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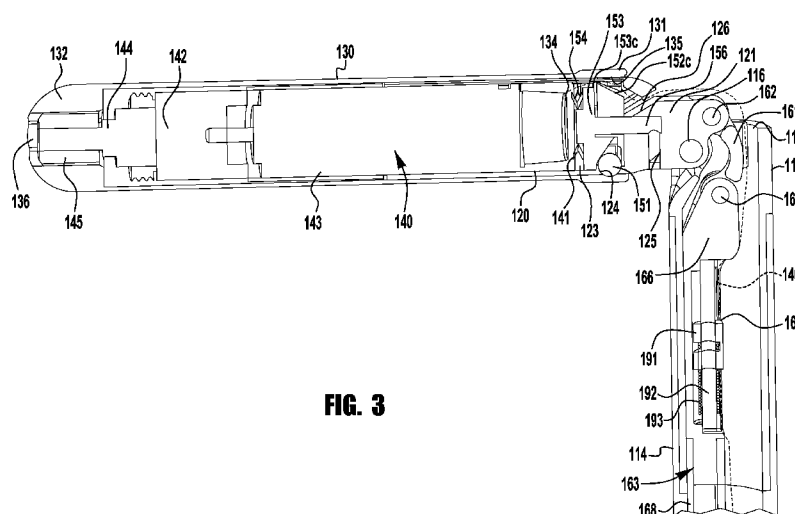


FIG. 3

(57) **Abstract:** A motor-driven instrument includes a shaft having a proximal end and a distal end, a retainer housing coupled to the distal end of the shaft, a rotary motor, and a tool head. The rotary motor including a motor body assembled with the retainer housing and an output shaft extending from a distal end of the motor body. The tool head includes a tubular proximal end secured to the retainer housing and receiving at least a portion of the motor body therein, and a distal end connected with the output shaft for rotation therewith.



MOTOR-DRIVEN TOOL-ENDED INSTRUMENTS

RELATED APPLICATION

[0001] This application claims the benefit of pending United States Provisional Patent Application No. 61/884,266 filed on September 30, 2013, entitled MOTOR-DRIVEN TOOL-ENDED INSTRUMENTS, the entire disclosure of which is fully incorporated herein by reference.

BACKGROUND

[0002] Conventional gas turbine engines, such as those used in aircraft, are enclosed in an engine casing and include a plurality of turbine blades secured to a drum. Such gas turbine engines, typically mounted on the wing of an aircraft, are frequently damaged by foreign objects, such as sand particles, stones, or other objects ingested by the engine during takeoff. These foreign objects ingested by the turbine engine often cause generally V-shaped nicks or chips on impact along the leading edge of the affected turbine blades. In order to prevent such notches or nicks from becoming more pronounced and potentially cracking the turbine blade, it is desirable to detect the nicks or notches early and, if possible, repair or blend the defects in the turbine blades. In general the term blending is used in the art for the process of smoothing a V-shaped notch or nick.

[0003] A conventional turbine blade inspection process involves a visual inspection of each turbine blade through a borescope or endoscope passed through observation ports or holes in the engine casing. For purposes of the present document, the word "endoscope" may be interpreted to include rigid borescopes, flexible fiber optic borescopes and videoscopes or any similar device. The borescope, a fiber optic cable connected to a light source, is inserted through borescope openings within the engine case and into the engine, for visual inspection of the turbine blades and other internal engine components. To avoid costly and time-consuming removal and disassembly of a gas turbine engine for repair or replacement of a damaged turbine blade, grinding or blending instruments have been adapted for insertion through the borescope openings in the engine case, allowing for repair of the damaged turbine blades without disassembly of the engine. The instrument includes a motor driven tool at the insertable end of the instrument that is operable to grind or blend the damaged portion of the turbine blade. Exemplary blending tools are described in U.S. Patent Nos. 5,102,221; 5,475,485; 5,644,394; 5,803,680; and 7,112,118, the entire disclosures of each of which are incorporated herein by reference.

SUMMARY

[0004] According to an exemplary embodiment of the present application, a motor-driven instrument includes a shaft having a proximal end and a distal end, a retainer housing coupled to the distal end of the shaft, a rotary motor, and a tool head. The rotary motor including a motor body assembled with the retainer housing and an output shaft extending from a distal end of the motor body. The tool head having a tubular proximal end secured to the retainer housing and receiving at least a portion of the motor body therein, and a distal end connected with the output shaft for rotation therewith.

[0005] In another exemplary embodiment, a tool-ended instrument includes a shaft having a proximal end and a distal end, and a retainer housing coupled to the distal end of the shaft. At least one bearing member extends radially outward through an opening in the retainer housing. A wedge block is disposed within the retainer housing and is biased toward a first position in which the wedge block forces the at least one bearing member radially outward through the opening. A tool head is axially secured to the retainer housing at a tubular proximal end having an inner peripheral groove that receives the at least one bearing member. The retainer housing includes a release aperture oriented to intersect with the wedge block, such that insertion of a tool into the release aperture moves the wedge block from the first position to a second position in which the at least one bearing member is permitted to retract into the retainer housing.

[0006] In still another exemplary embodiment, a tool-ended instrument includes a shaft having a proximal end and a distal end, a tool head pivotably coupled to the distal end of the shaft, and a slide member disposed within the shaft and coupled to the tool head. The slide member is axially slideable within the shaft for pivoting movement of the tool head. A threaded collar is assembled with the shaft and in threaded engagement with a threaded portion of the slide member. User rotation of the threaded collar axially slides the slide member for pivoting movement of the tool head.

[0007] In another exemplary embodiment, a method is contemplated for detaching a tool head from an articulating tool-ended instrument including a shaft having a proximal end and a distal end, a retainer housing pivotably coupled to the distal end of the shaft at a joint portion, and a tool head secured to the retainer housing by at least one bearing member extending radially outward of an opening in the retainer housing. In the exemplary method, a release tool is provided with a tool body defining a first bore, a second bore, and a neck

portion separating the first and second bores, a button disposed on an outer surface of tool body and including an inward projection intersecting the neck portion. The release tool is assembled with the instrument such that at least a portion of the tool head is received in the first bore, at least a portion of the shaft is received in the second bore, and the joint portion is received in the neck portion, with the button projection aligning with a release aperture in the retainer housing. The button is depressed, such that the button projection extends within the release aperture to engage a bearing release mechanism, thereby permitting the at least one bearing member to disengage from the tool head for detachment of the tool head from the retainer housing.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Further features and advantages will become apparent from the following detailed description made with reference to the accompanying drawings, wherein:

[0009] Figure 1 is a perspective view of a motor-driven, tool ended instrument, in accordance with an exemplary embodiment of the present application;

[0010] Figure 2 is an enlarged perspective view of the tool mounted portion of the instrument of Figure 1, shown with the tool head in phantom to illustrate additional features of the instrument;

[0011] Figure 3 is a cross-sectional view of the tool mounted portion of the instrument of Figure 1;

[0012] Figure 4 is an exploded view of the tool mounted portion of the instrument of Figure 1;

[0013] Figure 5 is a perspective view of a tool head release tool, in accordance with an exemplary embodiment of the present application;

[0014] Figure 6A is a perspective view of the tool head release tool of Figure 5, shown partially assembled with the instrument of Figure 1;

[0015] Figure 6B is a perspective view of the tool head release tool of Figure 5, shown assembled with the instrument of Figure 1;

[0016] Figure 7A is a partial cross-sectional view of the tool mounted portion of the instrument of Figure 1, shown assembled with the tool head release tool of Figure 5, with the release button in the neutral position;

[0017] Figure 7B is a partial cross-sectional view of the tool mounted portion of the instrument of Figure 1, shown assembled with the tool head release tool of Figure 5, with the release button in the depressed position;

[0018] Figure 7C is a partial cross-sectional view of the tool mounted portion of the instrument of Figure 1, shown assembled with the tool head release tool of Figure 5, with the release button in the depressed position and the tool head released from the retainer housing;

[0019] Figure 8A is a perspective view of a tool head, in accordance with an exemplary embodiment of the present application,

[0020] Figure 8B is a perspective view of another tool head, in accordance with another exemplary embodiment of the present application,

[0021] Figure 8C is a perspective view of another tool head, in accordance with another exemplary embodiment of the present application,

[0022] Figure 9 is an enlarged perspective view of the handle assembly of the instrument of Figure 1;

[0023] Figure 10 is a cross-sectional view of the handle assembly of the instrument of Figure 1;

[0024] Figure 11 is an exploded perspective view of the handle assembly of the instrument of Figure 1;

[0025] Figure 12 is a perspective view of another handle assembly for another tool ended instrument, in accordance with another exemplary embodiment of the present application;

[0026] Figure 13 is a cross-sectional view of the handle assembly of Figure 12; and

[0027] Figure 14 is an exploded perspective view of the handle assembly of Figure 12.

DETAILED DESCRIPTION

[0028] This Detailed Description merely describes exemplary embodiments and is not intended to limit the scope of the claims in any way. Indeed, the invention as claimed is broader than and unlimited by the exemplary embodiments, and the terms used in the claims have their full ordinary meaning. For example, while the specific embodiments described herein relate to articulating, rigid shaft mounted rotary blending tools for blending damaged surfaces of a turbine blade, the features of the present application may additionally or alternatively be applied to other types of insertable tools, including, for example, cutting, drilling, deburring or polishing tools, reciprocating or vibratory motorized tools, or tools for other types of applications, including other bore insertable tool applications and other

motorized tool ended instruments. As another example, the features of the present application may additionally or alternatively be applied to tools mounted to flexible shaft instruments or multi-articulated joint shaft instruments, or other types of powered tool ended instruments, including pulley driven tools and fluid powered tools.

[0029] The present application is directed in part to motor-driven tool ended instruments, including, for example, instruments configured for insertion through bores for tool-based operations (e.g., grinding, cutting) within a cavity. According to an exemplary aspect of the present application, an instrument may be provided with a rotary tool head attached to a distal end of the instrument. To power the tool head, the tool head may be attached to a drive system using a variety of arrangements. In one embodiment, a motor (e.g., a DC brushless motor, such as, for example, a Maxon EC-style motor) may be mounted to the distal end of the instrument for direct connection with the tool head. The motor and tool head may be provided with a drive connection for transmitting a rotary output from the motor to the tool head, and a bearing connection for axially securing the tool head to the motor and guiding the rotary motion of the tool head.

[0030] Figures 1-4 and 7A-11 illustrate an exemplary instrument 100 having a shaft 110 with a proximal end 111 and a distal end 112, and a tool retaining portion or retainer housing 120 coupled to the distal end 112 of the shaft 110. A tool head 130 is releasably or detachably coupled to the retainer housing 120. A motor 140 (Figures 2-4) is assembled with the retainer housing 120 and is coupled with the tool head 130 for powered rotation of the tool head.

[0031] Many different arrangements may be utilized for attaching a tool to a distal end of an instrument, allowing for rotation about the distal end and selective detachment from the distal end, for example, for replacement of the tool head. In an exemplary embodiment, the distal end of the instrument includes a retainer housing having one or more tool retaining bearing members (e.g., balls, pins, rings or other such components) that are biased outward into an inner peripheral groove in a proximal tubular end of the tool head to secure the tool head to the instrument. The grooved portion of the tool head is permitted to ride on the bearings to permit rotation of the tool head about the retainer housing of the instrument. The retainer housing may include a bearing release mechanism that is operable (e.g., using a tool or other user manipulation of the retainer housing) to retract of the bearings from the groove housing, thereby disengaging the tool head from the distal end of the instrument.

[0032] In the illustrated example, as shown in Figures 3 and 4, the retainer housing 120 defines an internal chamber 123 including a set of three ball bearings 151 retained within an insert 152 disposed in the chamber 123. The ball bearings 151 are forced outward through openings 124 in the retainer housing 120 by a spring biased wedge block 153. The openings 124 are sized to prevent complete passage of the ball bearings 151 through the openings, to secure the ball bearings within the retainer housing 120. The protruding portions of the ball bearings 151 are received in an inner peripheral groove 135 in a cylindrical or tubular wall 134 of the tool head 130 to axially secure the tool head to the retainer housing 120 while permitting rotation of the tool head 130 about the retainer housing 120. One or more biasing members (e.g., Belleville washer springs 154) may provide sufficient biasing force to the wedge block 153 to prevent retraction of the ball bearings 151 due to pulling forces applied to the tool head 130. The ball bearings 151 may include a hard, wear resistant material (e.g., ceramic, silicone nitride), and the grooved portion 135 of the tool head 130 may include a low friction, thermal resistant coating (e.g., graphite, chrome, oil) to facilitate smooth, high speed rotation of the tool head 130.

[0033] To release the tool head 130 from the retainer housing 120 of the instrument 100, the wedge block 153 may be forced against the biasing members 154, thereby permitting the ball bearings 151 to retract from the tool head groove 135 for axial separation of the tool head 130 from the retainer housing 120. In one embodiment, the tool head groove may be shaped such that a sufficient axial pulling force applied to the tool head transmits force to the wedge block (through the ball bearings) to permit separation and removal of the tool head. In another embodiment, the wedge block (or other such release mechanism component) is accessible by the user (e.g., through an access opening) for forced retraction and disengagement of the tool head. In the illustrated embodiment, the retainer housing 120 includes an aperture 125 positioned to intersect with a chamfered stem 156 of the wedge block 153. A tool may be inserted through the aperture 125 and against the chamfered stem 156 to move the wedge block 153 against the Belleville springs 154 for release of the ball bearings 151 from the tool head groove 135.

[0034] Many different types of release tools may be used for selective operation of a bearing release mechanism. Figures 5-7C illustrate an exemplary release tool 200 having a shaft receiving body 210 and a tool head releasing button 220 (see Figure 6B) assembled with the body 210 and disposed on an outer surface of the tool body 210. The exemplary body 210 includes hinged body halves 211, 212 (although a different number of body components may

be utilized) that together define a first cylindrical bore 214 for receiving at least a portion of the shaft 110 and a second cylindrical bore 216 for receiving at least a portion of the retainer housing 120. The first and second cylindrical bores 214, 216 are separated by a neck portion 215 that receives a narrower joint portion 105 between the retainer housing 120 and the shaft 110 to orient the instrument 100 for alignment of the retainer housing aperture 125 with the button 220 (shown carried by the first body half 211). As shown in Figures 7A-7C, when the release tool body 210 is assembled over the instrument 100 (Figures 6A and 6B), the tool body 210 holds the retainer housing 120 in rigid alignment with the shaft 110, and an internal projection 222 of the button 220 extends into the retainer housing aperture 125. When the button 220 is depressed, the button extension 222 engages the chamfered stem 156 of the wedge block 153, moving the wedge block against the Belleville springs 154 to permit retraction of the ball bearings 151 from the tool head groove 135, thereby allowing the tool head 130 to be separated from the retainer housing 120.

[0035] Many different tool driving arrangements may be utilized to rotate the tool head about the retainer housing of the instrument. In one embodiment, a motor is assembled with a distal end of the retainer housing and is sized such that a tubular tool head fits over the motor for bearing engagement with the retainer housing. A tool head and retainer housing may be sized to accommodate a wider range of motor sizes, including, for example, 4 mm, 6 mm, 12 mm, 18 mm, and 25 mm DC brushless motors.

[0036] In the illustrated example, a proximal end 141 of the motor housing 143 of a DC brushless motor 140 is received in an open distal end 122 of the retainer housing 120, and may be secured with the retainer housing 120, for example, by an epoxy, adhesive, retaining clip, or other such fastening arrangement. As shown, the proximal end 141 of the motor housing 143 may define a distal end of the retainer housing chamber 123, against which the Belleville springs 154 are compressed. The distal end 142 of the motor 140 includes an output shaft 144 for driving connection with a distal end 132 of the tool head 130. While many different types of interlocking, rotary driving connections may be utilized, in the illustrated example, a hex member 145 is affixed to the output shaft 144 and is received in a corresponding, complementary shaped socket 136 in the distal end 132 of the tool head 130.

[0037] Many different types of rotary tool heads may be utilized with the motor-driven mounting arrangements described above. For example, a fluted tool head may be utilized, to provide an axially extending cutting or grinding edge. Figures 8A, 8B, and 8C illustrate examples of tool heads 130a, 130b, 130c including fluted cutting edges 137a, 137b, 137c, for

example, for blending or grinding damaged turbine blade edges. As shown, the fluted portion of the tool head may (but need not) extend to the proximal tubular end of the tool head, such that the grooved portion does not extend around an entire 360° circumference, but extends around a sufficient portion of the tool head to retain the tool head on the retainer housing (e.g., by retaining at least two ball bearings 151 in the tool head groove 135a, 135b, 135c). An abrasive material (e.g., cubic boron nitride) may be bonded or otherwise applied to the grinding surfaces of the tool head. To provide a variety of tool heads, a tool head blank may be provided for attaching a variety of tool ends (e.g., by welding) or for machining a desired tool end into the tool head blank.

[0038] An end mounted motor and tool head arrangement, as described above, may be utilized with many different types of instruments. In one embodiment, a motor and tool head arrangement are provided at a distal end of a narrow, elongated shaft instrument, sized for insertion into an internal cavity, through an access bore or other opening. In exemplary embodiments, the instrument may be provided with an insertable portion having a maximum diameter of approximately 0.2 - 0.6 inches (e.g., 0.306 inches) and a minimum length of approximately 6 - 36 inches. As one example, the instrument may be sized for insertion through a 0.307 inch diameter bore of a turbine engine, with an insertable length of approximately 4 - 42 inches for blending or grinding operations on a damaged turbine blade.

[0039] A motor and tool head arrangement, such as the exemplary embodiments described above, may be assembled with many different types of insertable shafts, including rigid, flexible, and pivotable or jointed shafts. In one embodiment, a motor and tool head arrangement may be pivotably connected to a distal end of a rigid instrument shaft for articulating or pivoting movement of the tool head about the shaft. In the illustrated example, the instrument shaft 110 includes a main shaft portion 114 assembled at a proximal end to a proximal shaft housing 113 and assembled at a distal end to a distal shaft housing 115. In an exemplary embodiment, the main shaft portion includes one or more of carbon fiber, stainless steel, aluminum, and fiberglass, and the distal and proximal shaft housings include one or more of titanium, steel aluminum, and plastic. The main shaft portion 114 may be affixed to the shaft housings 113, 115 for example, by press fit engagement and/or an epoxy.

[0040] The proximal end 121 of the retainer housing 120 is pivotably connected to the distal shaft housing 115 (e.g., by a pivot pin 116), for pivoting or articulating movement of the retainer housing 120, motor 140, and tool head 130 about the shaft 110. The pivotable connection between the retainer housing 120 and the distal shaft housing 115 may include

any suitable range of pivot angles, including, for example, from approximately 0° (aligned or collinear with the shaft 110) to up to 150°, or from up to approximately 150° in a first pivoting direction to up to approximately 150° in a second, opposite pivoting direction. In an exemplary embodiment, the retainer housing 120 is pivotable from approximately 0° to approximately 130° (i.e., about a 50° angle with the shaft).

[0041] To facilitate proper positioning of a tool head after insertion into a cavity, the instrument may be provided with an articulation control mechanism operable to selectively adjust the articulated position or angle of the tool head with respect to a shaft in response to user manipulation of an articulation control interface (e.g., dial, knob, switch, button, etc.). The articulation control interface may be spaced apart from the articulating tool head, such that the articulation control interface is still operable when the tool head has been inserted into a remote cavity. Many different mechanical or electromechanical arrangements may be utilized, including knob driven threaded arrangements (e.g., rotatable about an axis aligned with or perpendicular to the shaft), axially slideable button or lever arrangements, and stepper motor driven button or remote operated arrangements. In the illustrated example, the instrument 100 includes a link 161 having a first end pivotably connected to the retainer housing 120 (e.g., by a first pin 162) and a second end pivotably connected to a distal end 166 of a slide member 163 (e.g., by a second pin 164). The slide member 163 is slideable within the shaft 110, causing the link 161 to apply a pulling or pushing force to the retainer housing 120 at the first pin 162 for pivoting movement of the retainer housing 120.

[0042] Many different types of articulation control interfaces may be utilized to move a slide member for pivoting movement of a tool head. In the illustrated example, as shown in Figures 9-11, a handle assembly 170 is provided at the proximal end 111 of the shaft 110, with a knob 171 that is rotatable in a first direction (e.g., counterclockwise) to axially slide the slide member 163 in an extending direction, and is rotatable in a second direction (e.g., clockwise) to axially slide the slide member 163 in a retracting direction. The exemplary knob 171 is provided at the base of a handle housing 172. As shown, the handle housing 172 may be surrounded by a soft sleeve 173 (e.g., rubber, polyurethane) for gripping by the user.

[0043] While many different mechanisms may be utilized to translate rotation of a knob to axial sliding movement of the slide member, in the illustrated embodiment, the knob 171 is coupled to a threaded collar 174 integral with the knob 171, which engages a threaded proximal end 165 of the slide member 163. As shown, the handle assembly 170 further includes a cap member 175 that extends through the knob 171 for attachment to the handle

housing 172 (e.g., by screws or other such fasteners). A flanged proximal end 175e of the cap member 175 retains the knob 171 on the handle assembly 170. The distal end 177 of the cap member 175 aligns with the threaded proximal end 165 of the slide member 163 to guide sliding movement and to prevent rotation of the threaded proximal end 165. When the knob 171 is rotated in a first (e.g., counterclockwise) direction, rotation of the threaded portion of the collar 174 with respect to the threaded proximal end 165 of the slide member 163 causes the slide member to slide in an extending direction to pivot the retainer housing 120 in a first direction (e.g., toward a lateral position with respect to the shaft). When the knob 171 is rotated in a second (e.g., clockwise) direction, rotation of the threaded collar portion 174 with respect to the threaded proximal end 165 of the slide member 163 causes the slide member to slide in a retracting direction to pivot the retainer housing 120 in a second direction (e.g., toward alignment with the shaft).

[0044] In the illustrated embodiment of Figures 1-4 and 7A-11, the knob 171 may be freely rotatable for pivoting adjustment of the tool head 130. In another embodiment, the knob may be configured to normally be in a non-operational position, for example, to prevent inadvertent articulation of the tool head. In the illustrated example of Figures 12-14, the knob 171a and the threaded collar 174a are separate components rotationally connected by a hex portion 178a disposed on an outer surface of the collar 174a, and a complementary hex-shaped opening 179a in the knob 171a (see Figure 14). The knob 171a is spring-biased (e.g., by compression spring 181a) away from interlocking alignment of the hex-shaped opening 179a with the hex portion 178a, such that rotation of the knob in this normal biased position does not rotate the threaded collar 174a. To pivot or articulate the tool head, the knob 171a is pulled against the spring 181a toward the proximal end of the handle assembly 170a for mating alignment of the hex portion 178a and the hex-shaped opening 179a. The knob 171a is then rotated to rotate the collar 174a and slide the slide member. Colored bands 182a, 186a may be provided on the collar 174a and handle housing 172a, respectively to provide visible indication that the knob 171a is in an inoperable or operable position.

[0045] To supply external power to the motor 140, wiring may extend from the motor through one or more passages in the instrument 100 and out of a proximal (e.g., non-insertable) portion of the instrument. In the illustrated example, as shown in Figure 3, motor wiring 146 from the motor 140 extends from the chamber 123 of the retainer housing 120, past the Belleville springs 154, past cutout portions 153c, 152c of the wedge block 153 and insert 152 and through a passage 126 in the proximal end 121 of the retainer housing 120.

The motor wiring 146 extends past the link 161 into an open distal end 112 of the distal shaft housing 115 and into a passage 167 in the distal end 166 of the slide member 163. As shown in Figure 10, the motor wiring 146 extends through the main shaft portion 114 alongside a central stem portion 168 of the slide member 163 and through a passage 117 in the proximal shaft housing 113 and into a cavity 169 in the handle assembly for connection with a breakout board 118 assembled with the proximal shaft housing 113. External wiring 119 connected with the breakout board 118 interfaces with a connector 176 that is assembled with the cap member 175 (e.g., by a threaded arrangement), for example, to provide for a detachable cable connection to the instrument 100 for connection with an external power source. In other embodiments, the external wiring may extend outward of the instrument (e.g., through the cap member) for connection with an external power source. As shown in the embodiment of Figures 12-14, a grommet 183a and grommet retention cap 184a may be secured to the cap member 175a (e.g., by fasteners 185a) to maintain the external wiring (not shown) in a taut (but not over-strained) condition through the handle assembly 170a.

[0046] To prevent the motor wiring 146 from bunching or looping at the instrument's joint portion 105 (particularly when the retainer housing 120 is returned from a pivoted or laterally extending position to a shaft aligned position), the instrument 100 may be provided with a wire retraction mechanism that retracts the motor wiring back into the instrument shaft. In the illustrated example, as shown in Figure 3, the distal end 166 of the slide member 163 includes a spring-loaded plunger 191 that is attached to the motor wiring 146, for example, by means of an adhesive, solder, or other such attachment. The plunger is slideable along a guide rod 192 assembled with the slide member distal end 166, and is biased toward a retracted position by a tension spring 193, permitting extension of the plunger 191 and motor wiring 146 when the retainer housing is pivoted to a lateral position, and to automatically return the plunger 191 and motor wiring 146 to the retracted position when the retainer housing is returned to the shaft aligned position.

[0047] Still other features may additionally or alternatively be used with the exemplary instruments described in the present application. For example, an insertable instrument including one or more of the features described above may include an endoscope or other videographic device assembled with the instrument for visual inspection of internal surfaces to be blended or otherwise modified by the tool. In other applications, an instrument (e.g., one of the exemplary instruments described above) may be used in combination with a

separate endoscopic device, for example, with the tool ended instrument inserted into a cavity through a first port and the endoscope inserted into the cavity through a second port.

[0048] While various inventive aspects, concepts and features of the inventions may be described and illustrated herein as embodied in combination in the exemplary embodiments, these various aspects, concepts and features may be used in many alternative embodiments, either individually or in various combinations and sub-combinations thereof. Unless expressly excluded herein all such combinations and sub-combinations are intended to be within the scope of the present inventions. Still further, while various alternative embodiments as to the various aspects, concepts and features of the inventions--such as alternative materials, structures, configurations, methods, devices and components, alternatives as to form, fit and function, and so on--may be described herein, such descriptions are not intended to be a complete or exhaustive list of available alternative embodiments, whether presently known or later developed. Those skilled in the art may readily adopt one or more of the inventive aspects, concepts or features into additional embodiments and uses within the scope of the present inventions even if such embodiments are not expressly disclosed herein. Additionally, even though some features, concepts or aspects of the inventions may be described herein as being a preferred arrangement or method, such description is not intended to suggest that such feature is required or necessary unless expressly so stated. Still further, exemplary or representative values and ranges may be included to assist in understanding the present disclosure; however, such values and ranges are not to be construed in a limiting sense and are intended to be critical values or ranges only if so expressly stated. Moreover, while various aspects, features and concepts may be expressly identified herein as being inventive or forming part of an invention, such identification is not intended to be exclusive, but rather there may be inventive aspects, concepts and features that are fully described herein without being expressly identified as such or as part of a specific invention, the inventions instead being set forth in the appended claims. Descriptions of exemplary methods or processes are not limited to inclusion of all steps as being required in all cases, nor is the order that the steps are presented to be construed as required or necessary unless expressly so stated.

What is claimed is:

1. A motor-driven instrument comprising:
 - a shaft having a proximal end and a distal end;
 - a retainer housing coupled to the distal end of the shaft;
 - a rotary motor including a motor body assembled with the retainer housing and an output shaft extending from a distal end of the motor body; and
 - a tool head having a tubular proximal end secured to the retainer housing and receiving at least a portion of the motor body therein, and a distal end connected with the output shaft for rotation therewith.
2. The motor-driven instrument of claim 1, further comprising at least one bearing member extending radially outward from the retainer housing for bearing engagement with an inner peripheral groove in the tubular proximal end of the tool head.
3. The motor-driven instrument of claim 2, wherein the at least one bearing member extends through an opening in the retainer housing.
4. The motor-driven instrument of claim 3, further comprising a wedge block disposed within the retainer housing and being biased by at least one spring member toward a tool head retaining position in which the wedge block forces the at least one bearing member radially outward through the opening into bearing engagement with the inner peripheral groove of the tool head.
5. The motor-driven instrument of claim 4, wherein the at least one spring member, the wedge block, and the at least one bearing member are captured between the proximal end of the motor housing and the proximal end of the retainer housing.
6. The motor-driven instrument of claim 4, wherein the retainer housing includes a release aperture oriented to intersect with the wedge block, such that insertion of a tool into the release aperture moves the wedge block from the tool head retaining position to a tool head releasing position in which the at least one bearing member is permitted to retract into the retainer housing.

7. The motor-driven instrument of claim 6, wherein the wedge block comprises a stem portion having a chamfered end that aligns with the release aperture for engagement by a tool inserted into the release aperture.
8. The motor-driven instrument of claim 1, wherein the output shaft includes a hex-shaped member received in a complementary shaped socket in the distal end of the tool head.
9. The motor-driven instrument of claim 1, wherein the retainer housing is pivotably connected to the distal end of the shaft.
10. The motor-driven instrument of claim 9, further comprising an articulation control mechanism and an articulation control interface each assembled with the shaft, the articulation control mechanism being operable to pivot the retainer housing with respect to the shaft in response to user manipulation of the articulation control interface.
11. The motor-driven instrument of claim 10, wherein the articulation control mechanism comprises a slide member disposed within the shaft and connected to the retainer housing, the slide member being axially slideable within the shaft for pivoting movement of the retainer housing.
12. The motor-driven instrument of claim 11, wherein the slide member is connected to the retainer housing by a link having a first end pivotably connected to the retainer housing and a second end pivotably connected to the slide member.
13. The motor-driven instrument of claim 11, wherein the articulation control interface comprises a knob assembled with the shaft and rotatable to axially slide the slide member within the shaft.
14. The motor-driven instrument of claim 13, wherein the articulation control interface further comprises a threaded collar in threaded engagement with a threaded portion of the slide member, such that rotation of the knob rotates the threaded collar to axially move the slide member.

15. The motor-driven instrument of claim 14, wherein the knob is spring biased out of engagement with the threaded collar, the knob being axially slideable into engagement with the threaded collar for user rotation of the threaded collar.
16. The motor-driven instrument of claim 1, wherein the tubular proximal end of the tool head is fluted.
17. A tool-ended instrument comprising:
a shaft having a proximal end and a distal end;
a retainer housing coupled to the distal end of the shaft;
at least one bearing member extending radially outward through an opening in the retainer housing;
a wedge block disposed within the retainer housing and being biased toward a first position in which the wedge block forces the at least one bearing member radially outward through the opening; and
a tool head having a tubular proximal end with an inner peripheral groove that receives the at least one bearing member to axially secure the tool head to the retainer housing;
wherein the retainer housing includes a release aperture oriented to intersect with the wedge block, such that insertion of a tool into the release aperture moves the wedge block from the first position to a second position in which the at least one bearing member is permitted to retract into the retainer housing.
18. A tool-ended instrument comprising:
a shaft having a proximal end and a distal end;
a tool head pivotably coupled to the distal end of the shaft;
a slide member disposed within the shaft and coupled to the tool head, the slide member being axially slideable within the shaft for pivoting movement of the tool head; and
a threaded collar assembled with the shaft and in threaded engagement with a threaded portion of the slide member, such that user rotation of the threaded collar axially slides the slide member for pivoting movement of the tool head.

19. The tool-ended instrument of claim 18, further comprising a retainer housing pivotably connected to the distal end of the shaft, the tool head being detachably coupled to the retainer housing.

20. A method for detaching a tool head from an articulating tool-ended instrument including a shaft having a proximal end and a distal end, a retainer housing pivotably coupled to the distal end of the shaft at a joint portion, and a tool head secured to the retainer housing by at least one bearing member extending radially outward of an opening in the retainer housing, the method comprising:

providing a release tool including first and second body halves defining a first bore, a second bore, and a neck portion separating the first and second bores, the first body half including a button disposed on an outer surface of the first body half and including an inward projection intersecting the neck portion;

assembling the release tool with the instrument such that at least a portion of the tool head is received in the first bore, at least a portion of the shaft is received in the second bore, and the joint portion is received in the neck portion, with the button projection aligning with a release aperture in the retainer housing; and

depressing the button, such that the button projection extends within the release aperture to engage a bearing release mechanism, thereby permitting the at least one bearing member to disengage from the tool head for detachment of the tool head from the retainer housing.

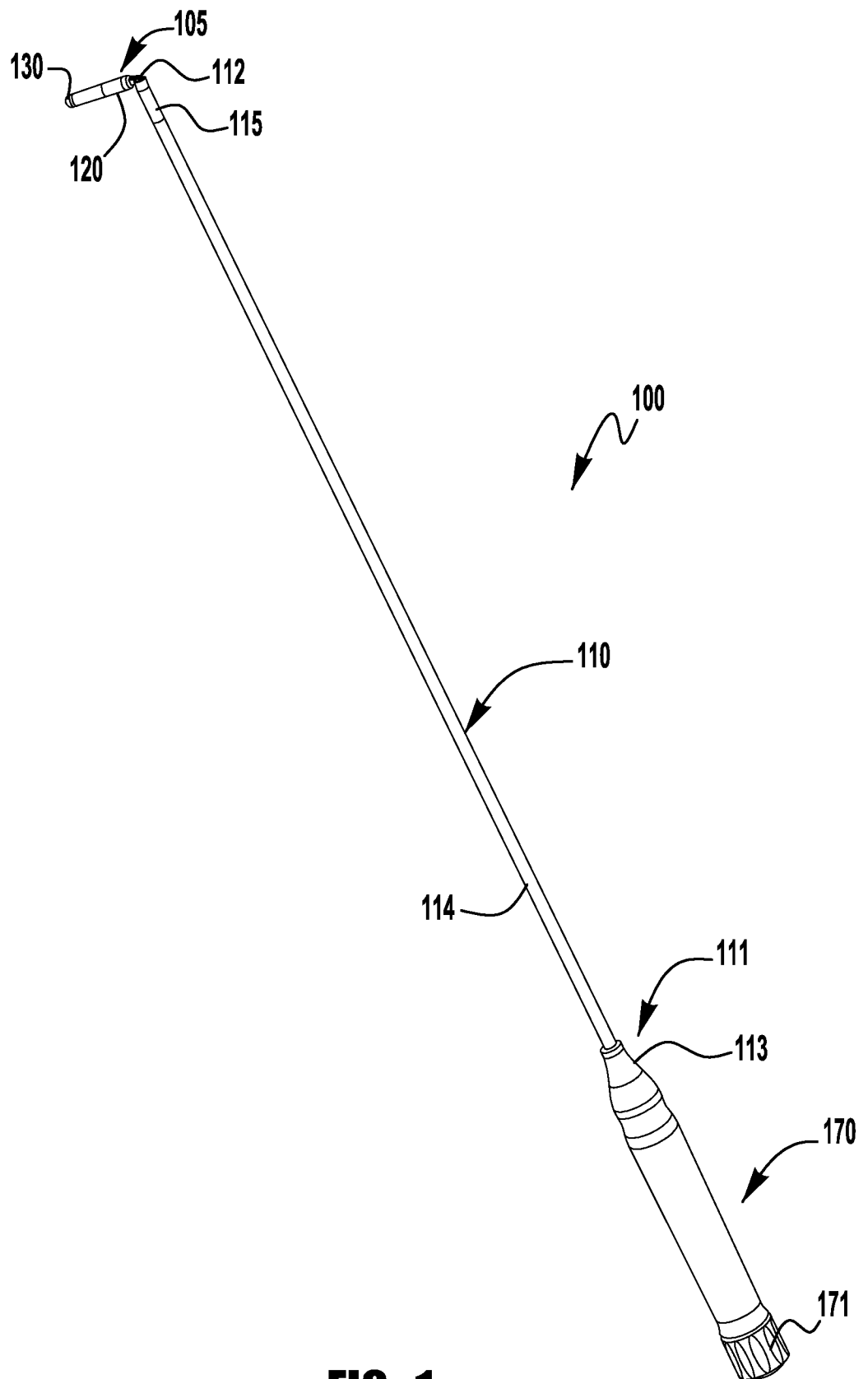


FIG. 1

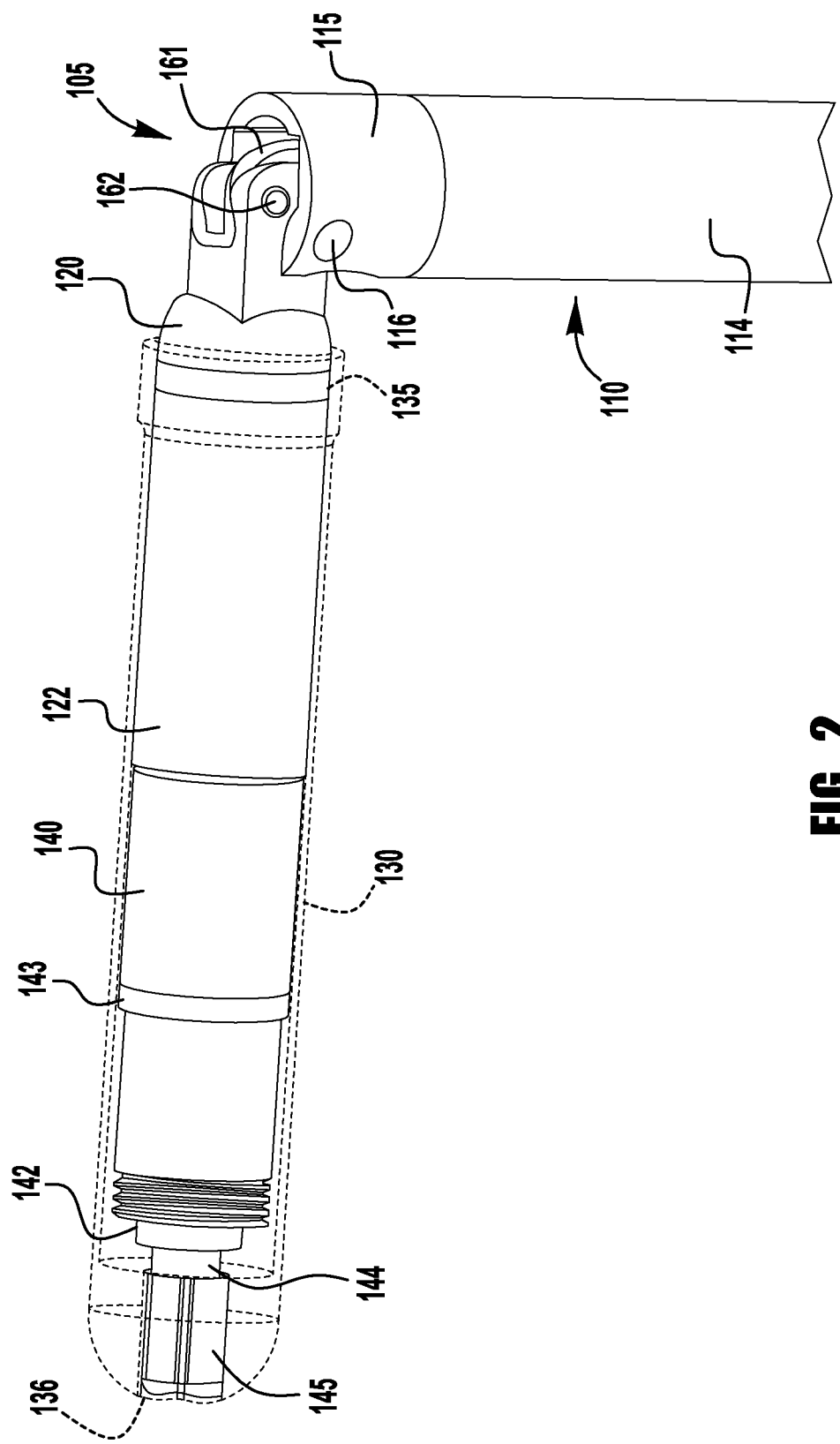


FIG. 2

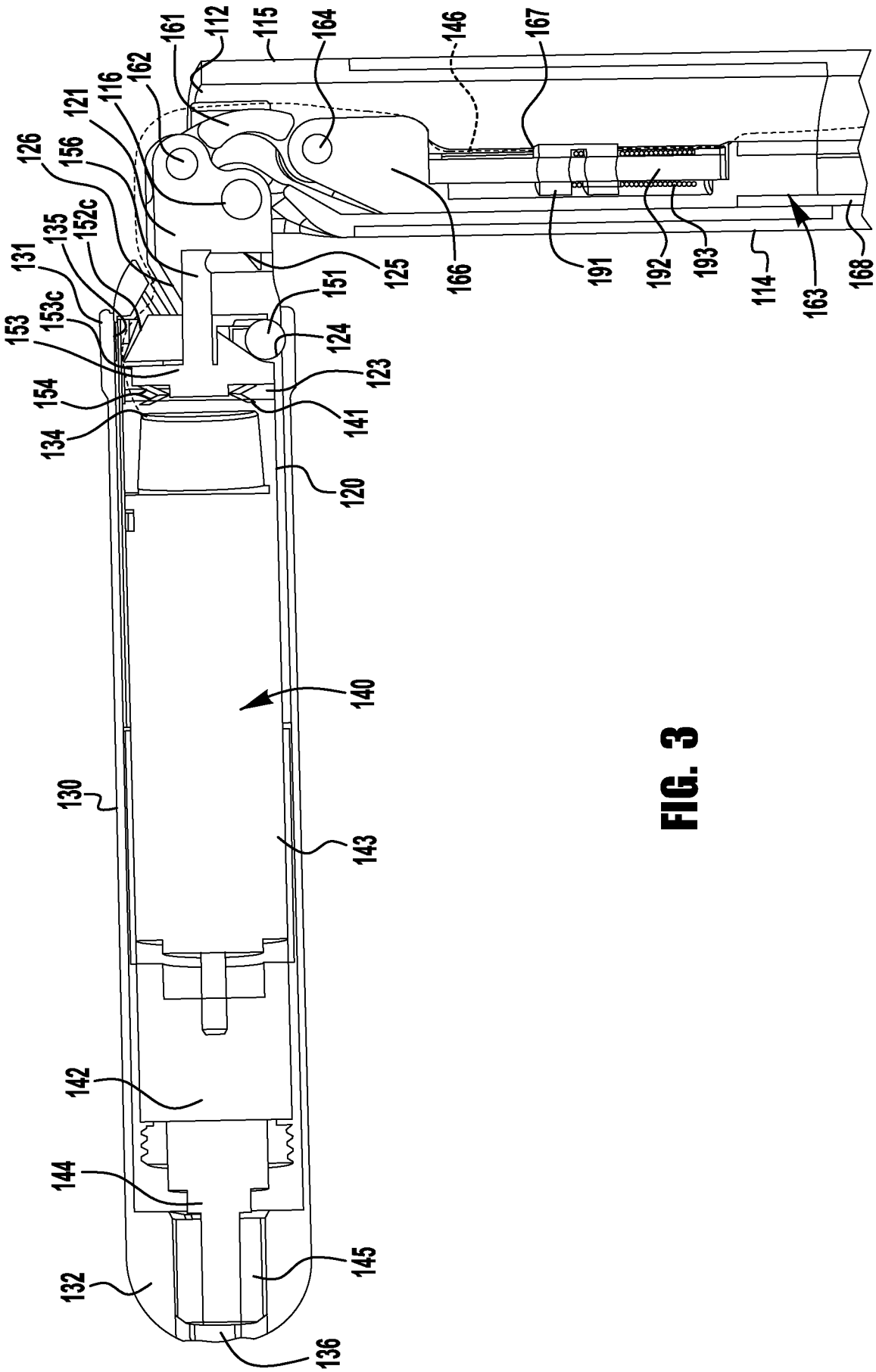


FIG. 3

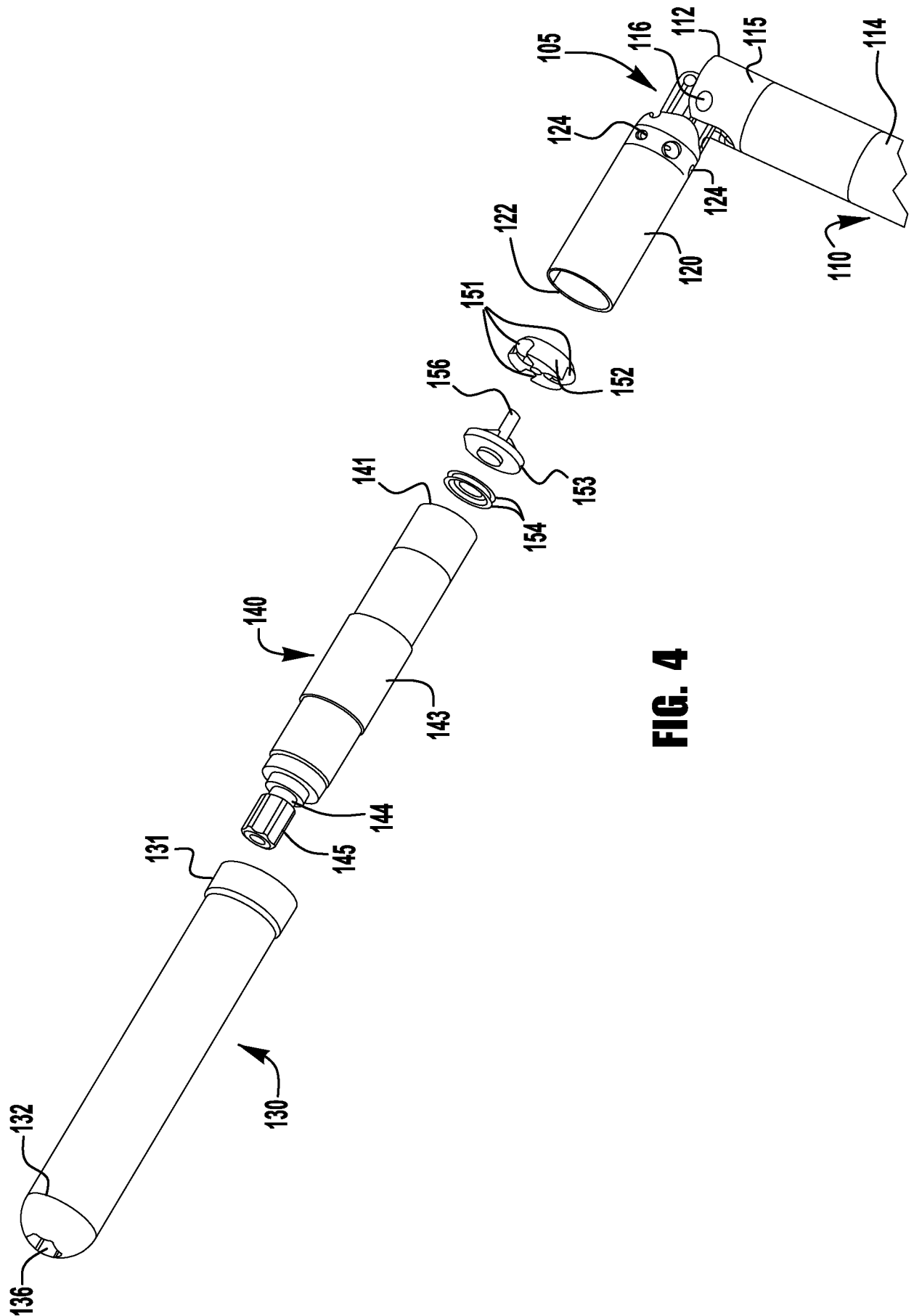


FIG. 4

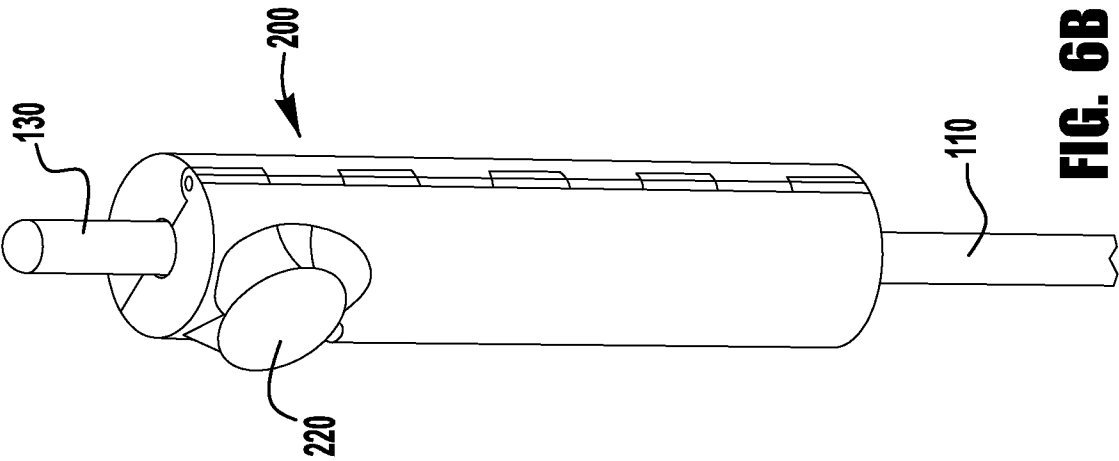


FIG. 6B

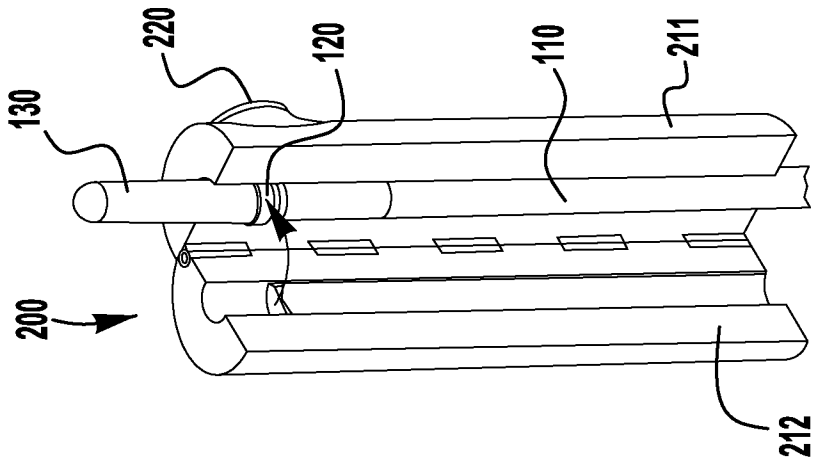


FIG. 6A

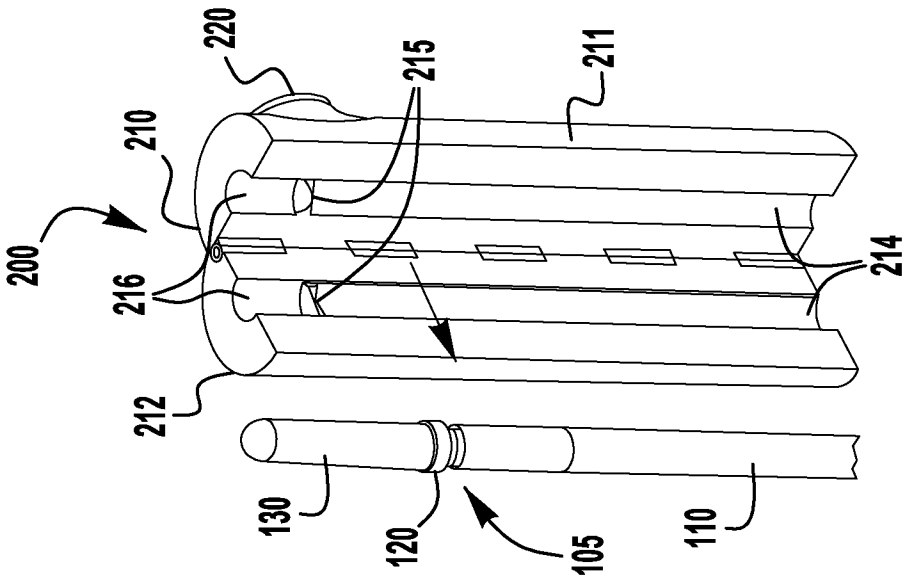


FIG. 5

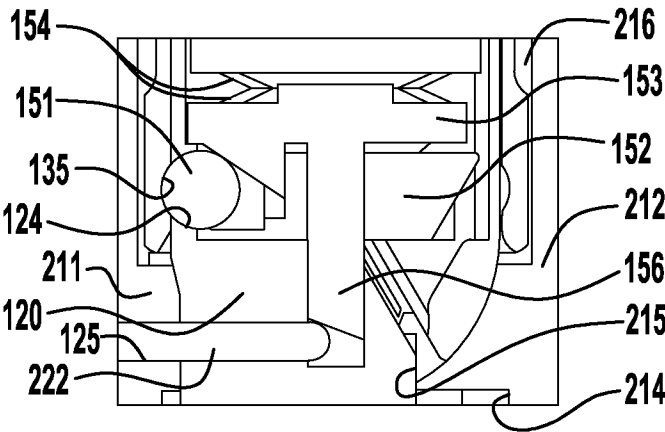


FIG. 7A

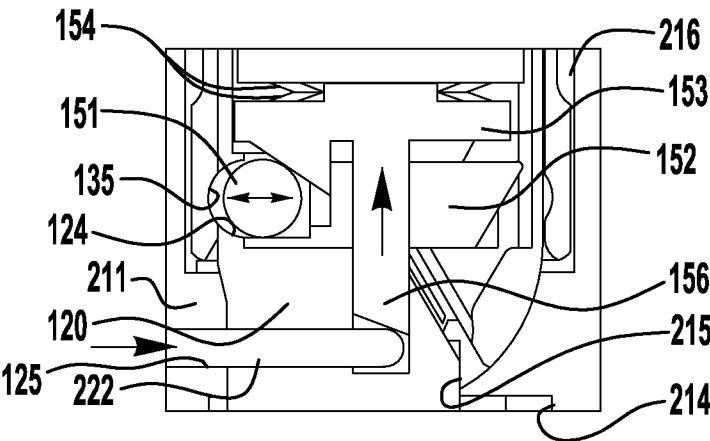


FIG. 7B

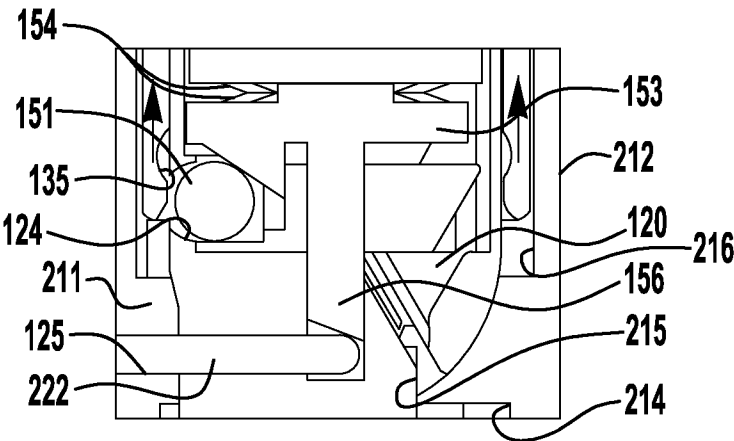
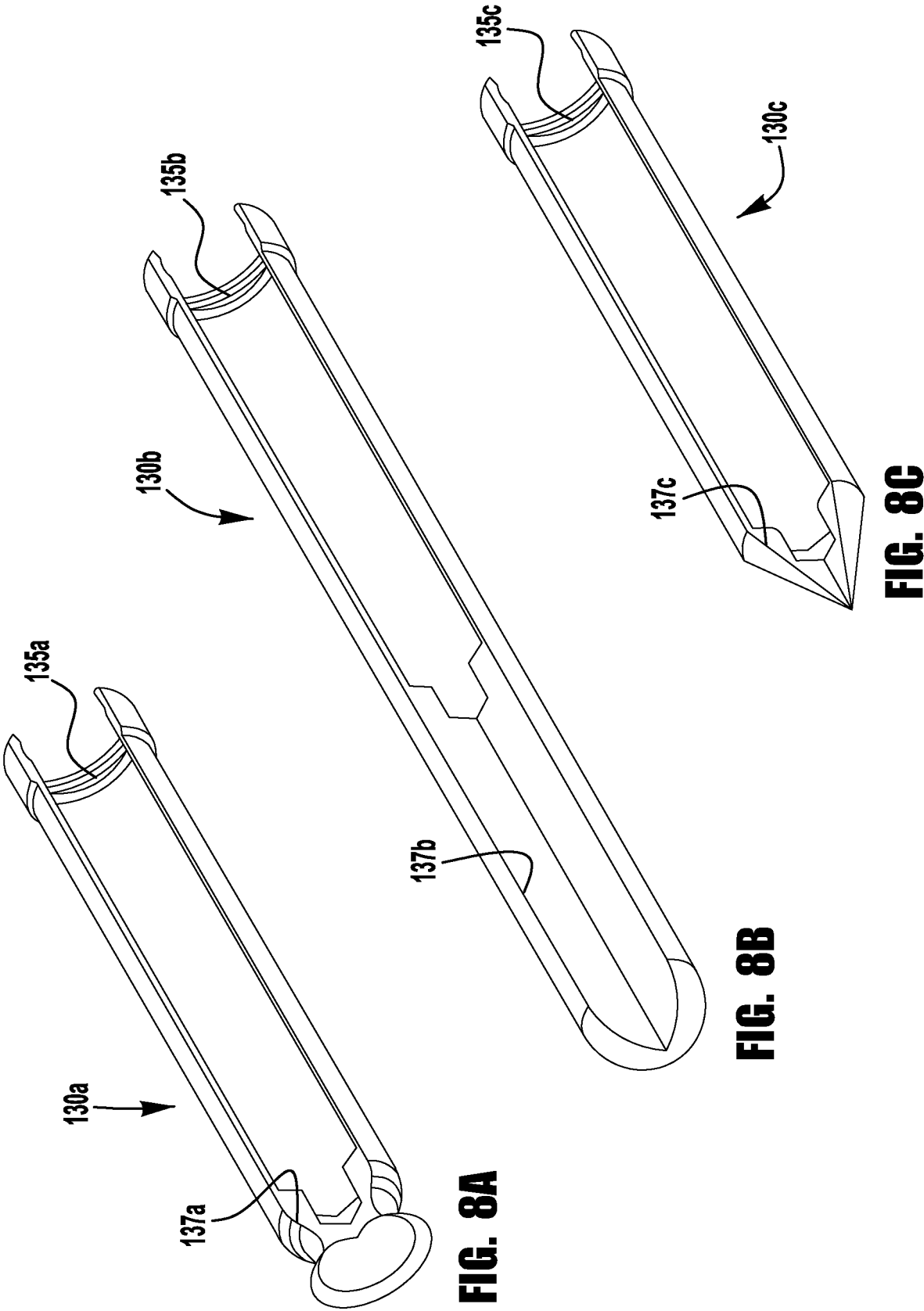
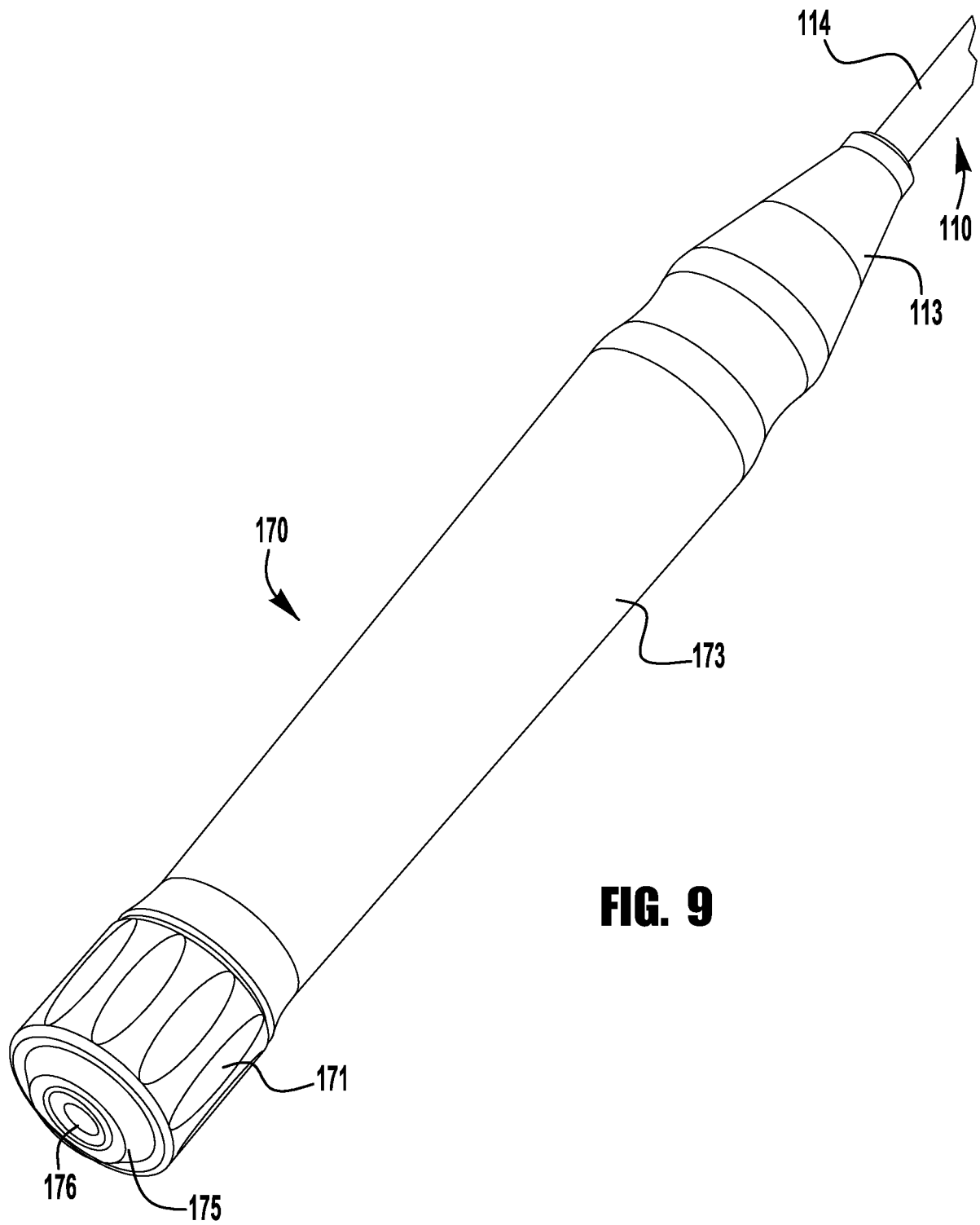


FIG. 7C





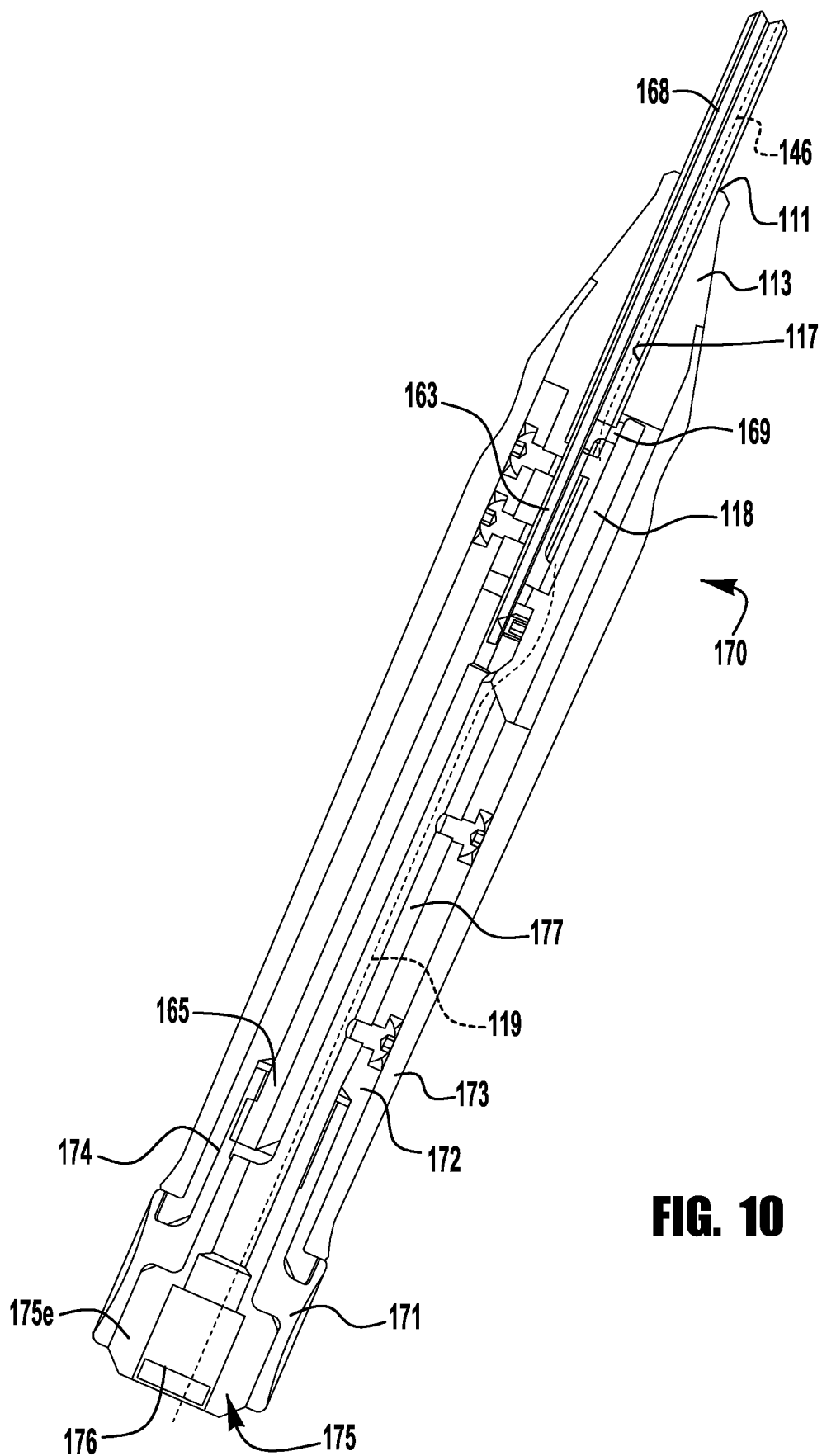


FIG. 10

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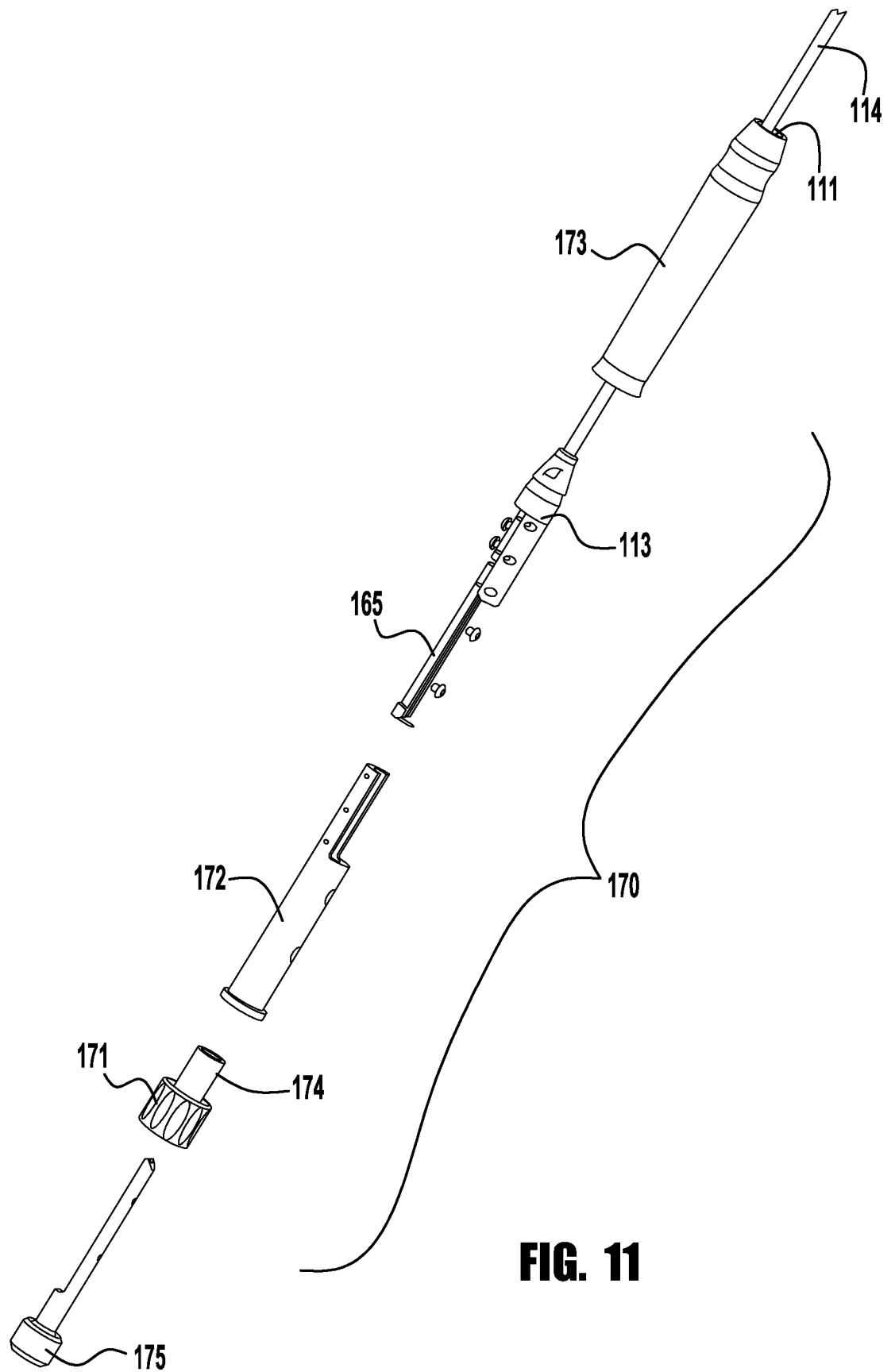


FIG. 11

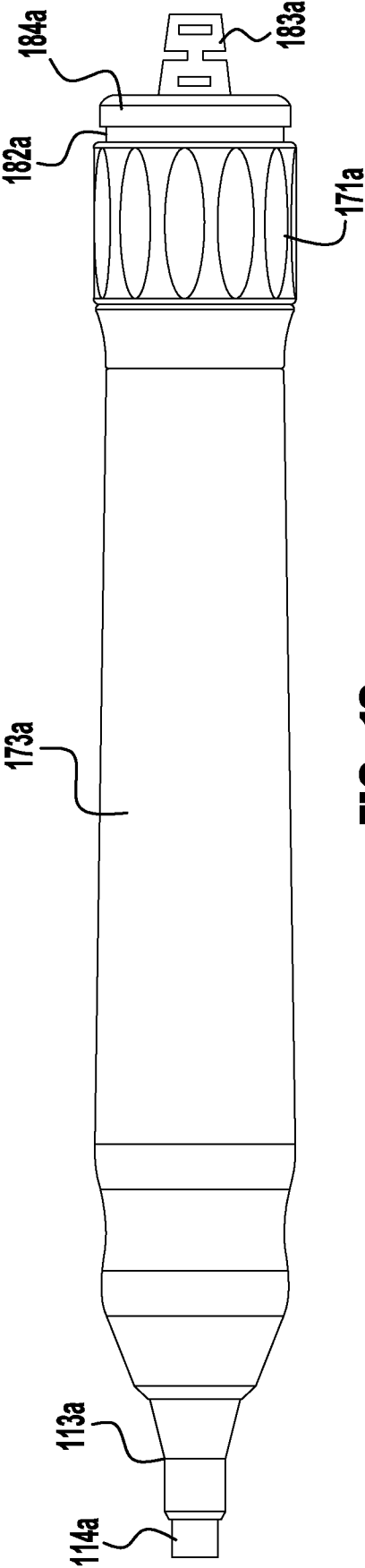


FIG. 12

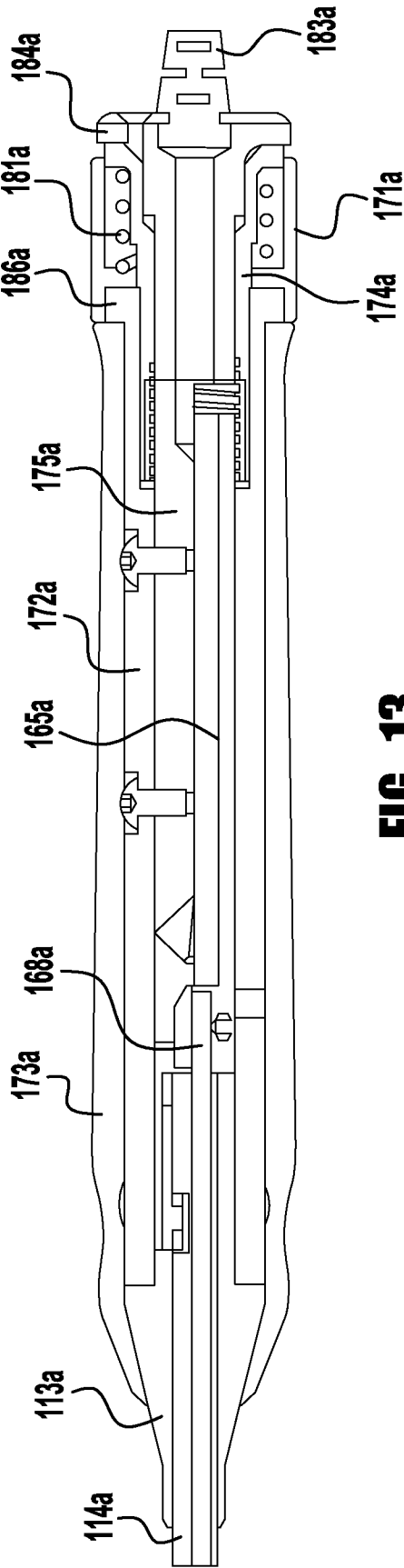


FIG. 13

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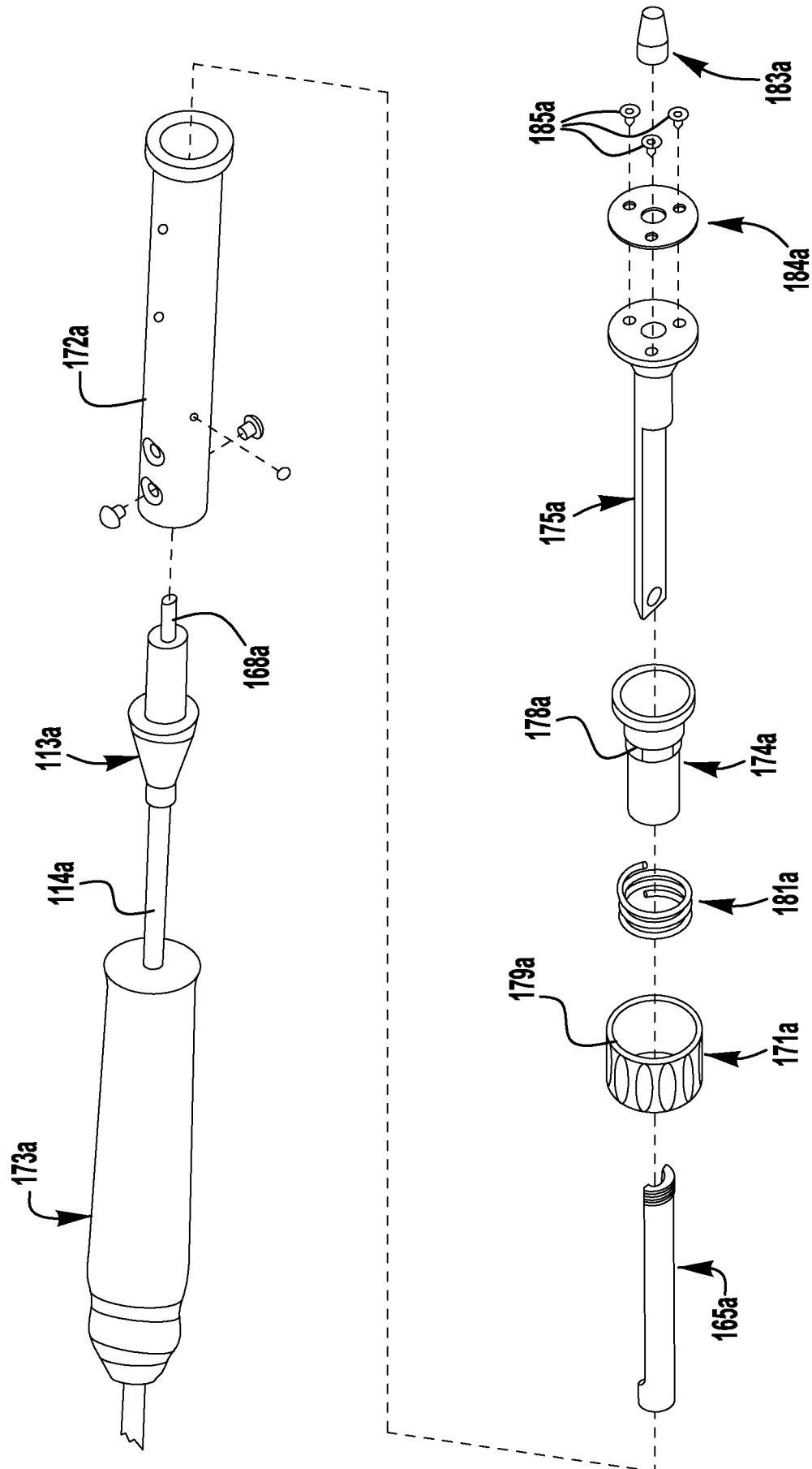


FIG. 14