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Voegele et al.

(54) **FINGERTIP SURGICAL INSTRUMENT**

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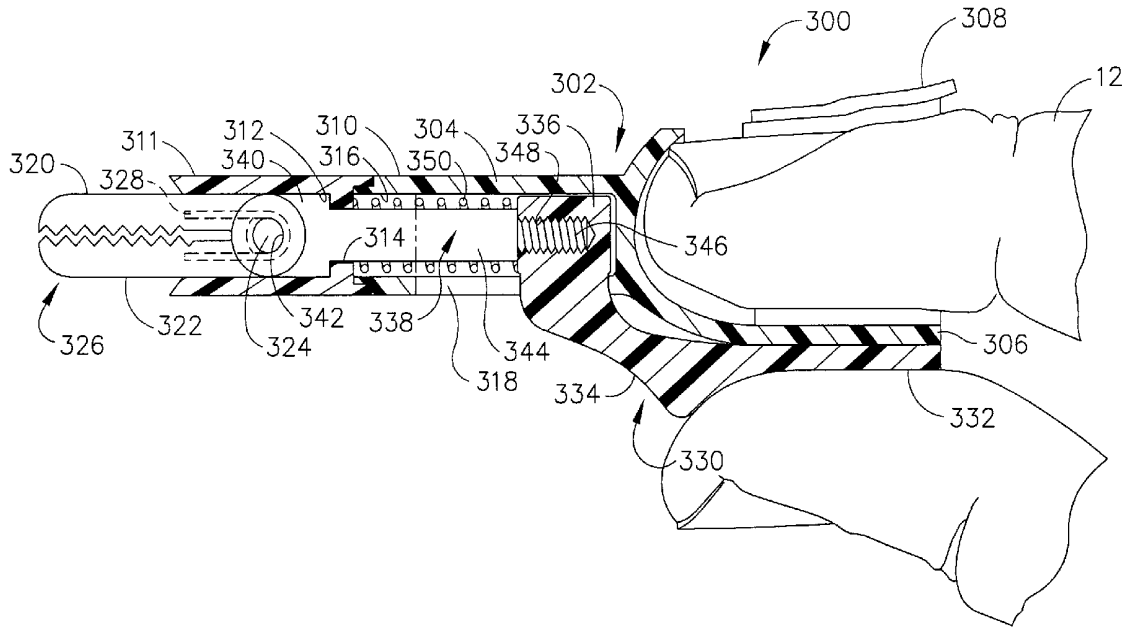
Publication Classification

(51) **Int. Cl.**
A61B 17/29 (2006.01)

(52) **U.S. Cl.** **606/206**

(57) **ABSTRACT**

Disclosed is a minimally invasive surgical instrument that may be used in hand-assisted laparoscopic surgeries. The device is a multifunctional surgical instrument that may be mounted directly on a surgeon's fingertip and inserted through an incision to allow the surgeon to manipulate tissue during a surgical procedure. Versions show a self-righting suture needle holder and a version with a dual pivoting jaw (e.g., grasper, cutter) that has an elongate neck to enhance the reach of the instrument. In addition, an elongate neck of an actuated fingertip instrument enhances the range reachable through a single incision.



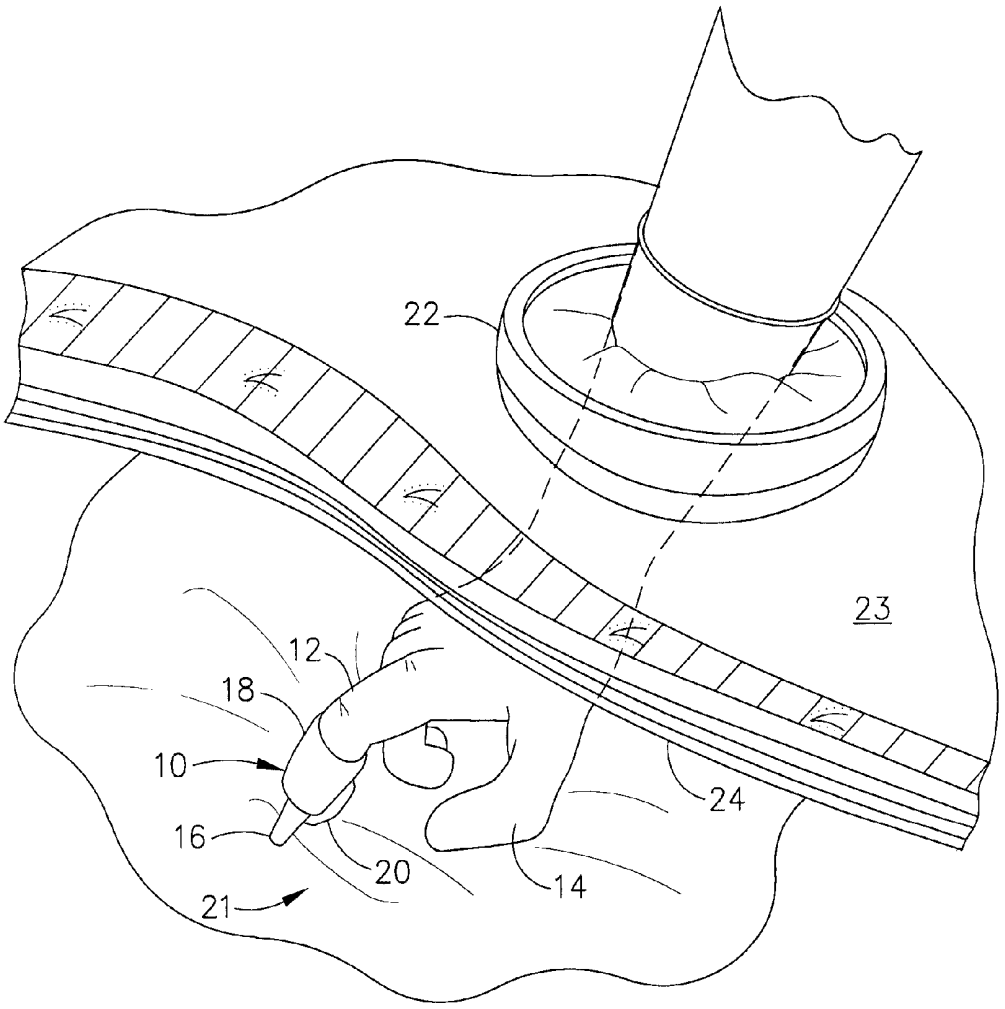


FIG. 1

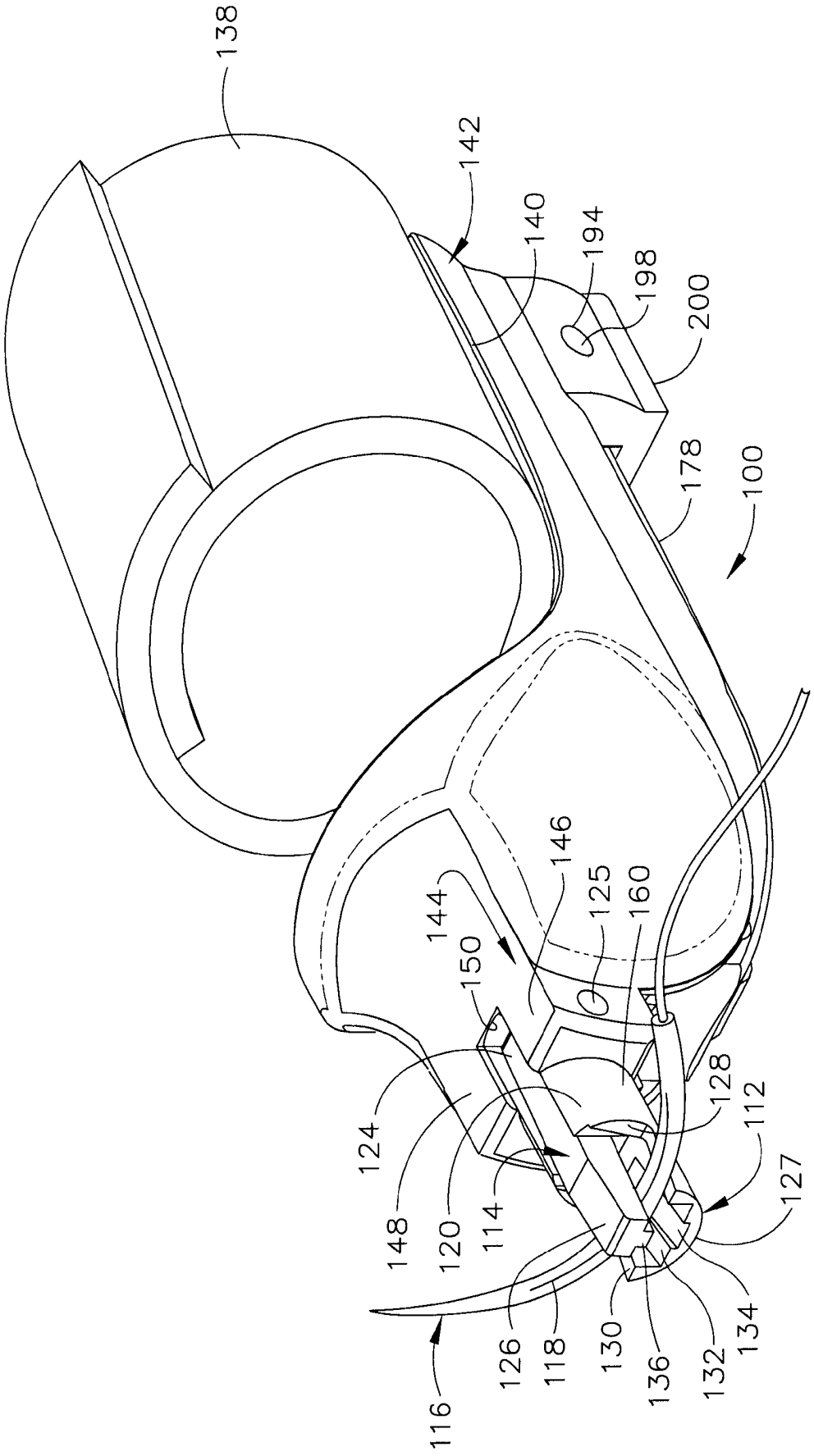

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FIG. 2

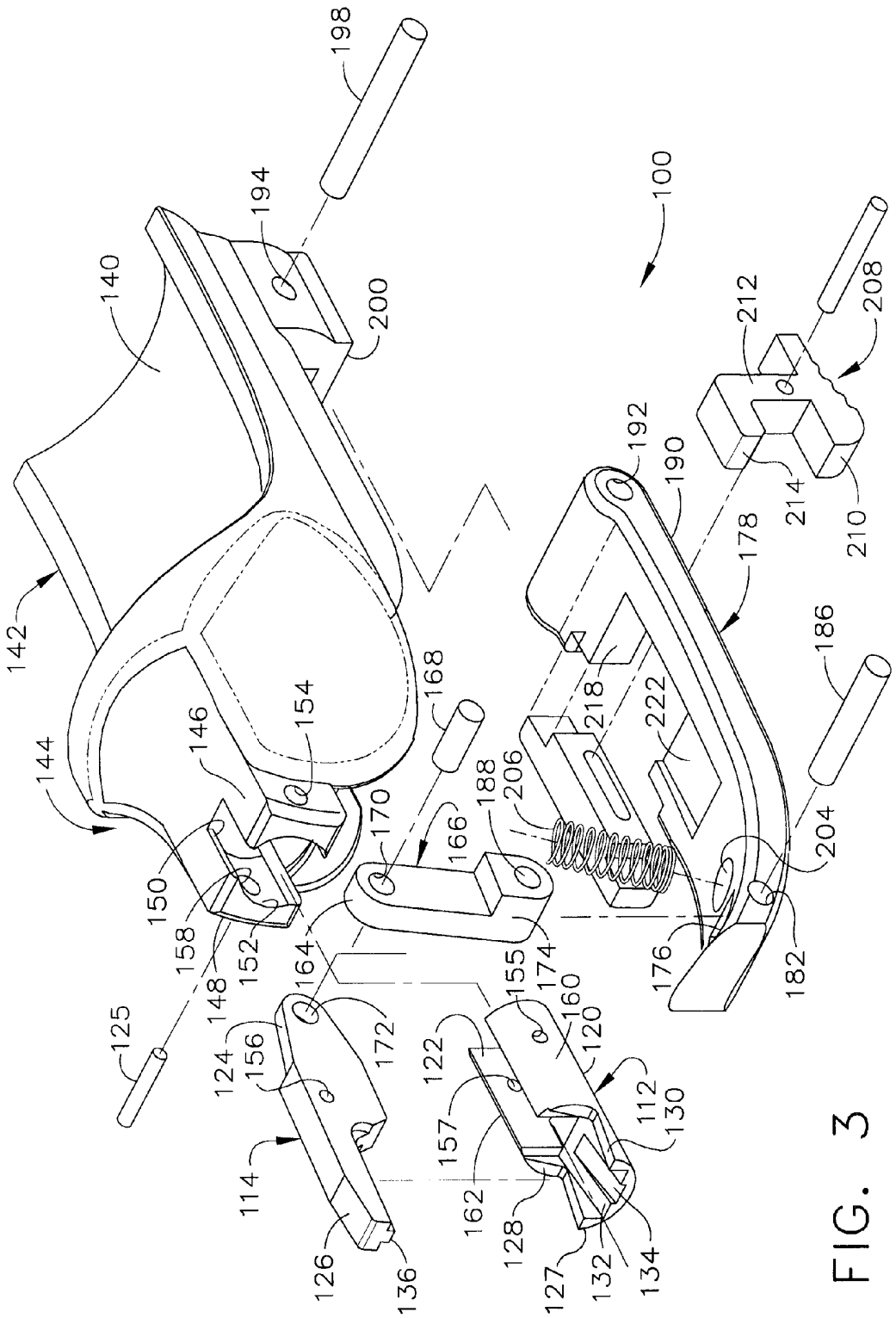
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FIG. 3

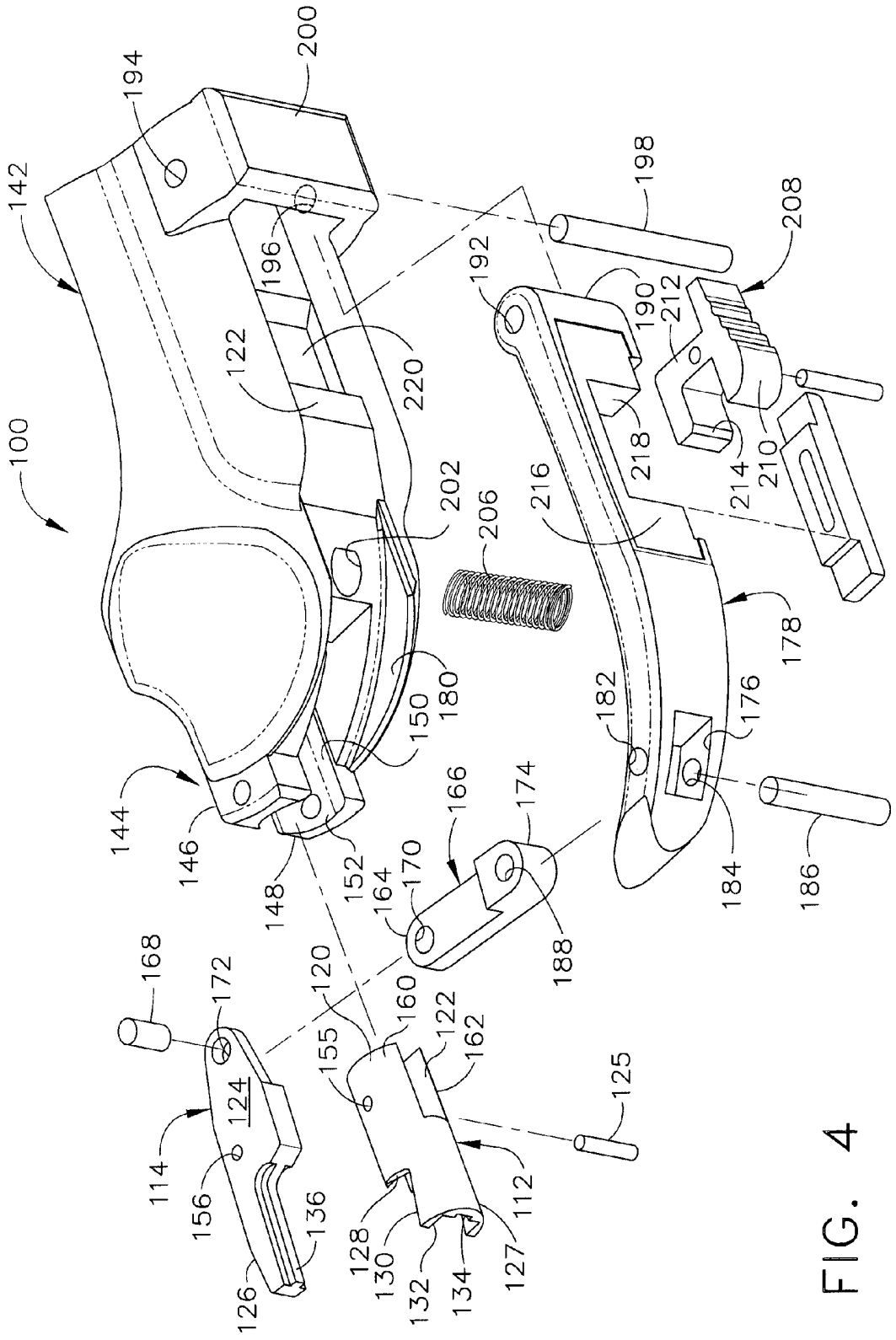
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FIG. 4

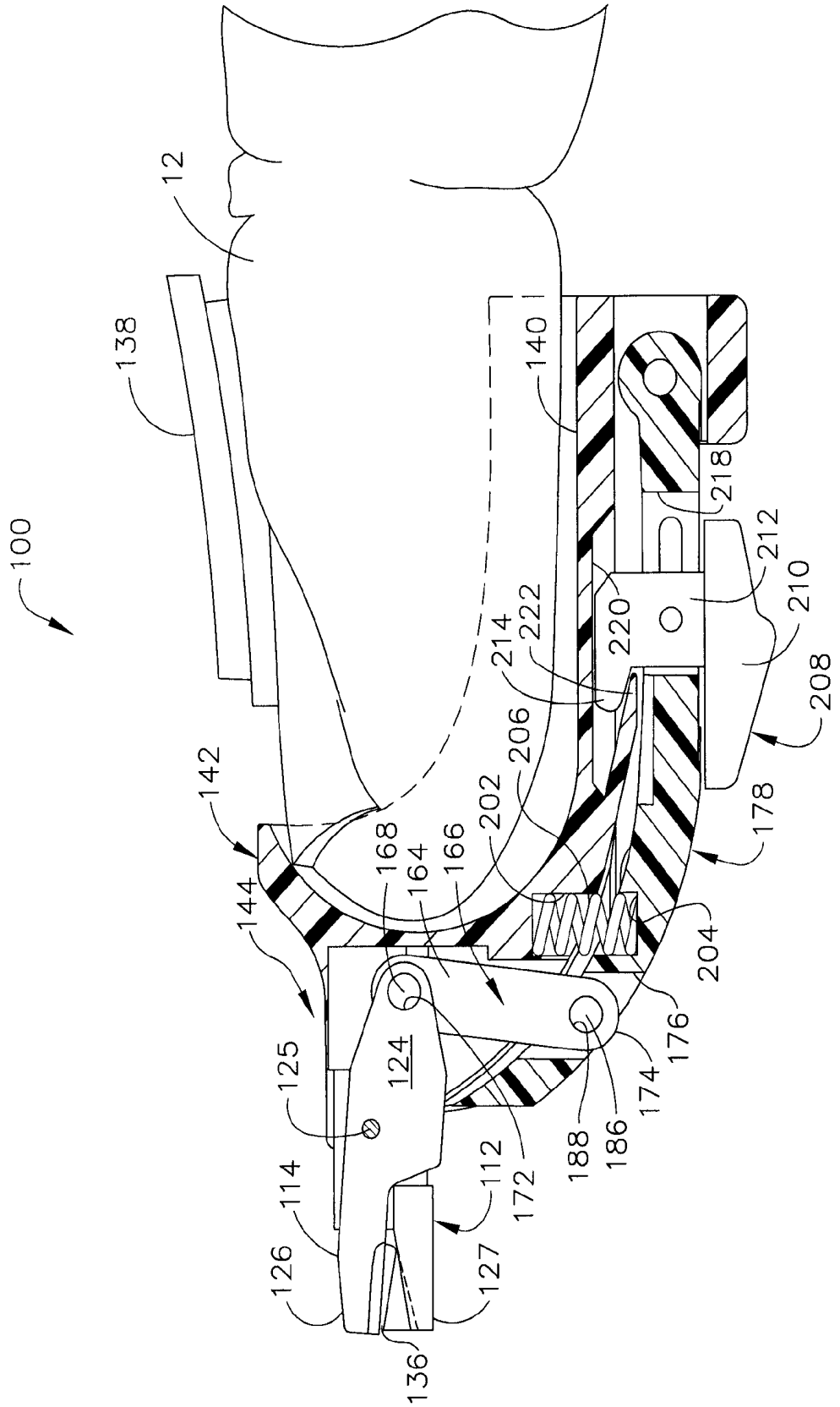
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FIG. 5

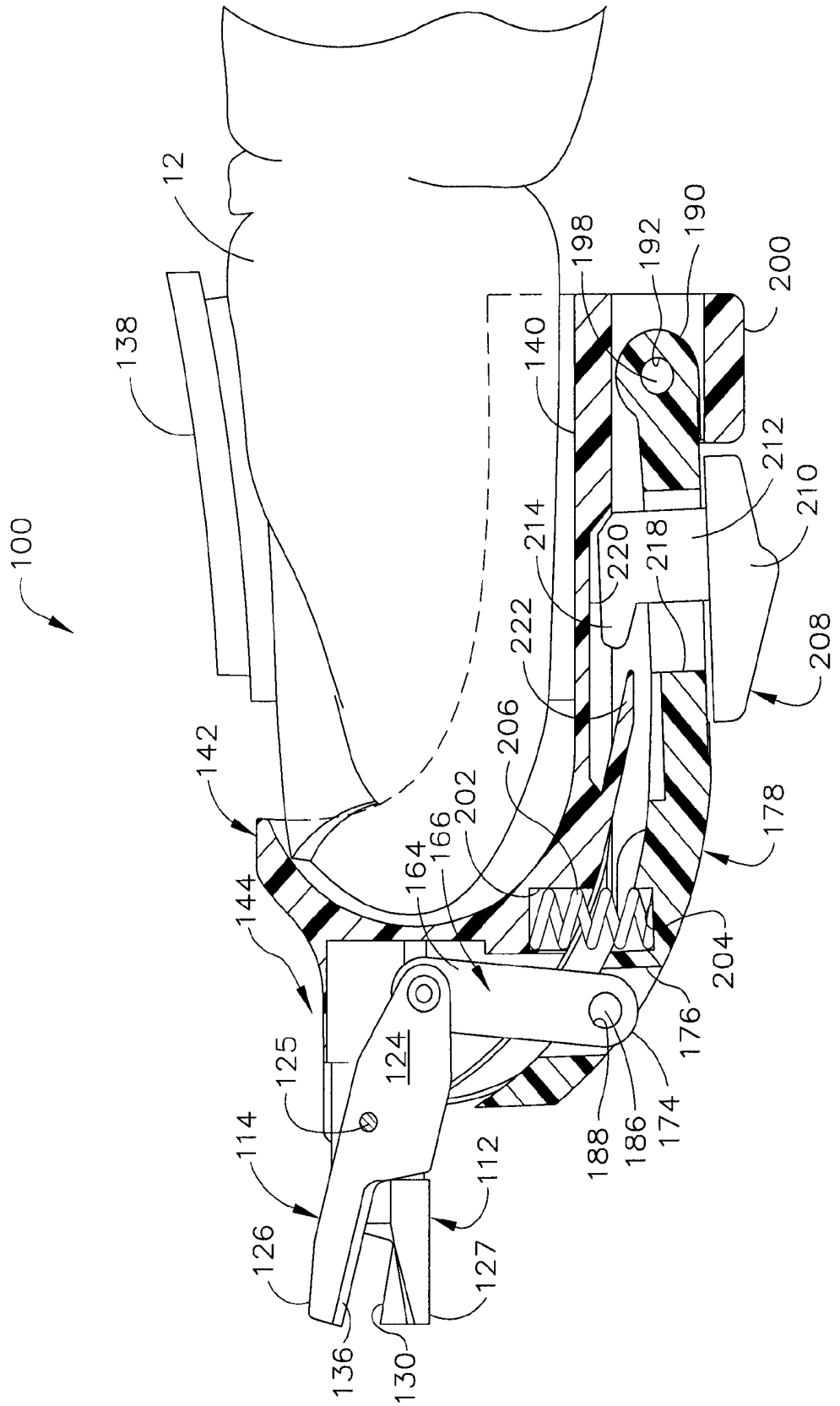
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FIG. 6

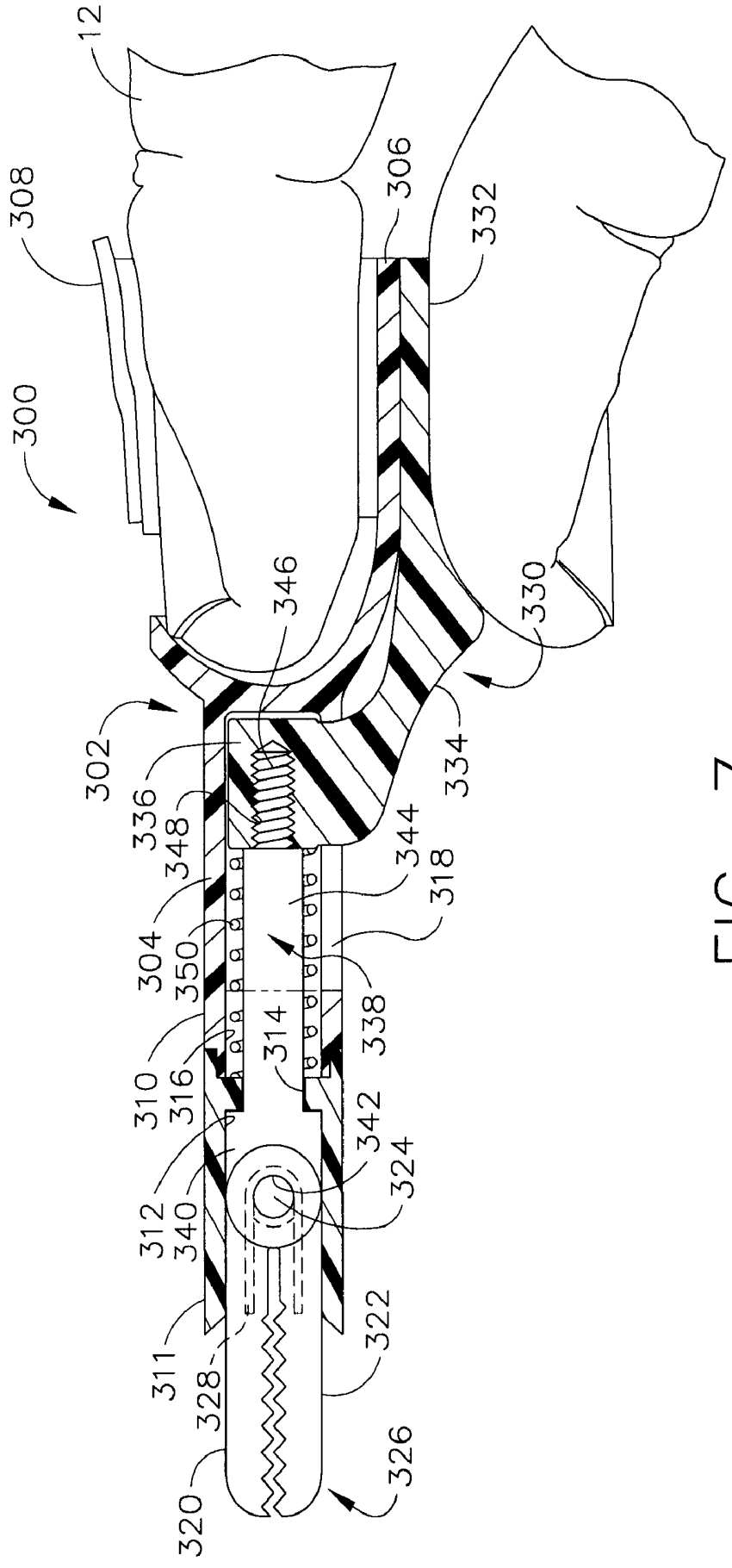
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FIG. 7

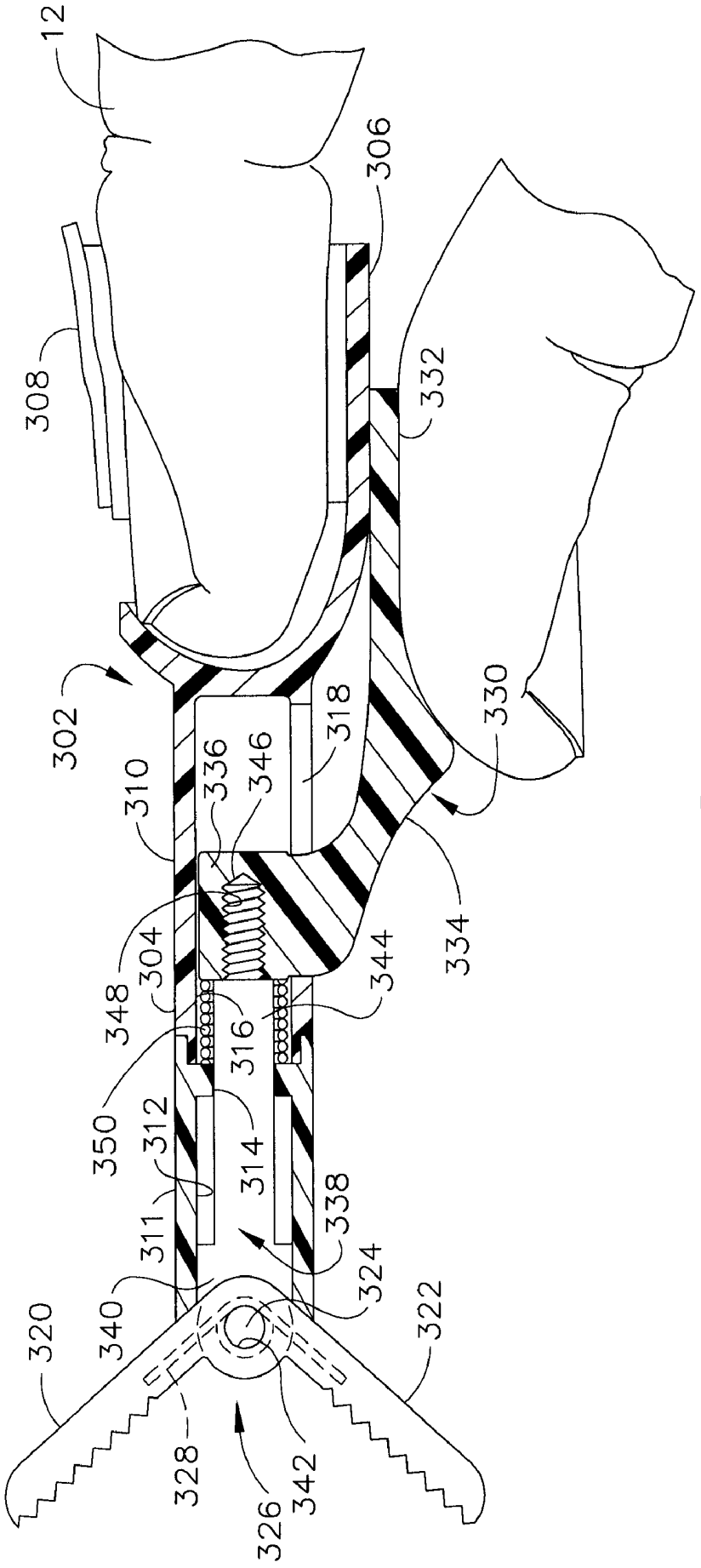
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FIG. 8

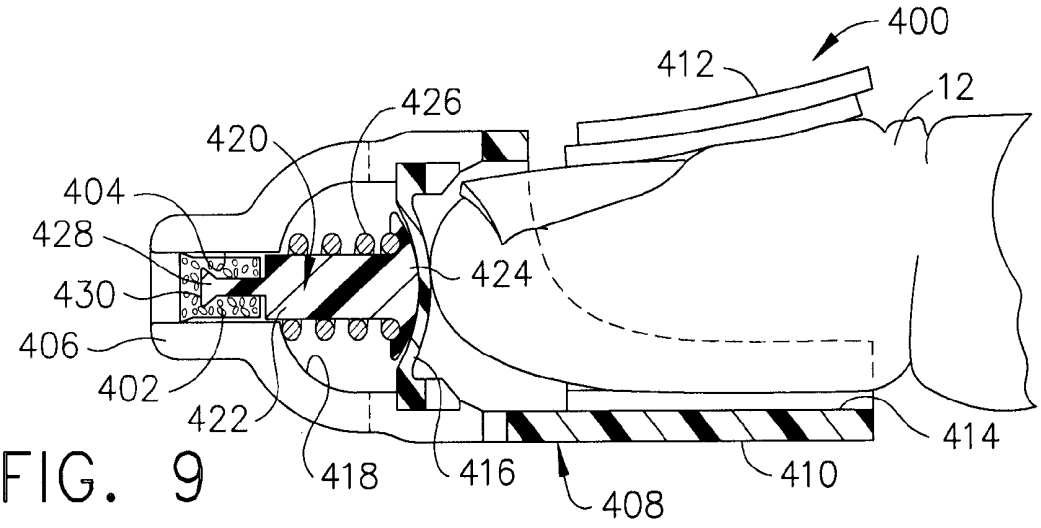

FIG. 9

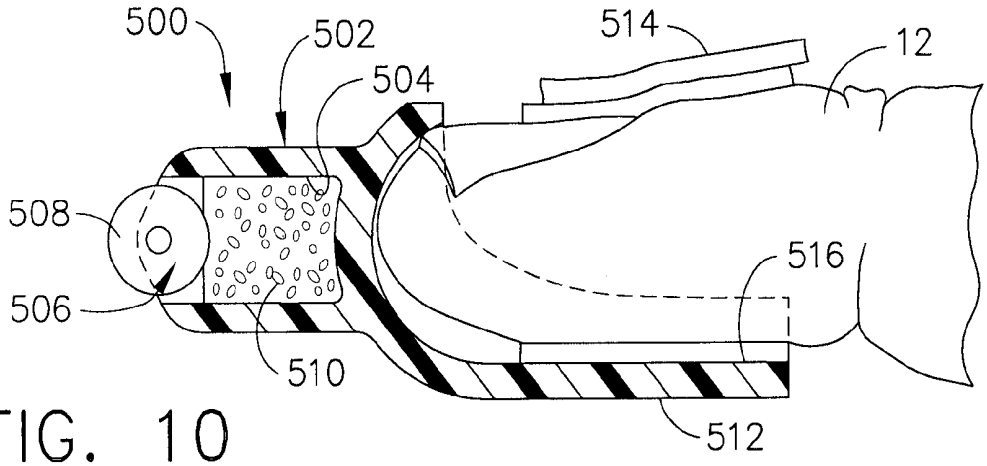

FIG. 10

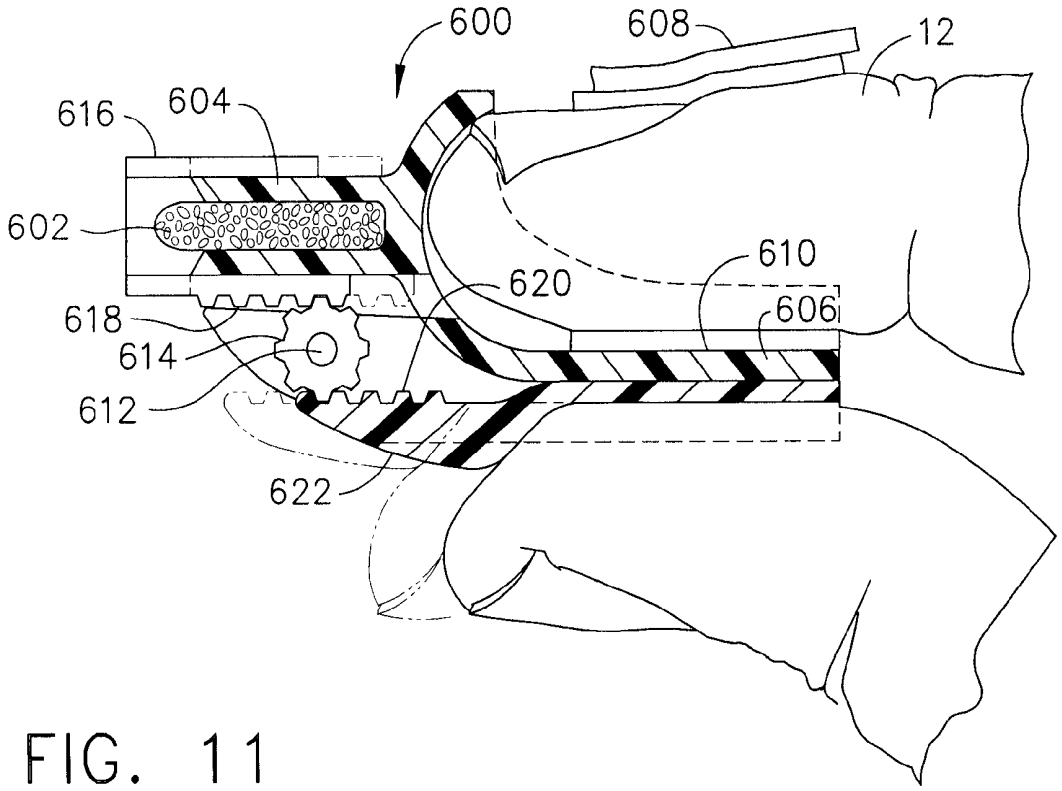

FIG. 11

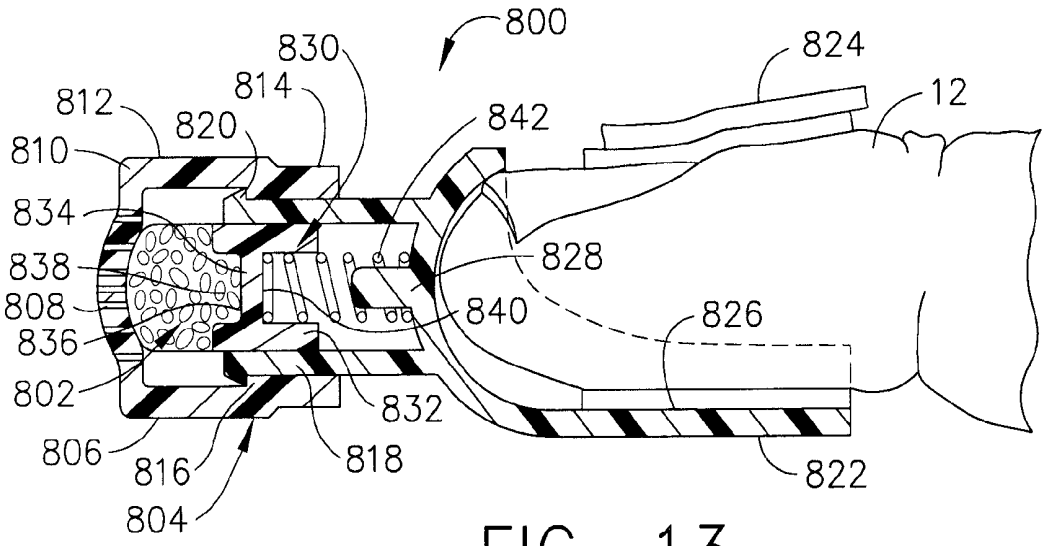
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FIG. 13

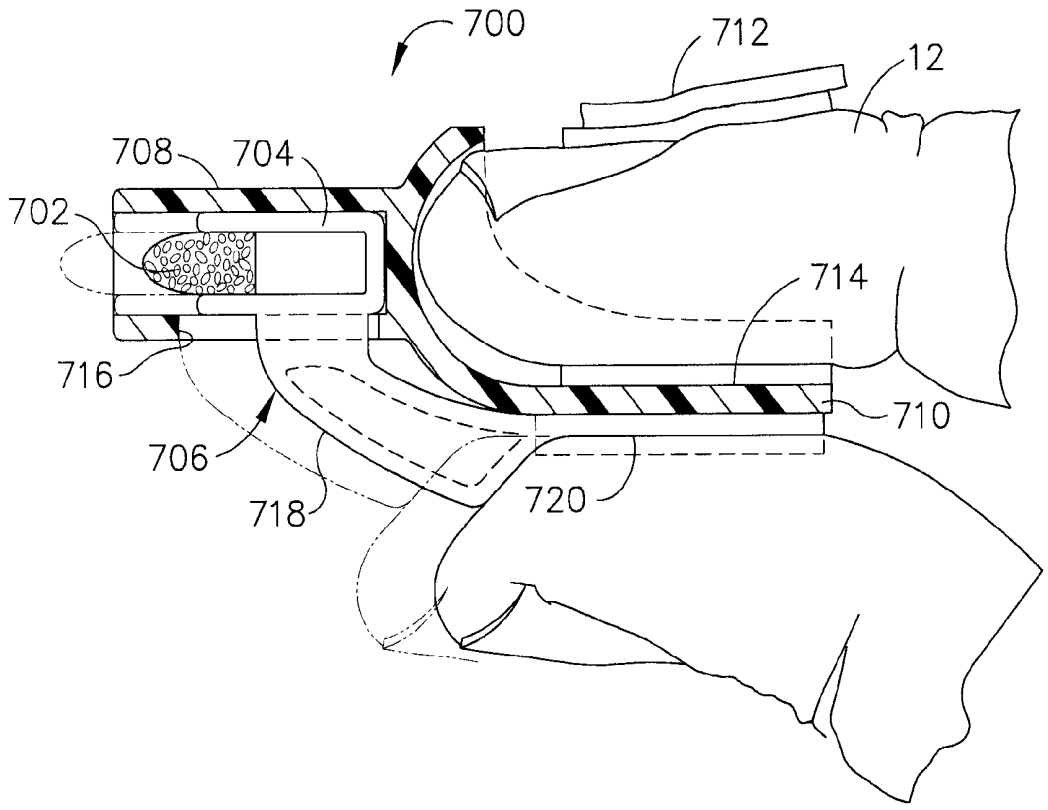
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FIG. 12

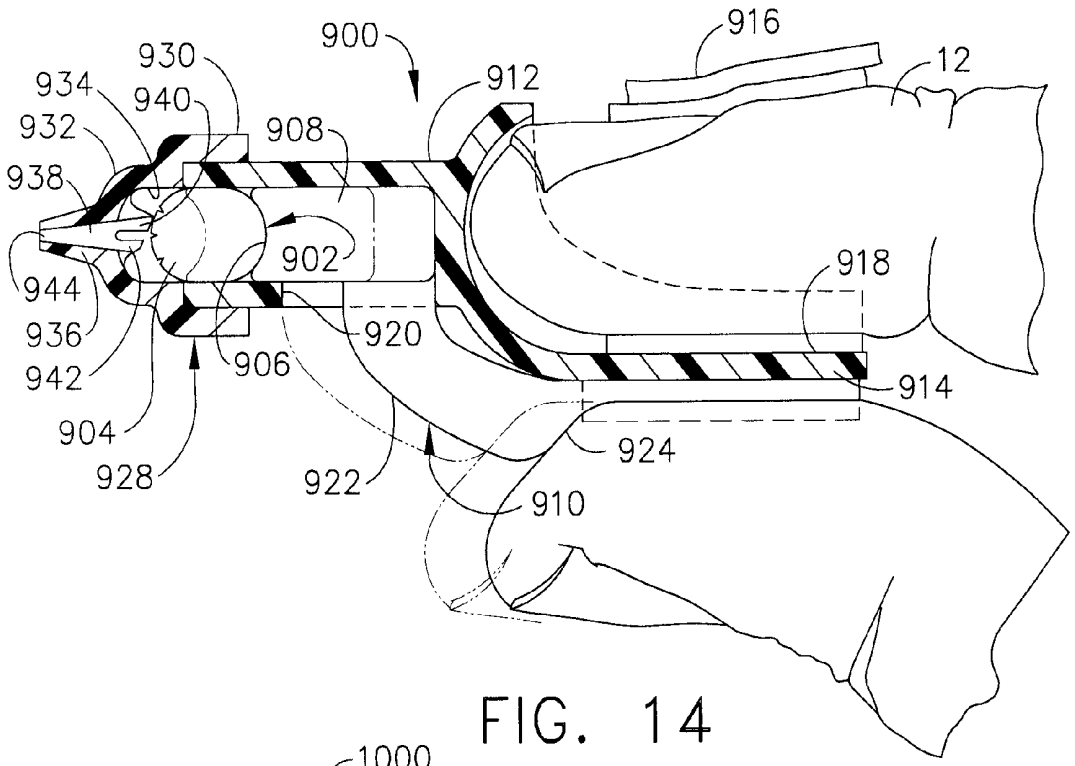
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FIG. 14

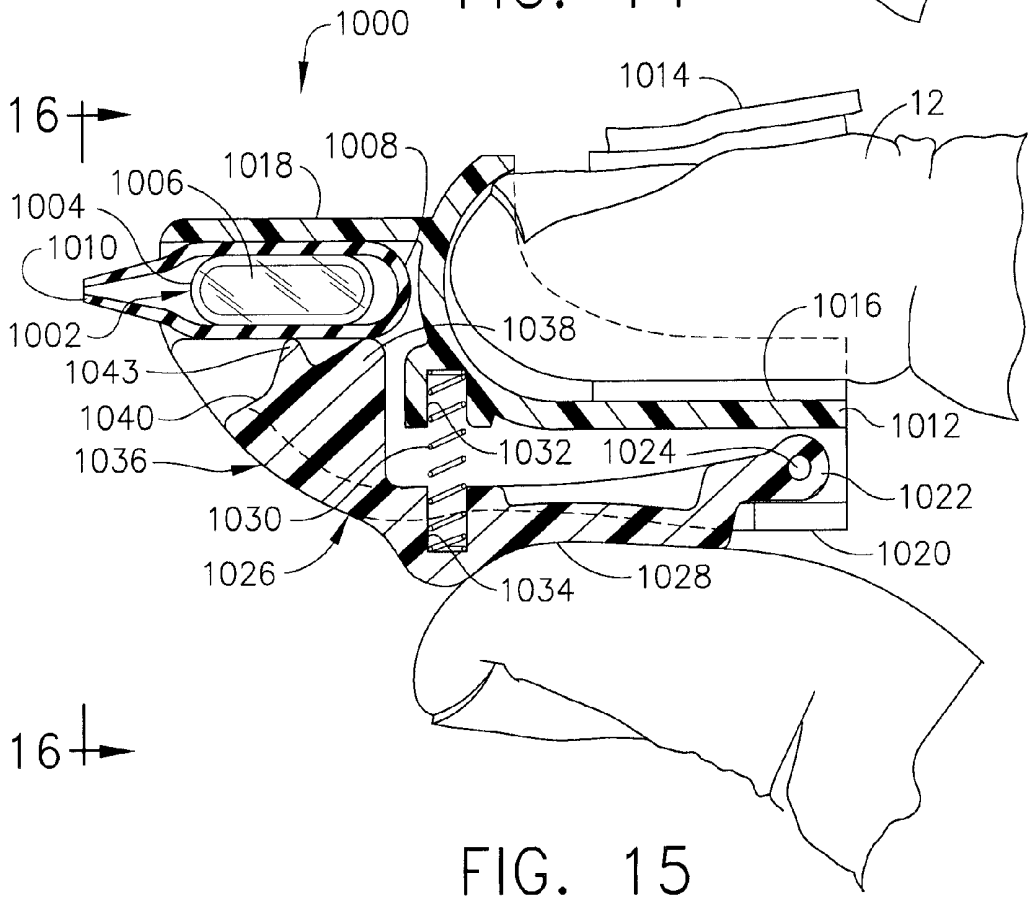
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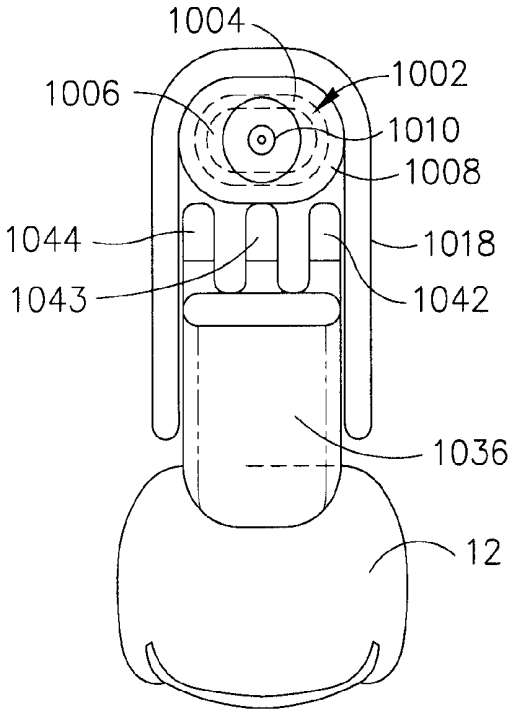
FIG. 15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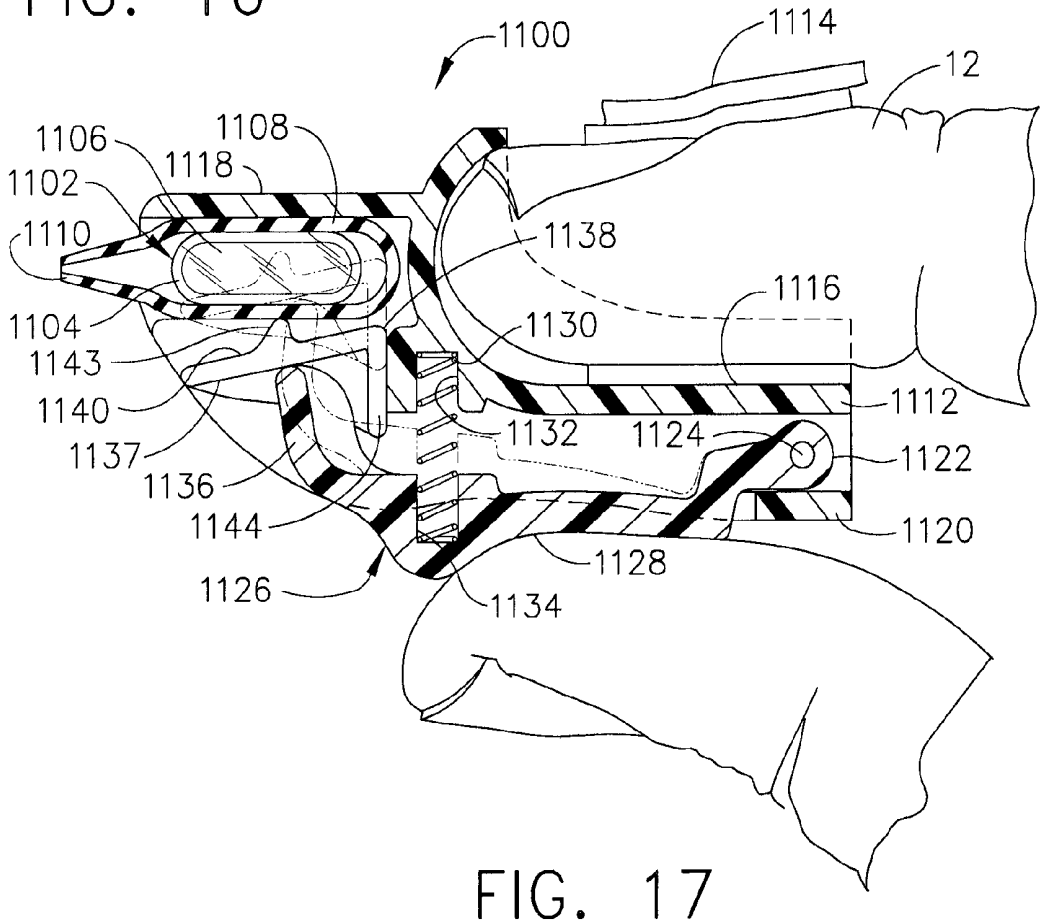
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FIG. 17

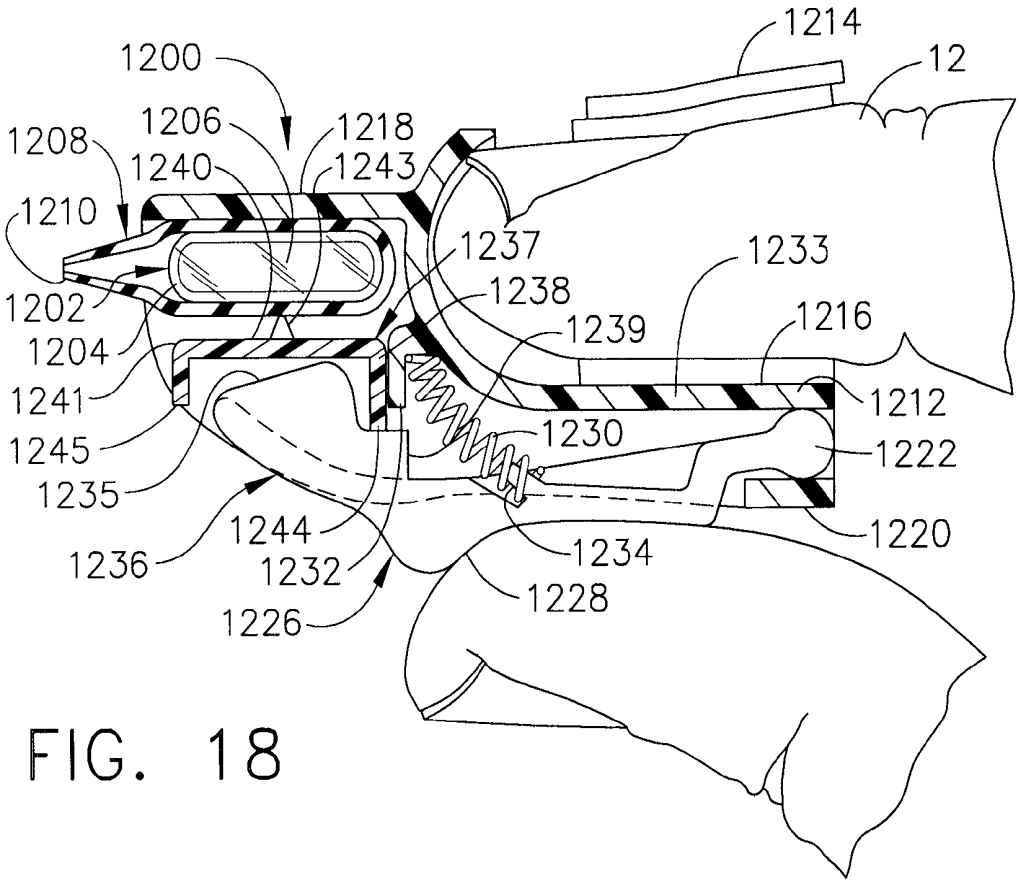
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FIG. 18

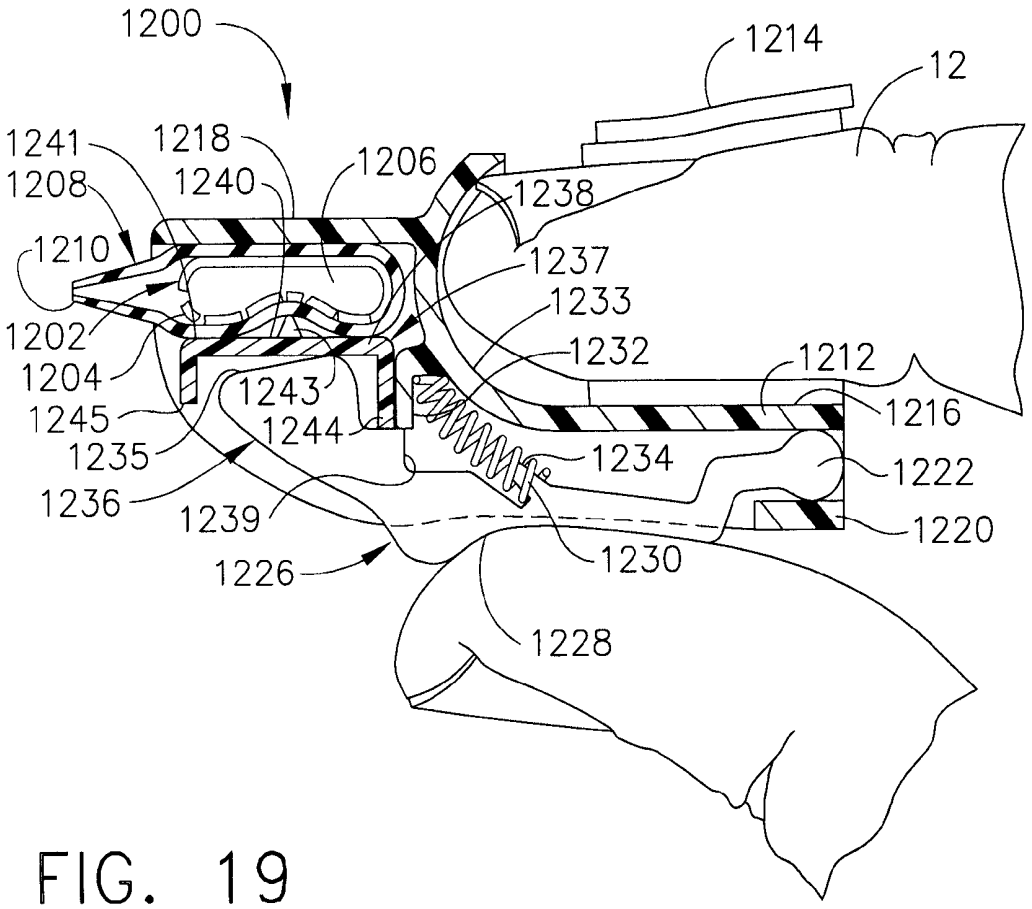
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FIG. 19

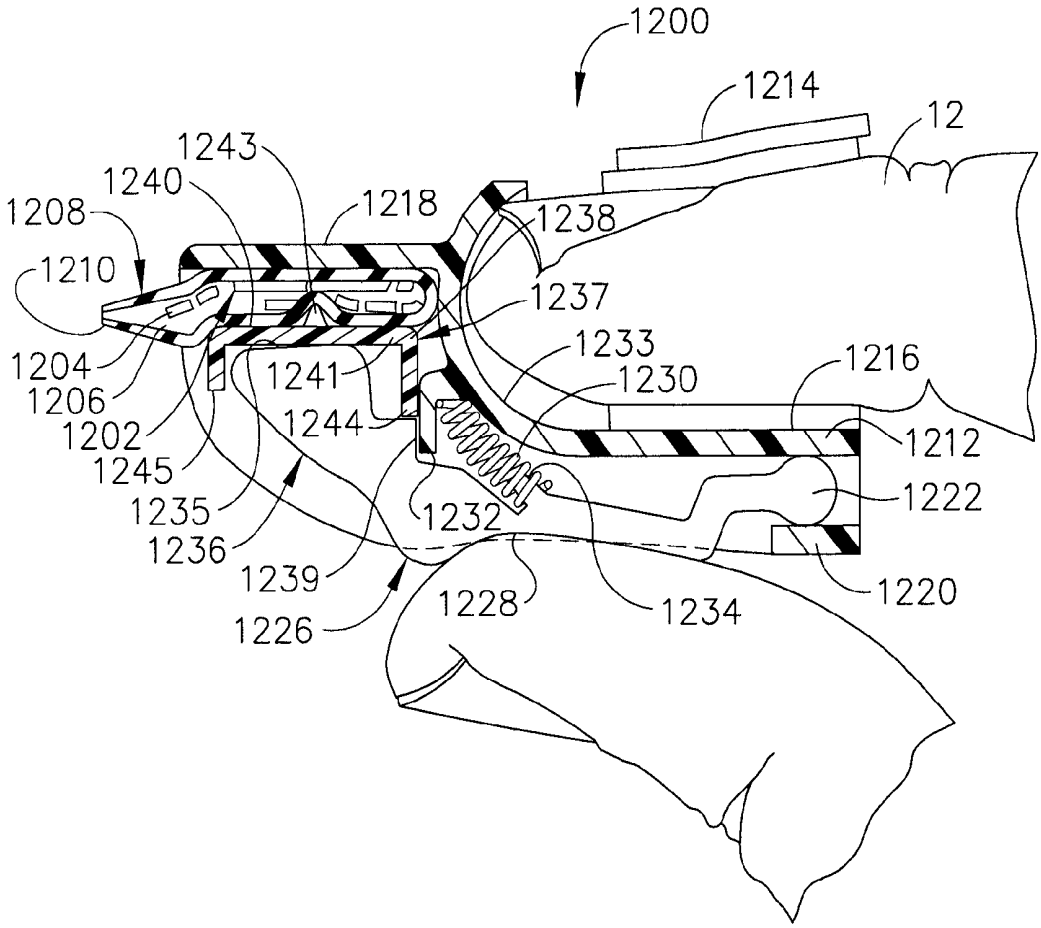
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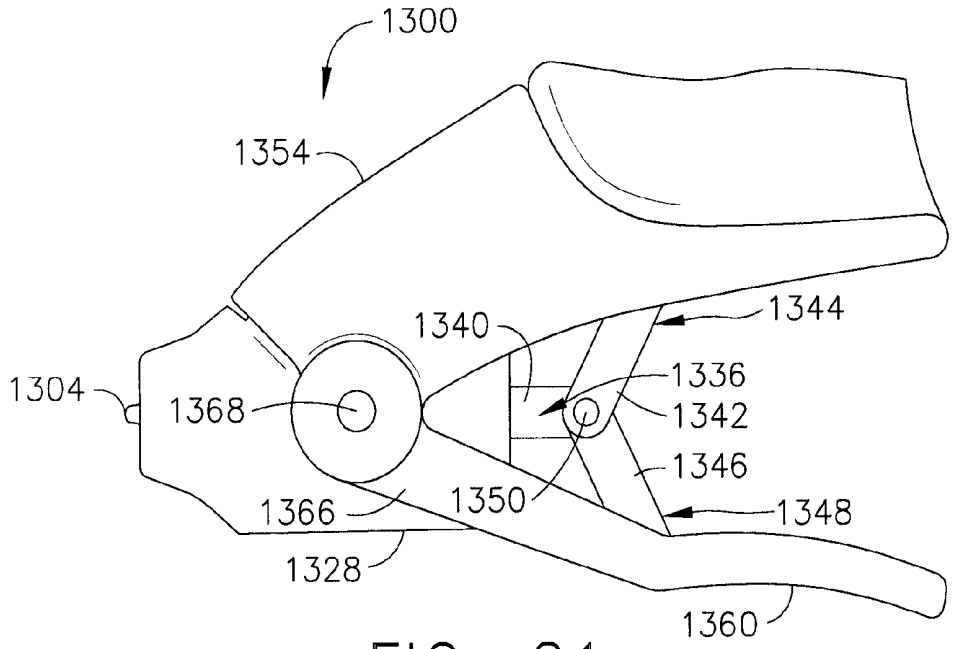
FIG. 20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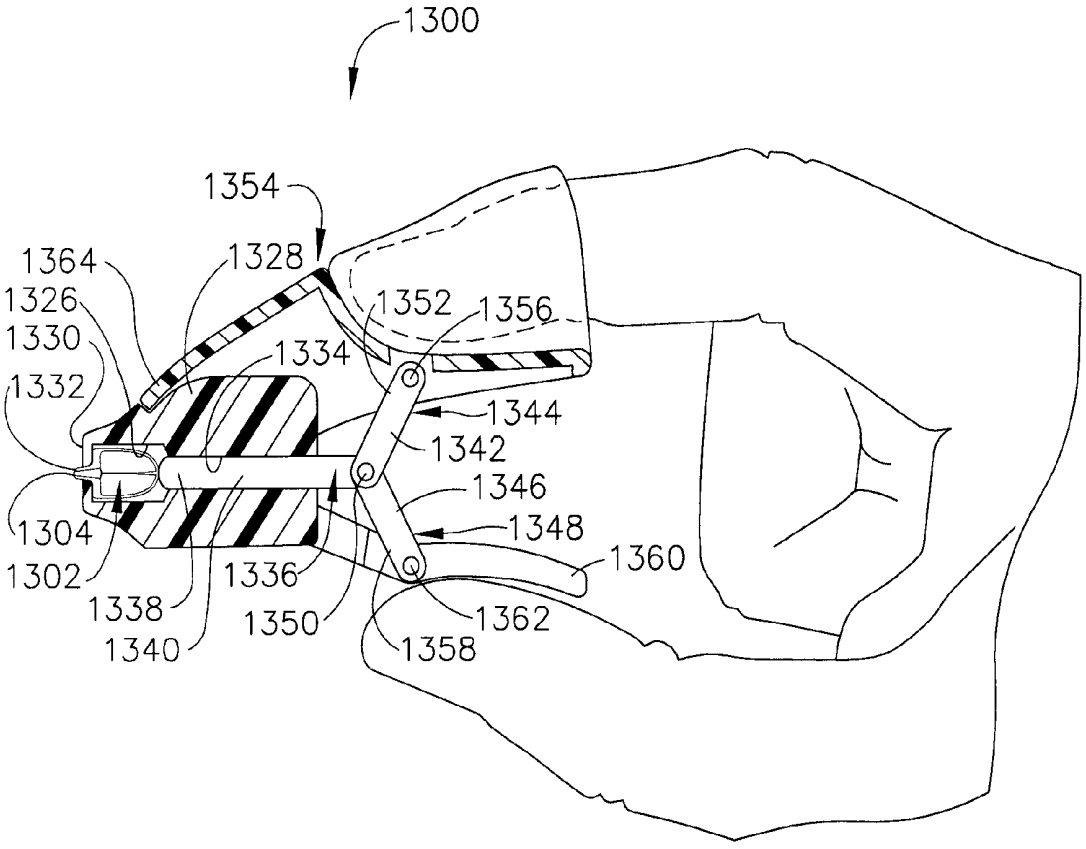
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FIG. 22

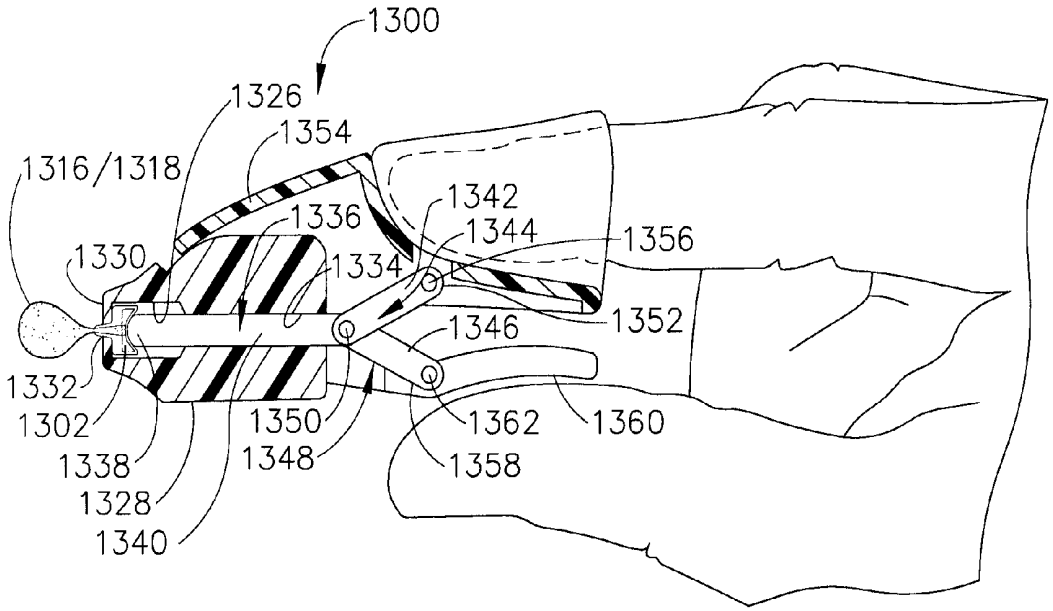


FIG. 23

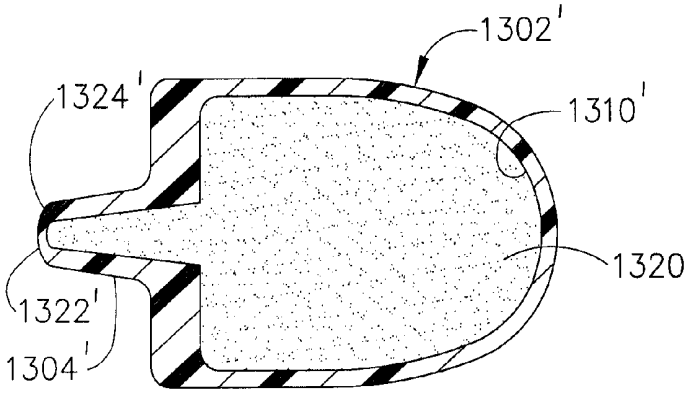
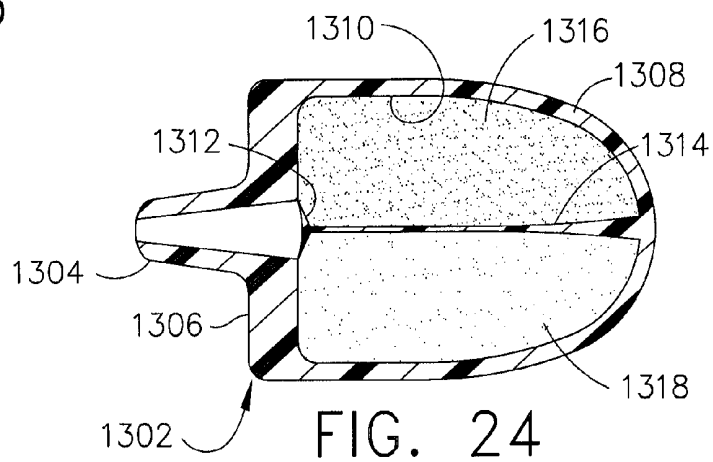


FIG. 25



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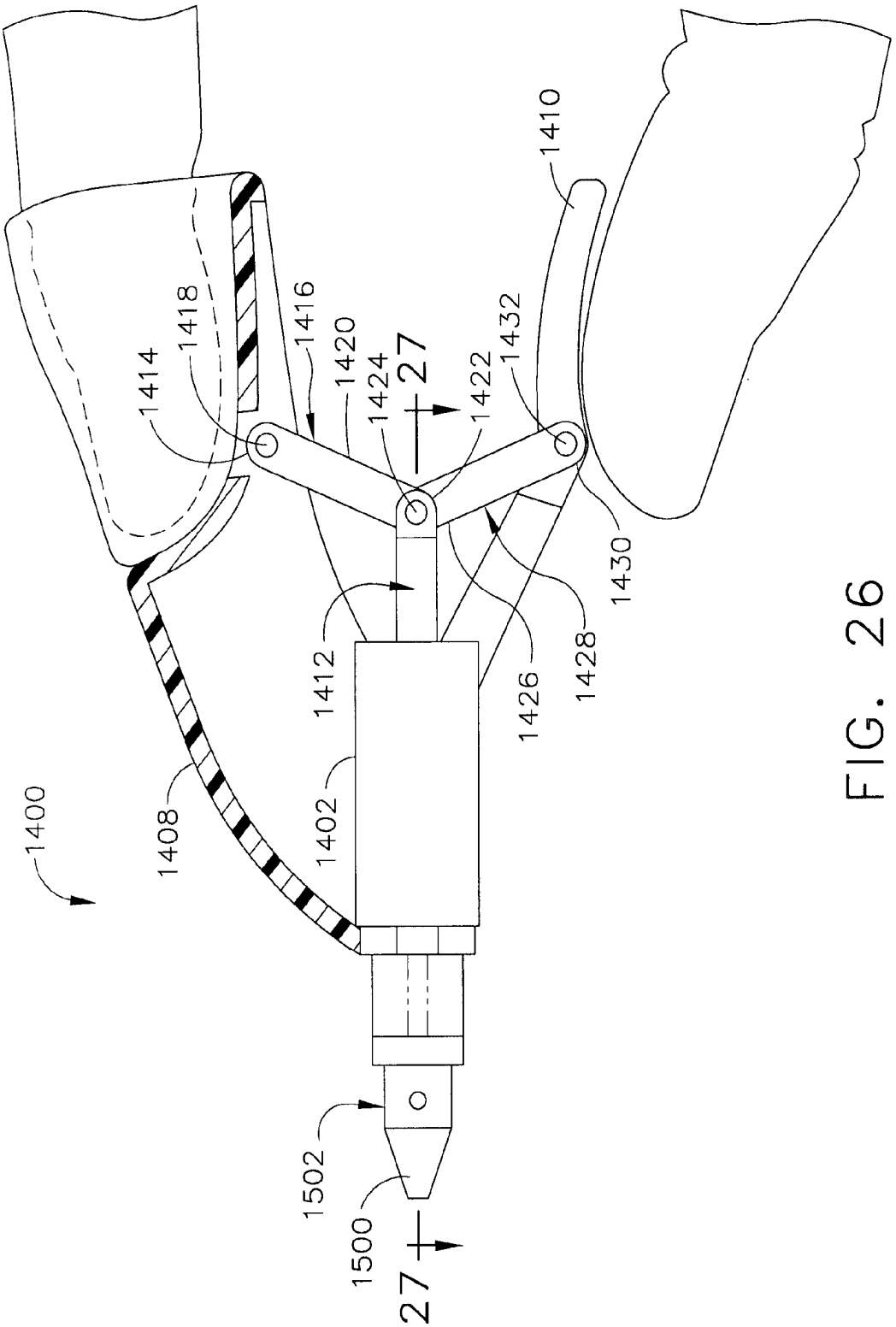
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FIG. 26

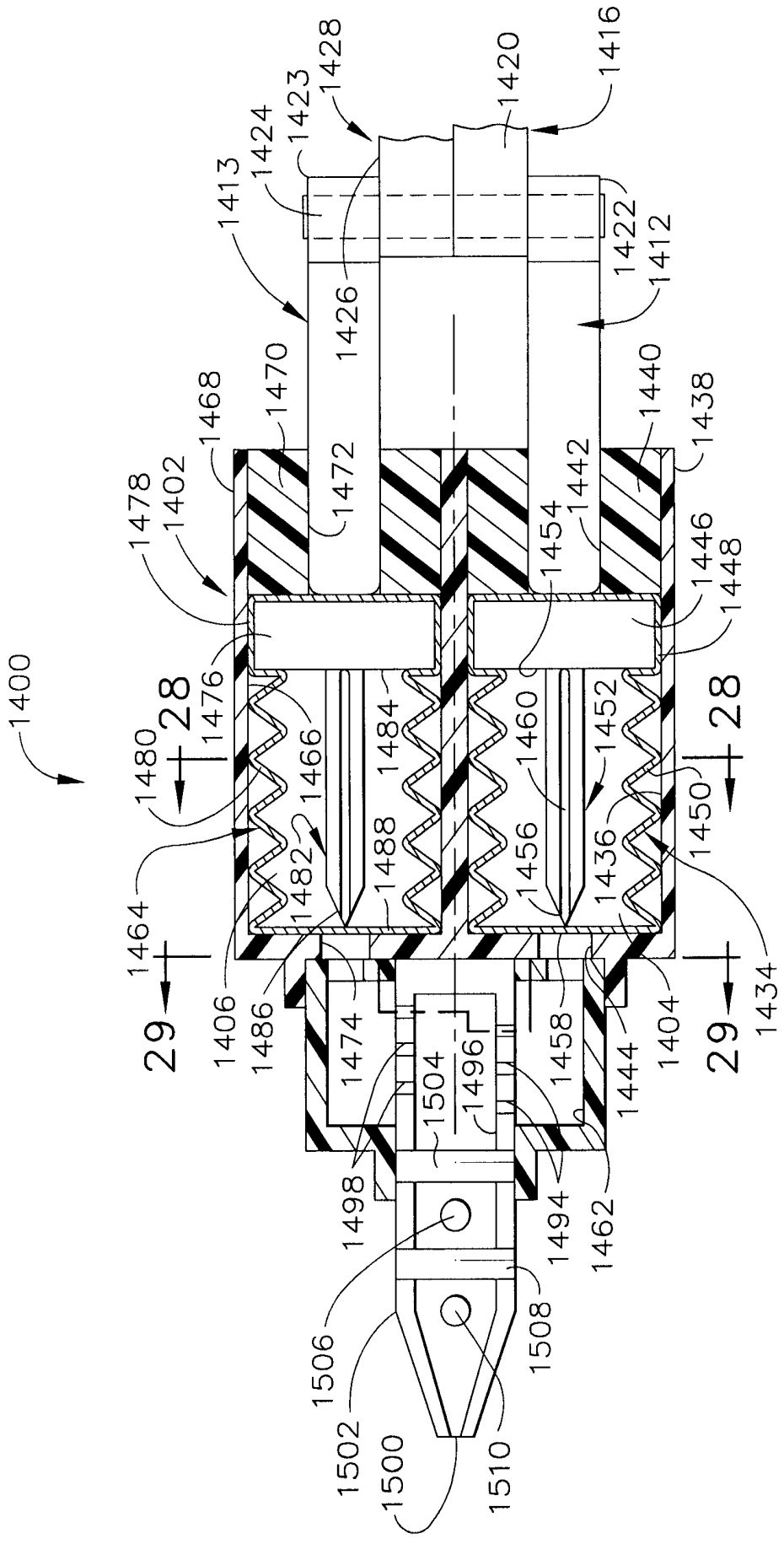
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FIG. 27

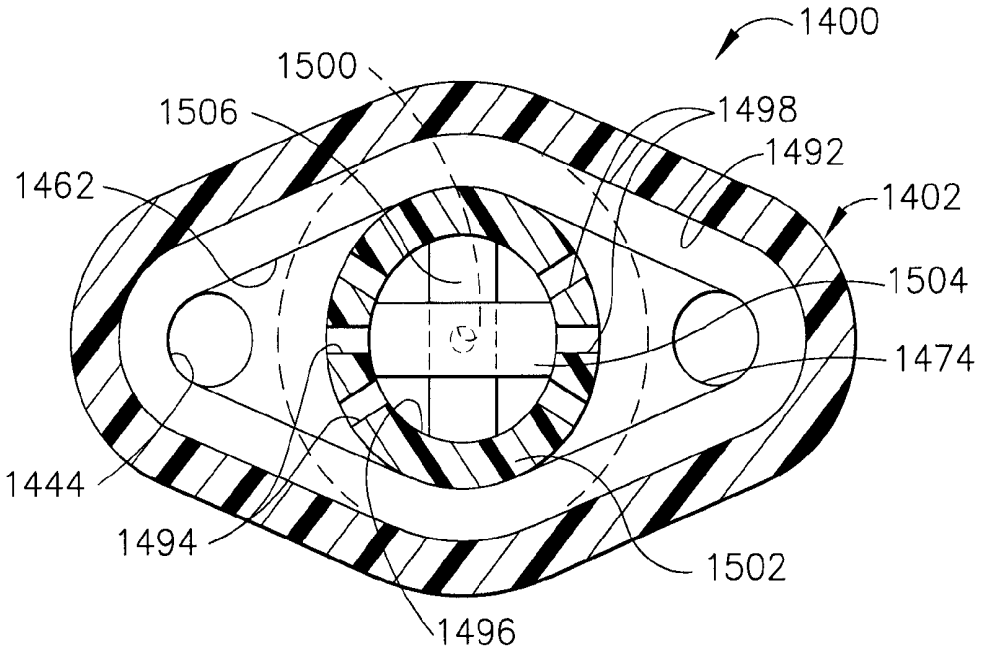
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FIG. 29

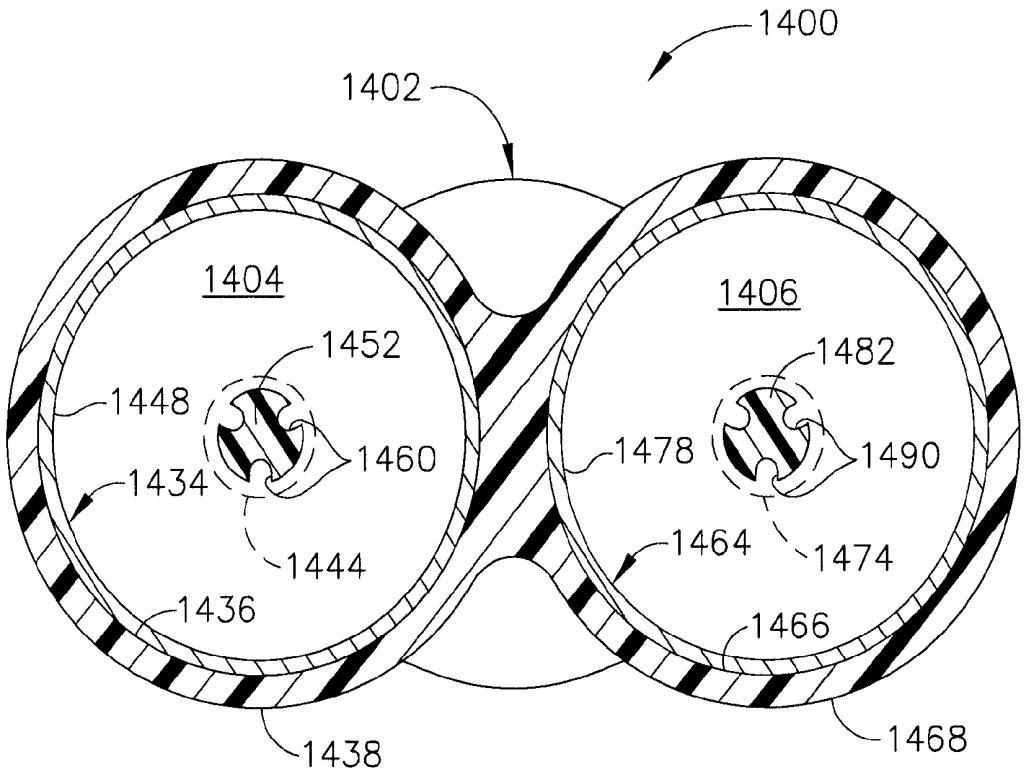
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FIG. 28

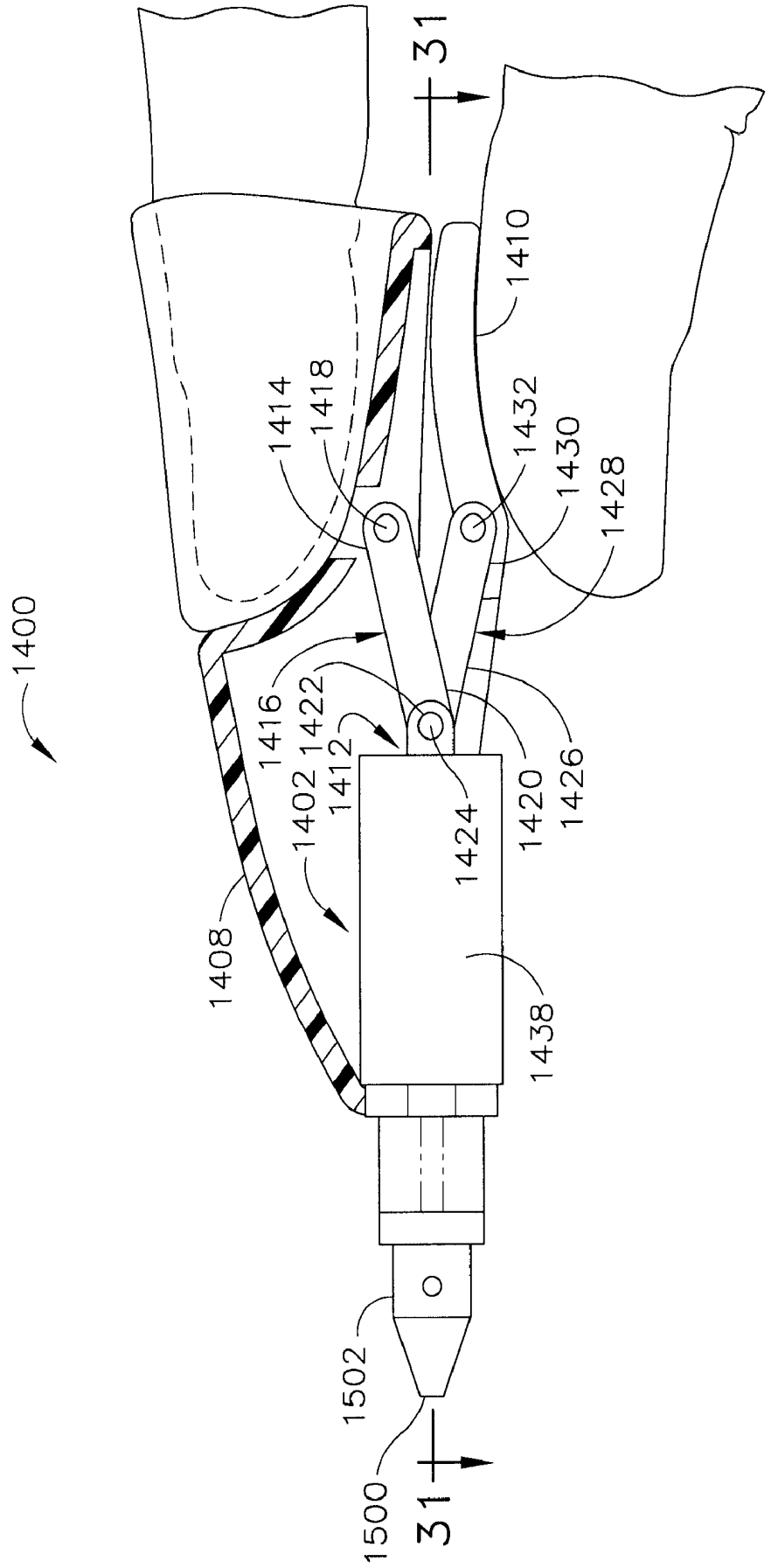
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FIG. 30

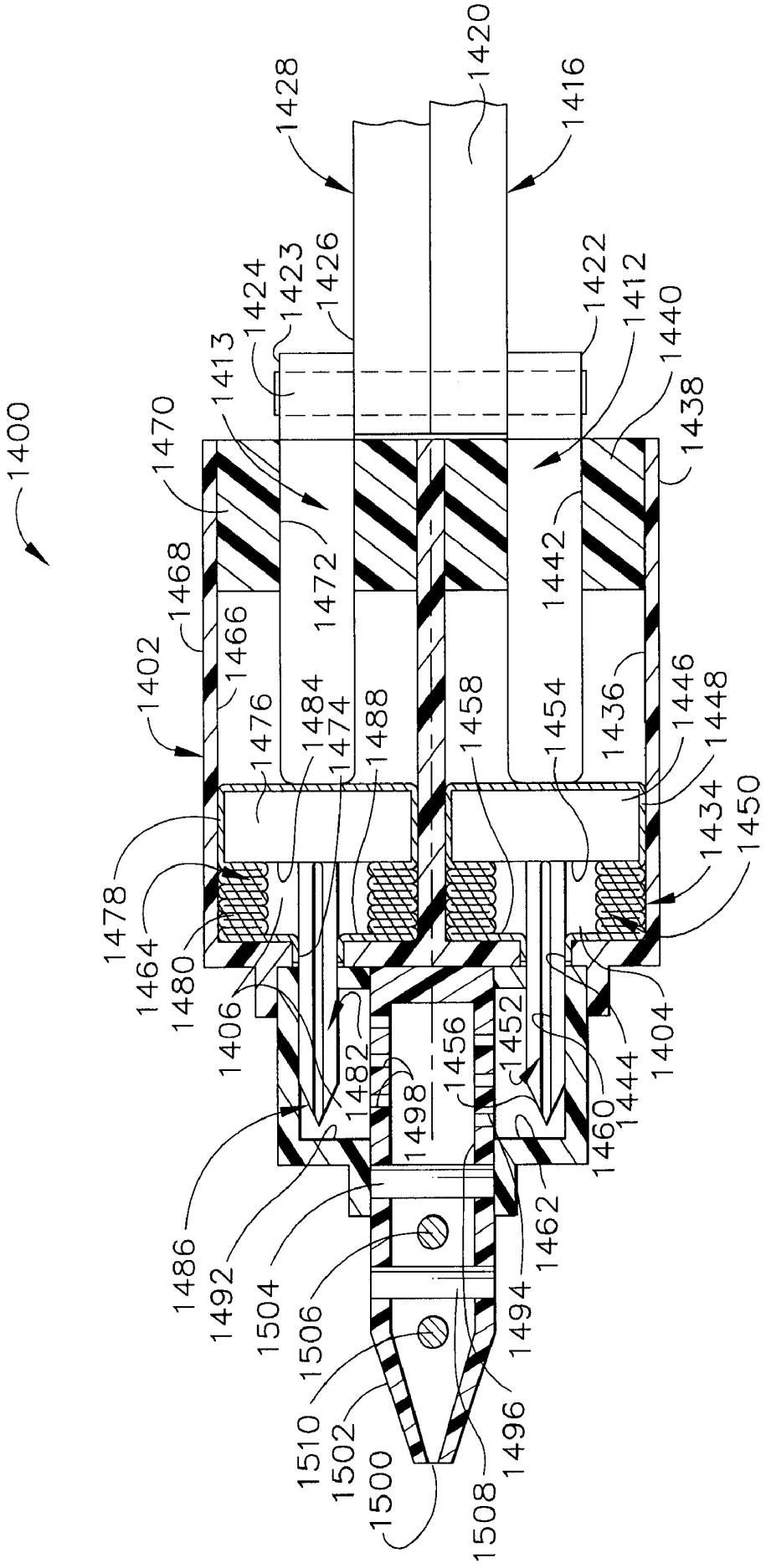
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FIG. 31

FINGERTIP SURGICAL INSTRUMENT

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] The present application is related to and claims the benefit of two commonly-owned U.S. patent applications (a) Ser. No. 11/533,506, entitled "Dispensing Fingertip Surgical Instrument" to Voegele et al. filed on Sep. 20, 2006; and (b) U.S. patent application Ser. No. 10/777,324, "Fingertip Surgical Instruments" to Voegele et al., filed Feb. 12, 2004, published as U.S. patent application Publ. No. 2004/0193211 A1 on Sep. 30, 2004, the disclosures of which are hereby incorporated by reference in their entirety.

[0002] The present application is further related to three U.S. patent applications: (1) U.S. patent application Ser. No. 10/777,740, "Fingertip Ultrasound Medical Instrument" to Voegele et al., filed Feb. 12, 2004, published Nov. 11, 2004 as U.S. patent application Publ. No. 2004/0225217 A1; (2) U.S. patent application Ser. No. 10/777,708, "Multifunctional Surgical Instrument" to Voegele et al., filed Feb. 12, 2004, published Oct. 7, 2004 as U.S. patent application Publ. No. 2004/0199204 A1; and (3) U.S. patent application Ser. No. 11/398,985 "A Multi-Port Insert For Use With A Laparoscopic Access Device" to Voegele et al., filed Apr. 5, 2006, which in turn claims the benefit of U.S. patent application Ser. No. 60/669,514 filed Apr. 8, 2005, the disclosures of all of which are hereby incorporated by reference in their entirety.

FIELD OF THE INVENTION

[0003] The present invention relates, in general, to minimally invasive surgical instruments that may be used in hand-assisted laparoscopic surgeries where the instruments are mounted directly on a surgeon's fingertip and are then inserted through an incision, perhaps pneumatically sealed with a laparoscopic disk, to allow the surgeon to manipulate internal tissue during a surgical procedure.

BACKGROUND OF THE INVENTION

[0004] Abdominal surgery typically involves an incision in the abdominal wall large enough to accommodate a surgeon's hands, multiple instruments, and illumination of the body cavity. While large incisions simplify access to the body cavity during a surgery, it also increases trauma, requires extended recovery time, and can result in unsightly scars. In response to these drawbacks, minimally invasive surgical methods have been developed.

[0005] In minimally invasive abdominal surgery, or laparoscopic surgery, several smaller incisions are made into the abdominal wall. One of the openings is used to inflate the abdominal cavity with gas, which lifts the abdominal wall away from underlying organs and provides space to perform the desired surgery. This process is referred to as insufflation of the body cavity. Additional openings can be used to accommodate cannulas or trocars for illuminating and viewing the cavity, as well as instruments involved in actually performing the surgery, e.g., instruments to manipulate, cut, or resect organs and tissue.

[0006] While minimally invasive surgical methods overcome certain drawbacks of traditional open surgical methods, there are still various disadvantages. In particular, there is limited tactile feedback from the manipulated tissue to the surgeon hands. In non-endoscopic surgery, a surgeon can easily verify the identification of structures or vessels within a conventional open surgery incision. In particular, the surgeon normally uses the sense of feel to verify the nature of visually identified operational fields. Further, in endoscopic surgery, tissue that is to be removed from the body cavity must be removed in pieces that are small enough to fit through one of the incisions.

[0007] Recently, new surgical methods have been developed that combine the advantages of the traditional and minimally invasive methods. It is sometimes referred to as hand assisted laparoscopic surgery ("HALS"). In these new methods, small incisions are still used to inflate, illuminate, and view the body cavity, but in addition, an intermediate incision is made into the abdominal wall to accommodate the surgeon's hand. The intermediate incision must be properly retracted to provide a suitable-sized opening, and the perimeter of the opening is typically protected with a surgical drape to prevent bacterial infection. A sealing mechanism is also required to prevent the loss of insufflation gases while the surgeon's hand is either inserted into or removed from the body cavity though the retracted incision.

[0008] While the hand provides a great deal of flexibility and retains the surgeon's sense of feel, fingers in themselves have limits as to their usefulness. Fingers lack the delicacy to pick up fine tissue. Fingers require making larger divisions when dissecting tissue. Fingers are subject to injury when holding tissue while energy modalities, such as ultrasound or RF, are used to treat the surgical site. Traditional instruments intended for conventional surgery, i.e. forceps and graspers, are too large for the limited body cavity environment. Traditional instruments also present the problem of being brought into and out of the laparoscopic site causing time-delaying deflation and re-insufflations of the body cavity. Laparoscopic equivalent instruments are delivered through a body wall port and have limited access to tissue. U.S. Pat. Nos. 6,149,642; and 5,925,064 disclose various aspects of laparoscopic surgery and fingertip devices for surgeon use.

[0009] With the advance represented by HALS procedures, there is a need for improved fingertip surgical instrumentation that can take advantage of the increased freedom created by having a hand inside the body cavity.

[0010] As an example, while suturing is often necessary in HALS procedures, generally known suturing instruments may prove difficult when repetitively gripping a curved suture needle and forming a stitch.

[0011] As yet a further example, while instruments for HALS necessarily need to be of limited dimensions in order to be effective within the close confines of the insufflated abdomen, some additional range of motion is often desirable.

[0012] Consequently, a significant need exists for an improved surgical instrument useful in HALS procedures.

BRIEF SUMMARY OF THE INVENTION

[0013] The invention overcomes the above-noted and other deficiencies of the prior art by providing a fingertip surgical instrument that has an end effector that may be efficiently actuated with one hand within the close confines of an insufflated body cavity in order to manipulate internal tissue.

[0014] In one aspect of the invention, a surgical instrument includes a fingertip mounting structure that is attachable to a fingertip of a surgeon so that his hand may be inserted through an incision to perform a hands assisted laparoscopy surgery (HALS) procedure, specifically suturing with an end effector having a pair of jaws with opposing generally convex and

concave registering surfaces that tend to properly orient (i.e., self righting) a curved suture needle.

[0015] In another aspect of the invention, a surgical instrument includes a fingertip mounting structure that is attachable to a fingertip of a surgeon so that his hand may be inserted through an incision to perform a hands assisted laparoscopy surgery (HALS) procedure. A pair of pivotal jaws are coupled by an elongate neck to the finger mounting portion so that an increased range of motion is achieved. A finger actuated member affects opening and closing the pair of pivotal jaws.

[0016] These and other objects and advantages of the present invention shall be made apparent from the accompanying drawings and the description thereof.

BRIEF DESCRIPTION OF THE FIGURES

[0017] The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the invention, and, together with the general description of the invention given above, and the detailed description of the embodiments given below, serve to explain the principles of the present invention.

[0018] FIG. **1** is a cut-away perspective view of an exemplary use of a fingertip surgical instrument attached to a gloved finger of a surgeon's hand inserted through a laparoscopic disk into an insufflated abdomen of a patient undergoing Hand Assisted Laparoscopy Surgery (HALS).

[0019] FIG. **2** is a left front perspective view of a self-righting needle holder, as a first illustrative version of the fingertip surgical instrument of FIG. **1**.

[0020] FIG. **3** is an exploded view of the self-righting needle holder of FIG. **2** from a position above, left and in front.

[0021] FIG. **4** is an exploded view of the self-righting needle holder of FIG. **2** from a position below, left and in front.

[0022] FIG. **5** is left side view taken in vertical longitudinal cross section through the self-righting needle holder of FIG. **2** mounted on an index finger and having a thumb slide positioned distally to close and lock an upper jaw.

[0023] FIG. **6** is left side view taken in vertical longitudinal cross section through the self-righting needle holder of FIG. **2** mounted on an index finger and having a thumb slide positioned proximally to unlock and open the upper jaw.

[0024] FIG. **7** is a left side view in vertical longitudinal cross section through an elongate grasper in an unactuated, closed position, as a second illustrative version of the fingertip surgical instrument of FIG. **1**.

[0025] FIG. **8** is a left side view in vertical cross section of the elongate grasper of FIG. **7** in an actuated, open position.

[0026] FIG. **9** is a left side view in elevation of yet an additional fingertip surgical instrument cut away to depict an extending inkpad for marking internal tissue actuated by pressure on an end effector nozzle.

[0027] FIG. **10** is a left side view in elevation of yet another alternative fingertip instrument partially cut away to expose a roller ball that applies ink to internal tissue.

[0028] FIG. **11** is a left side view in elevation of a further alternative fingertip surgical instrument partially cut away to expose a marking element extending from a finger mounted end effector tip that is unsheathed for use by distally advancing a thumb actuator.

[0029] FIG. **12** is a left side view in elevation of an additional alternative fingertip surgical instrument partially cut away to expose a marking element distally extending from a thumb actuator that is extended out of a fingertip mounted end effector nozzle for use.

[0030] FIG. **13** is a left side view in elevation of yet another alternative fingertip surgical instrument partially cut away to expose a marking solid element urged by a spring biased plunger into contact with a convex porous tip for marking internal tissue.

[0031] FIG. **14** is a left side view in elevation of another alternative fingertip surgical instrument partially cut away to expose a thumb actuator that longitudinally compresses an ampoule for piercing and dispensing flowable material out of a nozzle tip.

[0032] FIG. **15** is a left side view in elevation of yet a further alternative fingertip surgical instrument partially cut away to expose an upwardly pivoting thumb actuator that crushes an ampoule for dispensing flowable materials.

[0033] FIG. **16** is a front view taken in cross section along lines **16-16** of FIG. **15** of the further alternative fingertip surgical instrument of FIG. **15**.

[0034] FIG. **17** is a left side view in elevation of an additional alternative fingertip surgical instrument partially cut away to expose an upwardly pivoting thumb actuator that raises a linearly-moved actuator member to crush an ampoule and to dispense flowable material.

[0035] FIG. **18** is a left side view in elevation of another alternative fingertip surgical instrument partially cut away to expose a thumb actuator in an initial position prior to dispensing.

[0036] FIG. **19** is a left side view in elevation of the fingertip surgical instrument of FIG. **18** partially cut away to expose the thumb actuator having been depressed to break an ampoule.

[0037] FIG. **20** is a left side view in elevation of the fingertip surgical instrument of FIG. **18** partially cut away to expose the thumb actuator after distal advancement followed by further upward depression to dispense in a controlled fashion the flowable liquid released from the ampoule.

[0038] FIG. **21** is a left side view in elevation of an alternative fingertip surgical instrument for dispensing necked ampoules.

[0039] FIG. **22** is a left side view in elevation of the alternative fingertip surgical instrument of FIG. **21** mounted on an index finger and partially cut away to expose a two-compound necked ampoule prior to dispensing.

[0040] FIG. **23** is a left side view in elevation of the alternative fingertip surgical instrument of FIG. **22** partially cut away to expose the two-compound necked ampoule after dispensing.

[0041] FIG. **24** is a left side view in longitudinal vertical cross section through the two-compound necked ampoule of FIG. **22**.

[0042] FIG. **25** is a left side view in longitudinal vertical cross section through an alternative single compound necked ampoule for the alternative fingertip surgical instrument of FIG. **22**.

[0043] FIG. **26** is a left side view of yet another alternative fingertip surgical instrument for dispensing a larger quantity of two flowable materials mixed during dispensing with an upper finger holder cut away.

[0044] FIG. **27** is a top view of a distal portion of the fingertip surgical instrument in horizontal cross section along lines **27-27** through a longitudinal centerline.

[0045] FIG. **28** is an aft view taken in cross section along lines **28-28** of the fingertip surgical instrument of FIG. **27** through proximal cylindrical vessels, each containing one of the two flowable materials.

[0046] FIG. **29** is an aft view taken in cross section along lines **29-29** of the fingertip surgical instrument of FIG. **27** viewing manifolds and a central nozzle tube for mixing and dispensing the two flowable materials.

[0047] FIG. **30** is a left side view in elevation of the fingertip surgical instrument of FIG. **26** after actuation of the upper fingertip holder and opposing lower thumb actuator.

[0048] FIG. **31** is a top view in cross section taken along lines **31-31** of the fingertip surgical instrument of FIG. **30** after actuation and dispensing.

DETAILED DESCRIPTION OF THE INVENTION

[0049] Referring now to FIG. **1**, the environment for performing an endoscopic surgical procedure within an abdomen is illustrated, herein referred to as Hand Assisted Laparoscopic Surgery (HALS). A surgeon places a fingertip instrument **10** consistent with aspects of the present invention on his index finger **12** (although any finger can be used) of a gloved hand **14**. In particular, the fingertip instrument **10** includes an end effector (working element) **16** distally mounted on a finger tip attachment portion **18** with an actuator **20** movably attached thereto that is moved to actuate the end effector **16** to manipulate tissue **21** (e.g., dispense, mark, activate, pivot, scissor, grasp, etc.). A means for providing hand access, such as a lap disc **22**, for example, model LD111 available from Ethicon Endo-Surgery, Cincinnati, Ohio, is placed into an abdominal wall **23** to serve as a pressure seal. The surgeon inserts his arm and gloved hand **14** through the lap disc **22** and into an insufflated abdominal cavity **24**.

[0050] Needle Holder. In the afore-mentioned U.S. patent application Publ. No. 2004/0193211 A1, a needle holder was disclosed as one illustrative working element. In FIGS. **2-6** a version of the fingertip instrument **10** is depicted as a needle holder **100** advantageously including a lower jaw **112** and pivotally attached upper jaw **114** that advantageously form a self-righting grip to a curved suture needle **116** (FIG. **2**) having a flattened surface **118** on its concave side. The lower jaw **112** has a proximal cylindrical portion **120** with a vertically and proximally open slot **122** formed therein to receive a proximal rocker portion **124** of the upper jaw **114** that is pinned by a small horizontal pin **125** therein for pivotal opening and closing of a distal end **126** toward the lower jaw **112**.

[0051] In particular, a distal end **127** of the lower jaw **112** has a cylindrical solid shape with an upper distal removed portion **128** to form a lower contact tray surface **130** into which a rectilinear ramped recess **132** is formed into which in turn a deeper but narrower rectilinear ramped recess **134** is formed. The distal end **126** of the upper jaw **114** has a width easily accommodated by the rectilinear ramped recess **132**. The distal end **126** of the upper jaw **114** has a downwardly projecting longitudinal squared off ridge **136** that has a width easily accommodated within the deeper but narrower rectilinear ramped recess **134**. Thus, the distal end **126** of the upper jaw **114** has a T-shape in transverse cross section that interacts with the recess **132** in the lower jaw **112** to tend to roll a loosely gripped suture needle **116** toward an upright position with an increased grip. This capability facilitates efficient suturing within the close confines of a HALS procedure. It should be appreciated that the recesses **132**, **134** and the ridge **136** may be curved surfaces rather than squared off. Any shape that allows a downwardly projecting portion to be within a recessed area would serve to orient a suture needle **16**.

[0052] A wing or band **138** of adhesive tape (e.g., cloth surgical tape) or hook loop material (e.g., VELCRO) provides a finger tip attachment portion to secure a curved upper, proximal surface **140** of a sled-shaped finger holder **142** to an undersurface and fingertip of the last digit of the index finger **12**. It should be appreciated that the wing or band **138** may be formed from various types of adjustable attachment means that would be acceptable for surgical use and that may securely grip the finger **12**. With particular reference to FIGS. **3-4**, In addition to being attachable to the finger **12** for movement, the finger holder **142** supports components that are moveably attached for closing the jaws **112**, **114** and for locking the jaws **112**, **114** closed. A distal snout **144** includes left and right distal mounting arms **146**, **148** separated by a vertical slot **150** that widens into a longitudinal, distally open cylindrical recess **152** that receives the proximal cylindrical portion **120** of the lower jaw **112**, secured by pin **125** received respectively through five holes **154-158** formed in the left distal mounting arm **146**, a left arm **160** of the proximal cylindrical portion **120**, the proximal rocker portion **124** of the upper jaw **114**, a right arm **162** of the proximal cylindrical portion **120**, and the right distal mounting arm **148**.

[0053] The proximal rocker portion **124** of the upper jaw **114** rotates up and down along with an upper end **164** of a closure link **166** pinned for pivoting movement on the right with an upper pin **168** through right and left holes **170**, **172** respectively. A lower end **174** of the closure link **166** pivots within a front vertical slot **176** formed in a curved underslung actuating member **178** received within an elongate recess **180** formed in the undersurface of the sled shaped finger holder **142**. Left and right front horizontal through holes **182**, **184** formed in the actuating member **178** communicate with the front vertical slot **176** to receive a front horizontal pin **186** that also passes through a bottom hole **188** in the lower end **174** of the closure link **166**. An aft end **190** of the underslung actuating member **178** has a proximal horizontal through hole **192** that is aligned with left and right proximal holes **194**, **196** (FIG. **4**) to pivotally receive a proximal horizontal pin **198**, the holes **194**, **196** formed in a U-shaped bracket **200** attached to a proximal underside of the sled shaped finger holder **142**.

[0054] A downwardly open spring recess **202** (FIG. **4**) formed in the elongate recess **180** in the sled-shaped finger holder **142** is aligned with an upwardly open spring recess **204** (FIG. **3**) formed in the curved underslung actuating member **178** to receive a compression spring **206** that urges the actuating member **178** away from the finger holder **142** when allowed, drawing the closure link **166** to open the upper jaw **114** (FIG. **6**). Closure and locking of the upper jaw **114** is effected by distal movement of a thumb slide **208**. In particular, the thumb slide **208** has a lower thumb slide button portion **210** attached to an upward arm **212** having a locking tip **214** extending distally from a top end. A shallow rectangular recess **216** (FIG. **4**) is sized to contact an upper surface of the low thumb slide button portion **210** allowing some longitudinal sliding. A rightwardly open aperture **218** longitudinally centered in the shallow rectangular recess **216** is sized to allow the upward arm **212** to move a like amount fore and aft with the locking tip **214** received within a downwardly open locking recess **220** formed within the elongate recess **180** in the sled-shaped finger holder **142**. A locking ramp **222** across a front portion of the locking recess **220** guides the locking tip

214 into locking engagement with the sled shaped finger holder **142** when distally positioned (FIG. **5**) to close and lock the upper jaw **114**. The locking tip **214** is released when the thumb slide **208** is proximally positioned (FIG. **6**).

[0055] It should be appreciated that the locking features may be reversed such that drawing the thumb slide aft effects closing and locking or that the upper jaw is locked open in addition to or as an alternative to locking closed. As another alternative, the jaws may be coupled to a lever to both pivot toward the other. As yet another alternative, the lever may translated one of the jaws toward the other with neither jaw being pivotally attached to the other, allowing for parallel orientation of the jaws.

[0056] In FIGS. **7-8**, an alternative fingertip surgical instrument ("extended end effector fingertip surgical instrument") **300** is depicted as having a grasper or scissor end effector **302** that is actuated at a desired distance from the index finger **12** via an elongate neck **304**. The index finger **12** is placed upon a finger holder **306** that is then held in place by a wing or band **308**. It should be appreciated that the wing or band **308** may be formed from various types of adjustable attachment means that would be acceptable for surgical use and that securely grip the finger **12**. A distally projecting neck cannula **310** extends from the finger holder **306**. An outer sheath **311** with inwardly beveled outer edges is attached to a distal opening of the neck cannula **310** and defines a distal bore **312** that communicates and is longitudinally aligned through a narrow neck opening **314** at a proximal end of the outer sheath **311**. The narrow neck opening **314** communicates and is longitudinally aligned with a proximal cylindrical spring cavity **316** defined by the neck cannula **310**. A lower longitudinal actuator slot **318** passes through the neck cannula **310** to communicate with the cylindrical spring cavity **316**.

[0057] An upper jaw **320** and lower jaw **322**, which may have gripping, cutting, scissoring or other surfaces, rotate about a shared jaw axle **324** to form an end effector **326** sized to fit at least partially within the distal bore **312**. A U-shaped clip spring **328** passes around the axle **324** and has an upper distal end attached to the upper jaw **320** and a lower distal end attached to the lower jaw **322** to bias the jaws **320**, **322** to an open position (FIG. **8**). A thumb slide actuator **330** has a thumb gripping portion **332** that underlies the finger holder **306** that is attached to a connecting portion **334** that moves within the lower longitudinal actuator slot **318** to a cylindrical portion **336** that is sized for movement within the proximal cylindrical spring cavity **316**. A reciprocating shaft **338** is shaped with a bullet-shaped distal end **340** recessed on each side of an axle hole **342** to receive the jaws **320**, **322** and to proximally ground against narrow neck opening **314** with a narrower rod **344** extending back through the cylindrical spring cavity **316** terminating in a screw portion **346** that is threaded into a threaded screw hole **348** in the cylindrical portion **336** of the thumb slide actuator **330**. A compression spring **350** encompasses the narrower rod **344** and grounds against a proximal side of the narrow neck opening **314** and a distal side of the cylindrical portion **336** of the thumb slide actuator **330**, creating a proximal bias on the end effector **326**. When the bias withdraws the end effector **326** into the outer sheath, the opening bias on the end effector **326** is overcome and the jaws **320**, **322** close (FIG. **7**). The outer sheath **311** is assembled last to retain this spring **350**. Distal movement of the thumb slide actuator **330** overcomes this bias to extend the end effector **326** out of the distal bore **312** to allow the end effector **326** to open (FIG. **8**). Thus, coordinated movement of the entire fingertip surgical instrument **300** and the thumb slide actuator **330** allows manipulation or severing of internal tissue.

[0058] It should be appreciated that the configuration of the alternative fingertip surgical instrument **300** is illustrative and that applications consistent with the present invention may be biased open in the unactuated position. In addition, rather than both jaws actuating, one jaw may be fixed. Further, rather than relying upon a spring bias to pivot the jaws in one direction relative to each other, applications consistent with the present invention may include affirmative coupling with an actuator to transfer actuating motion to both open and to close the end effector. It should be appreciated that for clarity a straight and vertically aligned end effector is depicted, but the orientation of the end effector in applications consistent with the invention may include curved, longitudinal rotary and/or articulating structures for positioning prior to insertion or to remotely position the end effector after insertion. Further, for simplicity a fixed length elongated neck is depicted, but it should be appreciated that an adjustable (e.g., telescoping) portion of the elongate neck may be incorporated to adjust either prior to insertion or after insertion to a desired distance from the fingertip. It should be appreciated that the trigger may instead be a pivoting actuator whose motion is converted to a longitudinal reciprocating motion. As yet another alternative, the actuator may be slid an outer sheath over a fixed grasping portion rather than moving the grasping portion.

[0059] Internal Liquid Dispensers: Markers. Applications of an internal liquid dispensing instrument suitable for a HALS procedure are numerous. For instance, a fingertip ink marker may be used as a training tool to mark anatomic features. Another example is use as a planning tool to show where to make incisions, the path to follow, to establish orientation, and to cut profiles for feature alignment. As yet another example is use as a landmark identifier to avoid having to spend time relocating a structure. In addition to dispensing a marking liquid, other significant applications exist for the precise application of liquids as part of a HALS procedure, such fluid dispensers principally for but not limited to adhesives and sealants, with the dispensing of any fluid or gel chemistry for the additional purpose of drug delivery, barrier/scaffolding/buttress, or sclerosing/necrosing of tissue, with the application being of a permanent or temporary (time limited) nature. Dispersants may be self-contained or used with external activation sources such as moisture, oxygen (air) or lack of heat, light, etc. Applications may be surface, tissue to tissue or tissue to device in nature. Adhesives may be activated by moisture, peel-liner, or other delivery approaches. Absorbability of an ink, adhesive or physical marker conveyed as flowable material may be advantageous in certain applications. Mechanical forms may include a biocompatible collagen that has a tissue adhering adhesive.

[0060] Versions of a fingertip surgical instrument described hereafter thus include a fingertip mounting structure to which is attached a fluid containing structure that is selectively actuated to expose a fluid, liquid or gel (e.g., marking, adhesive, therapeutic compound) that is biocompatible and efficacious for application to internal tissue in a HALS procedure.

[0061] Returning to the drawings, in FIG. **9**, yet an additional alternative fingertip surgical instrument ("extending inkpad fingertip instrument") **400** includes a porous cylindrical ink dispensing component **402** held within a distal bore **404** of an end effector nozzle **406** formed in a finger holder

408. A proximal, finger portion **410** encompasses a lower and distal portion of the index finger **12**, retained therein by a wing or band **412** attached to an upward, proximal surface **414** of the finger portion **410**. It should be appreciated that the wing or band **412** may be formed from various types of adjustable attachment means that would be acceptable for surgical use and that securely grip the finger **12**. A cylindrical diaphragm **416** is attached across a wider cavity **418** defined inside of the end effector nozzle **406** proximal to and communicating with the distal bore **404**. A plunger **420** has a proximal shaft **422** sized to closely fit for translation within the distal bore **404** and has a rounded head **424** that contacts the diaphragm **416** from the distal side. A compression spring **426** larger than the diameter of the distal bore **404** encompasses the proximal shaft **422**, urging the rounded head **424** proximally to position the diaphragm **416** into contact with the fingertip of the index finger **12**. A small diameter plug attachment rod **428** extends distally from the proximal shaft **422** terminating in a flathead **430** embedded within the porous cylindrical ink dispensing component **402**. Thus, when the end effector nozzle **406** is pressed against tissue, the fingertip of the index finger **12** depresses against the diaphragm **416**, distally advancing the plunger **420** while compressing the compression spring **426**, which in turn distally extends the porous cylindrical ink dispensing component **402** into contact with the internal tissue to impart a marking, adhesive and/or therapeutic effect, depending upon a flowable material absorbed by the ink dispensing component **402**.

[0062] In FIG. **10**, yet another alternative fingertip surgical instrument ("rollerball fingertip instrument") **500** has a roller ball end effector **502** that includes a cylindrical reservoir **504** with a roller ball or disk **506** held for rotation and exposing a distal portion **508** to paint flowable material **510** drawn from the reservoir onto internal tissue (not shown). A finger mounting portion **512** is proximally attached to the cylindrical reservoir **504** to contact at least an undersurface and fingertip of the index finger **12**, while a band or wing **514** attached to a proximal upward surface **516** of the finger mounting portion **512** retains the finger **12** in contact, accommodating a range of finger sizes. It should be appreciated that the wing or band **514** may be formed from various types of adjustable attachment means that would be acceptable for surgical use and that securely grip the finger **12**. Thus, swiping contact with tissue causes the roller ball **506** to deposit flowable liquid **510** onto internal tissue. If a roller disk **506** is selected, a castor attachment may allow the roller disk **506** to readily align with the direction of swiping contact.

[0063] In FIG. **11**, yet a further alternative fingertip surgical instrument ("sheathed marking fingertip instrument") **600** has a marking element (e.g., ink soaked porous elongate rod) **602** partially embedded into a cylindrical end effector tip **604** attached to a finger mounting structure **606** that partially encompasses an index finger **12**. It should be appreciated that the amount of flowable material may be augmented by a reservoir that communicates with the marking element **602** or may be limited to the quantity that the marking element **602** may absorb. A wing or band **608** attached to an upward, proximal surface **610** of the finger mounting structure **606** grips the finger **12**. It should be appreciated that the wing or band **608** may be formed from various types of adjustable attachment means that would be acceptable for surgical use and that securely grip the finger **12**. A horizontal gear axle **612** is attached to the finger mounting structure **606** below the cylindrical end effector tip **604** to support a vertically aligned spur gear **614**. An outer cylindrical sleeve **616** encompasses the cylindrical end effector tip **604**, longitudinally translating between a distal position encompassing the marking element **602** as shown and a proximal position exposing the marking element **602** depicted in phantom. A lower rack portion **618** formed on an exterior of the outer cylindrical sleeve **616** is in gear engagement to the spur gear **614**, which in turn is in gear engagement to an upwardly presented gear rack portion **620** formed on a distal portion of a thumb slide **622**, coupled for longitudinal translation to the finger mounting structure **606**. Thus, distal movement of the thumb slide **622** causes the marking element **602** to be exposed for use. It should be appreciated that other mechanizations that tend to extend the marking element **602** or to withdraw a shielding component may be used consistent with aspects of the invention, to include but are not limited to a lever, flattening an arcuate member, etc.

[0064] In FIG. **12**, an additional alternative fingertip surgical instrument ("direct coupled sheath marking fingertip instrument") **700** has a marking element **702** partially embedded into a distally open cylindrical receptacle **704** of a thumb actuator **706**. The marking element **702** may be manually drawn out of the receptacle **704** prior to use to expose a suitable portion, adjusting for the available longitudinal length of the marking element **702**, especially for a marking element **702** that is mechanically rubbed off or dissolved by fluid. Alternatively, the marking element may comprise a porous structure that allows a flowable material retained therein to dispense upon contact. The cylindrical receptacle **704** translates within a distally open cylindrical end effector nozzle **708** that is attached to a finger mounting structure **710** that partially encompasses an index finger **12**. A wing or band **712** attached to an upward, proximal surface **714** of the finger mounting structure **710** grips the finger **12**. It should be appreciated that the wing or band **712** may be formed from various types of adjustable attachment means that would be acceptable for surgical use and that securely grip the finger **12**. A lower longitudinal slot **716** along at least a proximal portion of the end effector nozzle **708** allows longitudinal movement of a connecting arm **718** that connects the receptacle **704** to a thumb contacting surface **720**, forming the actuator **706**. Distal movement of the actuator **706** exposes the marking element **702** for use distal to the end effector nozzle **708** (shown in phantom) and proximal movement of the actuator **706** hides the marking element **702** as depicted.

[0065] In FIG. **13**, yet another alternative fingertip surgical instrument ("convex porous tip dispensing fingertip instrument") **800** has a marking element **802** containing flowable material which is enclosed within a dispensing end effector **804**. In particular, an outer cap **806** of the end effector **804** has a convex porous portion **808**, which in the illustrative version is composed of a resilient material for deflection under a force exerted by a fingertip, and is presented centrally on an otherwise flat circular end **810**, which in turn is attached to a distal cylindrical side wall **812** that transitions to a slightly smaller diameter proximal cylindrical side wall **814**, presenting an internal locking lip **816** at the transition. A distally open cylindrical bore **818** of the end effector **804** has a diameter to closely fit within the proximal cylindrical side wall **814** and presents an outer locking lip **820** at its distal end that locks inside distal to the internal locking lip **816**. A finger holder **822** is proximally attached to the distally open cylindrical bore **818** and partially encompasses an index finger **12**. A wing or band **824**, attached to an upward, proximal surface

826 of the finger holder 822, grips the finger 12. It should be appreciated that the wing or band 824 may be formed from various types of adjustable attachment means that would be acceptable for surgical use and that securely grip the finger 12. A spring post 828 extends distally from the finger holder 822 centered within the distally open cylindrical bore 818. A plunger 830 has a cylindrical side wall 832 sized to closely fit but translate within the distally open cylindrical bore 818 and spanned by a transverse seat disk 834 defining a shallow distal recess 836 that receives a smaller diameter base 838 of the marking element 802 that is otherwise sized to translate within the distally open cylindrical bore 818. The transverse seat disk 834 of the plunger 830 also defines a deeper proximal spring cavity 840 that receives a distal end of a compression spring 842 whose proximal end is received around the spring post 828. The spring biased plunger 830 maintains the marking element 802 in contact with an inner surface of the convex porous portion 808 of the outer cap 806 so that under cooperative deflection of the convex porous portion 808 that flowable material is forced out for application to internal tissue.

[0066] Internal Liquid Dispensing: Encapsulated Liquids. Some flowable materials to be dispensed may advantageously be encapsulated in ampoules or similar structures to preserve their properties until dispensing (e.g., a moisture or oxygen activated or two-part adhesive). An illustrative list of adhesives is contained in U.S. patent application Ser. No. 10/359,699 "Applicators, Dispensers And Methods For Dispensing And Applying Adhesive Material" to Goodman et al., filed 7 Feb. 2003, now published as U.S.2004/0190975A1 on 30 Sep. 2004, the disclosure of which is hereby incorporated by reference in its entirety.

[0067] In FIG. 14, another alternative fingertip surgical instrument ("pushed ampoule dispensing fingertip instrument") 900 has an ampoule 902 with distal scorings 904 whose proximal end is received within a distal recess 906 in a cylindrical pusher 908 of a thumb actuator 910. The cylindrical pusher 908 translates within a cylindrical end effector tube 912 that is attached to a finger holder 914 that partially encompasses an index finger 12. A wing or band 916 attached to an upward, proximal surface 918 of the finger holder 914 grips the finger 12. It should be appreciated that the wing or band 916 may be formed from various types of adjustable attachment means that would be acceptable for surgical use and that securely grip the finger 12. A lower longitudinal slot 920 along at least a proximal portion of the end effector tube 912 allows longitudinal movement of a connecting arm 922 that connects the pusher 908 to a thumb contacting surface 924, forming an actuator 926. A nozzle cap 928 has a wide diameter proximal ring 930 that fits over a distal portion of the end effector tube 912. The nozzle cap 928 includes a central bulbous portion 932 distally attached to the wide diameter proximal ring 930 and is sized to have an internal cavity 934 that continues the diameter of the end effector tube 912. A converging nozzle tip 936 is distally attached to the central bulbous portion 932. A spike member 938 internally received in the nozzle tip 936 extends an upper piercing arm 940 and a slightly shorter lower piercing arm 942 proximally toward the ampoule 902 in the internal cavity 934. It should be appreciated that the spike member 938 allows a longitudinal flow between the internal cavity 934 and an external orifice 944 of the nozzle tip 936. Distal movement of the actuator 926 impales the ampoule 902 upon the piercing arms 940, 942 of the spike member 938, filling the internal cavity 934 distal to the ampoule 902. Continued distal movement (shown in phantom) of the actuator 926 reduces the volume of the internal cavity 934, expelling the flowable material contents out of the external orifice 944 onto internal tissue.

[0068] In FIGS. 15-16, yet a further alternative fingertip surgical instrument ("bottom ampoule crushing dispensing fingertip instrument") 1000 has an ampoule 2 with an outer frangible elongate shell 1004 containing a flowable material 1006. The ampoule 1002 is contained within an elongate nozzle bulb 1008 have a converging nozzle orifice 1010 distally oriented. A finger holder 1012 receives and encompasses a distal and lower surface of an index finger 12, retained therein by a wing or band 1014 that is attached to a proximal upward surface 1016 of the finger holder 1012. It should be appreciated that the wing or band 1014 may be formed from various types of adjustable attachment means that would be acceptable for surgical use and that securely grip the finger 12. An end effector support portion 1018, having a uniform inverted U-shaped transverse cross section (FIG. 16) extends distally from the finger holder 1012 to encompass each side of the elongate nozzle bulb 1008 except distally and underneath. A U-shaped bracket 1020 extends below a proximal end of the finger holder 1012 to receive a proximal pivoting end 1022 of an actuator 1026 horizontally pinned therein by a pin 1024. A central portion 1028 of the actuator 1026 has a lower contour shaped for a thumb to rotate the actuator 1026 upwardly, resisted by a vertical compression spring 1030 whose top end is received in a downwardly open spring receptacle 1032 formed in the finger holder 1012 and an aligned upwardly open spring receptacle 1034 formed in the central portion 1028 of the actuator 1026. A distal portion 1036 of the actuator 1026 has a generally triangular vertical cross section (FIG. 15) and is laterally sized to closely fit for upward translation within the end effector support portion 1018. A top, proximal corner 1038 of a ramped surface 1040 of the distal portion 1036 initially makes nondeforming contact at an aft lower point on the elongate nozzle bulb 1008. Left, center and right upward bumps 1042, 1043, 1044 (FIG. 16) formed on the ramped surface 1040 initially make nondeforming contact to a longitudinal midpoint underneath the elongate nozzle bulb 8 respectively on a left, center and right side. It should be appreciated that upward actuation of the actuator 1026 causes the bumps 1042-1044 to fracture the elongate shell 1004 of the ampoule 1002 as the ramped surface 1040 progressively collapses a proximal portion of the elongate nozzle bulb 1008 to expel the flowable material 1006 out of the converging nozzle orifice 1010 until proximity with the end effector support portion 1018 and finger holder 1012 arrests further actuation.

[0069] In FIG. 17, yet an additional alternative fingertip surgical instrument ("rocker bottom ampoule crushing dispensing fingertip instrument") 1100 has an ampoule 1102 with a frangible elongate shell 1104 containing a flowable material 1106. The ampoule 1102 is contained within an elongate nozzle bulb 1108 have a converging nozzle orifice 1110 distally oriented. A finger holder 1112 receives and encompasses a distal and lower surface of an index finger 12, retained therein by a wing or band 1114 that is attached to a proximal upward surface 1116 of the finger holder 1112. It should be appreciated that the wing or band 1114 may be formed from various types of adjustable attachment means that would be acceptable for surgical use and that securely grip the finger 12. An end effector support portion 1118, having a uniform inverted U-shaped transverse cross section

extends distally from the finger holder **1112** to encompass each side of the elongate nozzle bulb **1108** except distally and underneath. A U-shaped bracket **1120** extends below a proximal end of the finger holder **1112** to receive a proximal pivoting end **1122** of an actuator **1126** horizontally pinned therein by a pin **1124**. A central portion **1128** of the actuator **1126** has a lower contour shaped for a thumb to rotate the actuator **1126** upwardly, resisted by a vertical compression spring **1130** whose top end is received in a downwardly open spring receptacle **1132** formed in the finger holder **1112** and an aligned upwardly open spring receptacle **1134** formed in the central portion **1128** of the actuator **1126**. A distal portion of the actuator **1126** is a curved upward bar portion **1136** laterally sized to closely fit for upward translation within the end effector support portion **1118**. A linearly-moved contact member **1137** has a rectangular plate surface **1140** whose midpoint rests upon the bar portion **1136** of the actuator **1126**. A downturned flange **1144** at a top, proximal corner **1138** of the rectangular plate surface **1140** abuts a distal vertical, transverse surface of the downwardly open spring receptacle **1132** of the finger holder **1112**. One or more upward bumps **1143** laterally arrayed across a longitudinal midpoint of the rectangular plate surface **1140** of the linearly-moved contact member **1137** are initially in nondeforming contact with a midpoint of an undersurface of the elongate nozzle bulb **1108**. It should be appreciated that upward actuation of the actuator **1126** causes the linearly-moved contact member **1137** to move upwardly, maintaining a slight downward cant of its distal edge, causing bump(s) **1143** to fracture the elongate shell **1104** of the ampoule **1102** as the rectangular plate surface **1140** progressively collapses a proximal portion of the elongate nozzle bulb **1108** to expel the flowable material **1106** out of the converging nozzle orifice **1110** until proximity with the end effector support portion **1118** and finger holder **1112** arrests further actuation. Thus, the contact member **1137** linearly guided by the structure of the finger holder **1112** converts the rotation movement from the distal end **1136** of the actuator **1126** so that an optimized orientation of breaking and compressive contact may be imparted to the elongate nozzle bulb **1108** and ampoule **1102** throughout a desired distance of translation, even for a distal end **1136** that substantially changes its angular orientation.

[0070] In FIGS. **18-20**, another alternative fingertip surgical instrument ("two-step ampoule crushing dispensing fingertip instrument") **1200** has an ampoule **1202** with a frangible elongate shell **1204** containing a flowable material **1206**. The ampoule **1202** is contained within an elongate nozzle bulb **1208** having a converging nozzle orifice **1210** distally oriented. A finger holder **1212** receives and encompasses a distal and lower surface of an index finger **12**, retained therein by a wing or band **1214** that is attached to a proximal upward surface **1216** of the finger holder **1212**. It should be appreciated that the wing or band **1214** may be formed from various types of adjustable attachment means that would be acceptable for surgical use and that securely grip the finger **12**. An end effector support portion **1218**, having a uniform inverted U-shaped transverse cross section extends distally from the finger holder **1212** to encompass each side of the elongate nozzle bulb **1208** except distally and underneath. A U-shaped bracket **1220** extends below a proximal end of the finger holder **1212** to receive a proximal rod-shaped pivoting end **1222** of an actuator **1226**. A central portion **1228** of the actuator **1226** has a lower contour shaped for a thumb to rotate the actuator **1226** upwardly (FIG. **18**), then distally (FIG. **19**), followed by more upward motion (FIG. **20**) to sequentially rupture the ampoule and then to dispense the flowable material **1206** in a controlled rate. An angled compression spring **1230** has a top end attached to the finger holder **1212** proximal to a downward grounding flange **1232** extending from a finger shaped portion **1233** of the finger holder **1212**. An upwardly and distally angled spring post **1234** formed in the central portion **1228** of the actuator **1226** receives a bottom end of the compression spring **1230** and aims toward the attachment of the top end of the compression spring **1230**. A distal portion **1236** of the actuator **1226** has a vertical foot shape laterally sized to closely fit for upward translation within the end effector support portion **1218** and a slightly downwardly canted upper surface **1235**. A crush detent step **1239** is formed on an upper transition between the distal portion **1236** and the central portion **1228** of the actuator **1226**. A linearly-moved actuator member **1237** has a rectangular plate surface **1240** whose midpoint rests upon the bar portion **1236** of the actuator **1226**. A downturned proximal flange **1244** at a top, proximal corner of the rectangular plate surface **1240** abuts a distal vertical, transverse surface presented by the downward grounding flange **1232** of the finger holder **1212**. Thus, the structure of the finger holder **1212** guides the actuator member **1237** for linear movement to present an optimized breaking and contact surface to the nozzle bulb **1208** and ampoule **1202** through the rotational movement of the distal portion **1136** of the actuator **1126**. A downturned distal flange **1245** from a top, distal corner of the rectangular plate surface **1240** resides in front of the distal portion **1236** of the actuator **1226**. One or more upward bumps **1243** laterally arrayed across a longitudinal midpoint of the rectangular plate surface **1240** of the linearly-moved actuator member **1237** are initially in nondeforming contact with a midpoint of an undersurface of the elongate nozzle bulb **1208** (FIG. **18**). Upward actuation of the actuator **1226** causes the linearly-moved actuator member **1237** to move upwardly, causing bump(s) **1243** to fracture the elongate shell **1204** of the ampoule **1202**. The downturned grounding flange **1232** then contacts the crush detent step **1239**, preventing any significant reduction in the volume of the elongate nozzle bulb **1208** (FIG. **19**). When dispensing is then desired in the ensuing moments, the actuator **1226** may be distally moved slightly and then upwardly depressed to progressively collapse the elongate nozzle bulb **1208** to expel the flowable material **1206** out of the converging nozzle orifice **1210** (FIG. **20**).

[0071] In FIGS. **21-24**, an alternative fingertip surgical instrument ("necked ampoule applier") **1300** receives a necked ampoule **1302** (FIG. **24**) having a nozzle neck **1304** surrounded by a thick walled distal disk **1306** attached to an elongate capsule wall **1308** to form a reservoir **1310**. For a dual chemical flowable material, in FIG. **24**, the reservoir **1310** has a neck plug **1312** that seals off the nozzle neck **1304** and a fragile bifurcating barrier **1314** that separates a first flowable material **1316** from a second flowable material **1318**. For a single chemical/mixture **1320**, in FIG. **25**, a necked ampoule **1302'** has a reservoir **1310'** filled with a single fragile neck barrier **1322'** plugging a nozzle neck **1304'**, such as at a distal orifice end **1324'**.

[0072] In FIGS. **21-23**, an ampoule cavity **1326** sized for the necked ampoule **1302** is formed within an end effector block **1328**. The ampoule cavity **1326** provides a distal circular nozzle surface **1330** against which the thick walled distal disk **1306** of the necked ampoule **1302** grounds and

provides a centered nozzle hole **1332** in the nozzle surface **1330** through which the nozzle neck **1304** of the necked ampoule **1302** extends. A plunger passage **1334** communicates horizontally from a proximal direction through the end effector block **1328** to communicate with the ampoule cavity **1326**. A rod plunger **1336** having a distal plunger end **1338** extends through the plunger passage **1334**, initially in nondeforming contact with a proximal end of the necked ampoule **1302**. A proximal plunger end **1340** of the rod plunger **1336** extends proximally out of the plunger passage **1334** of the end effector block **1328** a distance at least the longitudinal width of the necked ampoule **1302** (FIGS. **21-22**). Both a lower end **1342** of an upper scissor link **1344** and an upper end **1346** of a lower scissor link **1348** are pivotally attached by a center rivet **1350** to the proximal plunger end **1340**. An upper end **1352** of the upper scissor link **1344** is pivotally attached to a midpoint of an upper finger holder **1354** by an upper rivet **1356**. A lower end **1358** of the lower scissor link **1348** is pivotally attached at a midpoint to a lower thumb actuator **1360** by a lower rivet **1362**. Proximal ends **1364**, **1366** of the upper finger holder **1354** and the lower thumb actuator **1360** are pivotally attached at about a longitudinal midpoint of the end effector block **1328** by a horizontal axle attachment **1368** (FIG. **21**), forming an acute angle with one another bisected by the rod plunger **1336**. Actuation of the upper finger holder **1354** and the lower thumb actuator **1360**, as depicted in FIG. **23**, causes the scissor links **1344**, **1348** to rotate more toward the horizontal, translating the rod plunger **1336** distally, compressing the ampoule **1302** in a fashion to rupture the neck plug **1312** that seals off the nozzle neck **1304** and the fragile bifurcating barrier **1314** and to expel the flowable materials **1316**, **1318** from the reservoir **1310** of FIG. **24** or to open the distal orifice end **1324'** of the necked ampoule **1302'** of FIG. **25**.

[0073] In FIGS. **26-31**, yet another alternative fingertip surgical instrument ("two-component fingertip adhesive dispenser") **1400** includes an end effector dispenser **1402** that internally mixes a portion of a first flowable material **1404** with a portion of a second flowable material **1406** for extended dispensing (FIG. **27**). With particular reference to FIG. **26**, dispensing is effected by squeezing an upper finger holder **1408** toward a lower thumb actuator **1410**, both being distally, pivotally attached to the end effector dispenser **1402** (not shown). The motion is transferred to left and right rod plungers **1412**, **1413** (FIG. **27**) that extend proximally out of the end effector dispenser **1402**. In particular, an upper end **1414** of an upper scissor link **1416** is pivotally attached to a midpoint of the upper finger holder **1408** by an upper rivet **1418**. A lower end **1420** of the upper scissor link **1416** is pivotally attached to proximal ends **1422**, **1423** of the left and right rod plungers **1412**, **1413** by a center elongate rivet **1424**. An upper end **1426** of a lower scissor link **1428** is also pivotally attached to the proximal ends **1422**, **1423** of the rod plungers **1412**, **1413** by the center elongate rivet **1424**. A lower end **1430** of the lower scissor link **1428** is pivotally attached at a midpoint of the lower thumb actuator **1410** by a lower rivet **1432**.

[0074] With particular reference to FIGS. **27-29**, the first flowable material **1404** is contained within a left collapsible, generally cylindrical bladder **1434** sized to fit within a first cylindrical cavity **1436** formed within a left proximal cylindrical vessel **1438** of the end effector dispenser **1402**. A left proximal solid portion **1440** of the left proximal cylindrical vessel **1438** includes a left rod passage **1442** which is longitudinally defined and receives the left rod plunger **1412** and has a left distal opening **1444** also longitudinally defined. A left cylindrical disk plunger **1446**, laterally sized for the diameter of the first cylindrical cavity **1436**, is retained within a proximal end **1448** aft of accordion sidewalls **1450** of the collapsible, generally cylindrical bladder **1434**. A left generally cylindrical spike **1452** is attached to a longitudinal center of a distal surface **1454** of the left cylindrical disk plunger **1444** with a left sharp tip **1456** distally aimed longitudinally toward the left distal opening **1444** to pierce a distal wall **1458** of the bladder **1434**. Three longitudinal aligned, radially spaced channel recesses **1460** (FIG. **29**) formed along the length of the left generally cylindrical spike **1452** allow fluid material **1404** to flow out of the left cylindrical vessel **1438** into a left distal manifold chamber **1462** (FIG. **31**).

[0075] The second flowable material **1406** is contained within a right collapsible, generally cylindrical bladder **1464** sized to fit within a second cylindrical cavity **1466** formed within a right proximal cylindrical vessel **1468** of the end effector dispenser **1402**. A right proximal solid portion **1470** of the right proximal cylindrical vessel **1468** includes a right rod passage **1472** that is longitudinally defined and receives the right rod plunger **1413** and has a right distal opening **1474** also longitudinally defined. A right cylindrical disk plunger **1476**, laterally sized for the diameter of the second cylindrical cavity **1466**, is retained within a proximal end **1478** aft of accordion sidewalls **1480** of the collapsible, generally cylindrical bladder **1464**. A right generally cylindrical spike **1482** is attached to a longitudinal center of a distal surface **1484** of the right cylindrical disk plunger **1476** with a right sharp tip **1486** distally aimed longitudinally toward the right distal opening **1474** to pierce a distal wall **1488** of the bladder **1464**. Three longitudinal aligned, radially spaced channel recesses **1490** (FIG. **29**) formed along the length of the right generally cylindrical spike **1482** allow fluid material **1406** to flow out of the right cylindrical vessel **1468** into a right distal manifold chamber **1492** (FIG. **31**).

[0076] When the upper finger holder **1408** and lower thumb actuator **1410** are depressed toward each other as depicted in FIG. **30**, the first fluid material **1404** is pushed out of the left distal manifold chamber **1462** through left inward holes **1494** into a central nozzle cavity **1496** and the second fluid material **1406** is pushed out of the left distal manifold chamber **1492** through right inward holes **1498** into the central nozzle cavity **1496**. As the fluid materials **1404**, **1406** are pushed toward a nozzle orifice **1500**, a nozzle tube **1502** that defines the central nozzle cavity **1496** narrows. A proximal horizontal pin **1504**, then a proximal vertical pin **1506**, then a distal horizontal pin **1508**, and finally a distal vertical pin **1510** pass through a longitudinal centerline of the nozzle tube **1502**, longitudinally spaced from one another proximal to distal and alternatingly perpendicular to adjacent pins, to enhance turbulent, mixing interaction between the flowable materials **1404**, **1406**.

[0077] It should be appreciated that any patent, publication, or other disclosure material, in whole or in part, that is said to be incorporated by reference herein is incorporated herein only to the extent that the incorporated material does not conflict with existing definitions, statements, or other disclosure material set forth in this disclosure. As such, and to the extent necessary, the disclosure as explicitly set forth herein supersedes any conflicting material incorporated herein by reference. Any material, or portion thereof, that is said to be incorporated by reference herein, but which conflicts with

existing definitions, statements, or other disclosure material set forth herein will only be incorporated to the extent that no conflict arises between that incorporated material and the existing disclosure material.

[0078] While the present invention has been illustrated by description of several embodiments and while the illustrative embodiments have been described in considerable detail, it is not the intention of the applicants to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications may readily appear to those skilled in the art.

[0079] For example, in addition to a roller ball or porous dispensing component or swab, liquid dispensing may be enhanced by adding other types of applicator tips (e.g., polymer loop, a spatula, a rolling ball, a grate, and a brush.

What is claimed is:

1. A fingertip-mounted minimally invasive surgical instrument comprising:
- a first jaw comprising a concave contacting surface;
- a second jaw comprising a convex contacting surface;
- a finger mounting portion supporting the first and second jaws; and
- a finger actuated member supported for movement by the finger mounting portion and connected to a selected one of a group consisting of the first and second jaw to effect closure to a spacing sufficient to orient and grip a suture needle.

2. The fingertip-mounted minimally invasive surgical instrument of claim **1**, wherein the finger actuated member comprises a pivotally attached lever connected via a link to a proximal pivot portion of the selected one of the first and second jaw, the other one of the first and second jaw attached to the finger mounting portion.

3. The fingertip-mounted minimally invasive surgical instrument of claim **2**, further comprising a locking member attached for movement to a selected one of a group consisting of the finger mounting portion and the lever to selectively engage the other one to maintain the jaws in a closed state.

4. The fingertip-mounted minimally invasive surgical instrument of claim **3**, wherein the locking member comprises a thumb slide having a slide portion positioned to slide along a selected surface of the lever and having a locking tip connected to the slide portion positioned to reciprocate within a recess in the finger mounting portion that terminates in a locking recess.

5. A fingertip-mounted minimally invasive surgical instrument comprising:
- a finger mounting portion;
- pair of pivotally attached jaws;
- an elongate neck spacing the pair of pivotally attached jaws from the finger mounting portion; and
- a finger actuated member coupled for movement to the finger mounting portion and to the pair of pivotally attached jaws to effect opening and closing of the pair.

6. The fingertip-mounted minimally invasive surgical instrument of claim **5**, further comprising:
- a clip spring attached to the pair of pivotally attachment jaws imparting an opening bias; and
- an elongate outer sheath attached to the finger mounting portion and encompassing the elongate neck that is connected between the pivotal attachment between the jaws and the finger actuated member;
- wherein the finger actuated member is positionable distally to extend the pair of jaws out of the sheath for opening and proximally to draw a portion of the jaws into the sheath for closing.

7. A fingertip-mounted minimally invasive surgical instrument comprising:
- a pair of grasping jaws;
- a finger mounting portion supporting the first and second jaws;
- a finger actuated member supported for movement by the finger mounting portion operable to open and to close the jaws; and
- a locking member positionable to maintain the finger actuated member in a selected one of a group consisting of a jaws open state and a jaws closed state.

8. The fingertip-mounted minimally invasive surgical instrument of claim **7**, wherein the locking member comprises a thumb slide having a slide portion positioned to slide along a selected surface of the lever and having a locking tip connected to the slide portion positioned to reciprocate within a recess in the finger mounting portion that terminates in a locking recess.

9. The fingertip-mounted minimally invasive surgical instrument of claim **8**, wherein the finger actuated member is attached for pivotal movement toward the finger actuated member to effect the selected state, the locking recess holding the lever proximate to the finger actuated member when engaged.

* * * * *

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申请(专利权)人(译)	VOEGELE JAMESW GILL ROBERT P 投票WAYNE大号		
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摘要(译)

公开了一种可用于手助腹腔镜手术的微创手术器械。该装置是多功能手术器械，其可以直接安装在外科医生的指尖上并通过切口插入以允许外科医生在外科手术期间操纵组织。版本显示了自动复位缝合针夹持器和具有双枢转夹爪（例如，抓紧器，切割器）的形式，其具有细长颈部以增强器械的触及范围。此外，致动的指尖器械的细长颈部增强了通过单个切口可到达的范围。