 145. Accordingly, the proximalmost first link 143 is movably coupled to the distalmost first link 143 by engaging the respective pivot joints 149 of each first link 143 to one another. The proximalmost second link 145 is movably coupled to the distalmost second link 145 by engaging the respective pivot joints 149 of each second link 145 to one another. It should be understood that the end effector 146 may include additional and/or fewer links 143, 145 than those shown and described herein without departing from the scope of this disclosure. The proximalmost first link 143 and the proximalmost second link 145 are secured to and/or coupled with a distal end of the actuation wire 116 at the respective pivot joints 149 of each link 143, 145.

It should be appreciated that the actuation wire 116 is coupled to the proximalmost links 143, 145 within and/or through the clevis 144. As described in greater detail below, movement of the actuation wire 116 (e.g., translation) relative to the handle assembly 102 and/or the shaft 108 may provide movement of the plurality of links 143, 145 (including the proximalmost links 143, 145, the distalmost links 143, 145, and the like). With the plurality of links 143, 145 coupled to the jaws 147, 148 of the end effector 146, movement of the actuation wire 116 may further provide movement of the pair of jaws 147, 148 relative to the clevis 144 and/or to one another.

According to an exemplary method of using the medical device 100, the medical device 100 may be used to treat a target treatment site within a subject by positioning the end effector 146 adjacently thereto. The medical device 100 may be used for various suitable procedures, including, but not

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limited to, endoluminal surgical procedures such as endoscopic mucosal resection (EMR), endoscopic submucosal dissection (ESD), pre-oral endoscopic myotomy (POEM), and the like. It should be understood that the steps of the exemplary method described herein, and the sequence in which they are presented, are merely illustrative such that additional and/or fewer steps may be included without departing from the scope of this disclosure. It should further be appreciated that the exemplary method of utilizing the medical device 100 described and shown herein may be employed for various other procedures and used with various medical systems, devices, instruments, and/or assemblies, such as, for example, an endoscope (e.g., duodenoscope).

Referring back to FIGS. 1-2, the medical device 100 may be actuated by moving (e.g., rotating) the third (rotation) actuator 130 to rotate the end effector 146 relative to the articulation joint 140, the shaft 108, and/or the handle assembly 102. For example, the third (rotation) actuator 130 may be rotated in a clockwise and/or counter-clockwise direction relative to the central longitudinal axis 10 of the handle assembly 102. In this instance, with the actuation wire 116 disposed within the handle assembly 102 and secured to and/or coupled with the third (rotation) actuator 130 via the rotation joint 132, the actuation wire 116 is rotated when the third (rotation) actuator 130 rotates. Accordingly, rotation of the third (rotation) actuator 130 in a direction may provide a simultaneous rotation of the end effector 146 relative to and independent of the articulation joint 140, the shaft 108, and/or the handle assembly 102 as the end effector 146 is coupled to a distal end of the actuation wire 116. In other instances, the shaft 108 and/or the articulation joint 140 may be rotated with the end effector 146 of the medical device 100 in response to a rotation of the handle assembly 102 by a user of the medical device 100.

Further, the medical device 100 may be actuated by moving (e.g., pivoting) the second (articulation) actuator 120 to articulate the articulation joint 140. For example, the second (articulation) actuator 120 may be pivoted in a first (distal) direction A and/or a second (proximal) direction B relative to the handle assembly 102 of the medical device 100. In this instance, with the pair of drive wires 122 disposed within the handle assembly 102 and secured to the second (articulation) actuator 120 at the connection points 124, the drive wires 122 are actuated when the second (articulation) actuator 120 moves, thereby articulating the articulation joint 140. For example, movement of the second (articulation) actuator 120 in the first (distal) direction A may provide a proximal retraction (e.g., pulling) of at least one of the drive wires 122, and a simultaneous relaxation and/or distal extension of the other drive wire 122.

As described above, with each of the pair of drive wires 122T, 122B secured to opposing sides/portions of the distalmost articulation link 142 of the plurality of articulation links 142 (e.g., adjacent to the clevis 144), the articulation joint 140 is operable to articulate (e.g., bend, pivot, deflect, etc.) in a direction of the drive wire 122T, 122B that is retracted (i.e., pulled) proximally. In this instance, upon the second (articulation) actuator 120 being pivoted in the first (distal) direction A, the drive wire 122B positioned along a lower/bottom portion of the second (articulation) actuator 120 is tensioned and thereby pulled proximally relative to the opposing drive wire 122T positioned along an upper/top portion of the second (articulation) actuator 120. Accordingly, the top drive wire 122T is relaxed and/or extended distally relative to the bottom drive wire 122B.

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As seen in FIG. 3A, the plurality of articulation links 142 of the articulation joint 140 is articulated in the direction A' relative to the central longitudinal axis 10 of the handle assembly 102 and/or the shaft 108. As a result of pivoting the second (articulation) actuator 120 in the first (distal) direction A, the end effector 146 is moved in accordance with an articulation of the articulation joint 140 in a downward direction relative to the central longitudinal axis 10 of the handle assembly 102 and/or the shaft 108. Additionally and/or alternatively, the medical device 100 may be actuated by moving (e.g., pivoting) the second (articulation) actuator 120 in the second (proximal) direction B relative to the handle assembly 102 to articulate the articulation joint 140. In this instance, the drive wires 122T, 122B are actuated such that at least one of the drive wires 122T, 122B is retracted (i.e., pulled) proximally while the other drive wire 122T, 122B is relaxed and/or extended distally. As described above, the articulation joint 140 is operable to articulate (e.g., bend, pivot, deflect, etc.) in a direction of the drive wire 122T, 122B that is retracted (pulled) proximally. In this instance, the drive wire 122T, 122B positioned relative to the handle assembly 102 along an upper/top portion of the second (articulation) actuator 120 (e.g., the top drive wire 122T) is tensioned and thereby pulled proximally relative to the opposing drive wire 122T, 122B positioned along a lower/bottom portion of the second (articulation) actuator 120 (e.g., the bottom drive wire 122B).

Accordingly, the bottom drive wire 122B is relaxed and/or extended distally relative to the top drive wire 122T. As seen in FIG. 3B, the plurality of articulation links 142 of the articulation joint 140 is articulated in the direction B' relative to the central longitudinal axis 10 of the handle assembly 102 and/or the shaft 108. As a result of pivoting the second (articulation) actuator 120 in the second (proximal) direction B, the end effector 146 is moved in accordance with an articulation of the articulation joint 140 in an upward direction relative to the central longitudinal axis 10 of the handle assembly 102 and/or the shaft 108. In other examples, the second (articulation) actuator 120 and/or the pair of drive wires 122T, 122B may be configured such that actuation of the second (articulation) actuator 120 may provide lateral (e.g., left/right) articulation (e.g., deflection) of the end effector 146 relative to the articulation joint 140 and/or the shaft 108 of the medical device 100.

Referring now to FIGS. 4A-4B, the medical device 100 may be further actuated by actuating the first (actuation) actuator 110 to actuate the end effector 146. For example, the first (actuation) actuator 110 may be moved (e.g., translated) in a first (proximal) direction C relative to the handle assembly 102. In this instance, the slider 111 of the first (actuation) actuator 110 received within the slot 112 may be moved to a proximal, terminal end of the slot 112. With the hub 114 of the actuation wire 116 secured to and/or coupled with the first (actuation) actuator 110 within the slider 111, the actuation wire 116 may simultaneously translate with the first (actuation) actuator 110 in the first (proximal) direction C relative to the handle assembly 102.

In this instance, the actuation wire 116 moves proximally and pulls the plurality of first links 143 and the plurality of second links 145 in the first (proximal) direction C. In response, the plurality of links 143, 145 may move (e.g., pivot) about the respective pivot points 149 and relative to one another to move the pair of jaws 147, 148 relative to one another to a closed configuration. In other words, a proximal retraction of the actuation wire 116 moves the plurality of links 143, 145 toward one another thereby closing the pair of jaws 147, 148 relative to each other.

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Additionally and/or alternatively, referring now to FIGS. 5A-5B, the medical device **100** may be actuated by moving the first (actuation) actuator **110** in a second (distal) direction **D** relative to the handle assembly **102**. In this instance, the slider **111** of the first (actuation) actuator **110** received within the slot **112** may be moved to a distal, terminal end of the slot **112**. With the hub **114** of the actuation wire **116** secured to and/or coupled with the first (actuation) actuator **110** at the slider **111**, the actuation wire **116** may simultaneously translate with the first (actuation) actuator **110** in the second (distal) direction **D** relative to the handle assembly **102**.

In this instance, the actuation wire **116** may move distally and push the plurality of first links **143** and the plurality of second links **145** in the second (distal) direction **D**. In response, the plurality of links **143**, **145** may move (e.g., pivot) about the respective pivot points **149** and relative to one another to move the pair of jaws **147**, **148** outwardly relative to one another to an open configuration. In other words, a distal extension of the actuation wire **116** moves the plurality of links **143**, **145** away from one another thereby permitting the pair of jaws **147**, **148** to move outwardly (open) relative to each other.

Referring now to FIG. 6, another exemplary medical device **200** is schematically depicted in accordance with an example of this disclosure. Except as otherwise described below, the medical device **200** may be substantially similar to the medical device **100** described above, respectively, such that the same components are identified via the same reference numerals and/or similar components are identified via similar reference numerals plus the value of **100**. Accordingly, it should be understood that the medical device **200** may be configured and operable like the medical device **100** except for the differences explicitly noted herein. For example, the medical device **200** may include the handle assembly **102**, the shaft **108** (see FIG. 1), the articulation joint **140**, and/or the end effector **146** (see FIG. 1).

As described above, the medical devices shown and described herein may include additional and/or fewer actuators positioned along various walls **101**, **103**, **105** (and/or surfaces) of the handle assembly **102**. Further, the actuators of this disclosure may have various sizes, shapes, and/or configurations. For example, the medical device **200** includes one or more actuators **210**, **220**, **230** disposed along one or more walls **101**, **103**, **105** of the handle assembly **102**, and that are configured to actuate one or more components of the medical device **200**, such as, for example, an articulation joint **140** and/or an end effector **146**. As described in detail above, the one or more actuators **210**, **220**, **230** may be disposed on the handle assembly **102** in an ergonomic manner to facilitate control of the medical device **200** with a single hand of a user.

In the example, the medical device **200** includes a first (actuation) actuator **210** positioned along the top wall **101** of the handle assembly **102**, a second (articulation) actuator **220** positioned along at least a portion of the top wall **101** and at least one of the sidewalls **103** of the handle assembly **102**, and a third (rotation) actuator **230** positioned along at least one of the sidewalls **103** of the handle assembly **102**. In this instance, the second (articulation) actuator **220** and the third (rotation) actuator **230** may be positioned along the same sidewall **103** of the handle assembly **102**, however, it should be understood that in other examples the second (articulation) actuator **220** and the third (rotation) actuator **230** may be positioned along opposing sidewalls **103** of the handle assembly (see FIG. 7).

Still referring to FIG. 6, the first (actuation) actuator **210** of the medical device **200** is configured to translate relative

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to the handle assembly **102**, such as, for example, in one or more directions (e.g., distally, proximally, etc.) parallel to the central longitudinal axis **10** of the handle assembly **102**. In the example, the first (actuation) actuator **210** is a button/actuator that is sized and shaped in the form of a slidable switch that extends outwardly from the top wall **101** of the handle assembly **102**. The second (articulation) actuator **220** of the medical device **200** is configured to translate, pivot, and/or rotate relative to the handle assembly **102**, such as, for example in one or more directions (e.g., distally, proximally, etc.) parallel to the central longitudinal axis **10** of the handle assembly **102**.

For example, the second (articulation) actuator **220** may include a rocker **222** disposed along the sidewall **103** of the handle assembly **102** and a lever **224** disposed along the top wall **101** of the handle assembly **102**. In the example, the rocker **222** and the lever **224** of the second (articulation) actuator **220** are integrally formed such that the rocker **222** and the lever **224** form a unitary structure. Accordingly, the rocker **222** of the second (articulation) actuator **220** is configured to rotate along the sidewall **103** about an axis (not shown) that is transverse (e.g., perpendicular) to the central longitudinal axis **10** of the handle assembly **102**. Further, the lever **224** of the second (articulation) actuator **220** is configured to translate and/or pivot along the top wall **101** of the handle assembly **102**. In the example, rocker **222** of the second (articulation) actuator **220** extends laterally outward from an exterior surface of the sidewall **103** of the handle assembly **102** and the lever **224** extends laterally outward from an exterior surface of the top wall **101** of the handle assembly **102**.

Still referring to FIG. 6, the third (rotation) actuator **230** is configured to rotate (e.g., clockwise, counter-clockwise, etc.) along the sidewall **103** of the handle assembly **102** and about an axis (not shown) that is parallel to the central longitudinal axis **10** of the handle assembly **102**. In the example, the third (rotation) actuator **230** is a button/actuator that is sized and shaped in the form of a roller. Further, the third (rotation) actuator **230** extends at least partially outward along the top wall **101** and the bottom wall **105** of the handle assembly **102** such that the third (rotation) actuator **230** is at least partially accessible along the top wall **101**, the sidewall **103**, and the bottom wall **105** of the handle assembly **102**.

It should be understood that the actuators **210**, **220**, **230** of the medical device **200** are configured and operable identical to the actuators **110**, **120**, **130** of the medical device **100** shown and described above, respectively. Accordingly, the actuators **210**, **220**, **230** of the medical device **200** may actuate the articulation joint **140** and/or the end effector **146** of the medical device **200** in a substantially similar manner as the actuators **110**, **120**, **130** of the medical device **100** described in greater detail above. It should be appreciated that the medical device **200** may include additional and/or fewer actuators **210**, **220**, **230** on various other walls **101**, **103**, **105** (and/or surfaces) of the handle assembly **102** without departing from the scope of this disclosure. It should further be understood that, in other examples, the actuators **210**, **220**, **230** of the medical device **200** may have various other suitable configurations than those shown and described herein.

Referring now to FIG. 7, another exemplary medical device **300** is schematically depicted in accordance with an example of this disclosure. Except as otherwise described below, the medical device **300** may be substantially similar to the medical device **100**, **200** described above, respectively, such that the same components are identified via the

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same reference numerals and/or similar components are identified via similar reference numerals plus the value of 100. Accordingly, it should be understood that the medical device **300** may be configured and operable like the medical device **100**, **200** except for the differences explicitly noted herein. For example, the medical device **300** may include the handle assembly **102**, the shaft **108** (see FIG. 1), the articulation joint **140** (see FIG. 1), the end effector **146** (see FIG. 1), and/or the second (articulation) actuator **220**.

In the example, the medical device **300** includes a first (actuation) actuator **310** positioned along the top wall **101** of the handle assembly **102** and a third (rotation) actuator **330** positioned along at least one of the sidewalls **103** of the handle assembly **102**. In this instance, the second (articulation) actuator **220** and the third (rotation) actuator **330** may be positioned along opposing sidewalls **103** of the handle assembly **102**. The first (actuation) actuator **310** of the medical device **300** is configured to translate relative to the handle assembly **102**, such as, for example, in one or more directions (e.g., distally, proximally, etc.) parallel to the central longitudinal axis **10** of the handle assembly **102**. In the example, the first (actuation) actuator **310** is a button that is sized and shaped in the form of a slidable switch that is disposed within a recess **107** formed along the top wall **101** of the handle assembly **102**.

Still referring to FIG. 7, the third (rotation) actuator **330** is configured to rotate (e.g., clockwise, counter-clockwise, etc.) along the sidewall **103** of the handle assembly **102** and about an axis (not shown) that is transverse (e.g., perpendicular) to the central longitudinal axis **10** of the handle assembly **102**. In the example, the third (rotation) actuator **330** is a button/actuator that is sized and shaped in the form of a roller. Further, the third (rotation) actuator **330** extends at least partially outward along at least the top wall **101** of the handle assembly **102** such that the third (rotation) actuator **330** is at least partially accessible along the top wall **101** and the sidewall **103** of the handle assembly **102**.

It should be understood that the first (actuation) actuator **310** and the third (rotation) actuator **330** of the medical device **300** are configured and operable identical to the first (actuation) actuators **110**, **210** and the third (rotation) actuators **130**, **230** of the medical devices **100**, **200** shown and described above, respectively. Accordingly, the actuators **310**, **330** of the medical device **300** may actuate the articulation joint **140** and/or the end effector **146** of the medical device **300** in a substantially similar manner as the first (actuation) actuators **110**, **210** and the third (rotation) actuators **130**, **230** of the medical devices **100**, **200** described in greater detail above. It should be appreciated that the medical device **300** may include additional and/or fewer actuators **310**, **220**, **330** on various other walls **101**, **103**, **105** (and/or surfaces) of the handle assembly **102** without departing from the scope of this disclosure. It should further be understood that, in other examples, the actuators **310**, **220**, **330** of the medical device **300** may have various other suitable configurations than those shown and described herein.

Referring now to FIG. 8, another exemplary medical device **400** is schematically depicted in accordance with an example of this disclosure. Except as otherwise described below, the medical device **400** may be substantially similar to the medical device **100**, **200**, **300** described above, respectively, such that the same components are identified via the same reference numerals and/or similar components are identified via similar reference numerals plus the value of 100. Accordingly, it should be understood that the medical device **400** may be configured and operable like the medical device **100**, **200**, **300** except for the differences

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explicitly noted herein. For example, the medical device **400** may include the handle assembly **102** and the articulation joint **140**.

The handle assembly **102** of the medical device **400** includes the first (actuation) actuator **110**, the second (articulation) actuator **120**, and a third (guidewire) actuator **430**. The third (guidewire) actuator **430** is positioned along at least one of the sidewalls **103** of the handle assembly **102**. The third (guidewire) actuator **430** includes one or more rollers **432** configured to rotate about an axis that is transverse to the central longitudinal axis **10** of the handle assembly **102** (see FIG. 1). As described further herein, the third (guidewire) actuator **430** is configured and operable to actuate one or more components of the medical device **400**, such as, for example, a guidewire **436**. In the example, the handle assembly **102** further includes an irrigation port **109** disposed along the top wall **101** that is in fluid communication with one or more lumens of the handle assembly **102** and/or one or more other components of the medical device **400** (e.g., a working channel of a shaft **408**).

Still referring to FIG. 8, the medical device **400** may include a coiled shaft **408** extending distally from the distal end **104** of the handle assembly **102**, with the articulation joint **140** positioned at a distal end of the coiled shaft **408**. Further, the medical device **400** may include an end effector **446** positioned at a distal end of the articulation joint **140**. The end effector **446** of the medical device **400** may extend distally from the distalmost articulation link **142** of the articulation joint **140**. Further, the end effector **446** may include an extension line **447**, a tubular member **448**, and a distal opening **449**. In the example, the extension line **447** and the tubular member **448** may include a nonlinear (e.g., curved) configuration such that the distal opening **449** of the end effector **446** is positioned at least partially transverse to a proximal end of the end effector **446**.

The tubular member **448** of the end effector **446** may include one or more inner lumens that are aligned with and/or in communication with one or more working channels of the coiled shaft **408** (see FIG. 9). Further, the distal opening **449** at a distal end of the tubular member **448** may be further aligned with and/or in communication with the one or more working channels of the coiled shaft **408** via the one or more inner lumens of the tubular member **448**. The tubular member **448** is configured and operable to position one or more medical devices and/or instruments received through the handle assembly **102** and/or coiled shaft **408** proximate to a target treatment site. The extension line **447** of the end effector **446** is secured to, and between, a proximal end of the tubular member **448** and a distal end of the tubular member **448**, adjacent to the distal opening **449**.

Still referring to FIG. 8, the extension line **447** is configured to tension a distal end of the tubular member **448** toward the proximal end of the tubular member **448** to form the nonlinear configuration of the tubular member **448**. In other words, the extension line **447** is operable to apply a force on a distal end of the tubular member **448** to thereby form a bend and/or angle along a longitudinal length of the tubular member **448** between the opposing terminal ends of the tubular member **448**. In this instance, the distal opening **449** at a distal end of the tubular member **448** is positioned and/or aligned relatively transverse to the central longitudinal axis **10** of the handle assembly **102** (see FIG. 1), rather than collinear with and/or parallel to the central longitudinal axis **10**. It should be appreciated that with the tubular member **448** of the end effector **446** including the nonlinear and/or curved configuration, the medical device **400** may facilitate positioning one or more medical instruments and/



or devices (e.g., devices/guidewire **436** received through the coiled shaft **408**) at a target treatment site.

Referring now to FIG. 9, the coiled shaft **408** may include one or more lumens extending therethrough, such as, for example, one or more working channels that are sized and shaped to receive one or more medical instruments and/or devices therethrough. By way of example only, the coiled shaft **408** of the medical device **400** may include a working channel **409** configured to receive a guidewire (e.g., guidewire **436**), a working channel **410** configured to receive an imaging device (e.g., camera), a pair of working channels **412** configured to receive the pair of drive wires **122B**, **122T**, and/or a working channel **413** configured to receive a cautery wire. It should be understood that the number and arrangement of working channels **409**, **410**, **412**, **413** shown and described herein are merely illustrative such that the coiled shaft **408** may include additional, fewer, and/or various other lumens/working channels configurations.

The coiled shaft **408** of the medical device **400** may further include an exterior surface having a protective plastic sheath **414** disposed thereon. In the example, the one or more working channels **409**, **410**, **412**, **413** of the coiled shaft **408** are insulated by the protective plastic sheath **414** included along the exterior of the coiled shaft **408**. In some examples, the coiled shaft **408** may be a coil disposed over the working channels **409**, **410**, **412**, **413**. For example, the coiled shaft **408** may be a coil having a pair of layers (e.g., a dual-layer coil), with a first layer extending about the working channels **409**, **410**, **412**, **413** in a first direction (e.g., clockwise) and a second layer extending about the working channels **409**, **410**, **412**, **413** in a second direction (e.g., counter-clockwise).

Referring now to FIG. 10, a partial schematic of the handle assembly **102** of the medical device **400** is depicted. In the example, the third (guidewire) actuator **430** may include a pair of rollers **432** disposed within the handle assembly **102**, with at least one of the pair of rollers **432** being accessible to a user of the medical device **400** (e.g., extending through a surface of the handle assembly **102**). The pair of rollers **432** of the third (guidewire) actuator **430** are configured to rotate about an axis that is at least partially transverse (e.g., perpendicular) to the central longitudinal axis **10** of the handle assembly **102** (see FIG. 1). The handle assembly **102** of the medical device **400** may further include an opening **434** along the third (guidewire) actuator **430** that is sized, shaped and configured to receive a guidewire **436** therethrough.

The opening **434** of the handle assembly **102** is positioned in alignment with a region between the pair of rollers **432** of the third (guidewire) actuator **430**. In this instance, the guidewire **436** inserted through the opening **434** is received between the pair of rollers **432**. Accordingly, it should be appreciated that actuation (e.g., rotation) of the third (guidewire) actuator **430** in a first direction (e.g., clockwise, counter-clockwise, etc.) may provide for a relative movement of the guidewire **436** in the handle assembly **102** and/or the coiled shaft **408** in a first direction, and actuation of the third (guidewire) actuator **430** in a second direction may provide for another relative movement of the guidewire **436** in the handle assembly **102** and/or the coiled shaft **408**.

Still referring to FIG. 10, in the example, the pair of rollers **432** of the third (guidewire) actuator **430** may each include one or more ridges and/or cavities (formed between an adjacent pair of ridges) extending along a longitudinal length of the roller **432**. The one or more ridges and/or cavities of the pair of rollers **432** may be configured and

operable to engage the guidewire **436** to facilitate movement of the guidewire **436** relative to the handle assembly **102**. Although not shown, it should be understood that a proximal end of the guidewire **436** may be positioned proximate to the opening **434** of the handle assembly **102** and a distal end of the guidewire **436** may extend through the working lumen **409** of the coiled shaft **408** and distally from the distal opening **449** of the end effector **436**.

Each of the aforementioned devices, assemblies, and methods may be used to facilitate access to a target treatment site and provide enhanced control of ancillary tools/devices for use at the target treatment site. By providing a medical device with a handle assembly capable of controlling and moving a plurality of tools/devices (end effector) coupled to the medical device, a user may interact with a target treatment site using the various tools/devices of the medical instrument during a procedure via an intuitive interface of the handle assembly. In this instance, a user may reduce overall procedure time, increase efficiency of procedures, and/or avoid unnecessary harm to a subject's body caused by limited control of the ancillary tools/devices. Additionally, a user may control and move the plurality of tools/devices (end effector) of the medical device with a single hand, and about a plurality of degrees of freedom, pursuant to the intuitive interface of the handle assembly.

It will be apparent to those skilled in the art that various modifications and variations may be made in the disclosed devices and methods without departing from the scope of the disclosure. Other aspects of the disclosure will be apparent to those skilled in the art from consideration of the specification and practice of the features disclosed herein. It is intended that the specification and examples be considered as exemplary only.

We claim:

1. A medical device, comprising:

- a handle assembly including a plurality of actuators, wherein at least a distal portion of the handle assembly defines a longitudinal axis of the medical device, wherein a first actuator of the plurality of actuators is configured to translate proximally and distally relative to the handle assembly along a second axis parallel to the longitudinal axis, wherein the first actuator is positioned along a top wall of the handle assembly; wherein a second actuator of the plurality of actuators is configured to pivot about a third axis perpendicular to the longitudinal axis, wherein a first portion of the second actuator is positioned along the top wall and a second portion of the second actuator is positioned along a sidewall of the handle assembly; and wherein a third actuator of the plurality of actuators is configured to rotate relative to the handle assembly and about the longitudinal axis or a fourth axis parallel to the longitudinal axis, wherein the third actuator is positioned along the sidewall of the handle assembly.

2. The medical device of claim 1, wherein the first actuator includes a slider slideably received within a slot of the handle assembly, wherein the first actuator includes a cavity configured to receive a proximal end of an actuation wire, and wherein the cavity is disposed on the slider.

3. The medical device of claim 2, wherein each of a first drive wire and a second drive wire are fixed to the second actuator.

4. The medical device of claim 2, wherein the actuation wire is configured to actuate an end effector.

5. The medical device of claim 1, wherein the first actuator is a slidable switch, the second actuator is a rocker, and the third actuator is a roller.

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6. The medical device of claim 1, wherein the first actuator is adjacent to the first portion of the third actuator, and wherein the second actuator is distal to the first actuator and the third actuator.

7. The medical device of claim 1, wherein the third actuator extends at least partially outward along the top wall and a bottom wall of the handle assembly.

8. The medical device of claim 1, wherein the first portion of the second actuator includes a lever and the second portion of the second actuator includes a rocker.

9. A medical device comprising:

a shaft defining a longitudinal axis, wherein a distal portion of the shaft includes an articulation portion; and a handle fixed to a proximal end of the shaft, the handle having:

a first actuator that is movable in a first direction relative to the handle;

a second actuator that is movable in a second direction relative to the handle; and

a third actuator that is movable in a third direction relative to the handle;

wherein the first direction is parallel to the longitudinal axis of the shaft, and the third direction is about the longitudinal axis of the shaft or parallel to the longitudinal axis of the shaft,

wherein a first drive wire configured to articulate the articulation portion in the first direction extends along the third actuator on a first side of the third actuator, wherein a second drive wire configured to articulate the articulation portion in the second direction extends through the shaft and around the third actuator on a second side of the third actuator, and wherein the second side of the third actuator is opposite the first side of the third actuator; and

wherein a proximal end of the first drive wire is secured to the second actuator at a first connection point on a first side of the second actuator, wherein a proximal end of the second drive wire is secured to the second actuator at a second connection point on a second side of the second actuator,

wherein, in an unactuated state of the handle, the first drive wire extends between the second actuator and the third actuator without crossing the second drive wire that extends between the second actuator and the third actuator.

10. The medical device of claim 9, wherein the first actuator includes a slider slideably disposed between the second actuator and the third actuator.

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11. The medical device of claim 10, wherein the slider includes a channel, and wherein the first drive wire extends through the channel.

12. The medical device of claim 10, wherein a proximal end of an actuation wire is fixed within a cavity of the slider, wherein the actuation wire is configured to actuate an end effector fixed to a distal end of the shaft.

13. The medical device of claim 12, wherein the actuation wire extends through the third actuator.

14. The medical device of claim 9, wherein the first actuator is a trigger, the second actuator is a rocker, and the third actuator is a roller.

15. The medical device of claim 9, wherein the third actuator includes a rotation joint, wherein the rotation joint is rotatably fixed relative to the third actuator and longitudinally translatable relative to the third actuator.

16. The medical device of claim 9, wherein the third actuator extends at least partially outward relative to a top wall of the handle.

17. A medical device comprising:

a handle having:

a first actuator that is movable in a first direction relative to the handle, wherein the first actuator comprises a slider, wherein the first actuator is positioned along a top wall of the handle;

a second actuator that is movable in a second direction relative to the handle, wherein the second actuator includes a rocker and a lever, wherein the rocker and the lever are integrally formed, wherein the rocker is positioned along a first sidewall of the handle, and wherein the lever extends over the top wall of the handle; and

a third actuator that is movable in a third direction relative to the handle, wherein the third actuator is positioned along a second sidewall of the handle, opposite the first sidewall of the handle;

wherein the slider of the first actuator is disposed between the second actuator and the third actuator.

18. The medical device of claim 17, wherein the slider is slideably disposed within a slot of the handle.

19. The medical device of claim 17, wherein the third actuator is a roller and is configured to rotate an end effector of the medical device.

20. The medical device of claim 17, wherein an axis of rotation of the second actuator is parallel to an axis of rotation of the third actuator.

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