



## SLIDING STOP FOR PULLEY OF ENDOSCOPE PULL WIRE

### PRIORITY CLAIM

**[0001]** This application claims the benefit of priority to U.S. Provisional Patent Application Serial No. 63/507,614, filed June 12, 2023; the contents of which are incorporated herein by reference.

### TECHNICAL FIELD

**[0002]** The present disclosure relates generally to medical devices comprising elongate bodies configured to be inserted into incisions or openings in anatomy of a patient to provide diagnostic or treatment operations.

**[0003]** More specifically, the present disclosure relates to medical devices, such as endoscopes, having a controller connected to an elongate body, e.g., a working shaft, to adjust pull wires that extend through the elongate body to induce bending in a distal tip portion of the elongate body.

### BACKGROUND

**[0004]** Endoscopes can be used for one or more of 1) providing passage of other devices, e.g., therapeutic devices or tissue collection devices, toward various anatomical portions, and 2) imaging of such anatomical portions. Such anatomical portions can include the gastrointestinal tract (e.g., esophagus, stomach, duodenum, pancreaticobiliary duct, intestines, colon), renal area (e.g., kidney(s), ureter, bladder, urethra) and other internal organs (e.g., reproductive systems, sinus cavities, submucosal regions, respiratory tract), and the like.

**[0005]** Conventional endoscopes can be involved in a variety of clinical procedures, including, for example, illuminating, imaging, detecting and diagnosing one or more disease states, providing fluid delivery (e.g., saline or other preparations via a fluid channel) toward an anatomical region, providing passage (e.g., via a working channel) of one or more therapeutic devices for sampling or treating an anatomical region, and providing suction passageways for collecting fluids (e.g., saline or other preparations) and the like.

**[0006]** In conventional endoscopy, the distal portion of the endoscope can be configured for supporting and orienting a therapeutic device, such as with the use of an elevator. In some systems, two endoscopes can be configured to work together with a first endoscope guiding a second endoscope inserted therein with the aid of the elevator. Such systems can be helpful

in guiding endoscopes to anatomic locations within the body that are difficult to reach. For example, some anatomic locations can only be accessed with an endoscope after insertion through a circuitous path. For example, duodenoscopy procedures (e.g., Endoscopic Retrograde Cholangio-Pancreatography, hereinafter “ERCP” procedures) involve the use of an auxiliary scope (also referred to as a daughter scope or cholangioscope) that can be advanced through the working channel of a main scope (also referred to as a mother scope or duodenoscope). Furthermore, another device (e.g., a treatment device), such as a tissue retrieval device used for biopsies, can be inserted into the auxiliary scope. As such, the treatment device can be controlled and guided via pushing and pulling of the shafts of the main scope and auxiliary scope, such as via the use of pull wires extending within the shafts of the main scope and auxiliary scope. The pull wires are typically anchored at a distal end of the shaft, connected to a controller at a proximal end of the shaft, and freely slidable within the shaft therebetween. Operation of an actuator, e.g., a knob or lever, on the controller can cause a pulley to pull or tension the pull wire to induce bending of the shaft. Typically, pull wires are arranged in pairs to produce opposite bending of the shaft with a single actuator.

#### SUMMARY

[0007] The present disclosure recognizes that problems to be solved with conventional medical devices, and in particular endoscopes and duodenoscopes, include, among other things, the differential between rotating a pull wire pulley and the actual amount the tip of the endoscope deflects. For example, a working shaft of an endoscope can extend along an axis. The working shaft can be flexible to follow the contours of anatomy in which it is inserted. Bending can be induced in the working shaft by a pull wire to facilitate guiding of the working shaft into various portions of the anatomy. For example, it can be useful to bend a distal portion of the working shaft to turn the working shaft from one anatomic duct to an adjoining anatomic duct. As mentioned, bending of the working shaft can be accomplished by the use of pull wires extending within the working shaft between an actuation mechanism and the distal tip portion of the working shaft. The actuation mechanism can include a pulley to which a pair of pull wires are attached. Rotation of the pulley in a first direction can tension a first of the pull wires to induce bending of the working shaft in a first direction. Rotation of the pulley in a second direction can tension a second of the pull wires to induce bending of the working shaft in a second direction. Typically, however, there is not a one-to-one relationship in the bending of the working shaft and the rotation of the pulley. For example, a ninety-degree rotation of the pulley does not typically result in a ninety-degree

bend in the working shaft. The amount of deflection of the distal tip portion of the working shaft is controlled by the radius of the pulley. A larger pulley radius induces more bending. However, due to space constraints within the endoscope controller, the radius of the pulley is limited. Thus, the pulley typically needs to be rotated a greater amount than is desired to bend the working shaft. For example, excessive bending of the working shaft can cause damage to the endoscope. Furthermore, unlimited rotation of the pulley can result in damage to the distal tip portion of the working shaft. Furthermore, additional winding of the pull wire results in additional slack being introduced in the opposing pull wire on the opposite side of the pulley. Excess amounts of slack can result in a pull wire becoming tangled within other parts of the controller. As such, it is typically desirable to put a stop within the controller housing to limit the amount that a pull wire pulley can be rotated, thereby limiting the amount that the distal tip of the working channel can be bent or deflected.

**[0008]** The present disclosure can help provide solutions to these and other problems by providing systems, devices and methods for rotating a pull wire pulley beyond three-hundred-sixty degrees while still having a rotational stop in place. In examples, a sliding stop can be positioned to engage a circumferential stop of a pulley and fixed stops within the endoscope controller. The pulley can be rotated in a first direction to move the circumferential stop of the pulley over a first fixed stop to push the sliding stop against the second fixed stop. The pulley can be rotated in a second direction to move the circumferential stop of the pulley over the second fixed stop to push the sliding stop against the first fixed stop. The first and second fixed stops can be circumferentially spaced such that the circumferential stop of the pulley can be rotated more than three-hundred-sixty degrees before movement of the sliding stop is arrested by one of the fixed stops.

**[0009]** In an example, an endoscope can comprise an elongate flexible shaft, a first pull wire extending from the elongate flexible shaft, a handpiece housing connected to the elongate flexible shaft, and a pulley mechanism disposed in the handpiece housing and connected to the first pull wire to apply tension to the first pull wire by rotation, the pulley mechanism can comprise a first pulley connected to the first pull wire, a first moveable stop extending from the first pulley to move with the first pulley, and a sliding stop disposed in the handpiece housing and engageable with the first moveable stop, wherein the sliding stop can be stopped in at least two different locations along a route over which the first moveable stop moves and the sliding stop can slide between the at least two different locations when the sliding stop engages with the first moveable stop.

[0010] In another example, a sliding stop mechanism for an endoscope pull wire can comprise a first pulley for connecting to a first pull wire and rotation about a pulley axis, a first moveable stop extending from the first pulley to move with the first pulley, and a sliding stop engageable with the first moveable stop, wherein the sliding stop can be stopped in at least two different locations along a route over which the first moveable stop moves and the sliding stop can slide between the at least two different locations when the sliding stop engages with the first moveable stop.

[0011] In additional examples, a method for bending an insertion shaft of an endoscope with a pull wire can comprise rotating a pulley in a first direction about a rotation axis along a first path to disengage a moveable stop from a first fixed stop, rotating the pulley about the rotation axis to pull the pull wire, continuing to rotate the pulley about the rotation axis in the first direction to move the moveable stop past the first fixed stop, and engaging the moveable stop with a second fixed stop to prevent overbending of the insertion shaft.

#### BRIEF DESCRIPTION OF DRAWINGS

[0012] FIG. 1 is a schematic diagram of an endoscopy system comprising an imaging and control system and an endoscope, such as duodenoscope, with which the pull wire pulley system of the present disclosure can be used.

[0013] FIG. 2 is a schematic diagram of the imaging and control system of FIG. 1 showing the imaging and control system connected to the endoscope.

[0014] FIG. 3 is an exploded view of an example controller for endoscopes that can be used with the endoscopy system of FIGS. 1 and 2 and that can include a pull wire pulley system of the present disclosure.

[0015] FIG. 4 is an example cross-sectional view of the controller of FIG. 3 showing a pulley stack positioned between housing pieces to operate pull wires of an endoscope working shaft.

[0016] FIG. 5A is a perspective view of a first housing piece for the controller of FIGS. 3 and 4 showing an actuator socket and rotation stops for the pulley stack.

[0017] FIG. 5B is a perspective view of the actuator socket of FIG. 5A with a sliding stop positioned between the rotation stops.

[0018] FIG. 6 is a perspective view of a pulley stack comprising first and second pulleys that can be used with the rotation stops and sliding stops of FIGS. 5A and 5B to form a stop mechanism of the present disclosure.

[0019] FIG. 7 is a cross-sectional view of the pulley stack of FIG. 6 showing first and second pulleys having first and second stop spokes, respectively.

[0020] FIGS. 8A, 8B and 8C are perspective, top and side views of a rotation stop ring of FIGS. 5A – 7.

[0021] FIGS. 9A, 9B and 9C are perspective, top and side views of a sliding stop ring of FIGS. 5A – 7.

[0022] FIGS. 10A and 10B are perspective and top views of the first pulley including a circumferential stop for the stop mechanism of the present disclosure.

[0023] FIG. 11A is a cross-sectional view of a pair of stop walls of the first pulley and a sliding stop ring positioned between rotation stops of the first housing piece of the controller.

[0024] FIG. 11B is a perspective, close-up view of the pair of stop walls of the circumferential stop, the slide stop of the sliding stop ring and the rotation stops of the rotation stop ring of FIG. 11A.

[0025] FIG. 12A is a first schematic view of the first pulley at a first rotational extreme where the slide stop engages a first rotation stop through engagement of the slide stop.

[0026] FIG. 12B is a second schematic view of the first pulley at a second rotational extreme where the slide stop engages a second rotation stop through engagement of the slide stop.

[0027] FIG. 13 is a perspective view of a second sliding stop ring configured to engage with the second pulley of FIG. 6 and 7 and a second rotation stop ring.

[0028] FIG. 14 is a block diagram illustrating operations of various methods for operating a sliding stop mechanism of the present disclosure.

#### DETAILED DESCRIPTION

[0029] FIG. 1 is a schematic diagram of endoscopy system 10 comprising imaging and control system 12 and endoscope 14. The system of FIG. 1 is an illustrative example of an endoscopy system suitable for use with the systems, devices and methods described herein, such as stop mechanisms for pull wires. However, the pull wire devices and methods of the present disclosure can be used in other configurations of endoscopy systems as well.

According to some examples, endoscope 14 can be insertable into an anatomical region for imaging and/or to provide passage of other devices, such as auxiliary scopes and biopsy devices or one or more therapeutic devices for treatment of a disease state associated with the anatomical region. Endoscope 14 can, in advantageous aspects, interface with and connect to imaging and control system 12. In the illustrated example, endoscope 14 comprises a

duodenoscope, though other types of endoscopes can be used with the features and teachings of the present disclosure.

**[0030]** Imaging and control system 12 can comprise control unit 16, output unit 18, input unit 20, light source unit 22, fluid source 24 and suction pump 26.

**[0031]** Imaging and control system 12 can include various ports for coupling with endoscopy system 10. For example, control unit 16 can include a data input/output port for receiving data from and communicating data to endoscope 14. Light source unit 22 can include an output port for transmitting light to endoscope 14, such as via a fiber optic link. Fluid source 24 can include a port for transmitting fluid to endoscope 14. Fluid source 24 can comprise a pump and a tank of fluid or can be connected to an external tank, vessel or storage unit. Suction pump 26 can comprise a port used to draw a vacuum from endoscope 14 to generate suction, such as for withdrawing fluid from the anatomical region into which endoscope 14 is inserted. Output unit 18 and input unit 20 can be used by a user, e.g., an operator, of endoscopy system 10 to control functions of endoscopy system 10 and view output of endoscope 14. Control unit 16 can additionally be used to generate signals or other outputs from treating the anatomical region into which endoscope 14 is inserted. In examples, control unit 16 can generate electrical output, acoustic output, a fluid output and the like for treating the anatomical region with, for example, cauterizing, cutting, freezing and the like.

**[0032]** Endoscope 14 can comprise insertion section 28, functional section 30 and handle section 32, which can be coupled to cable section 34 and coupler section 36. Coupler section 36 can be connected to control unit 16 to connect to endoscope 14 to multiple features of control unit 16, such as input unit 20, light source unit 22, fluid source 24 and suction pump 26.

**[0033]** Insertion section 28 can extend distally from handle section 32 and cable section 34 can extend proximally from handle section 32. Insertion section 28 can be elongate and include a bending section, and a distal end to which functional section 30 can be attached. The bending section can be controllable (e.g., by control knob 38 on handle section 32) to maneuver the distal end through tortuous anatomical passageways (e.g., stomach, duodenum, kidney, ureter, etc.). In examples, a pair of pull wires, such as pull wires 224A and 224B of FIG. 4, can be anchored at functional section 30, extend through insertion section 28 and can be connected to control knob 38 to control bending or deflecting of the bending section. Insertion section 28 can also include one or more working channels (e.g., an internal lumen) that can be elongate and support insertion of one or more therapeutic tools of functional section 30, such as an auxiliary scope. The working channel can extend between handle

section 32 and functional section 30. Additional functionalities, such as fluid passages, guide wires, and pull wires can also be provided by insertion section 28 (e.g., via suction or irrigation passageways, and the like).

**[0034]** Handle section 32 can comprise control knob 38 as well as port 40A. As mentioned, control knob 38 can be coupled to a pull wire, or other actuation mechanisms, extending through insertion section 28. In examples, handle section 32 can include levers, wheels or other control elements for pushing and pulling of pull wires. Port 40A, as well as other ports, such as port 40B (FIG. 2), can be configured to couple various electrical cables, guide wires, auxiliary scopes, tissue collection devices, fluid tubes and the like to handle section 32 for coupling with insertion section 28.

**[0035]** Imaging and control system 12, according to examples, can be provided on a mobile platform (e.g., cart 41) with shelves for housing light source unit 22, suction pump 26, image processing unit 42 (FIG. 2), etc. Alternatively, several components of imaging and control system 12 shown in FIGS. 1 and 2 can be provided directly on endoscope 14 so as to make the endoscope “self-contained.”

**[0036]** Functional section 30 can comprise components for treating and diagnosing anatomy of a patient. Functional section 30 can comprise module 50 comprising an imaging device, an illumination device and an elevator.

**[0037]** FIG. 2 is a schematic diagram of endoscopy system 10 of FIG. 1 comprising imaging and control system 12 and endoscope 14. FIG. 2 schematically illustrates components of imaging and control system 12 coupled to endoscope 14, which in the illustrated example comprises a duodenoscope. Imaging and control system 12 can comprise control unit 16, which can include or be coupled to image processing unit 42, treatment generator 44 and drive unit 46, as well as light source unit 22, input unit 20 and output unit 18. Coupler section 36 can be connected to control unit 16 via cable 49 (shown schematically in FIG. 2) to connect to endoscope 14 to multiple features of control unit 16, such as image processing unit 42 and treatment generator 44. In examples, port 40A can be used to insert another instrument or device, such as a daughter scope or auxiliary scope, into endoscope 14. Such instruments and devices can be independently connected to control unit 16 via cable 47. In examples, port 40B can be used to connect coupler section 36 to various inputs and outputs, such as video, air, light and electric. Control unit 16 can be configured to activate a camera to view target tissue distal of endoscope 14. Likewise, control unit 16 can be configured to activate light source unit 22 to shine light on endoscope 14 or other devices extending therefrom.

**[0038]** Image processing unit 42 and light source unit 22 can each interface with endoscope 14 (e.g., at functional section 30) by wired or wireless electrical connections. Imaging and control system 12 can accordingly illuminate an anatomical region, collect signals representing the anatomical region, process signals representing the anatomical region, and display images representing the anatomical region on output unit 18. Imaging and control system 12 can include light source unit 22 to illuminate the anatomical region using light of desired spectrum (e.g., broadband white light, narrow-band imaging using preferred electromagnetic wavelengths, and the like). Imaging and control system 12 can connect (e.g., via an endoscope connector) to endoscope 14 for signal transmission (e.g., light output from light source, video signals from imaging system in the distal end, diagnostic and sensor signals from a diagnostic device, and the like).

**[0039]** Fluid source 24 (FIG. 1) can be in communication with control unit 16 and can comprise one or more sources of air, saline or other fluids, as well as associated fluid pathways (e.g., air channels, irrigation channels, suction channels) and connectors (barb fittings, fluid seals, valves and the like). Fluid source 24 can be utilized as an activation energy for a biasing device or a pressure-applying device of the present disclosure. Imaging and control system 12 can also include drive unit 46, which can be an optional component. Drive unit 46 can comprise a motorized drive for advancing a distal section of endoscope 14, as described in at least PCT Pub. No. WO 2011/140118 A1 to Frassica et al., titled “Rotate-to-Advance Catheterization System,” which is hereby incorporated in its entirety by this reference.

**[0040]** As discussed herein, control knob 38 of handle section 32 can be connected to a pulley to alternatively pull two wires in opposite directions to bend the distal portion of insertion section 28. With the present disclosure, sliding stops can operate in conjunction with the pulley to allow desirable amounts of bending of insertion section 28 by allowing the pulley to be cranked over lengthy rotations, including over three-hundred-sixty degrees, in two directions to pull the pull wires, but also including hard stops to prevent insertion section 28 and the pull wires to become damaged.

**[0041]** FIG. 3 is an exploded view of controller 200 for endoscopes that can be used with the endoscopy system of FIGS. 1 and 2. FIG. 4 is a cross-sectional view of controller 200 of FIG. 3. FIG. 3 and FIG. 4 are discussed concurrently. In examples, controller 200 can function similarly as handle section 32 of FIGS. 1 and 2 and can include similar functionality.

**[0042]** Controller 200 can comprise first housing component 202A and second housing component 202B. Pulley stack 204 can be located between first housing component 202A

and second housing component 202B. Shaft 206 can extend from controller 200. Pulley stack 204 can comprise pulley portion 208 and drive portion 210. Drive portion 210 can extend through port 212 in first housing component 202A and can connect to knob assembly 217. Pulley portion 208 can comprise first pulley 214A and second pulley 214B. Drive portion 210 can comprise first shaft 216A and second shaft 216B. Knob assembly 217 can comprise first knob 218A and second knob 218B.

**[0043]** Pulley portion 208 of pulley stack 204 can be supported between first housing component 202A and second housing component 202B along rotation axis AA and can be configured to rotate therebetween. First pulley 214A can be positioned in first socket 222A and second pulley 214B can be positioned in second socket 222B, as shown in FIG. 4. Drive portion 210 can extend through port 212 to be accessible from the exterior of first housing component 202A and second housing component 202B. Knob assembly 217 can couple to drive portion 210. First knob 218A can connect to first shaft 216A and second knob 218B can connect to second shaft 216B. First pull wire 224A (FIG. 4) can be connected to first pulley 214A and second pull wire 224B (FIG. 4) can be connected to second pulley 214B. First knob 218A can be turned or cranked to rotate first shaft 216A and first pulley 214A independent of second knob 218B, second shaft 216B and second pulley 214B. Second knob 218B can be turned or cranked to rotate second shaft 216B and second pulley 214B independent of first knob 218A, first shaft 216A and first pulley 214A.

**[0044]** First pull wire 224A can comprise a pair of pull wires attached to opposite sides of first pulley 214A. Second pull wire 224B can comprise a pair of pull wires attached to opposite sides of second pulley 214B. The four pull wires can extend through shaft 206 spaced circumferentially apart at ninety-degree intervals to allow for pulling of shaft 206 in four different directions and combinations thereof. Rotation of first knob 218A can cause one of the pull wires comprising first pull wire 224A to become taught and bend the distal end portion of shaft 206 in a first direction while the other of the pull wires comprising first pull wire 224A becomes slack. Rotation of second knob 218B can cause one of the pull wires comprising second pull wire 224B to become taught and bend the distal end portion of shaft 206 in another direction while the other of the pull wires comprising second pull wire 224B becomes slack.

**[0045]** The relationship between the amount of rotation of each of first pulley 214A and second pulley 214B and the bending induced in the distal end portion of shaft 206 can be proportional. For example, more rotation of first pulley 214A and second pulley 214B can cause more bending of shaft 206. However, as mentioned above, over-rotation of first pulley

214A or second pulley 214B can induce undesirable outcomes in shaft 206 or first pull wire 224A and second pull wire 224B. For example, shaft 206 can become over-stressed and become damaged, and pull wire 224A and pull wire 224B can become overly slack and become entangled. As such, controller 200 can be provided with a stop mechanism, such as the sliding stop mechanisms of the present disclosure, to prevent rotation of first pulley 214A and second pulley 214B beyond certain rotational limits. Typical pull wire pulley-stop mechanism limit rotation of pull wire pulleys to less than three-hundred-sixty degrees. The pulley-stop mechanisms of the present application can allow for rotation of first pulley 214A and second pulley 214B beyond three-hundred-sixty degrees while also providing a stop to limit deflection of shaft 206. In particular, the pulley-stop mechanisms of the present disclosure can comprise a sliding stop that changes circumferential positions between fixed stops on a housing to engage a moveable stop on a pulley. As such, the circumferential stop can be moved along a first path that is greater than three-hundred-sixty degrees to engage the sliding stop with either of the fixed stops, as discussed in greater detail below.

**[0046]** FIGS. 5A – 13 are discussed with reference to a sliding stop mechanism incorporated on first housing component 202A for engagement with first pulley 214A. However, a second sliding stop mechanism of similar construction can be incorporated on second housing component 202B for engagement with second pulley 214B. For example, stop spoke 250B (FIG. 7) of second pulley 214B can interact with second moveable ring 240B and second stop ring 230B (FIG. 13).

**[0047]** FIG. 5A is a perspective view of first housing component 202A for controller 200 of FIGS. 3 and 4 showing first socket 222A and first stop ring 230A for first pulley 214A. FIG. 5B is a perspective view of first housing component 202A of FIG. 5A with the addition of first moveable ring 240A positioned adjacent first stop ring 230A. FIG. 5A and FIG. 5B are discussed concurrently.

**[0048]** First stop ring 230A can comprise first rotation stop 232A and second rotation stop 234A, which can be attached to stop body 236. Port 212 can comprise flange 237 and first socket 222A can comprise track or trough 238. First moveable ring 240A can comprise base ring 242A and projection 244A.

**[0049]** Trough 238 can comprise an annular depression or track within first housing component 202A that surrounds port 212. Trough 238 can include sidewall 226 disposed opposite flange 237. Trough 238 can be sized to receive first stop ring 230A and first moveable ring 240A, as can be seen in FIG. 11A and FIG. 11B. First stop ring 230A can be located at the outer diameter of trough 238 proximate sidewall 226 and first moveable ring

240A can be located at the inner diameter of trough 238 proximate flange 237. As can be seen in FIG. 6 and FIG. 7, the outer diameter of first moveable ring 240A can fit within the inner diameter of first stop ring 230A.

**[0050]** First stop ring 230A can be attached to first housing component 202A in a fixed manner. In examples, first stop ring 230A can be inserted into trough 238 in a force fit or snap fit arrangement with sidewall 226. First stop ring 230A can be glued or adhered in place. In additional examples, first stop ring 230A can comprise an integral component that is monolithic with the material of first housing component 202A. In various examples, stop body 236 can be omitted and first rotation stop 232A and second rotation stop 234A can extend from trough 238 of first housing component 202A. First rotation stop 232A and second rotation stop 234A can comprise handpiece housing stops or fixed stops. First rotation stop 232A and second rotation stop 234A can be located at fixed positions relative to rotation axis AA of pulley stack 204 and can, thus, be configured to not move while pulley stack 204 is being operated. First rotation stop 232A and second rotation stop 234A can comprise flange projecting away from first housing component 202A toward first pulley 214A (see FIG. 11A). As can be seen in FIG. 5B, first rotation stop 232A and second rotation stop 234A can extend beyond base ring 242A of first moveable ring 240A. First rotation stop 232A and second rotation stop 234A can comprise rectangular bodies, as illustrated, but can additionally have other shapes.

**[0051]** First moveable ring 240A can be disposed radially between flange 237 and first stop ring 230A relative to rotation axis AA of pulley stack 204. Slide stop or projection 244A can project or extend radially outward from base ring 242A to overlap stop body 236. As such, projection 244A can circumferentially engage each of first rotation stop 232A and second rotation stop 234A. Projection 244A can comprise a rectangular body, as illustrated, but can additionally have other shapes. First rotation stop 232A and second rotation stop 234A and projection 244A can have rectangular cross-sectional profiles and can be positioned to extend across trough 238 so that opposite faces of projection 244A can engage flush or nearly flush with faces of first rotation stop 232A and second rotation stop 234A.

**[0052]** FIG. 6 is a perspective view of pulley stack 204 comprising first pulley 214A and second pulley 214B that can be used with first stop ring 230A and first moveable ring 240A of the present disclosure. FIG. 7 is a cross-sectional view of pulley stack 204 of FIG. 6 showing first pulley 214A and second pulley 214B. FIG. 6 and FIG. 7 are discussed concurrently.

**[0053]** First pulley 214A can comprise first stop spoke 250A, which can comprise first wall 252A and second wall 254A, for interacting with first stop ring 230A on first housing component 202A through first moveable ring 240A. Second pulley 214B can comprise second stop spoke 250B having first and second walls for interacting with second stop ring 230B (FIG. 13) on second housing component 202B through first moveable ring 240A.

**[0054]** Second pulley 214B can be positioned adjacent first pulley 214A so that second shaft 216B extends into first shaft 216A. Second shaft 216B can be longer than first shaft 216A so that the tip of second shaft 216B protrudes from first shaft 216A. Thus, first knob 218A can be connected to first shaft 216A and second knob 218B can be connected to second shaft 216B. Second shaft 216B can rotate independently within first shaft 216A. Thus, first knob 218A can be rotated to control the rotational position of first pulley 214A relative to rotation axis AA of pulley stack 204 and second knob 218B can be rotated to control the rotational position of second pulley 214B relative to rotation axis AA of pulley stack 204.

**[0055]** First pulley 214A and second pulley 214B can comprise spools or barrels around which first pull wire 224A and second pull wire 224B can be attached, respectively, and wound therearound. As such, first pulley 214A and second pulley 214B can comprise cylindrical components having curved surfaces forming drums around which pull wires can be wound without kinking or the like.

**[0056]** First stop spoke 250A can have axially projecting walls that extend in radial directions. In particular, first wall 252A and second wall 254A can form a wedge-shaped structure having opposing circumferential surfaces to engage with projection 244A.

**[0057]** FIGS. 8A, 8B and 8C are perspective, top and side views of first stop ring 230A of FIGS. 5A – 7. FIGS. 8A, 8B and 8C are discussed concurrently. First stop ring 230A can comprise stop body 236 from which first rotation stop 232A and second rotation stop 234A can extend.

**[0058]** First stop ring 230A can comprise an annular body configured to rotate within trough 238 (FIGS. 5A and 5B). First stop ring 230A can comprise opposing radial sidewalls, including sidewall 235A and sidewall 235B, for abutting sidewall 226 (FIG. 5A) of first socket 222A and base ring 242A of first moveable ring 240A (FIG. 5B), respectively. Base wall 233 can be configured to abut first socket 222A (FIG. 5A) and thus can include contours or buttresses to align the center of stop body 236 with rotation axis AA of pulley stack 204. In the illustrated example, base wall 233 is flat. However, as discussed with reference to FIG. 13, base wall 233 can include contouring or features, such as standoffs, to facilitate mating flush with first housing component 202A. Cut 239 can be positioned between first

rotation stop 232A and second rotation stop 234A. Cut 239 can comprise a segment of stop body 236 having a smaller thickness than the remaining portion. Cut 239 can provide clearance for projection 244A to allow for greater engagement between projection 244A with first rotation stop 232A and second rotation stop 234A.

**[0059]** First stop ring 230A can comprise a component to add onto first housing component 202A. First stop ring 230A can be fabricated from the same material as first housing component 202A. As discussed, first stop ring 230A can be integrated into first housing component 202A. First stop ring 230A can be fabricated of any suitable material such as plastic or metal. First stop ring 230A can be sufficiently rigid to arrest movement of first moveable ring 240A without breaking. However, first stop ring 230A can be fabricated of material having some degree of resiliency to reduce the effects of impacts between first stop ring 230A and first moveable ring 240A, while still being capable of arresting movement of first moveable ring 240A.

**[0060]** Stop body 236 can have thickness T1 outside of first rotation stop 232A and second rotation stop 234A and can have thickness T2 between first rotation stop 232A and second rotation stop 234A at cut 239. Thickness T1 can be greater than thickness T2. First rotation stop 232A and second rotation stop 234A can project distance D1 from stop body 236.

**[0061]** FIGS. 9A, 9B and 9C are perspective, top and side views of a first moveable ring 240A of FIGS. 5A – 7B. FIGS. 9A, 9B and 9C are discussed concurrently. First moveable ring 240A can comprise base ring 242A and projection 244A.

**[0062]** First moveable ring 240A can comprise an annular body configured to rotate within trough 238 (FIGS. 5A and 5B). First moveable ring 240A can comprise opposing radial sidewalls, including sidewall 245A and sidewall 245B, for abutting first stop ring 230A (FIG. 5A) and flange 237 (FIG. 5A), respectively. Base wall 247 can be configured to abut first socket 222A (FIG. 5A).

**[0063]** First moveable ring 240A can be fabricated from the same material as first housing component 202A. First moveable ring 240A can be fabricated of any suitable material such as plastic or metal. First stop ring 230A can be sufficiently rigid to arrest movement of first moveable ring 240A without breaking. However, first moveable ring 240A can be fabricated of material having some degree of resiliency to reduce the effects of impacts between first stop ring 230A and first moveable ring 240A, while still being capable of arresting movement of first moveable ring 240A.

**[0064]** Base ring 242A can have thickness T3, which can be larger than thickness T1 of stop body 236 (FIG. 8C). Thickness T3 can be greater than thickness T1. Projection 244A can

project distance D2 from base ring 242. Distance D2 can be greater than distance D1 of first rotation stop 232A and second rotation stop 234A (FIG. 8C).

**[0065]** FIG. 10A and FIG. 10B are perspective and top views, respectively, of first pulley 214A including first stop spoke 250A of FIGS. 6A – 7B. First stop spoke 250A can comprise first wall 252A and second wall 254A. First wall 252A and second wall 254A can comprise circumferential stops or moveable stops.

**[0066]** First pulley 214A can comprise disk 260, inner rim 262 and outer rim 264. First shaft 216A can extend from inner rim 262. First stop spoke 250A can extend axially out of disk 260 and can connect inner rim 262 and outer rim 264. First wall 252A and second wall 254A can extend from inner rim 262 at a joint location and can be spaced from each other at outer rim 264. First stop spoke 250A can be flush with the top of outer rim 264 and can be recessed below the top of inner rim 262. However, in other examples, first stop spoke 250A can project beyond outer rim 264.

**[0067]** First pulley 214A can be fabricated of any suitable material, such as plastic or metal. First pulley 214A can be sufficiently rigid to arrest movement of first moveable ring 240A without breaking. However, first pulley 214A can be fabricated of material having some degree of resiliency to reduce the effects of impacts between first pulley 214A and first moveable ring 240A, while still being capable of arresting movement of first pulley 214A.

**[0068]** Second stop spoke 250B (FIG. 7) can be configured similarly as first stop spoke 250A. Second pulley 214B can be configured similarly as first pulley 214A, except second stop spoke 250B can be located on the side opposite from which second shaft 216B extends.

**[0069]** FIG. 11A is a cross-sectional view of first wall 252A and second wall 254A of first pulley 214A and projection 244A of first moveable ring 240A positioned between first rotation stop 232A and second rotation stop 234A of first stop ring 230A. FIG. 11B is a perspective, close-up view of first wall 252A, second wall 254A, projection 244A, first rotation stop 232A and second rotation stop 234A of FIG. 11A. FIG. 11A and FIG. 11B are discussed concurrently.

**[0070]** First stop ring 230A can be fixedly attached to first housing component 202A at first socket 222A. First stop ring 230A can be positioned to center first rotation stop 232A and second rotation stop 234A about longitudinal axis BB of controller 200 to allow first pull wire 224A to extend from first pulley 214A to shaft 206, as seen in FIG. 4. First stop ring 230A can additionally be positioned so that stop body 236 is centered about rotation axis AA.

**[0071]** First moveable ring 240A can be positioned adjacent first stop ring 230A so that projection 244A is positioned between first rotation stop 232A and second rotation stop

234A. Projection 244A can extend radially from base ring 242A to engage cut 239. Thus, projection 244A can extend radially to slide circumferentially along the surface of cut 239. First moveable ring 240A is configured to freely rotate about flange 237. That is, first moveable ring 240A is not fixed into any rotational position by external constraints. However, engagement of projection 244A with either of first rotation stop 232A or second rotation stop 234A limits the amount that first moveable ring 240A can rotate about rotation axis AA. As can be seen in FIG. 11A, projection 244A is taller than first rotation stop 232A and second rotation stop 234A so as to be able to engage first stop spoke 250A.

**[0072]** First pulley 214A can be positioned spaced apart from first moveable ring 240A and first stop ring 230A along rotation axis AA of pulley stack 204. First stop spoke 250A can be recessed within outer rim 264. However, projection 244A can be tall enough to reach beyond outer rim 264 to engage first stop spoke 250A. As such, first knob 218A can be rotated to rotate first pulley 214A in two directions to push projection 244A through engagement with first stop spoke 250A into engagement with first rotation stop 232A and second rotation stop 234A.

**[0073]** FIG. 12A is a first schematic view of first pulley 214A at a first rotational extreme where first stop spoke 250A engages first wall 252A through engagement of first moveable ring 240A. First knob 218A can be rotated counter-clockwise about rotation axis AA relative to the orientation of FIG. 12B to push projection 244A downward into engagement with second rotation stop 234A. As can be seen, projection 244A second wall 254A and second rotation stop 234A can have generally radially oriented surfaces relative to rotation axis AA so that flush or near flush engagement can be achieved. First wall 252A and second wall 254A of first pulley 214A can be located in a plane above first rotation stop 232A and second rotation stop 234A so that, without the presence of first moveable ring 240A, first pulley 214A could freely rotate about rotation axis AA without interference. However, the positioning of first moveable ring 240A allows projection 244A to have axial length relative to rotation axis AA to engage with both of first wall 252A and second wall 254A and both of first rotation stop 232A and second rotation stop 234A. The positioning of FIG. 12A represents one rotational extreme for first pulley 214A whereby the distal tip of shaft 206 (FIG. 4) can be pulled or bent in a first direction the maximum amount. First pulley 214A can be rotated to the opposite rotational extreme whereby the distal tip of shaft 206 (FIG. 4) can be pulled or bent in a second direction the maximum amount, as shown in FIG. 12B.

**[0074]** FIG. 12B is a second schematic view of first pulley 214A at a second rotational extreme where first stop spoke 250A engages second wall 254A through engagement of first moveable ring 240A.

**[0075]** First knob 218A can be rotated clockwise about rotation axis AA relative to the orientation of FIG. 12B to push projection 244A upward into engagement with first rotation stop 232A. From the position of FIG. 12A, first stop spoke 250A can disengage with projection 244A and can continue to be rotated to pass over first rotation stop 232A and over second rotation stop 234A. Thereafter, first stop spoke 250A can engage projection 244A and can continue to rotate to push projection 244A away from second rotation stop 234A to engage with first rotation stop 232A. As such, first pulley 214A can be rotated over three-hundred-sixty degrees from the position of FIG. 12A to the position of FIG. 12B.

**[0076]** In the illustrated example, first rotation stop 232A and second rotation stop 234A can be positioned approximately seventy-five degrees from each other spaced equidistant from longitudinal axis BB to allow for equal amounts of bending of shaft 206 in each direction. In examples, first rotation stop 232A and second rotation stop 234A can be spaced greater than or less than seventy-five degrees. In examples, first rotation stop 232A and second rotation stop 234A can be spaced apart sixty degrees, ninety degrees, one-hundred-twenty degrees or one-hundred-eighty degrees. In examples, first rotation stop 232A and second rotation stop 234A can be asymmetrically placed about longitudinal axis BB to induce different amounts of bending of shaft 206 in different directions.

**[0077]** FIG. 13 is a perspective view of second moveable ring 240B configured to engage with second pulley 214B of FIG. 6 and 7 and second stop ring 230B. Second stop ring 230B can comprise slide pad 231 from which first rotation stop 232B and second rotation stop 234B. Second moveable ring 240B can comprise base ring 242B, second projection 244B, first stabilizer 246A and second stabilizer 246B. Second housing component 202B can comprise curved sidewall 203.

**[0078]** Second moveable ring 240B can operate in conjunction with second pulley 214B in the same manner that first moveable ring 240A and first pulley 214A operate with each other. However, second moveable ring 240B can include additional features. For example, base ring 242B can include first stabilizer 246A and second stabilizer 246B. First stabilizer 246A and second stabilizer 246B can be configured to extend along surface of second pulley 214B, such as outer rim 264B (FIG. 7) to maintain second moveable ring 240B parallel or otherwise aligned and engaged with second pulley 214B. Additionally, to obverse side of base ring 242B can include contours that are inversely shaped to curved sidewall 203 to allow second

moveable ring 240B to align parallel to second pulley 214B. For example, base ring 242B can include projections or standoffs extending from base ring 242B in the opposite direction of second projection 244B to engage curved sidewall 203 to keep second moveable ring 240B parallel to second pulley 214B so that second projection 244B can slide along slide pad 231.

**[0079]** FIG. 14 is a block diagram illustrating operations of methods 400 for bending pull wire 224A (FIG. 4) to, for example, induce bending in shaft 206. FIG. 14 is discussed with reference to first pulley 214A, but operations 402 – 416 can be used with second pulley 214B. In examples, some of operations 402 – 416 can be omitted and in examples operations 402 – 416 can be performed in other sequences.

**[0080]** At operation 402, first pulley 214A can be rotated about rotation axis AA. For example, first knob 218A can be rotated to rotate first shaft 216A (FIG. 4) to rotate first pulley 214A. First pulley 214A can be rotated to disengage first stop spoke 250A (e.g., moveable stop) from first rotation stop 232A (e.g., fixed stop).

**[0081]** At operation 404, which can comprise a sub-step of operation 402, first pulley 214A can be rotated to disengage first stop spoke 250A from a first side of projection 244A (e.g., slide stop) that is engaged with first rotation stop 232A.

**[0082]** At operation 406, first pulley 214A can be rotated to engage first stop spoke 250A to engage a second side of projection 244A.

**[0083]** At operation 408, projection 244A can be pushed into engagement with second rotation stop 234A.

**[0084]** At operation 410, first pulley 214A can be rotated about rotation axis AA to pull on pull wire 224A. As such, shaft 206 can be bent or curved to facilitate steering and performing medical procedures.

**[0085]** At operation 412, which can comprise a sub-step of operation 406, first stop spoke 250A can be rotated past second rotation stop 234A on the way to engaging the second side of projection 244A.

**[0086]** At operation 414, which can comprise a sub-step of operation 408, first stop spoke 250A can be engaged with second rotation stop 234A to prevent overbending of shaft 206.

**[0087]** At operation 416, first pulley 214A can be rotated in a second direction opposite the first direction to disengage first stop spoke 250A from second rotation stop 234A.

**[0088]** As discussed herein, the present disclosure is useful in providing sliding stop mechanisms for actuating or pulling on pull wires beyond three-hundred-sixty degrees while still having a rotational stop in place. The sliding stop mechanisms can increase the amount

of angulation of an endoscope shaft tip without increasing the size, i.e., diameter, of the pulley, while also preventing damage to the endoscope shaft or the pull wires.

### Examples

**[0089]** Example 1 is an endoscope comprising: an elongate flexible shaft; a first pull wire extending from the elongate flexible shaft; a handpiece housing connected to the elongate flexible shaft; and a pulley mechanism disposed in the handpiece housing and connected to the first pull wire to apply tension to the first pull wire by rotation, the pulley mechanism comprising: a first pulley connected to the first pull wire; a first moveable stop extending from the first pulley to move with the first pulley; and a sliding stop disposed in the handpiece housing and engageable with the first moveable stop; wherein the sliding stop can be stopped in at least two different locations along a route over which the first moveable stop moves and the sliding stop can slide between the at least two different locations when the sliding stop engages with the first moveable stop.

**[0090]** In Example 2, the subject matter of Example 1 optionally includes wherein: the handpiece housing further comprises: a pulley socket; and a first fixed stop located proximate the pulley socket.

**[0091]** In Example 3, the subject matter of Example 2 optionally includes wherein the sliding stop comprises: a slide ring disposed between the first pulley and the pulley socket, the sliding stop extending from the slide ring to be engageable with the first fixed stop and the first moveable stop; wherein the first pulley can be rotated to push the first moveable stop into engagement with the first fixed stop.

**[0092]** In Example 4, the subject matter of Example 3 optionally includes wherein the pulley socket, the first pulley and the slide ring are aligned along a rotation axis.

**[0093]** In Example 5, the subject matter of Example 4 optionally includes wherein the sliding stop extends: axially outward from the slide ring toward the first pulley to engage the first moveable stop; and radially outward from the slide ring to engage the first fixed stop.

**[0094]** In Example 6, the subject matter of Example 5 optionally includes wherein the sliding stop is axially longer than the first fixed stop.

**[0095]** In Example 7, the subject matter of any one or more of Examples 5–6 optionally include wherein: the pulley socket comprises a circular track; the first fixed stop is located within the circular track; and the slide ring comprises an annular body configured to rotate about the rotation axis on the circular track radially inward of first fixed stop.

**[0096]** In Example 8, the subject matter of Example 7 optionally includes a second fixed stop circumferentially spaced from the first fixed stop within the circular track; and a second pull wire extending from the elongate flexible shaft to connect to the first pulley.

**[0097]** In Example 9, the subject matter of Example 8 optionally includes wherein: the first pulley can be rotated in a first direction so that the first moveable stop pushes the sliding stop into engagement with the first fixed stop; and the first pulley can be rotated in a second direction so that the first moveable stop pushes the sliding stop into engagement with the second fixed stop.

**[0098]** In Example 10, the subject matter of any one or more of Examples 4–9 optionally include wherein the first pulley can rotate over three-hundred-sixty degrees in either direction about the rotation axis.

**[0099]** In Example 11, the subject matter of any one or more of Examples 3–10 optionally include wherein the pulley mechanism further comprises: a first shaft extending from the first pulley and through the handpiece housing at the pulley socket; and a first knob extending from the first shaft.

**[0100]** In Example 12, the subject matter of any one or more of Examples 1–11 optionally include a second pulley mounted within the handpiece housing to rotate independent of the first pulley; a second pull wire extending from the elongate flexible shaft and connected to the second pulley; a second moveable stop extending from the second pulley; a second fixed stop disposed within the handpiece housing proximate the second pulley; and a second slide ring having a second sliding stop extending from the second slide ring to be engageable with the second fixed stop and the second moveable stop.

**[0101]** Example 13 is a sliding stop mechanism for an endoscope pull wire, the sliding stop mechanism comprising: a first pulley for connecting to a first pull wire and rotation about a pulley axis; a first moveable stop extending from the first pulley to move with the first pulley; and a sliding stop engageable with the first moveable stop; wherein the sliding stop can be stopped in at least two different locations along a route over which the first moveable stop moves and the sliding stop can slide between the at least two different locations when the sliding stop engages with the first moveable stop.

**[0102]** In Example 14, the subject matter of Example 13 optionally includes a handpiece housing stop comprising a first flange and a second flange that define the at least two different locations, respectively; and a slide ring from which the sliding stop extends, the slide ring being rotatable between the first flange and the second flange; wherein the first pulley can be rotated in a first direction to push the first moveable stop into engagement with

the first flange and a second direction to push the first moveable stop into engagement with the second flange.

**[0103]** In Example 15, the subject matter of Example 14 optionally includes a handpiece housing comprising: the handpiece housing stop; and a pulley socket comprising an annular track from which the first flange and the second flange extend; and the first pulley further comprises a first shaft extending from the first pulley along the pulley axis and out of the handpiece housing at the pulley socket.

**[0104]** In Example 16, the subject matter of Example 15 optionally includes wherein the sliding stop extends: axially outward from the slide ring toward the first pulley to engage the first moveable stop; and radially outward from the slide ring to engage the first flange.

**[0105]** In Example 17, the subject matter of Example 16 optionally includes wherein the sliding stop is axially longer than the first flange.

**[0106]** In Example 18, the subject matter of any one or more of Examples 15–17 optionally include wherein the handpiece housing stop is fixed relative to the handpiece housing.

**[0107]** Example 19 is a method for bending an insertion shaft of an endoscope with a pull wire, the method comprising: rotating a pulley in a first direction about a rotation axis along a first path to disengage a moveable stop from a first fixed stop; rotating the pulley about the rotation axis to pull the pull wire; continuing to rotate the pulley about the rotation axis in the first direction to move the moveable stop past the first fixed stop; and engaging the moveable stop with a second fixed stop to prevent overbending of the insertion shaft.

**[0108]** In Example 20, the subject matter of Example 19 optionally includes wherein the pulley can be rotated along the first path over three-hundred-sixty degrees to disengage the first fixed stop and engage the second fixed stop.

**[0109]** In Example 21, the subject matter of any one or more of Examples 19–20 optionally include wherein rotating the pulley in the first direction about the rotation axis along the first path to disengage the moveable stop from the first fixed stop comprises: disengaging the moveable stop from a first side of a sliding stop engaged with the first fixed stop; rotating the moveable stop to engage a second side of the sliding stop; and pushing the sliding stop into engagement with the second fixed stop.

**[0110]** In Example 22, the subject matter of Example 21 optionally includes wherein rotating the pulley in the first direction about the rotation axis along the first path to disengage the moveable stop from the first fixed stop comprises: rotating the moveable stop past the second fixed stop while traveling to engaging the second side of the sliding stop.

**[0111]** In Example 23, the subject matter of any one or more of Examples 19–22 optionally

include rotating the pulley in a second direction about the rotation axis along a second path to disengage the moveable stop from the second fixed stop.

[0112] Each of these non-limiting examples can stand on its own, or can be combined in various permutations or combinations with one or more of the other examples.

#### Notes

[0113] The above detailed description includes references to the accompanying drawings, which form a part of the detailed description. The drawings show, by way of illustration, specific embodiments in which the invention can be practiced. These embodiments are also referred to herein as “examples.” Such examples can include elements in addition to those shown or described. However, the present inventor also contemplates examples in which only those elements shown or described are provided. Moreover, the present inventor also contemplates examples using any combination or permutation of those elements shown or described (or one or more aspects thereof), either with respect to a particular example (or one or more aspects thereof), or with respect to other examples (or one or more aspects thereof) shown or described herein.

[0114] In the event of inconsistent usages between this document and any documents so incorporated by reference, the usage in this document controls.

[0115] In this document, the terms “a” or “an” are used, as is common in patent documents, to include one or more than one, independent of any other instances or usages of “at least one” or “one or more.” In this document, the term “or” is used to refer to a nonexclusive or, such that “A or B” includes “A but not B,” “B but not A,” and “A and B,” unless otherwise indicated. In this document, the terms “including” and “in which” are used as the plain-English equivalents of the respective terms “comprising” and “wherein.” Also, in the following claims, the terms “including” and “comprising” are open-ended, that is, a system, device, article, composition, formulation, or process that includes elements in addition to those listed after such a term in a claim are still deemed to fall within the scope of that claim. Moreover, in the following claims, the terms “first,” “second,” and “third,” etc. are used merely as labels, and are not intended to impose numerical requirements on their objects.

[0116] The above description is intended to be illustrative, and not restrictive. For example, the above-described examples (or one or more aspects thereof) may be used in combination with each other. Other embodiments can be used, such as by one of ordinary skill in the art upon reviewing the above description. The Abstract is provided to allow the reader to quickly ascertain the nature of the technical disclosure. It is submitted with the

understanding that it will not be used to interpret or limit the scope or meaning of the claims. Also, in the above Detailed Description, various features may be grouped together to streamline the disclosure. This should not be interpreted as intending that an unclaimed disclosed feature is essential to any claim. Rather, inventive subject matter may lie in less than all features of a particular disclosed embodiment. Thus, the following claims are hereby incorporated into the Detailed Description as examples or embodiments, with each claim standing on its own as a separate embodiment, and it is contemplated that such embodiments can be combined with each other in various combinations or permutations. The scope of the invention should be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled.

CLAIMS:

1. An endoscope comprising:
  - an elongate flexible shaft;
  - a first pull wire extending from the elongate flexible shaft;
  - a handpiece housing connected to the elongate flexible shaft; and
  - a pulley mechanism disposed in the handpiece housing and connected to the first pull wire to apply tension to the first pull wire by rotation, the pulley mechanism comprising:
    - a first pulley connected to the first pull wire;
    - a first moveable stop extending from the first pulley to move with the first pulley; and
    - a sliding stop disposed in the handpiece housing and engageable with the first moveable stop;wherein the sliding stop can be stopped in at least two different locations along a route over which the first moveable stop moves and the sliding stop can slide between the at least two different locations when the sliding stop engages with the first moveable stop.
2. The endoscope of claim 1, wherein:
  - the handpiece housing further comprises:
    - a pulley socket; and
    - a first fixed stop located proximate the pulley socket.
3. The endoscope of claim 2, wherein the sliding stop comprises:
  - a slide ring disposed between the first pulley and the pulley socket, the sliding stop extending from the slide ring to be engageable with the first fixed stop and the first moveable stop;
  - wherein the first pulley can be rotated to push the first moveable stop into engagement with the first fixed stop.
4. The endoscope of claim 3, wherein the pulley socket, the first pulley and the slide ring are aligned along a rotation axis.
5. The endoscope of claim 4, wherein the sliding stop extends:

- axially outward from the slide ring toward the first pulley to engage the first moveable stop; and
- radially outward from the slide ring to engage the first fixed stop.
6. The endoscope of claim 5, wherein the sliding stop is axially longer than the first fixed stop.
  7. The endoscope of claim 5, wherein:
    - the pulley socket comprises a circular track;
    - the first fixed stop is located within the circular track; and
    - the slide ring comprises an annular body configured to rotate about the rotation axis on the circular track radially inward of first fixed stop.
  8. The endoscope of claim 7, further comprising:
    - a second fixed stop circumferentially spaced from the first fixed stop within the circular track; and
    - a second pull wire extending from the elongate flexible shaft to connect to the first pulley.
  9. The endoscope of claim 8, wherein:
    - the first pulley can be rotated in a first direction so that the first moveable stop pushes the sliding stop into engagement with the first fixed stop; and
    - the first pulley can be rotated in a second direction so that the first moveable stop pushes the sliding stop into engagement with the second fixed stop.
  10. The endoscope of claim 4, wherein the first pulley can rotate over three-hundred-sixty degrees in either direction about the rotation axis.
  11. The endoscope of claim 3, wherein the pulley mechanism further comprises:
    - a first shaft extending from the first pulley and through the handpiece housing at the pulley socket; and
    - a first knob extending from the first shaft.
  12. The endoscope of claim 1, further comprising:

a second pulley mounted within the handpiece housing to rotate independent of the first pulley;

a second pull wire extending from the elongate flexible shaft and connected to the second pulley;

a second moveable stop extending from the second pulley;

a second fixed stop disposed within the handpiece housing proximate the second pulley; and

a second slide ring having a second sliding stop extending from the second slide ring to be engageable with the second fixed stop and the second moveable stop.

13. A sliding stop mechanism for an endoscope pull wire, the sliding stop mechanism comprising:

a first pulley for connecting to a first pull wire and rotation about a pulley axis;

a first moveable stop extending from the first pulley to move with the first pulley; and

a sliding stop engageable with the first moveable stop;

wherein the sliding stop can be stopped in at least two different locations along a route over which the first moveable stop moves and the sliding stop can slide between the at least two different locations when the sliding stop engages with the first moveable stop.

14. The sliding stop mechanism of claim 13, further comprising:

a handpiece housing stop comprising a first flange and a second flange that define the at least two different locations, respectively; and

a slide ring from which the sliding stop extends, the slide ring being rotatable between the first flange and the second flange;

wherein the first pulley can be rotated in a first direction to push the first moveable stop into engagement with the first flange and a second direction to push the first moveable stop into engagement with the second flange.

15. The sliding stop mechanism of claim 14, further comprising:

a handpiece housing comprising:

the handpiece housing stop; and

a pulley socket comprising an annular track from which the first flange and the second flange extend; and

the first pulley further comprises a first shaft extending from the first pulley along the pulley axis and out of the handpiece housing at the pulley socket.

16. The sliding stop mechanism of claim 15, wherein the sliding stop extends:  
axially outward from the slide ring toward the first pulley to engage the first moveable stop; and  
radially outward from the slide ring to engage the first flange
17. The sliding stop mechanism of claim 16, wherein the sliding stop is axially longer than the first flange.
18. The sliding stop mechanism of claim 15, wherein the handpiece housing stop is fixed relative to the handpiece housing.
19. A method for bending an insertion shaft of an endoscope with a pull wire, the method comprising:  
rotating a pulley in a first direction about a rotation axis along a first path to disengage a moveable stop from a first fixed stop;  
rotating the pulley about the rotation axis to pull the pull wire;  
continuing to rotate the pulley about the rotation axis in the first direction to move the moveable stop past the first fixed stop; and  
engaging the moveable stop with a second fixed stop to prevent overbending of the insertion shaft.
20. The method of claim 19, wherein the pulley can be rotated along the first path over three-hundred-sixty degrees to disengage the first fixed stop and engage the second fixed stop.
21. The method of claim 19, wherein rotating the pulley in the first direction about the rotation axis along the first path to disengage the moveable stop from the first fixed stop comprises:  
disengaging the moveable stop from a first side of a sliding stop engaged with the first fixed stop;  
rotating the moveable stop to engage a second side of the sliding stop; and

pushing the sliding stop into engagement with the second fixed stop.

22. The method of claim 21, wherein rotating the pulley in the first direction about the rotation axis along the first path to disengage the moveable stop from the first fixed stop comprises:

rotating the moveable stop past the second fixed stop while traveling to engaging the second side of the sliding stop.

23. The method of claim 19, further comprising rotating the pulley in a second direction about the rotation axis along a second path to disengage the moveable stop from the second fixed stop.

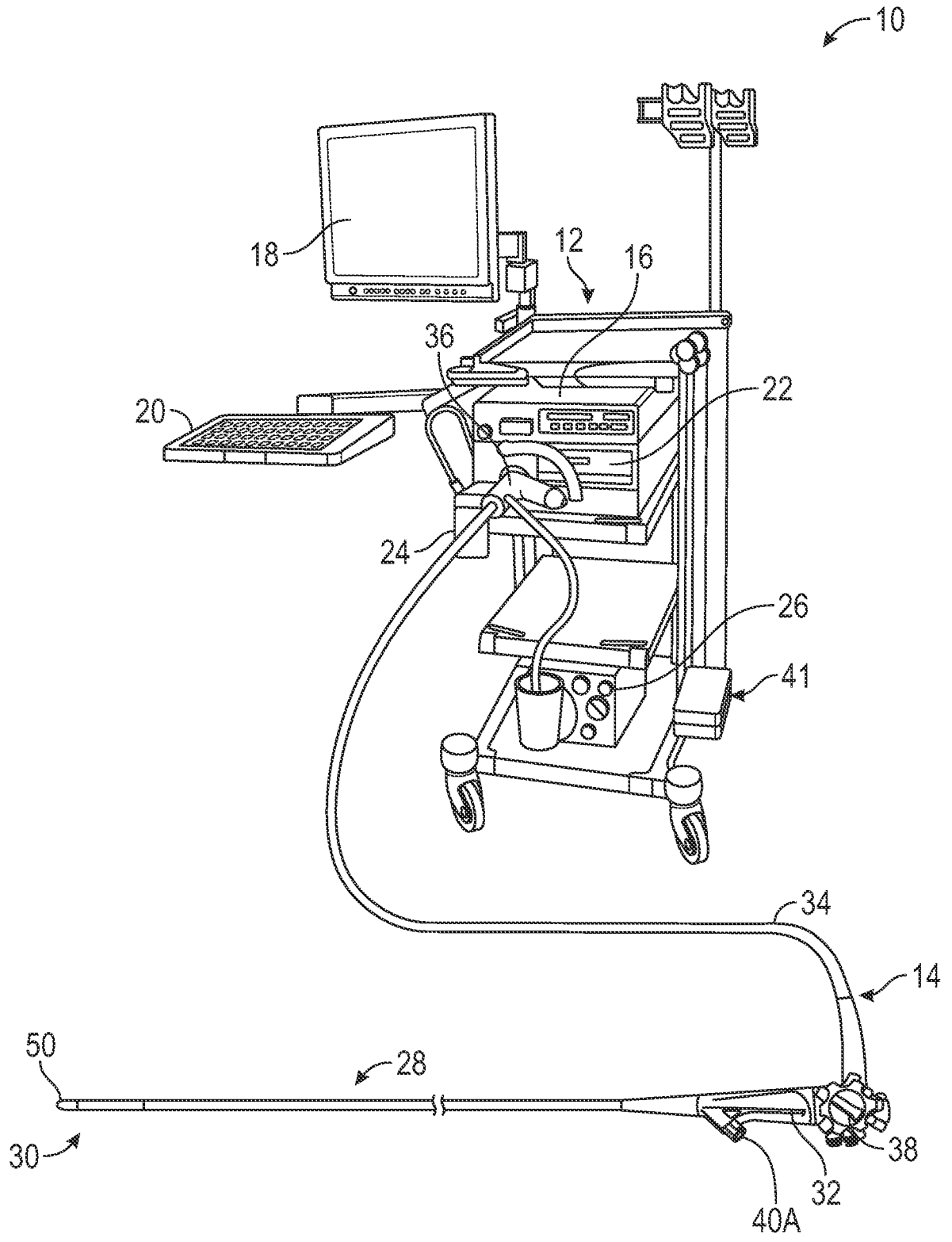


FIG. 1

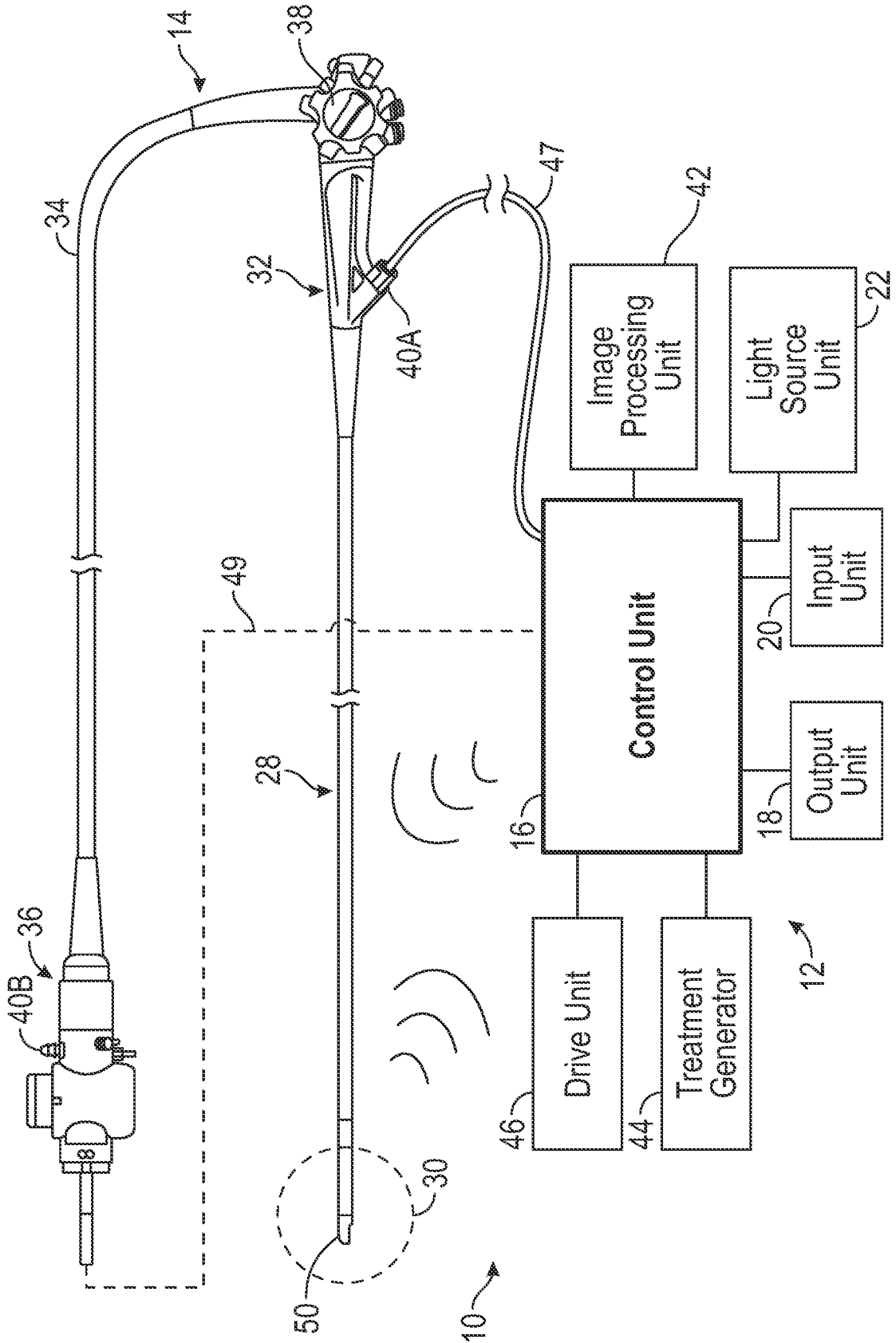


FIG. 2

3/13

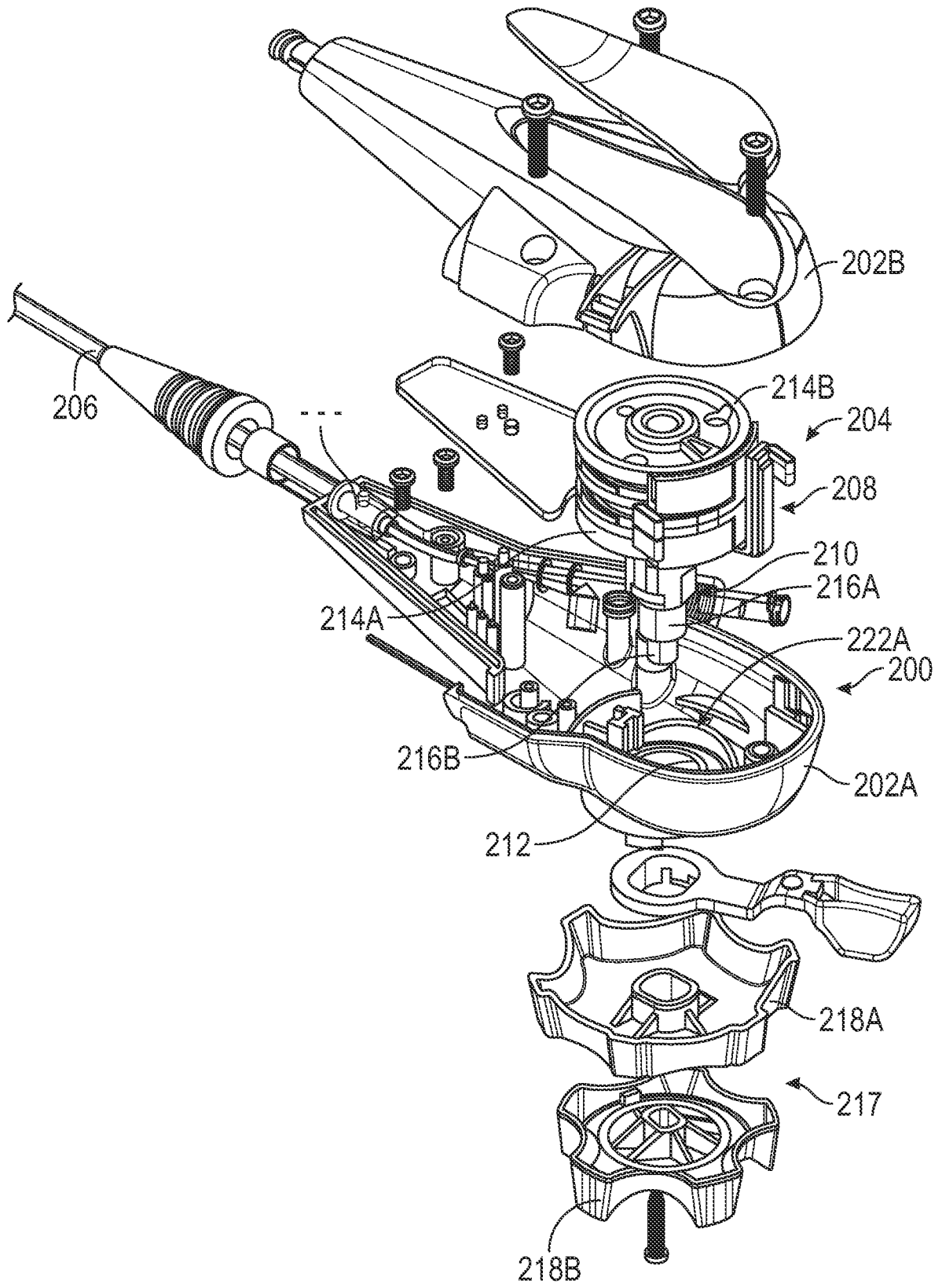


FIG. 3

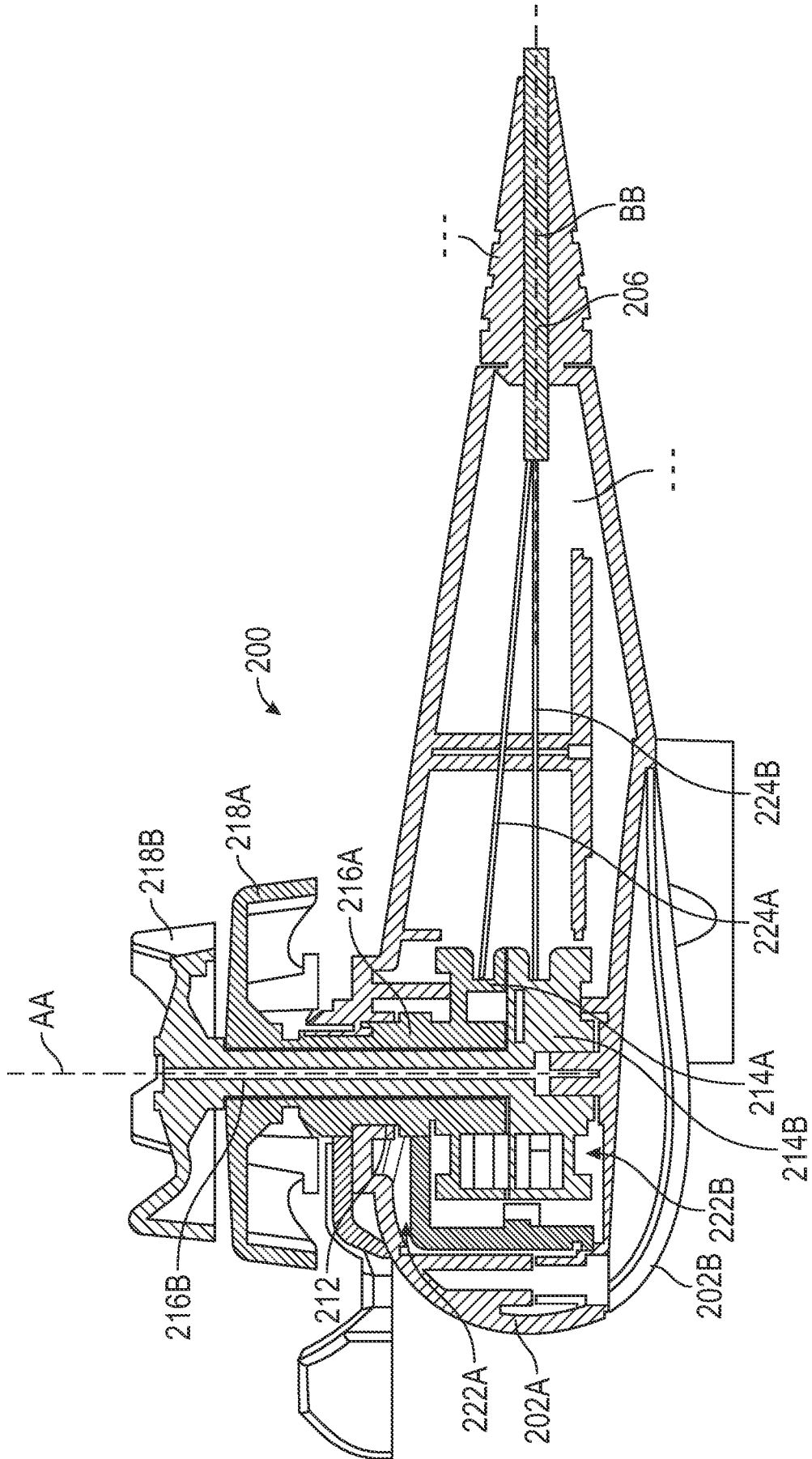


FIG. 4

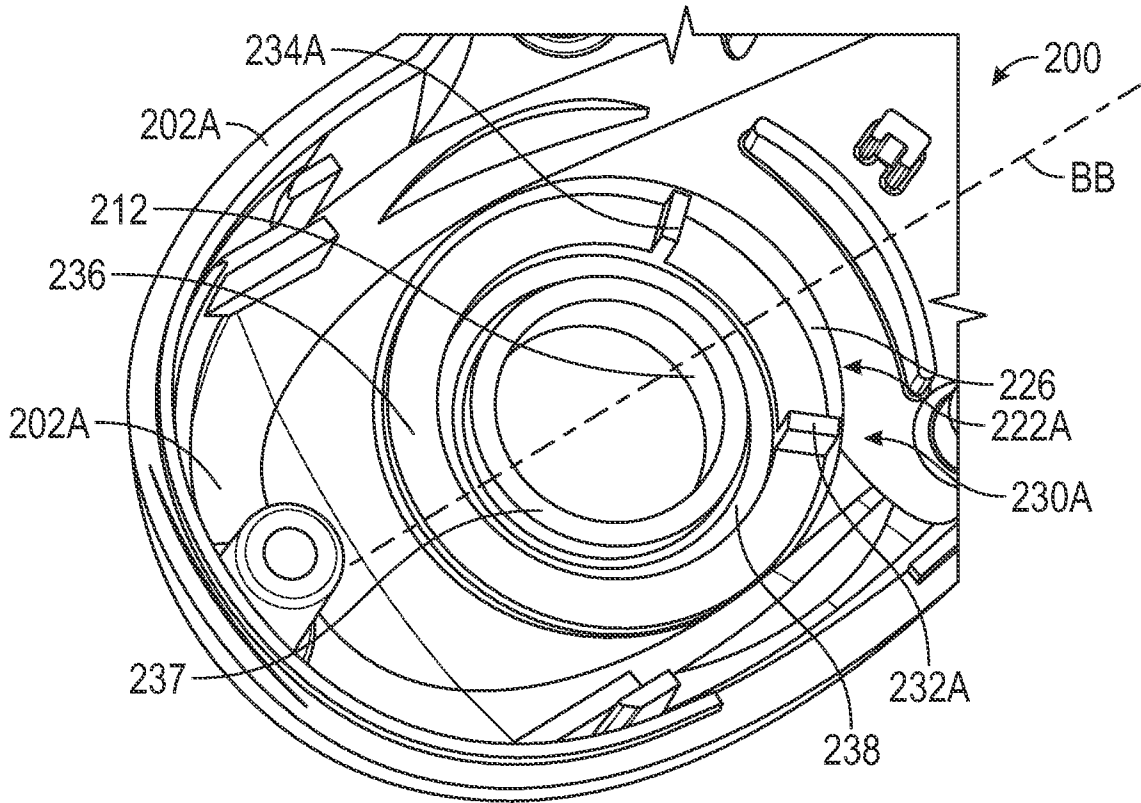


FIG. 5A

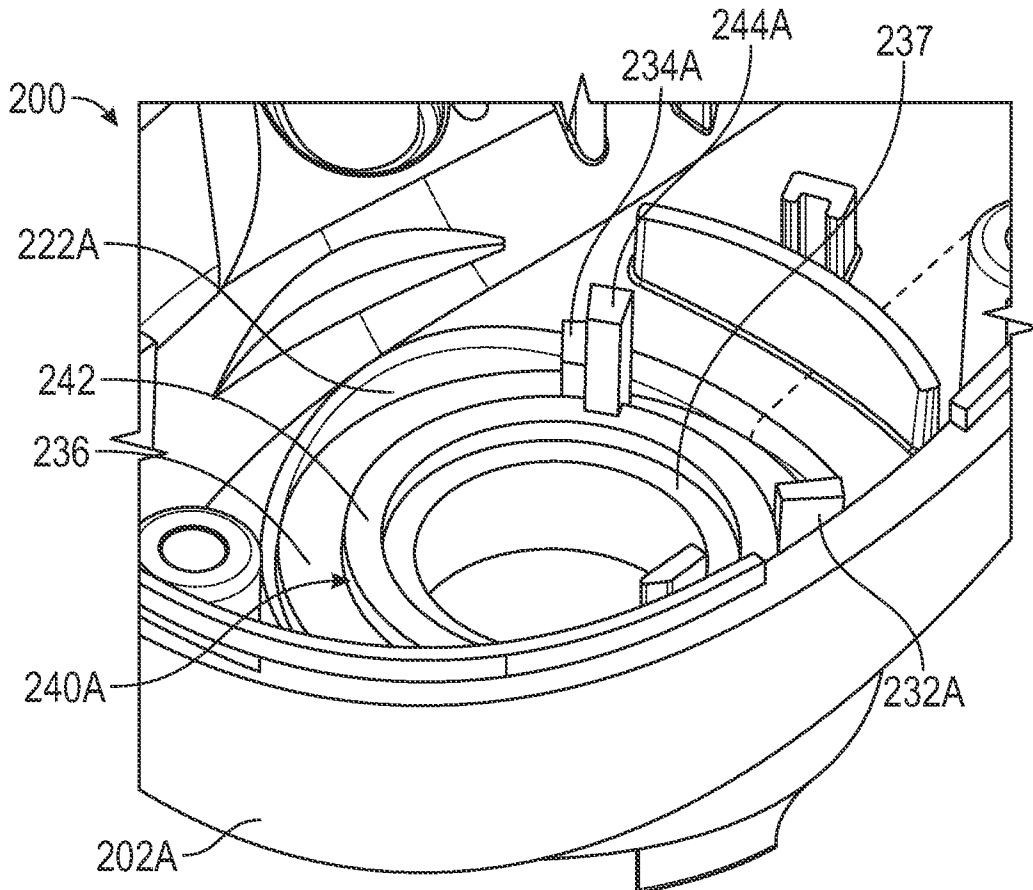


FIG. 5B

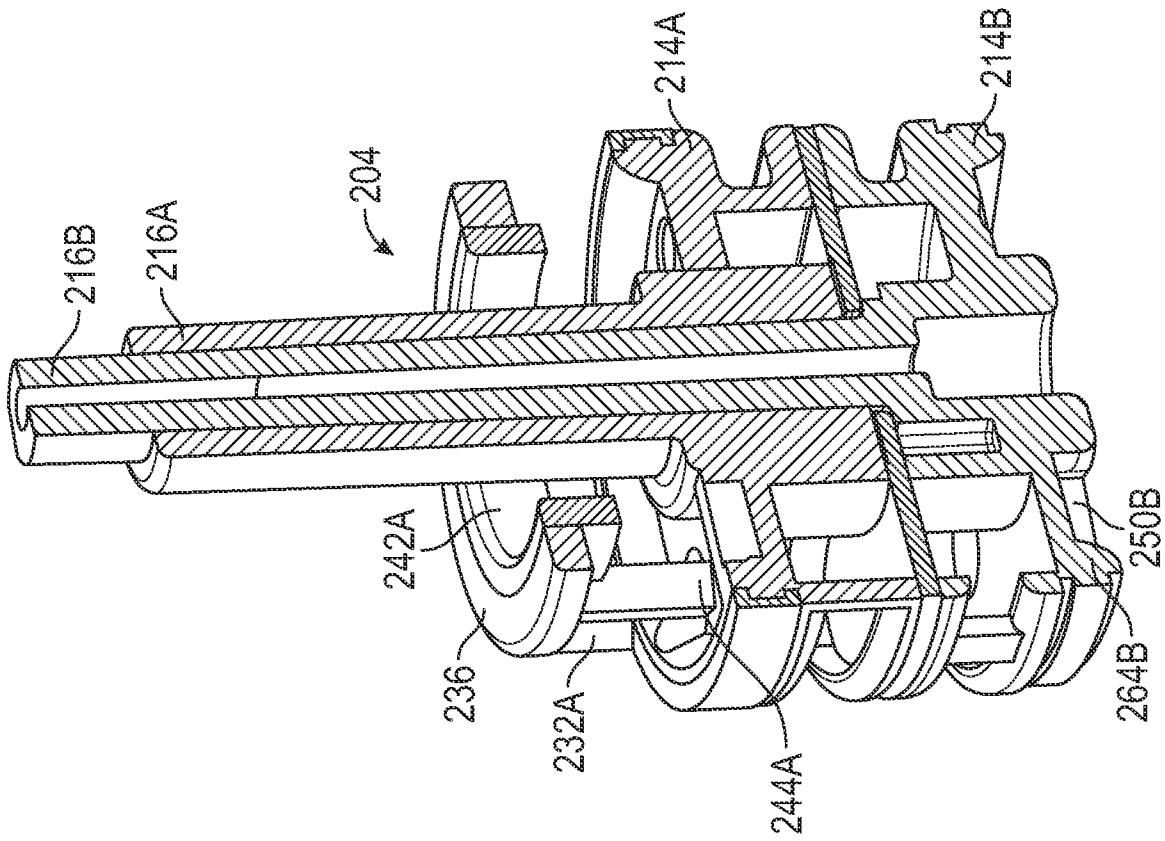


FIG. 7

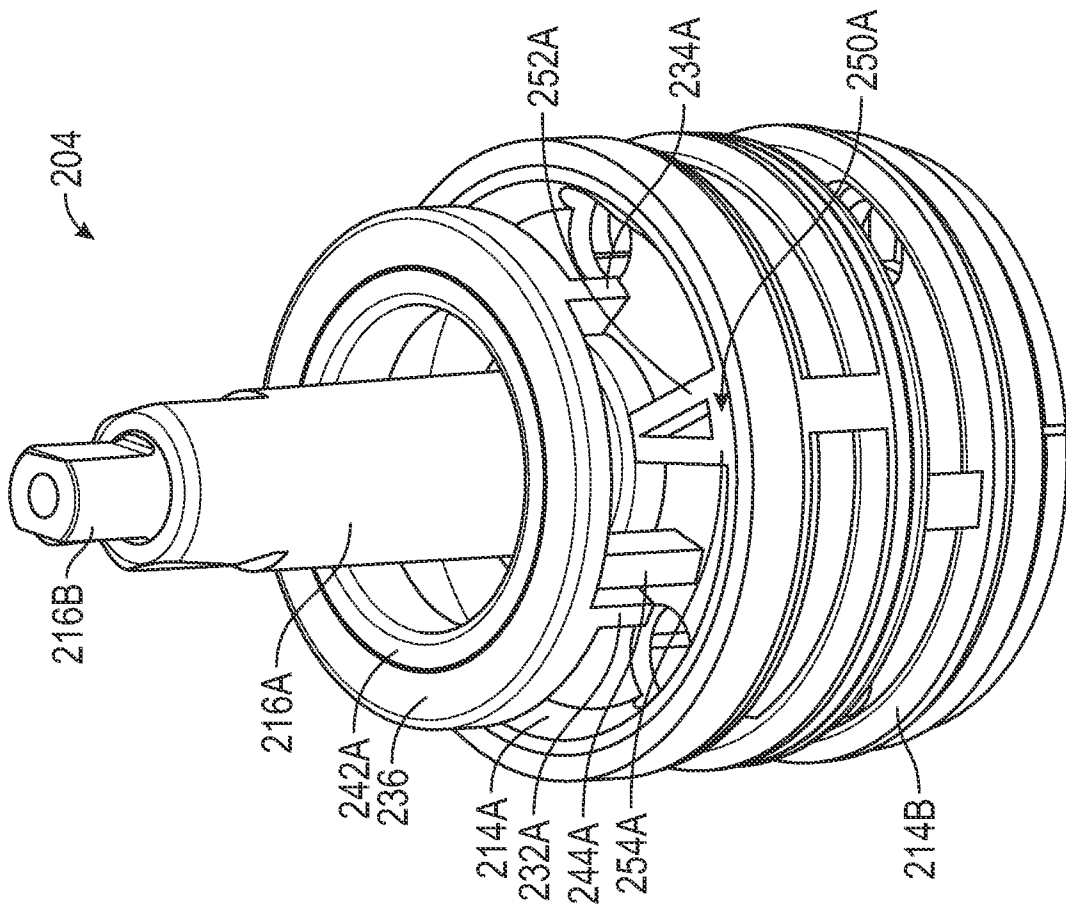


FIG. 6

7/13

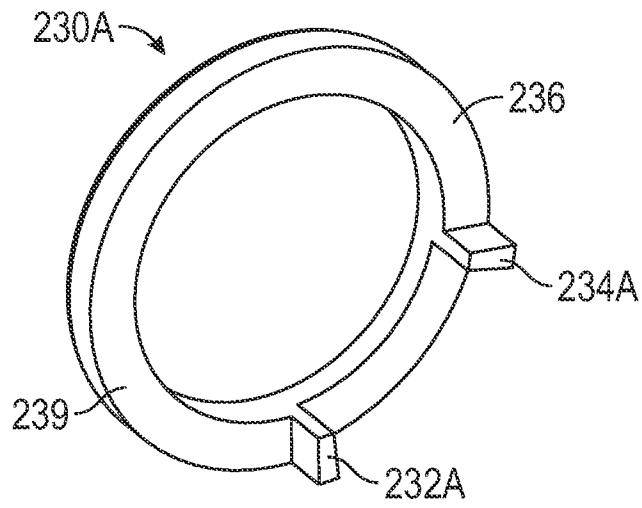


FIG. 8A

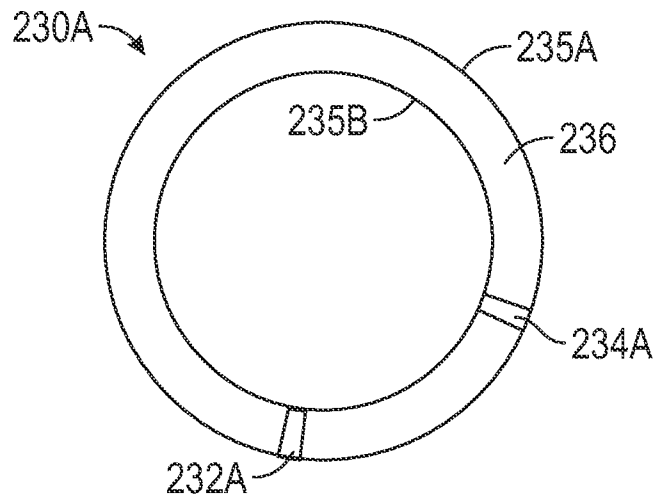


FIG. 8B

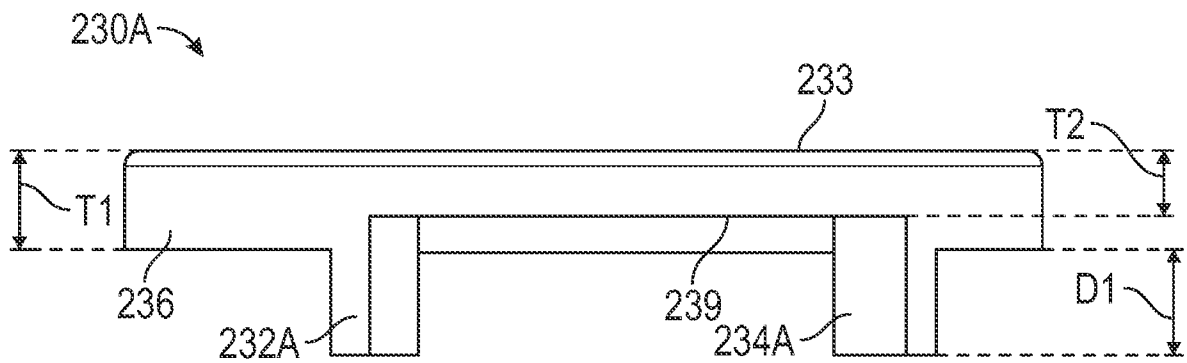


FIG. 8C

8/13

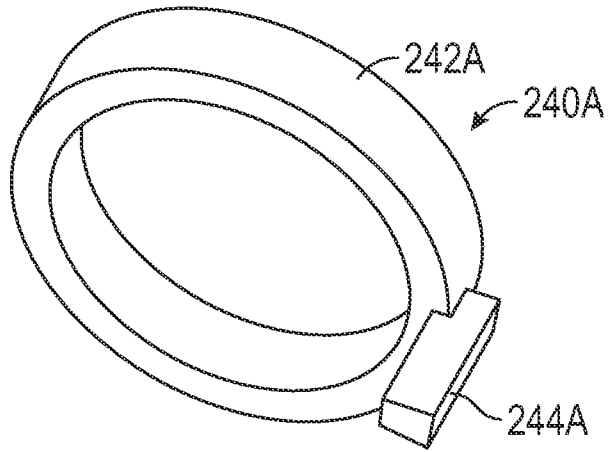


FIG. 9A

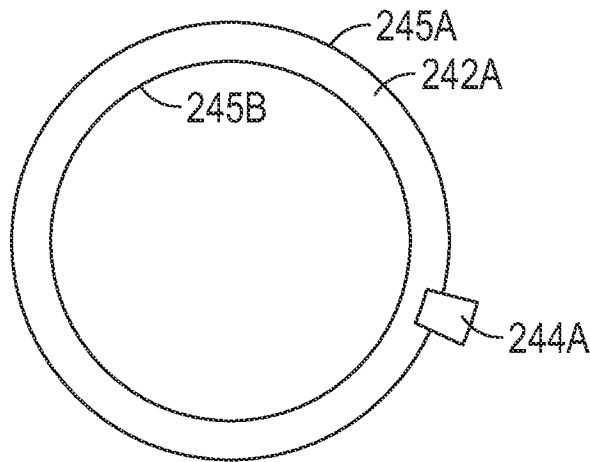


FIG. 9B

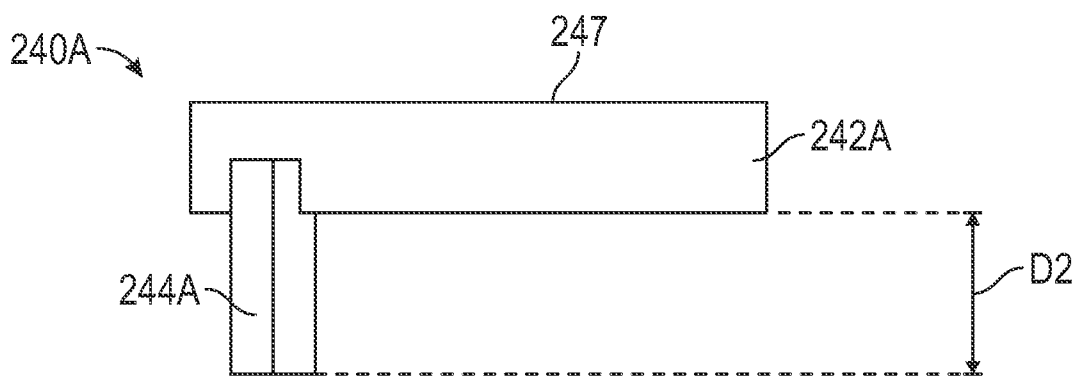


FIG. 9C

9/13

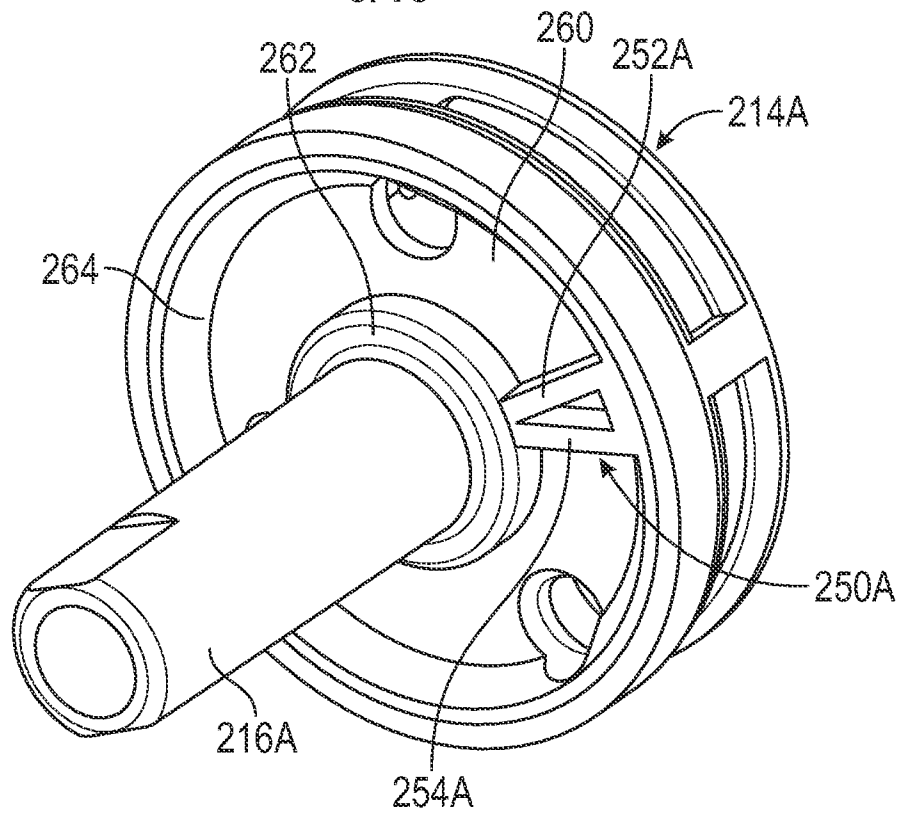


FIG. 10A

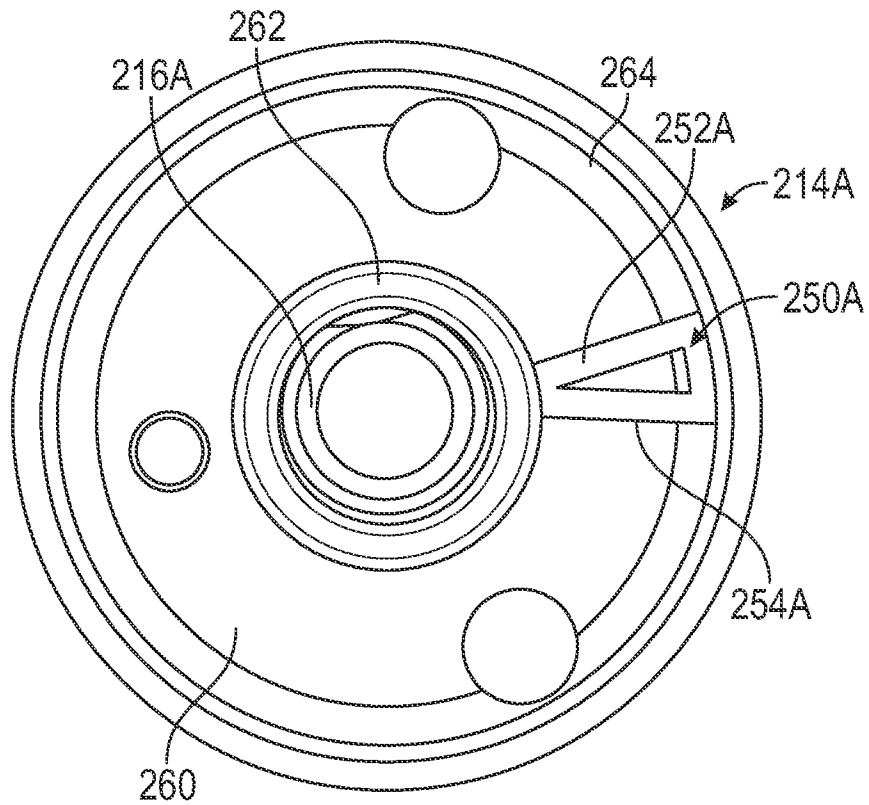


FIG. 10B

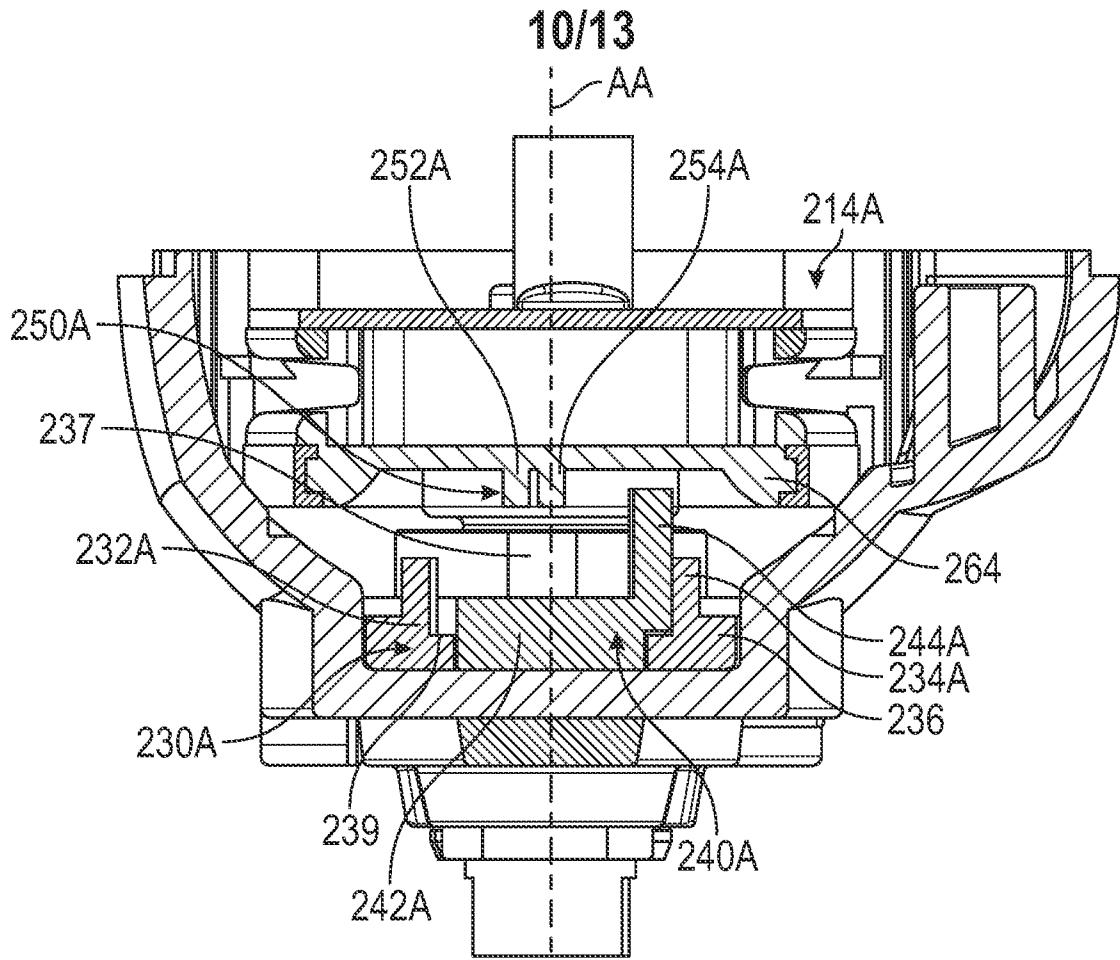


FIG. 11A

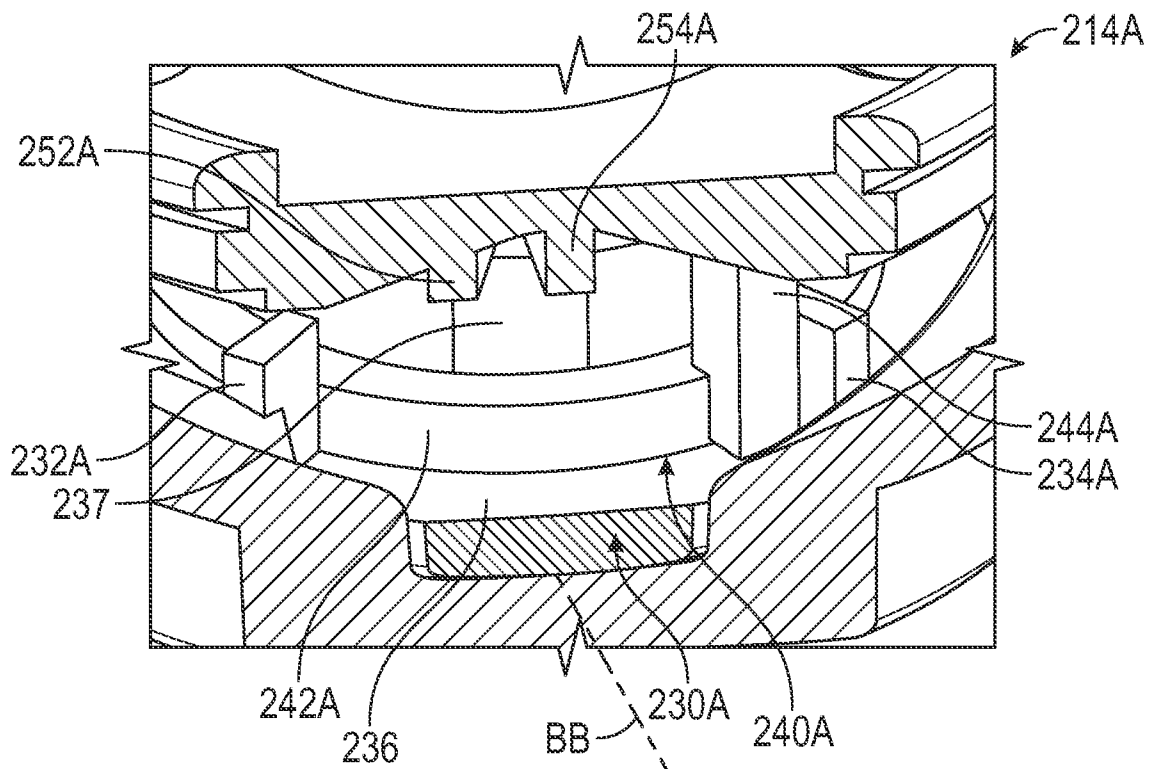


FIG. 11B

11/13

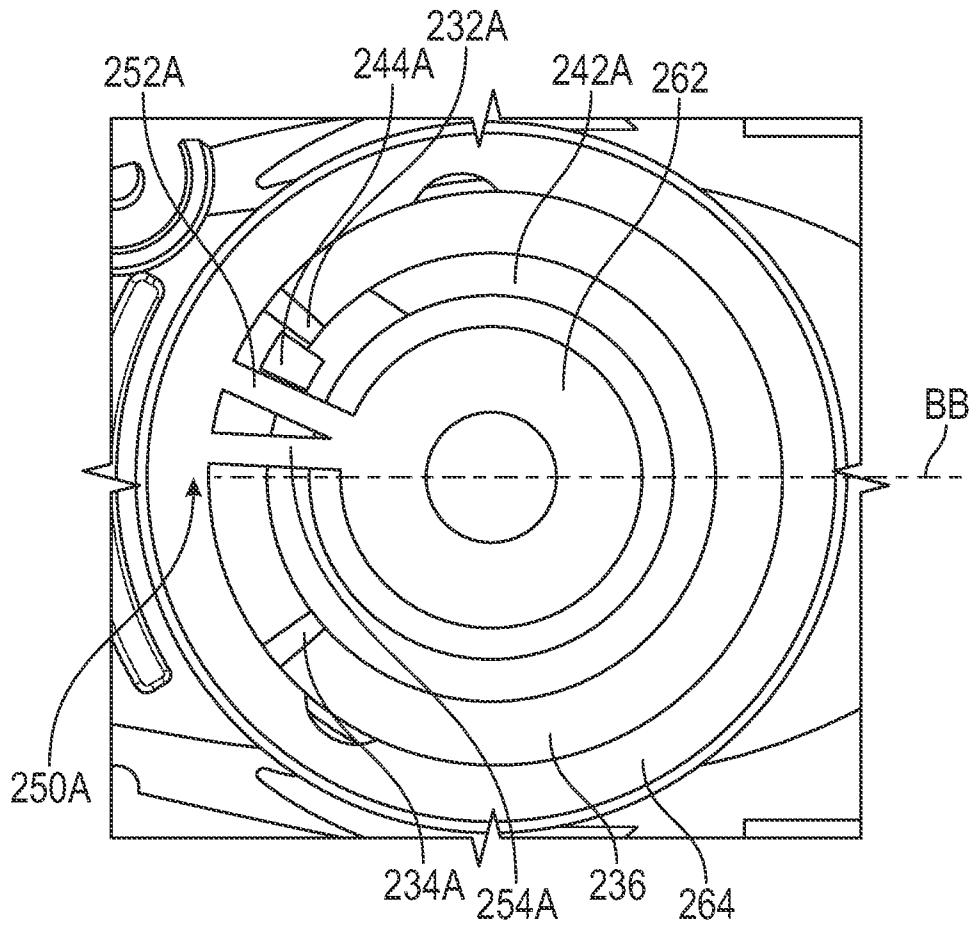


FIG. 12A

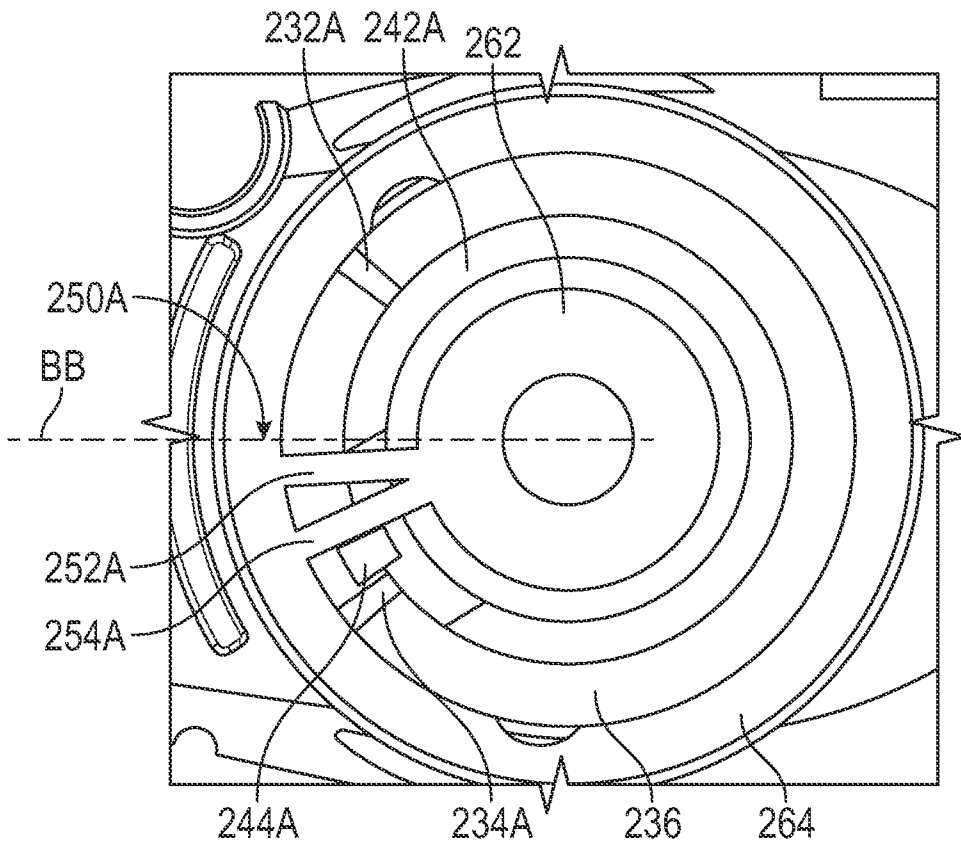


FIG. 12B

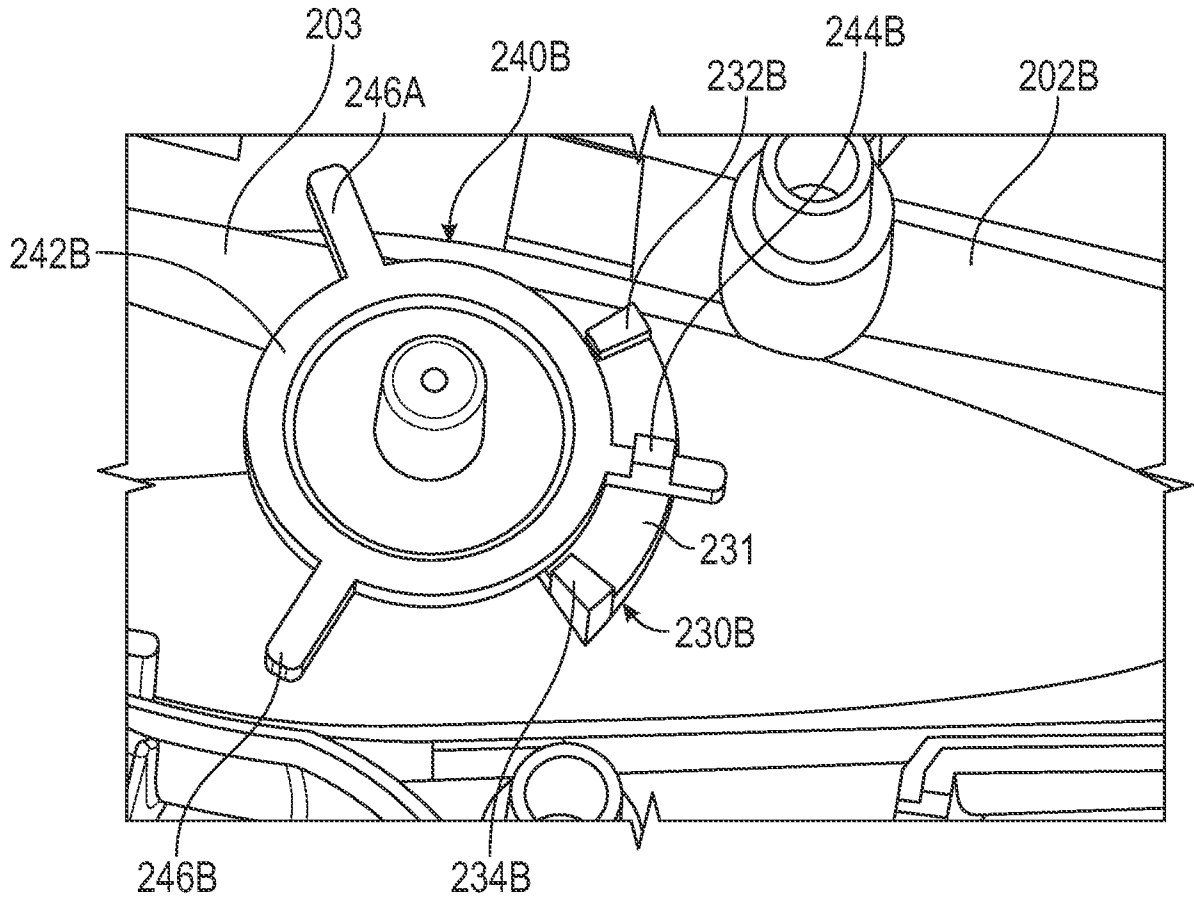


FIG. 13

13/13

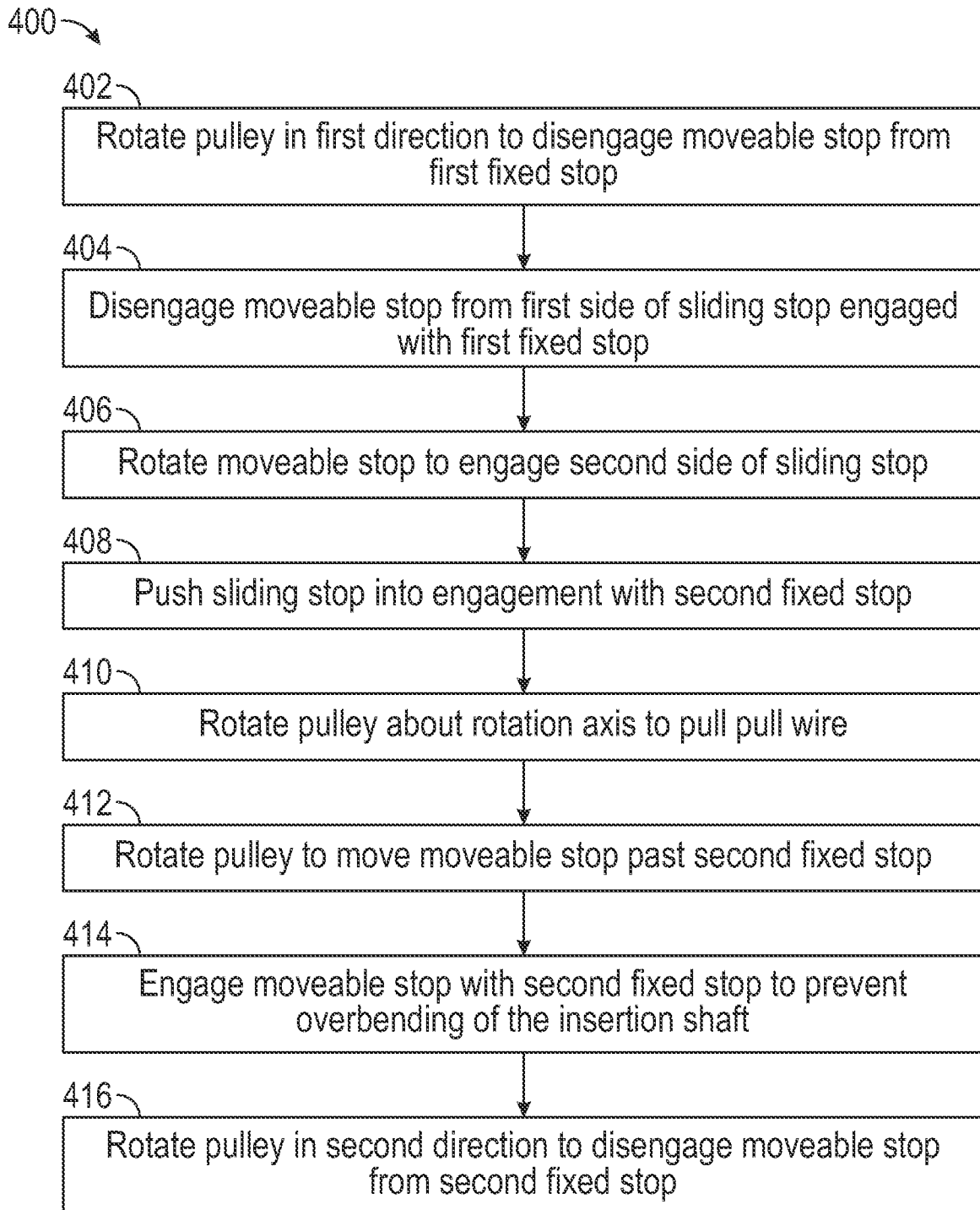


FIG. 14

# INTERNATIONAL SEARCH REPORT

International application No  
PCT/US2024/033354

**A. CLASSIFICATION OF SUBJECT MATTER**  
 INV. A61B1/005  
 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**

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP H04 8340 A (ASAHI OPTICAL CO LTD) 13 January 1992 (1992-01-13) figures 2, 3, 4 page 244 - page 245 -----	1 - 23
A	JP 2006 156138 A (KENWOOD CORP) 15 June 2006 (2006-06-15) paragraphs [0001], [0003] - [0005] figures 1, 2 -----	1 - 23
A	JP 2008 264107 A (HOYA CORP) 6 November 2008 (2008-11-06) paragraphs [0034] - [0040] figures 1, 2, 4, 5 -----	1 - 23

Further documents are listed in the continuation of Box C.
  See patent family annex.

\* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family
----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Date of the actual completion of the international search	Date of mailing of the international search report
<b>30 August 2024</b>	<b>13/09/2024</b>

Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer  <p style="text-align: center;"><b>Höß, Theresa</b></p>
----------------------------------------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No PCT/US2024/033354
---------------------------------------------------

Patent document cited in search report	A	Publication date	Patent family member(s)	Publication date
JP H048340	A	13-01-1992	JP 2918171 B2 JP H048340 A	12-07-1999 13-01-1992
-----				
JP 2006156138	A	15-06-2006	JP 4508849 B2 JP 2006156138 A	21-07-2010 15-06-2006
-----				
JP 2008264107	A	06-11-2008	NONE	
-----				