Office de la Propriété Intellectuelle du Canada
Un organisme d'Industrie Canada

Canadian Intellectual Property Office
An agency of Industry Canada

CA 2829818 A1 2012/09/20

(21) 2 829 818

(12) DEMANDE DE BREVET CANADIEN
CANADIAN PATENT APPLICATION

(13) A1

(86) Date de dépôt PCT/PCT Filing Date: 2012/03/13
(87) Date publication PCT/PCT Publication Date: 2012/09/20
(85) Entrée phase nationale/National Entry: 2013/09/10
(86) N° demande PCT/PCT Application No.: US 2012/028899
(87) N° publication PCT/PCT Publication No.: 2012/125621
(30) Priorité/Priority: 2011/03/15 (US13/048,559)

(51) Cl.Int./Int.Cl. *A61B 17/064* (2006.01), *A61B 17/072* (2006.01), *A61B 17/12* (2006.01), *A61B 17/128* (2006.01)

(71) Demandeur/Applicant:
ETHICON ENDO-SURGERY INC., US

(72) Inventeurs/Inventors:
SCHEIB, CHARLES J., US;
SHANKARSETTY, JEEVAN M., IN

(74) Agent: NORTON ROSE FULBRIGHT CANADA LLP/S.E.N.C.R.L., S.R.L.

(54) Titre : AGRAFEUSES CHIRURGICALES
(54) Title: SURGICAL FASTENER INSTRUMENTS

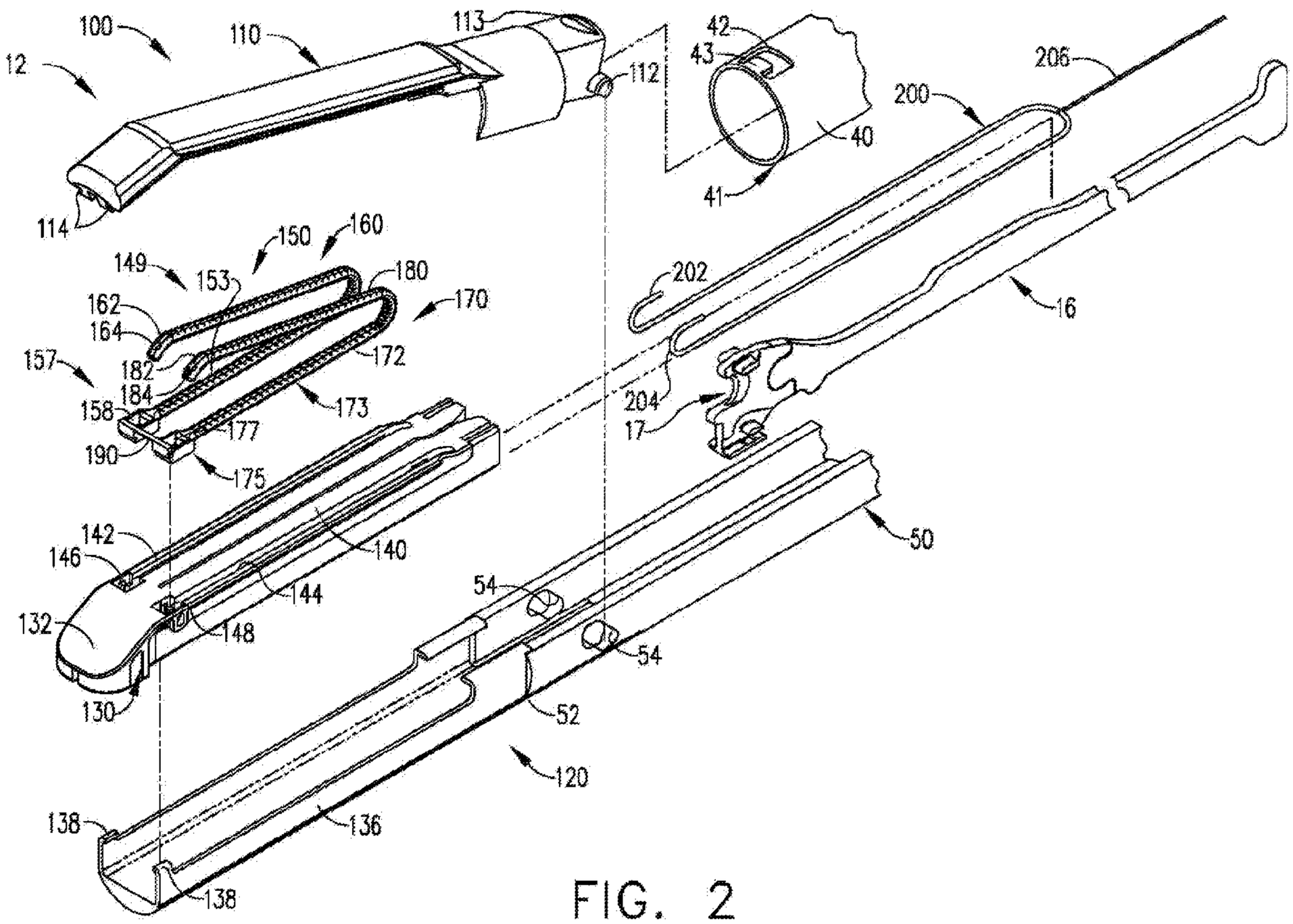

FIG. 2

(57) Abrégé/Abstract:
Surgical instruments and cartridges for cutting and fastening tissues and organs such as vessels are disclosed. In various non-limiting forms, the surgical instrument includes a first jaw that operably supports a substantially flexible elongated tissue closure assembly therein. A second jaw is movably supported relative to the first jaw and is selectively movable between open and closed positions in response to opening and closing motions applied thereto. A closure retraction assembly is configured to selectively apply cinching motions to the substantially flexible elongated tissue closure assembly.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
20 September 2012 (20.09.2012)

WIPO | PCT

(10) International Publication Number
WO 2012/125621 A1

(51) International Patent Classification:
A61B 17/064 (2006.01) *A61B 17/12* (2006.01)
A61B 17/072 (2006.01) *A61B 17/128* (2006.01)

(21) International Application Number:
PCT/US2012/028899

(22) International Filing Date:
13 March 2012 (13.03.2012)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
13/048,559 15 March 2011 (15.03.2011) US

(71) Applicant *(for all designated States except US)*: **ETHICON ENDO-SURGERY, INC.** [US/US]; 4545 Creek Road, Cincinnati, OH 45242 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **SCHEIB, Charles, J.** [US/US]; 11329 Donwiddle Drive, Loveland, OH 45140 (US). **SHANKARSETTY, Jeevan, M.** [IN/IN]; #15/2, 5th 'c' Cross, 3rd Block, Nandini, Layout, Bangalore 560096 (IN).

(74) Agents: **JOHNSON, Philip, S.** et al.; Johnson & Johnson, One Johnson & Johnson Plaza, New Brunswick, NJ 08933 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: SURGICAL FASTENER INSTRUMENTS

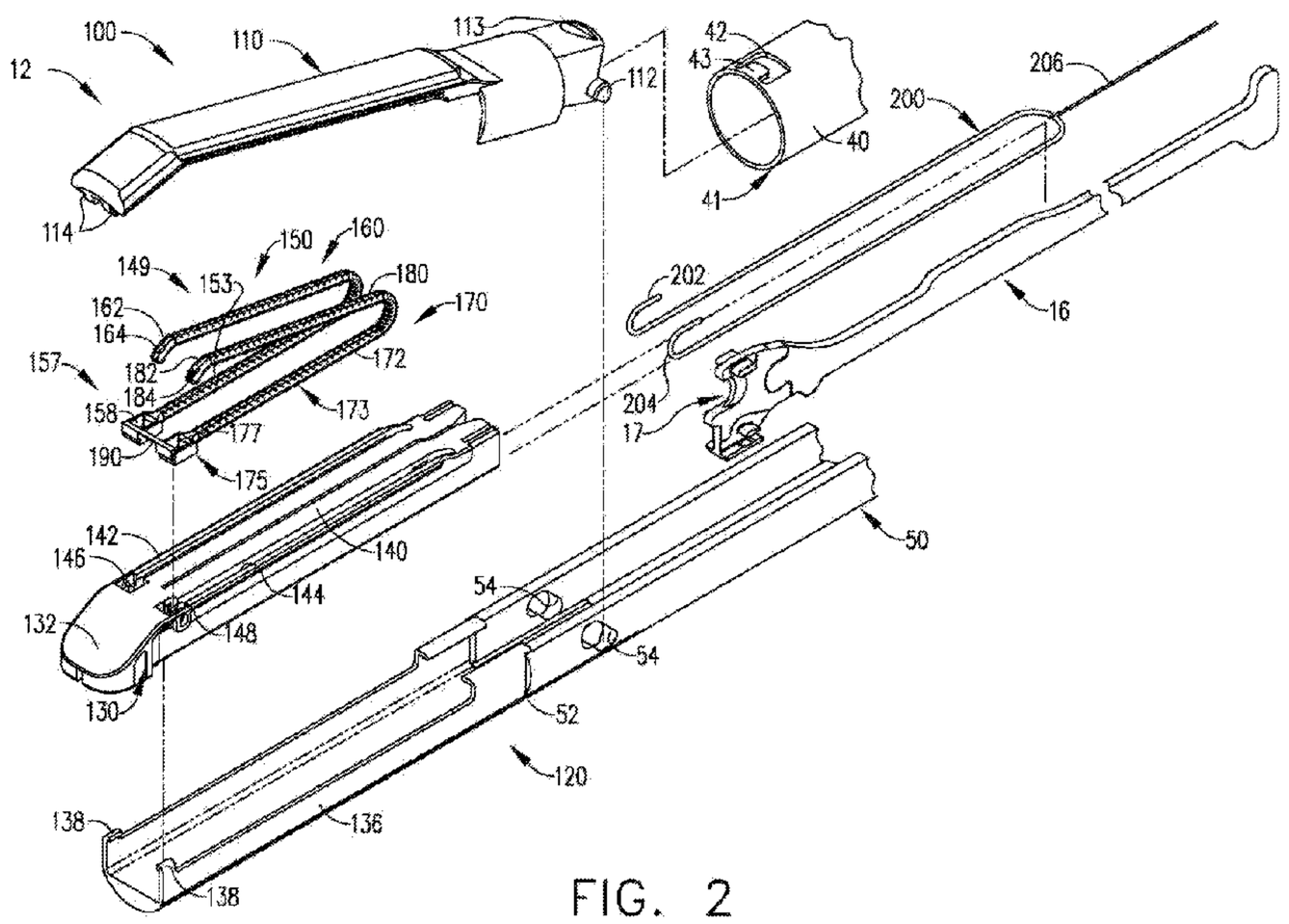

FIG. 2

(57) Abstract: Surgical instruments and cartridges for cutting and fastening tissues and organs such as vessels are disclosed. In various non- limiting forms, the surgical instrument includes a first jaw that operably supports a substantially flexible elongated tissue closure assembly therein. A second jaw is movably supported relative to the first jaw and is selectively movable between open and closed positions in response to opening and closing motions applied thereto. A closure retraction assembly is configured to selectively apply cinching motions to the substantially flexible elongated tissue closure assembly.

WO 2012/125621 A1

WO 2012/125621 A1

Declarations under Rule 4.17:

— *as to the identity of the inventor (Rule 4.17(i))*

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

TITLE

SURGICAL FASTENER INSTRUMENTS

BACKGROUND

Technical Field

[0001] The present invention relates to surgical instruments and, in various embodiments, to surgical cutting and fastening instruments for cutting and fastening tissue and organs such as vessels and the like.

Background

[0002] Surgical staplers have been used to simultaneously make a longitudinal incision in tissue and apply lines of staples on opposing sides of the incision. Such instruments commonly include a pair of cooperating jaw members that, if the instrument is intended for endoscopic or laparoscopic applications, are capable of passing through a cannula passageway. One of the jaw members receives a staple cartridge having at least two laterally spaced rows of staples. The other jaw member defines an anvil that has staple-forming pockets aligned with rows of unformed staples supported in the cartridge. Examples of such devices are disclosed in U.S. Patent No. 7,000,818, entitled "Surgical Stapling Instrument Having Separate Distinct Closing and Firing Systems", issued February 21, 2006, the disclosure of which is herein incorporated by reference in its entirety. Other surgical cutting and stapling instruments employ what is commonly referred to as a "disposable loading unit" or "DLU". Such devices support a staple cartridge and a fresh knife in the form of a "unit" that is configured to be operably attached to the surgical stapling instrument. The units are designed to be discarded after the staples have been fired. Examples of such instruments are disclosed in U.S. Patent No. 5,865,361 entitled "Surgical Stapling Apparatus", issued February 2, 1999, the entire disclosure of which is herein incorporated by reference.

[0003] In use, a clinician is able to close the jaw members of the stapler upon tissue to position the tissue prior to firing. Once the clinician has determined that the jaw members are properly gripping tissue, the clinician can then fire the surgical stapler, thereby severing and stapling the tissue. The simultaneous severing and stapling avoids complications that may arise when performing such actions sequentially with different surgical tools that respectively only sever or staple.

[0004] Current methods of vascular transection employ one of the above-described endocutter devices to apply staples to achieve hemostasis. However, the staples punch through the vessel during their formation which thereby increases the possibility of a leak and also prolongs the healing time. Such leaks which emanate from the transection site can at times be difficult to locate.

[0005] Accordingly, there is a need for surgical staple cartridge arrangements that address many of the challenges discussed above.

[0006] The foregoing discussion is intended only to illustrate some of the shortcomings present in the field of the invention at the time, and should not be taken as a disavowal of claim scope.

SUMMARY

[0007] In accordance with general aspects of at least one form, there is provided a surgical fastening instrument that includes a first jaw that operably supports a substantially flexible elongated tissue closure assembly therein. A second jaw is movably supported relative to the first jaw and is selectively movable between open and closed positions in response to opening and closing motions applied thereto. A closure retraction assembly is configured to selectively apply cinching motions to the substantially flexible elongated tissue closure assembly.

[0008] In accordance with other general aspects of at least one form, there is provided a fastener cartridge for cutting and occluding a vessel. In at least one form, the fastener cartridge comprises a body portion that has a deck face and a centrally disposed slot therein for receiving a cutting member of a surgical instrument therethrough. The deck face is configured to operably support a pair of substantially flexible elongated closure members wherein one member is supported on a first side of the centrally disposed slot and the other member is disposed on a second side of the slot. A closure retraction assembly is at least partially operably supported in the body portion and is configured to selectively apply cinching motions to each of the substantially flexible elongated closure members.

[0009] In accordance with still other general aspects of at least one form, there is provided a closure assembly for use with a surgical fastener cartridge that has a closure retraction assembly therein. In at least one form, the closure assembly comprises a first absorbable closure member that has a first lower elongated portion that is supportable on a portion of the fastener cartridge. The first absorbable closure member has a first locking end that defines a first locking aperture.

The first absorbable closure member further has a first upper elongated portion that is integrally formed with the first lower elongated portion. The first closure member further has a first hook-shaped end that is supported in spaced relation to the first locking end. The closure assembly further includes a second absorbable closure member that has a second lower elongated portion that is supportable on another portion of the fastener cartridge and has a second locking end that defines a second locking aperture. The second absorbable closure member has a second upper elongated portion that is integrally formed with the second lower elongated portion and has a second hook-shaped end that is supported in spaced relation to the first locking end. A bridge member couples the first absorbable closure member and the second absorbable closure member in spaced relation to each other.

BRIEF DESCRIPTION OF DRAWINGS

[0010] The above-mentioned and other features and advantages of this invention, and the manner of attaining them, will become more apparent and the invention itself will be better understood by reference to the following description of embodiments of the invention taken in conjunction with the accompanying drawings, wherein:

[0011] FIG. 1 is a side view of one form of a non-limiting surgical cutting and fastening instrument embodiment;

[0012] FIG. 2 is a partial exploded assembly view of a non-limiting end effector embodiment;

[0013] FIG. 3 is a perspective view one form of a non-limiting end effector embodiment supporting a portion of a vessel therein;

[0014] FIG. 4 is a cross-sectional view of a portion of the end effector of FIG. 3;

[0015] FIG. 5 is a perspective view of one form of a non-limiting closure assembly embodiment;

[0016] FIG. 5A is a perspective view of the closure assembly of FIG. 5 in a clinched position;

[0017] FIG. 5B is another perspective view of the closure assembly of FIGS. 4 and 5A with a lock end thereof shown in cross-section to illustrate the pointed locking tabs in locking engagement with the suture slits to retain the suture in a cinched position;

[0018] FIG. 6 is another perspective view of the end effector embodiment of FIG. 3 in a partially closed orientation;

[0019] FIG. 7 is a cross-sectional view of a portion of the end effector of FIG. 6;

[0020] FIG. 8 is another perspective view of the end effector of FIGS. 3 and 6 in a clamped orientation and after the sutures have been cinched around portions of the vessel clamped therein;

[0021] FIG. 9 is a cross-sectional perspective view of the end effector depicted in FIG. 8;

[0022] FIG. 10 is another cross-sectional view of the end effector depicted in FIG. 8;

[0023] FIG. 11 is another cross-sectional view of the end effector depicted in FIG. 10 wherein the first jaw has been moved to an open position;

[0024] FIG. 12 is a perspective view of one form of another non-limiting closure assembly embodiment;

[0025] FIG. 13 is a perspective view one form of a non-limiting end effector embodiment operably supporting a wound closure assembly embodiment and a portion of a vessel therein;

[0026] FIG. 14 is a perspective view the end effector of FIG. 13 in a clamped orientation;

[0027] FIG. 15 is a cross-sectional perspective view of the end effector of FIG. 14;

[0028] FIG. 16 is another cross-sectional view of the end effector of FIGS. 14 and 15;

[0029] FIG. 17 is another cross-sectional view of the end effector of FIGS.14-16 after the wound closure devices have been retracted and the firing bar has cut through the vessel;

[0030] FIG. 18 is another cross-sectional view of the end effector depicted in FIG. 17 wherein the first jaw has been moved to an open position; and

[0031] FIG. 19 is a perspective view of one form of another non-limiting end effector embodiment

DETAILED DESCRIPTION

[0032] The Applicant of the present application also owns U.S. Patent Application entitled "Surgical Staple Cartridges With Tissue Tethers For Manipulating Divided Tissues and Methods of Using Same", Attorney Docket No. END6867USNP/100553, which was filed on even date herewith and which is herein incorporated by reference in its entirety.

[0033] Certain exemplary embodiments will now be described to provide an overall understanding of the principles of the structure, function, manufacture, and use of the devices and methods disclosed herein. One or more examples of these embodiments are illustrated in the

accompanying drawings. Those of ordinary skill in the art will understand that the devices and methods specifically described herein and illustrated in the accompanying drawings are non-limiting exemplary embodiments and that the scope of the various embodiments of the present invention is defined solely by the claims. The features illustrated or described in connection with one exemplary embodiment may be combined with the features of other embodiments. Such modifications and variations are intended to be included within the scope of the present invention.

[0034] Reference throughout the specification to "various embodiments," "some embodiments," "one embodiment," or "an embodiment", or the like, means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment. Thus, appearances of the phrases "in various embodiments," "in some embodiments," "in one embodiment", or "in an embodiment", or the like, in places throughout the specification are not necessarily all referring to the same embodiment. Furthermore, the particular features, structures, or characteristics may be combined in any suitable manner in one or more embodiments. Thus, the particular features, structures, or characteristics illustrated or described in connection with one embodiment may be combined, in whole or in part, with the features structures, or characteristics of one or more other embodiments without limitation. Such modifications and variations are intended to be included within the scope of the present invention.

[0035] The terms "proximal" and "distal" are used herein with reference to a clinician manipulating the handle portion of the surgical instrument. The term "proximal" referring to the portion closest to the clinician and the term "distal" referring to the portion located away from the clinician. It will be further appreciated that, for convenience and clarity, spatial terms such as "vertical", "horizontal", "up", and "down" may be used herein with respect to the drawings. However, surgical instruments are used in many orientations and positions, and these terms are not intended to be limiting and/or absolute.

[0036] Various exemplary devices and methods are provided for performing laparoscopic and minimally invasive surgical procedures. However, the person of ordinary skill in the art will readily appreciate that the various methods and devices disclosed herein can be used in numerous surgical procedures and applications including, for example, in connection with "open" surgical procedures. As the present Detailed Description proceeds, those of ordinary skill in the art will

further appreciate that the various instruments disclosed herein can be inserted into a body in any way, such as through a natural orifice, through an incision or puncture hole formed in tissue, etc. The working portions or end effector portions of the instruments can be inserted directly into a patient's body or can be inserted through an access device such as a trocar that has a working channel through which the end effector and elongated shaft of a surgical instrument can be advanced.

[0037] Turning to the Drawings wherein like numerals denote like components throughout the several views, FIG. 1 depicts one embodiment of a surgical instrument 10 that is capable of practicing various unique benefits of at least one form of the present invention. As shown in FIG. 1, in one non-limiting form, the surgical instrument 10 generally includes a handle portion 30 that is connected to an implement portion 12, the latter further comprising a shaft assembly 14 distally terminating in an end effector 100. The shaft assembly 14 includes a movable closure tube assembly 40 that is axially movable on a spine 50 that extends from the handle portion 30 to be coupled to the end effector 100. As shown in FIG. 1, the shaft assembly 14 does not include an articulation joint for facilitating articulation of the end effector relative to a longitudinal axis A-A defined by the shaft assembly 14. In other non-limiting embodiments, the shaft assembly 14 may include at least one articulation joint for facilitating the articulation of the end effector relative to the longitudinal axis. In this and other non-limiting embodiments, the shaft assembly 14 may operably interface with the handle portion 30 such that the end effector 100 may be selectively rotated about the longitudinal axis A-A. As the present Detailed Description proceeds, it will become apparent that the unique and novel features of various non-limiting embodiments of the present invention may be effectively employed with a variety of different surgical instruments that employ different handle and shaft arrangements. For example, various portions of the instrument 10 may be identical to portions of the surgical instruments disclosed in U.S. Patent No. 7,000,818, entitled "Surgical Stapling Instrument Having Separate Distinct Closing and Firing Systems", the disclosure of which is herein incorporated by reference in its entirety. Thus, the construction and operation of the components of instrument 10 that are not needed to understand the various embodiments and forms of the present invention will not be specifically discussed herein.

[0038] In at least one non-limiting embodiment, the end effector 100, in general, comprises a pair of "jaws" 110, 120 that are configured to cut and fasten the ends of the severed tissue such

as, for example, a vessel. However, while the various non-limiting embodiments disclosed herein are particularly well adapted for cutting and occluding vessels, the various embodiments of the present invention could conceivably be effectively employed to cut and fasten other forms of tissue. As will be discussed in further detail below, jaw 120 supports a tissue fastening cartridge 130 that operably supports a tissue closure assembly 149. See FIG. 2. The instrument 10 includes a firing bar 16 which generally has a sharpened tissue-cutting edge or blade member 17 on a distal portion thereof. As the firing bar 16 is driven distally through the shaft assembly 14 and distally through the vessel fastening cartridge, the tissue-cutting edge severs the tissue clamped between the jaws 110, 120.

[0039] In the non-limiting embodiment depicted in FIG. 1, the handle portion 30 is fashioned with a pistol grip 34. A closure trigger 36 is pivotally mounted to the handle portion 30 and operably interfaces with the closure tube assembly 40 to effectuate axial movement thereof on the spine member 50. As the closure trigger 36 is pivotally drawn by the clinician towards the pistol grip portion 34, the closure tube assembly 40 is driven in the distal direction to interact with jaw 120 to cause clamping or closing thereof toward the tissue fastening cartridge 130. The handle portion 30 further supports a firing trigger 38 that is outboard of the closure trigger 36. The firing trigger 38 operably interfaces with the firing bar 16. The firing bar 16 is driven distally when the closure trigger 36 and is pivotally drawn by the clinician towards the pistol grip 34. As the firing bar 16 is driven distally through the tissue fastening cartridge 130, the clamped tissue is severed.

[0040] As can be seen in FIGS. 4, 7, 10, and 11, in various non-limiting embodiments, the tissue fastening cartridge 130 is supported on a distal end portion 52 of the spine 50 or it may be supported in an elongated channel that is coupled to the spine 50. The tissue fastening cartridge 130 comprises a cartridge body 132 that may be molded from, for example, a polymer material and be provided with a centrally disposed slot 134 that is configured to operably receive the distal end 17 of the firing bar 16 therein as the firing bar 16 is driven therethrough. The cartridge body 132 may be affixed to the distal end 52 of the spine 50 by a U-shaped cartridge tray 136 that extends around the distal end 52 of the spine 50 and retainingly interfaces with the cartridge body 132. For example, the cartridge body 132 may snappingly interface with snap detents 138 on the cartridge tray 136.

[0041] In various non-limiting embodiments, the tissue fastening cartridge 130 is configured to operably support a flexible elongated tissue closure assembly, generally designated as 149. As can be seen in FIG. 5, in at least one form, the tissue closure assembly 149 includes a pair of interlinked suture strips 150 and 170. The flexible elongated tissue closure assembly 149 includes a first suture strip 150 that has an elongated first body portion 152 that is substantially U-shaped. The first suture strip 150 may be fabricated from a bioabsorbable material and include a first elongated lower portion 153 that terminates in a first lock end 157. The first suture strip 150 further has a first upper portion 160 that terminates in a first hook end 162. Each of the first lower and upper portions 153, 160 has a plurality of slits 154 therein that facilitates the bending and cinching of the suture strip 150 as will be discussed in further detail below. The first lock end 157 defines a first locking cavity 158 that is configured to receive the first hook end 162 therethrough.

[0042] The tissue closure assembly 149 further includes a second suture strip 170 that has a second elongated body portion 172 that is substantially U-shaped. The second suture strip 170 may also be fabricated from a bioabsorbable material and include a second elongated lower portion 173 that terminates in a second lock end 175. The second suture strip 170 further has a second upper portion 180 that terminates in a second hook end 182. Each of the second lower and upper portions 173, 180 has a plurality of slits 174 therein that facilitate the bending and cinching of the second suture strip 170 as will be discussed in further detail below. The second lock end 175 defines a second locking cavity 177 that is configured to receive the second hook end 182 therethrough. The second suture strip 170 may be linked to the first suture strip150 with a bridge member 190 that links the lock ends 157, 175 together.

[0043] FIGS. 5A and 5B further illustrate the tissue closure assembly 149 with each of the suture strips 150, 170 in a cinched orientation. As indicated above, the first suture strip 150 has a plurality of slits 154 therein and the second suture strip 170 has a plurality of slits 174 formed therein. When working on thin walled vessels such as pulmonary veins which are very delicate, any projections on the strips 150, 170 may inadvertently puncture the vessel or otherwise cause trauma. As can be most particularly seen in FIG. 5B, for example, the slits 174 (and likewise, slits 154) are provided at an angle so that when the sutures 150, 170 are cinched, they form a relatively smooth inner surface for compressing the vessel. As can also be seen in FIG. 5B, the lock end 175 may be formed with at least one and preferably a pair of offset pointed locking tabs

178, 179 that are configured to engage the slits 174 on opposing sides of the suture 170 during the cinching process to lock the suture 170 in position. It will be understood that the first lock end 150 is formed with similar pointed locking tabs (not shown).

[0044] The cartridge body 132 has a deck face 140 that is in confronting relationship with the underside of jaw 110. The deck face 140 has a first closure-receiving groove 142 for supporting the first lower suture portion 153 and a second closure-receiving groove 144 for supporting the second lower suture portion 173. See FIG. 2. In addition, a first locking receptacle 146 is provided in the cartridge body 132 for receiving the first lock end 157 therein and a second locking receptacle 148 is provided for receiving the second lock end 175 therein as shown.

[0045] In various non-limiting embodiments, jaw 110 is selectively movable relative to jaw 120 to clamp a vessel "V" or other tissue therebetween. Jaw 110 is pivotally coupled to the spine 50 by a pair of trunions 112 that extend through elongated trunion slots 54 formed in the spine 50, allowing the jaw 110 to pivot from an open position to a closed position relative to jaw 120 in response to opening and closing motions received from the closure tube assembly 40. As can be seen in FIGS. 2, 3, 6, and 8-11, the distal end 41 of the closure tube assembly 40 includes a horseshoe aperture 42 and tab 43 for engaging an opening tab 113 on jaw 110. When the closure tube assembly 40 is advanced distally on the end effector frame 50, the horseshoe aperture 42 applies a closing motion to the tab 113 to move the jaw 110 toward jaw 120. When the closure tube assembly 40 is withdrawn in the proximal direction, the tab 43 engages the tab 113 to move jaw 110 away from jaw 120 to an open position. In various embodiments, the jaw 110 further has a pair of closure- retaining slots 114 therein for supporting the first upper suture portion 160 and the second upper suture portion 180 therein.

[0046] As can be seen in FIG. 9, the surgical instrument 10 further includes a closure retraction assembly 200. In various non-limiting embodiments, the closure retraction assembly 200 includes a first retraction hook 202 and a second retraction hook 204 that extend from a central actuation member 206. The retraction hooks 202, 204 may be fabricated from a suitable metal or other material and the central actuation member 206 may be fabricated from similar material. The central actuation member 206 extends through a longitudinal passage (not shown) in the spine 50 and interfaces with a retraction actuator 210 that is operably supported on the handle portion 30. The retraction actuator 210 may, for example, comprise a pivot member that is attached to or otherwise operably communicates with the central actuation member 206 such that

by pivoting the retraction actuator 210 in the "A" direction (FIG. 1), the closure retraction assembly 200 will be pulled in the proximal direction "PD" (FIG. 9). As can be most particularly seen in FIG. 5, the first hook end 162 of the first suture strip 150 has a hook-receiving hole 164 therethrough that is adapted to be hookingly engaged by the first retraction hook 202 of the closure retraction assembly 200. Similarly, the second hook end 182 of the second suture strip 170 has a hook-receiving hole 184 therethrough that is adapted to be hookingly engaged by the second retraction hook 204 of the closure retraction assembly 200.

[0047] Operation of the surgical instrument 10 will now be described with reference to FIGS. 1, 3, 4 and 6-11. In use, the end effector 100 is introduced into the patient adjacent the vessel "V" to be cut and fastened. The end effector 100 may, for example, be introduced into the patient through a cannula of a trocar that has been installed in the patient. The end effector may also be inserted through an open incision in the patient as well. Once the end effector has been placed into the patient adjacent the vessel "V", jaw 110 is pivoted to the open position using the closure trigger 36 (FIG. 1). The clinician then manipulates the open end effector such that the vessel "V" is positioned between the jaws 110, 120 such that the vessel "V" is located between the upper suture portions 160, 180 and their corresponding lower suture portions 153, 173 supported on the cartridge deck face 140. See FIGS. 3 and 4.

[0048] Once the vessel "V" is received between the upper and lower suture portions 160, 180 as shown in FIGS. 3 and 4, the clinician can start to pivot the closure trigger 36 towards the pistol grip portion 34 of the handle portion 30 (FIG. 1) to advance the closure tube assembly 40 in the distal direction "DD". As the distal end 41 of the closure tube assembly 40 moves distally, it initially contacts the tab 113 on jaw 110. Continued movement of the closure tube assembly 40 in the distal direction "DD" moves jaw 110 distally relative to jaw 120 until the trunions 112 reach the top end of the trunion slots 54. Further distal movement of the closure tube assembly 40 causes the distal end 41 of the closure tube assembly 40 to slide distally over the tab 113 on jaw 110 such that the tab 113 is received within the horseshoe aperture 42 in the closure tube assembly 40. See FIG. 6. Such movement of the closure tube assembly 40 forces jaw 110 to pivot towards jaw 120. Such axial and pivotal travel of jaw 110 causes the suture hook ends 162, 182 to move into registration with the locking cavities 158, 177, respectively. Thereafter, the clinician pivots the retraction actuator 210 in the "A" direction (FIG. 1) to pull the closure retraction assembly 200 in the proximal direction "PD" (FIG. 9). Such movement of the closure

retraction assembly 200 causes the first retraction hook 202 to hookingly engage the hook-receiving hole 164 of the first suture 150 and the second retraction hook 204 to hookingly engage the hook-receiving hole 184 of the second suture 170. Further pivotal travel of the retraction actuator 210 pulls the suture hook ends 162, 182 to cinch the sutures 150, 170 about the vessel "V" on opposite sides of the knife slot 134 in the cartridge body 132. The pointed locking tabs in each of the lock ends 157, 175 lock the sutures 150, 170 in position as was discussed above.

[0049] After the clinician has cinched the sutures 150, 170 about the vessel "V" on each side of the knife slot 134, the clinician then pivots the closure trigger 36 to the fully closed position wherein it is releasably locked using known locking structures. Such movement of the closure trigger 36 to the fully closed position causes jaw 110 to clamp the vessel "V" between the jaws 110, 120. Thereafter, the clinician advances the firing bar 16 distally by activating the firing trigger 38 or other actuator arrangement to thereby drive the tissue-cutting edge on the distal end 17 of the firing bar 16 through knife slot 134 in the cartridge body 132 an ultimately through the vessel "V". As the distal end 17 of the firing bar 16 is advanced distally through the end effector, the distal end may interact with the first jaw 110 to retain it in the clamped position as it cuts through the vessel. Such action cuts the vessel between the two cinched sutures 150, 170. The distal end of the firing bar 16 must then be withdrawn out of the end effector to enable the clinician to move jaw 110 to the open position and thereby release the cut vessel "V" therefrom.

[0050] After the vessel "V" has been cut to create a first occluded vessel end "V1" and a second occluded vessel end (not shown), the firing bar 16 is retracted. In various embodiments, for example, the firing trigger 28 springedly returns when the clinician removes pressure. Such action causes the retraction of the firing bar 16 in the proximal direction. Other firing bar retraction and retraction arrangements are known and may be employed. In the embodiment depicted in FIG. 1, a release button 31 interacts with the closure trigger such that when the release button is depressed, the closure trigger 36 is unlocked. The closure trigger 36 may be spring biased to return it to the starting position once it has been unlocked. Movement of the closure trigger 36 to the starting position causes the retraction of the closure tube assembly 40 in the proximal direction "PD". Such movement of the closure tube assembly 40 causes the tab 43 to contact the tab 113 on jaw 110 to move it to the initial starting or open position. See FIG. 11.

[0051] Once jaw 110 has been returned to the open position, the bridge 190 extending between the first and second sutures 150, 170 retains the first and second occluded vessel ends together to

enable them to be inspected. Once the clinician has inspected the occluded vessel ends, the first and second sutures 150, 170 are cut to detach them from their respective closure retraction hooks 202, 204, respectively. If desired, the clinician may also cut the bridge 190 to separate the occluded ends of the vessel. Thereafter, the end effector 100 may be withdrawn from the patient. If the clinician wishes to reuse the device 10, the clinician must first remove the hook ends 156 and 176 from the previously used closure assembly 149 from their respective retraction hooks 202, 204 and return the retraction hooks 202, 204 to their respective starting positions in the cartridge body 132 (FIG. 4). A closure assembly 149 is then installed into the cartridge body 132 (Fig. 3). Thereafter, the instrument 10 may again be reused.

[0052] FIGS. 12-18 illustrate the use of the device 10 in connection with another form of a flexible elongated tissue closure assembly 149'. As can be most particularly seen in FIG. 12, the closure assembly 149'comprises a first absorbable closure member 310 that has a body portion 312 that has a plurality of unidirectional barbs 314 formed thereon. The closure assembly 149' further includes a second absorbable closure member 330 that has a body portion 332 that has a plurality of unidirectional barbs 334 formed thereon. The first and second closure members 310, 330 may be fabricated from those wound closure devices manufactured by Covidien of Mansfield, Massachusetts under the trademark V-Loc™. As can be further seen in FIG. 12, the body portion 312 of the first closure member 310 has a first elongated lower portion 316 that terminates in a first lock end 318 wherein the end 315 is looped around and welded to form a first locking loop 320. The first closure member 310 further has a first elongated upper portion 322 that is integrally formed with the first elongated lower portion 316 and has a first hook-shaped end 324. The first hook-shaped end 324 terminates in a welded first distal loop 326 that extends through the first locking loop 320. Similarly, the body portion 332 of the second closure member 330 has a second elongated lower portion 336 that terminates in a second lock end 338 wherein the end 335 is looped around and welded to form a second locking loop 340. The second closure member 330 further has a second elongated upper portion 342 that is integrally formed with the second elongated lower portion 336 and has a second hook-shaped end 344. The second hook-shaped end 344 terminates in a welded second distal loop 346 that extends through the second locking loop 340. In various embodiments, the locking loops 320, 340 are attached to an absorbable bridge 350.

[0053] The flexible elongated tissue closure assembly 149'may be installed into the cartridge body 132 in the manner described above with respect to the closure assembly 149. In this embodiment, however, jaw 110' which is otherwise substantially identical to jaw 110 described above has two downwardly projecting lateral fins 115 to provide further support to the first and second closure members 310, 330. See FIGS. 13 and 14.

[0054] Operation of the instrument 10 with the flexible elongated tissue closure assembly 149' can be understood with reference to FIGS. 13-18. FIG. 13 depicts the end effector 100 after it has been introduced into the patient and the vessel "V" has been acquired between the jaws 110' and 120. The clinician then starts to pivot the closure trigger 36 towards the pistol grip portion 34 of the handle 30 (FIG. 1) to advance the closure tube assembly 40in the distal direction "DD". As the distal end 41 of the closure tube assembly 40 moves distally, it initially contacts the tab 113 on jaw 110'. Continued movement of the closure tube assembly 40 in the distal direction "DD" moves jaw 110' distally relative to jaw 120 until the trunions 112 reach the top end of the trunion slots 54. Further distal movement of the closure tube assembly 40 causes the distal end 41 of the closure tube assembly 40 to slide distally over the tab 113 on jaw 110' such that the tab 113 is received within the horseshoe aperture 42 in the closure tube assembly 40. See FIG. 14. Such movement of the closure tube assembly 40 forces jaw 110' to pivot towards jaw 120. Such axial and pivotal travel of jaw 110' causes the hooked portions 320, 340 and more particularly the distal loops 322, 342 to move into registration with the respective locking loops 318, 328. Thereafter, the clinician pivots the retraction actuator 210 in the "A" direction (FIG. 1) to pull the closure retraction assembly 200 in the proximal direction "PD" (FIG. 15). Such movement of the closure retraction assembly 200 causes the first retraction hook 202 to hookingly engage the distal loop 322 of the first closure member 310 and the second retraction hook 204 to hookingly engage the second distal loop 342 of the second closure member 330. Further pivotal travel of the retraction actuator 210 pulls the hook ends 202, 204 to cinch the closure members 310, 330 about the vessel "V" on opposite sides of the knife slot 134 in the cartridge body 132.

[0055] After the clinician has cinched the wound closure members 310, 330 about the vessel "V" on each side of the knife slot 134, the clinician then pivots the closure trigger 36 to the fully closed position wherein it is releasably locked using known locking structures. Such movement of the closure trigger 36 to the fully closed position causes jaw 110' to clamp the vessel "V"

between jaws 110', 120. See FIG. 16. Thereafter, the clinician advances the firing bar 16 distally by activating the firing trigger 38 or other actuator arrangement to thereby drive the tissue-cutting edge on the distal end of the firing bar 16 through knife slot 134 in the cartridge body 132 an ultimately through the vessel "V".

[0056] After the vessel "V" has been cut to create a first occluded vessel end "V1" and a second occluded vessel end (not shown), the firing bar 16 is retracted. The clinician may then move jaw 110' to the open position shown in FIG. 18. The bridge 150 extending between the first and second closure members 310, 330 retains the first and second occluded vessel ends together for inspection. Once the clinician has inspected the occluded ends, the first and second closure members 310, 330 are cut to detach them from their respective retraction hooks 202, 204, respectively. If desired, the clinician may also cut the bridge 350 to separate the occluded ends of the vessel. Thereafter, the end effector 100 may be withdrawn from the patient. If the clinician wishes to reuse the device 10, the clinician must first remove the looped ends 322, 342 from their respective retraction hooks 202, 204 and return the retraction hooks 202, 204 to their respective starting positions in the cartridge body 132 (FIG. 15). A new closure assembly 149' is then installed into the cartridge body 132. Thereafter, the instrument 10 may again be reused.

[0057] FIG. 19 illustrates another end effector embodiment 100" that may be used in connection with the instrument 10. This non-limiting embodiment employs a fastener cartridge 400 that is configured to also deploy a single line of surgical staples on each side of the vessel cut line. A variety of surgical staple cartridge arrangements are known. For example, U.S. Patent No. 7,000,818 which has been herein incorporated by reference, discloses various forms of surgical staple cartridges. The cartridge 400 of various embodiments of the present invention may be substantially similar to those cartridges or other known staple cartridges except for the differences noted below. For example, in addition to a first row 404 of staple openings 406 located in the cartridge body 402 on the first side 403 of the elongated knife slot 408 and a second row of 410 of staple openings 412 on the second side 414 of the elongated knife slot 408, the cartridge body 402 is also configured as described above to operably support one of the closure assemblies 149, 149' in the manners described above.

[0058] Jaw 110" of the end effector 100" is substantially similar to the jaws 110, 110' as described above, except that the jaw 110" also is configured to act as an anvil for forming the staples supported within the cartridge 400. For example, the undersurface of jaw 110" is

provided with two series of staple forming pockets that register with the corresponding staple openings in the cartridge body 402 when the jaw 110" is pivoted and locked into the clamping position. Such staple forming pockets serve to form the staples as they driven through the vessel "V" in a known manner.

[0059] The end effector 100" may also be used/activated in a similar manner as was described above with respect to the end effectors 100, 100'. For example, the clinician manipulates jaw 110" in the above described manners to acquire the vessel "V" as shown in FIG. 19. Jaw 110" is then locked into clamping position and the clinician may then actuate the retraction actuator 210 to cinch the sutures or closure members which ever the case may be. When the clinician then actuates the firing bar 16 to move distally, the firing bar 16 will not only cut the through the vessel, the firing bar also causes the staples that are operably supported in the staple pockets to be driven out of the staple pockets into the corresponding staple forming pockets provided in the underside of jaw 110". For example, as described in U.S. Patent No. 7,000,818, the staples may be operably supported on staple driver members that are movably supported in each of the staple pockets in the cartridge body. As the distal end portion of the firing bar 16 is driven distally into the cartridge body 402, it interacts with a wedge sled movably supported therein. As the wedge sled is distally advanced through the cartridge body 402 by the firing bar 16, the staple drivers are forced upward within their respective pockets to thereby drive out the staples support thereon out of the pocket and into forming contact with the underside of jaw 110" and ultimately through the cut ends of the vessel. Thus, the occluded ends of the vessel are not only sealed with a suture or wound closure device, they are also sealed with a line of staples.

[0060] The non-limiting embodiments described herein have been described in the context of surgical instrument arrangements that are handheld and manually operated or actuated. Those of ordinary skill in the art will readily understand that the unique and novel features of the various non-limiting embodiments of the present invention disclosed may also be effectively attained in applications wherein the closure devices used to open and close the jaws as well as those control arrangements for activating the firing bar and suture actuation members may be controlled by a robot or robots or by other automated system arrangements. Accordingly, the protection afforded to the various non-limiting embodiments disclosed herein should not be limited to instruments that are handheld and/or are manually operated. Further, the various non-limiting embodiments disclosed herein may be affectively employed with surgical instrument

arrangements that are powered (e.g., by electricity, pneumatics, fluids, etc.) and that may or may not be handheld and that may or may not be manually actuated or actuated by robots or other automated control system arrangements. The various embodiments of the present invention disclosed herein are intended to encompass such modifications.

[0061] The devices disclosed herein can be designed to be disposed of after a single use, or they can be designed to be used multiple times. In either case, however, the device can be reconditioned for reuse after at least one use. Reconditioning can include any combination of the steps of disassembly of the device, followed by cleaning or replacement of particular pieces, and subsequent reassembly. In particular, the device can be disassembled, and any number of the particular pieces or parts of the device can be selectively replaced or removed in any combination. Upon cleaning and/or replacement of particular parts, the device can be reassembled for subsequent use either at a reconditioning facility, or by a surgical team immediately prior to a surgical procedure. Those skilled in the art will appreciate that reconditioning of a device can utilize a variety of techniques for disassembly, cleaning/replacement, and reassembly. Use of such techniques, and the resulting reconditioned device, are all within the scope of the present application.

[0062] Preferably, the invention described herein will be processed before surgery. First, a new or used instrument is obtained and if necessary cleaned. The instrument can then be sterilized. In one sterilization technique, the instrument is placed in a closed and sealed container, such as a plastic or TYVEK bag. The container and instrument are then placed in a field of radiation that can penetrate the container, such as gamma radiation, x-rays, or high-energy electrons. The radiation kills bacteria on the instrument and in the container. The sterilized instrument can then be stored in the sterile container. The sealed container keeps the instrument sterile until it is opened in the medical facility.

[0063] 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 materials 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.

[0064] While this invention has been described as having exemplary designs, the present invention may be further modified within the spirit and scope of the disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the invention using its general principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains.

What is claimed is:

1. A surgical fastening instrument, comprising:

a first jaw operably supporting a substantially flexible elongated tissue closure assembly therein;

a second jaw movably supported relative to said first jaw and being selectively movable between open and closed positions in response to opening and closing motions applied thereto; and

a closure retraction assembly configured to selectively apply cinching motions to said substantially flexible elongated tissue closure assembly.

2. The surgical fastening instrument of claim 1 wherein said substantially flexible elongated tissue closure assembly comprises:

a first absorbable suture; and

a second absorbable suture.

3. The surgical fastening instrument of claim 2 wherein said first and second absorbable sutures are linked together by a absorbable bridge member.

4. The surgical fastening instrument of claim 2 wherein said first absorbable suture comprises a first substantially U-shaped flexible first body portion terminating in a first locking end that defines a first locking aperture and a first hooked-shaped end spaced from said first locking aperture and in substantial registration therewith and wherein said second absorbable suture comprises a second substantially U-shaped flexible second body portion terminating in a second locking end that defines a second locking aperture and a second hooked-shaped end spaced from said second locking aperture and in substantial registration therewith.

5. The surgical fastening instrument of claim 4 wherein said closure retraction assembly comprises:

a first retraction hook that is movably supported for selective hooking engagement with said first hooked-shaped end after said first hook-shaped end has been advanced through said first locking aperture; and

a second retraction hook that is movably supported for selective hooking engagement with said second hooked shaped end after said second hook-shaped end has been advanced through said second locking aperture.

6. The surgical instrument of claim 1 wherein said substantially flexible elongated tissue closure assembly comprise:

a first absorbable closure member having a plurality of unidirectional barbs thereon; and

a second absorbable closure member having a plurality of unidirectional barbs thereon.

7. The surgical fastening instrument of claim 6 wherein said first and second absorbable closure members are linked together by a absorbable bridge member.

8. The surgical fastening instrument of claim 6 wherein said first absorbable closure member comprises a first substantially U-shaped flexible first body portion terminating in a first locking end that defines a first locking aperture and a first hooked-shaped end spaced from said first locking aperture and in substantial registration therewith and wherein said second absorbable closure member comprises a second substantially U-shaped flexible second body portion terminating in a second locking end that defines a second locking aperture and a second hooked-shaped end spaced from said second locking aperture and in substantial registration therewith.

9. The surgical fastening instrument of claim 8 wherein said first locking end and said second locking end are linked together by a bridge member.

10. The surgical fastening instrument of claim 1 further comprising:

a first plurality of staples operably supported in said first jaw on a first side of a slot configured to receive said cutting member therein: and

a second plurality of staples operably supported in said first jaw on a second side of said slot.

11. A fastener cartridge for cutting and occluding a vessel, comprising:

a body portion having a deck face and a centrally disposed slot therein for receiving a cutting member of a surgical instrument therethrough, said deck face configured to operably support a pair of substantially flexible elongated closure members wherein one member is supported on a first side of said centrally disposed slot and the other member is disposed on a second side of said slot; and

a closure retraction assembly at least partially operably supported in said body portion and configured to selectively apply cinching motions to each of said substantially flexible elongated closure members.

12. The fastener cartridge of claim 11 further comprising:

a first plurality of unformed staples operably supported in said body portion on a first side of said slot; and

a second plurality of unformed staples operably supported in said body portion on a second side of said slot.

13. The fastener cartridge of claim 11 wherein said closure retraction assembly comprises:

a first retraction hook operably configured to hookingly engage a portion of a first one of the substantially flexible elongated closure members; and

a second retraction hook operably configured to hookingly engage a portion of a second one of the substantially flexible elongated closure members.

14. A closure assembly for use with a surgical fastener cartridge having a closure retraction assembly therein, said closure assembly comprising:

a first absorbable closure member having a first lower elongated portion supportable on a portion of the fastener cartridge and having a first locking end defining a first locking aperture, said first absorbable closure member having a first upper elongated portion integrally formed

with said first lower elongated portion and having a first hook-shaped end supported in spaced relation to said first locking end;

a second absorbable closure member having a second lower elongated portion supportable on another portion of the fastener cartridge and having a second locking end defining a second locking aperture, said second absorbable closure member having a second upper elongated portion integrally formed with said second lower elongated portion and having a second hook-shaped end supported in spaced relation to said first locking end; and

a bridge member coupling said first absorbable closure member and said second absorbable closure member in spaced relation to each other.

15. The closure assembly of claim 14 wherein said first absorbable closure member comprises a first suture and wherein said second absorbable closure member comprises a second suture.

16. The closure assembly of claim 14 wherein said first absorbable member has a first plurality of first unidirectional barbs formed thereon and wherein said second absorbable member has a second plurality of second unidirectional barbs formed thereon.

17. The closure assembly of claim 14 wherein said first locking end comprises a first locking loop formed in an end of said first lower portion of said first absorbable closure member and defining said first locking aperture therein and wherein said first upper portion of said first absorbable closure member has a first hook portion that extends through said first locking aperture and terminates in a first retraction loop and wherein said second locking end comprises a second locking loop formed in an end of said second lower portion of said second absorbable closure member and defining said second locking aperture therein and wherein said second upper portion of said first absorbable closure member has a second hook portion that extends through said second locking aperture and terminates in a second retraction loop.

18. The closure assembly of claim 17 wherein said first locking loop and said second locking loop are linked together by said bridge member.

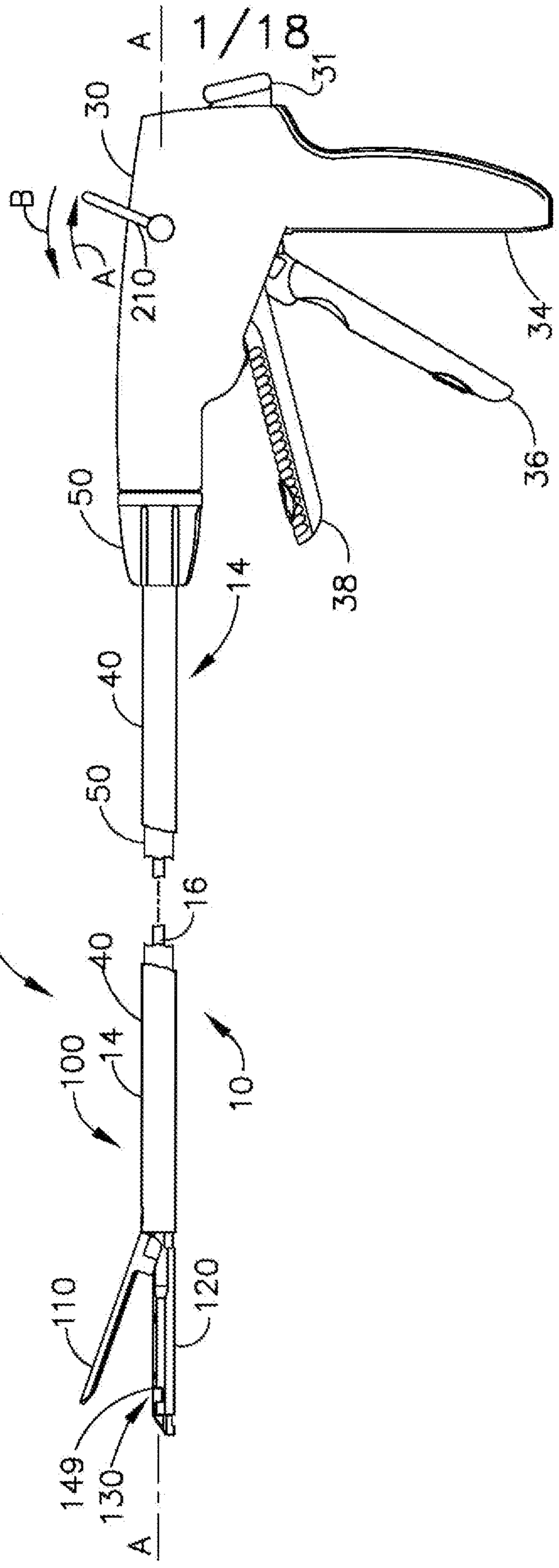
1/18
A
31
30
B
A
210
34
36
38
50
14
40
50
16
12
40
100
14
10
110
120
149
130
A

FIG. 1

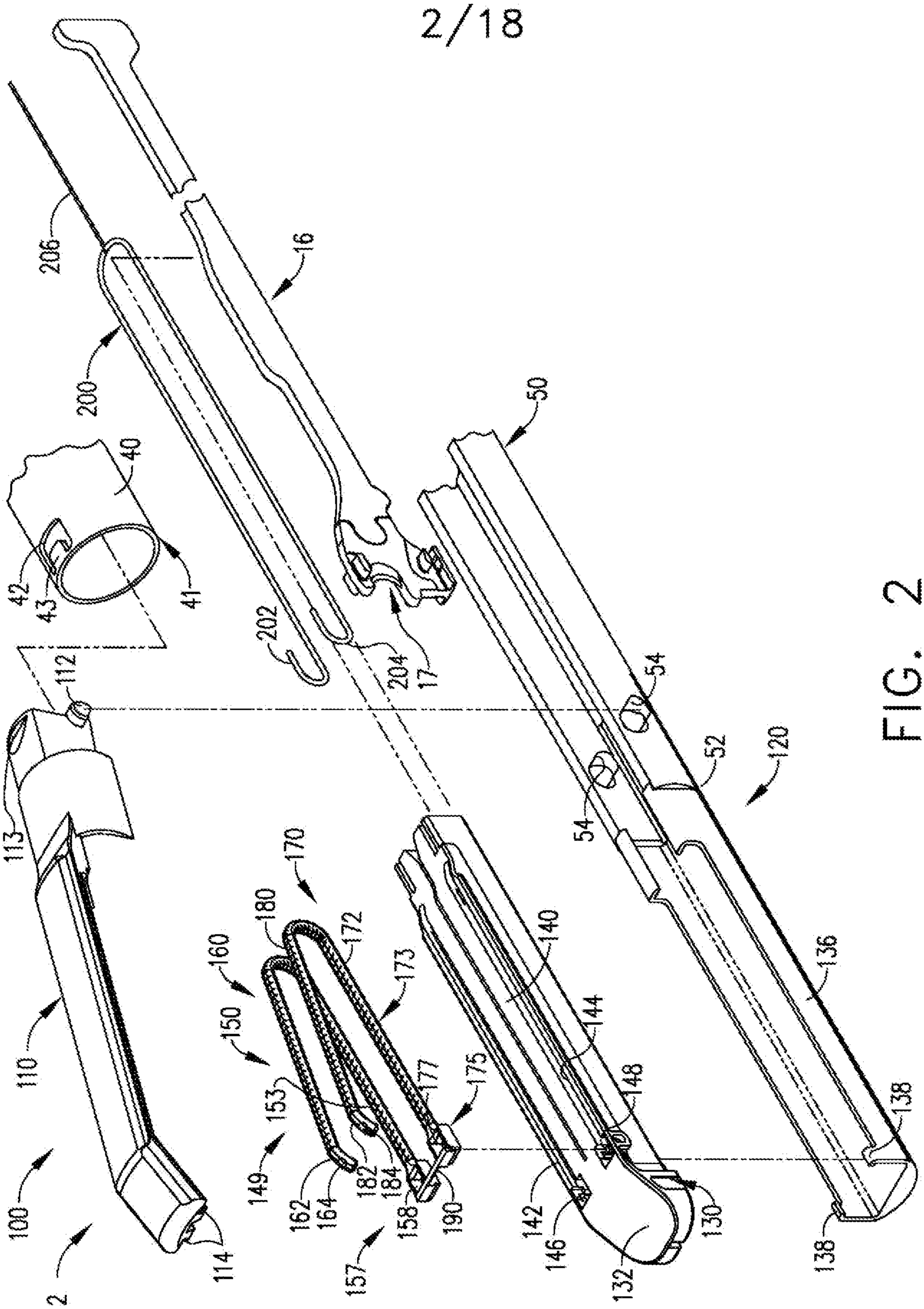
206
16
200
50
40
42
43
41
202
204
17
54
112
52
120
113
170
180
172
160
140
173
136
110
150
144
153
148
100
149
175
177
138
162
164
182
184
158
190
142
146
130
157
132
12
114

FIG. 2

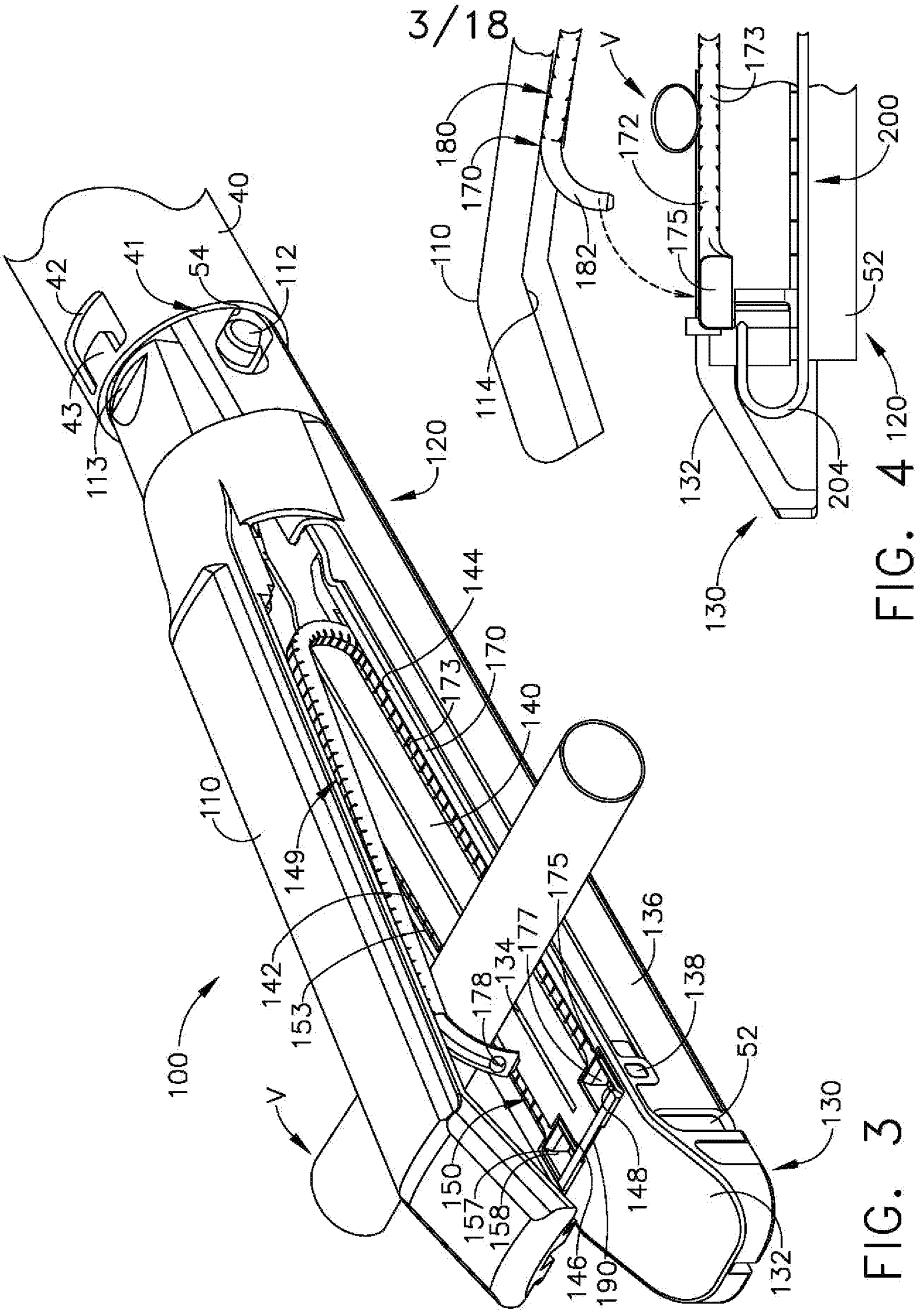
100
110
120
130
132
140
142
144
146
148
149
150
153
157
158
170
172
173
175
177
178
180
182
190
200
204
V
40
41
42
43
52
54
112
113
114
134
136
138

FIG. 3

FIG. 4

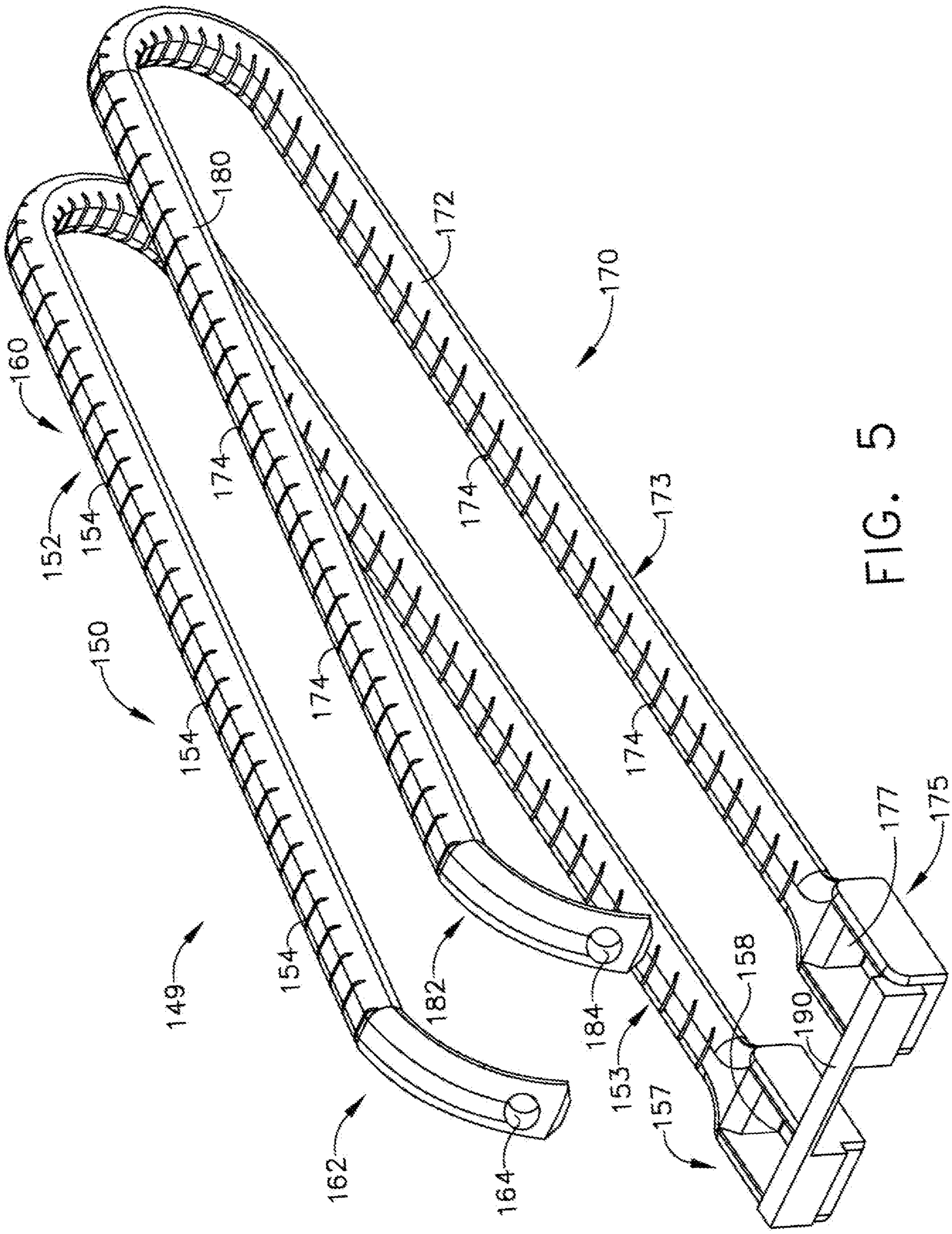
160
180
172
170
174
173
152
154
150
154
174
174
177
175
154
182
158
184
153
190
157
162
164
149

FIG. 5

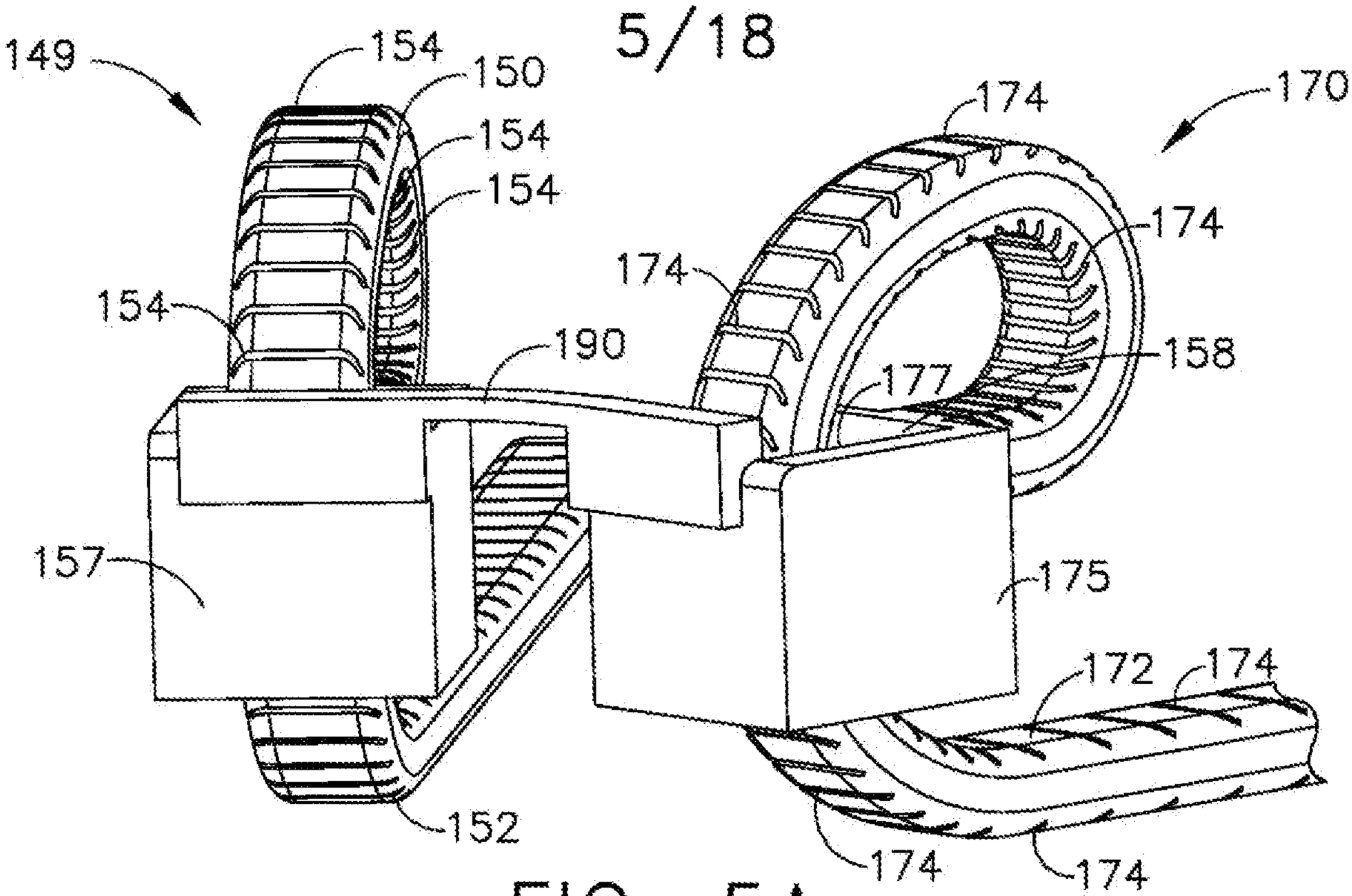
149
154
150
154
154
154
190
174
174
170
174
158
177
157
175
172
174
152
174
174

FIG. 5A

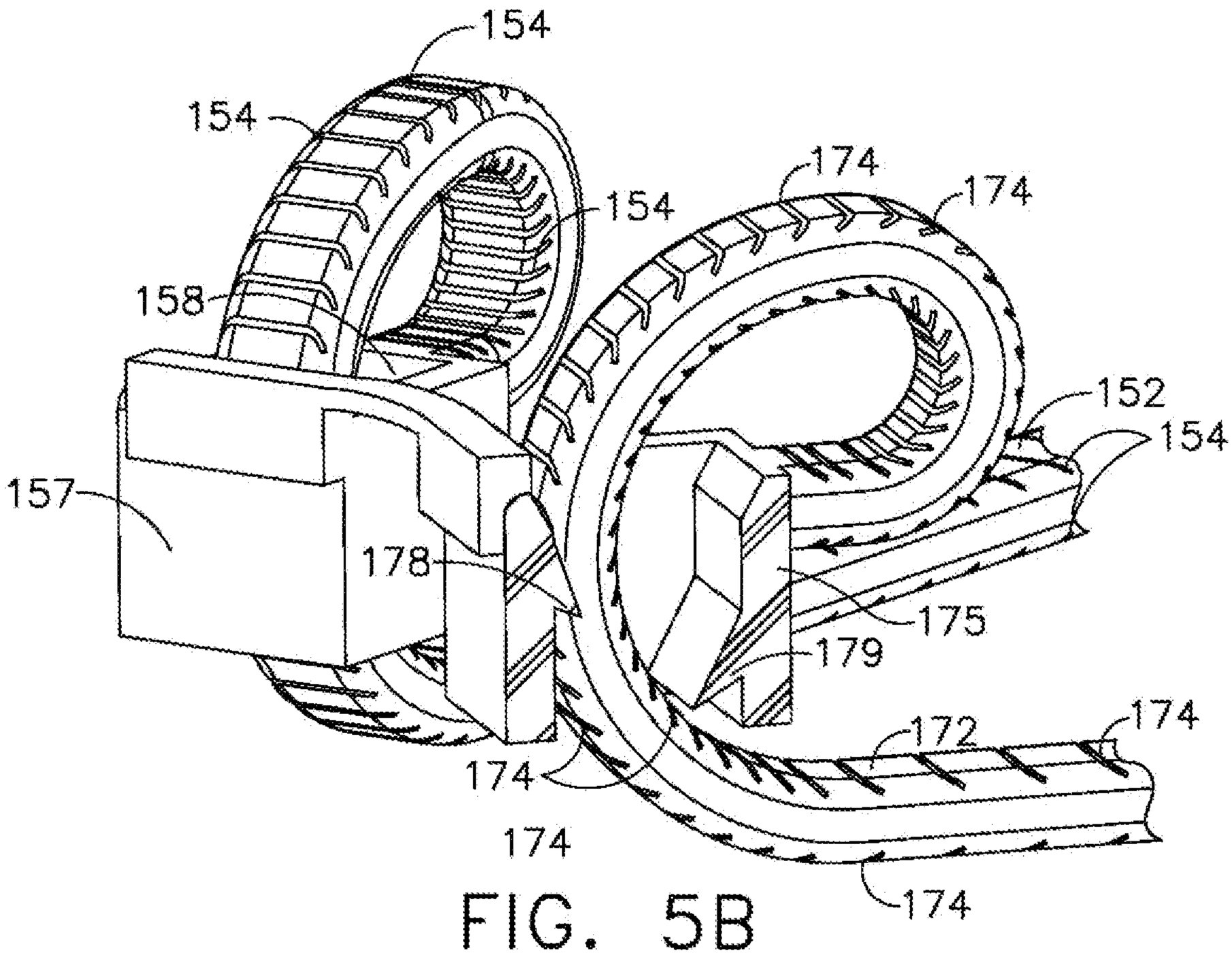
154
154
154
174
174
158
152
154
157
178
175
179
172
174
174
174
174

FIG. 5B

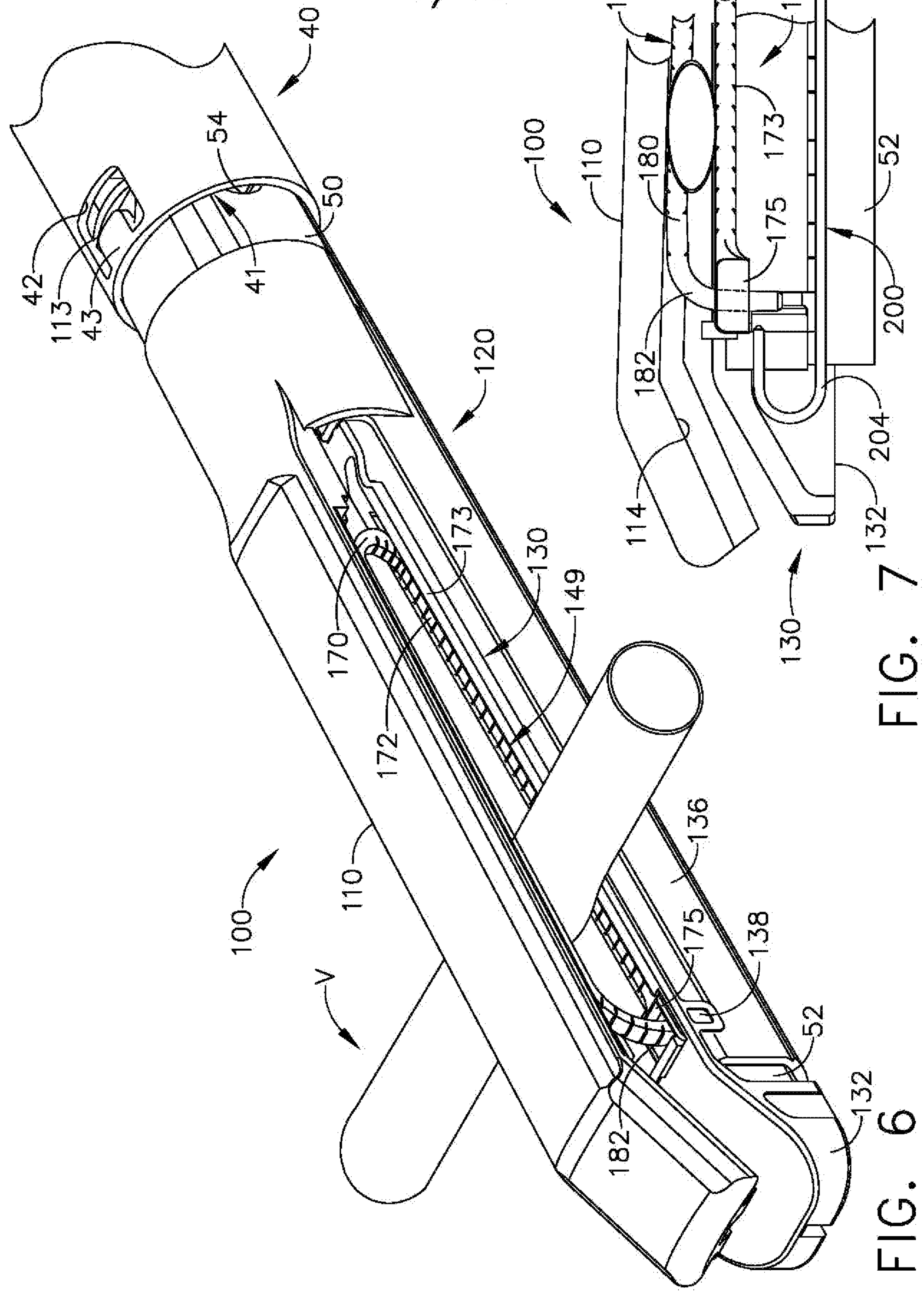
40
54
50
42
113
43
41
120
173
130
149
170
172
100
110
V
136
175
138
182
52
132
144
180
200
204
114

FIG. 6

7

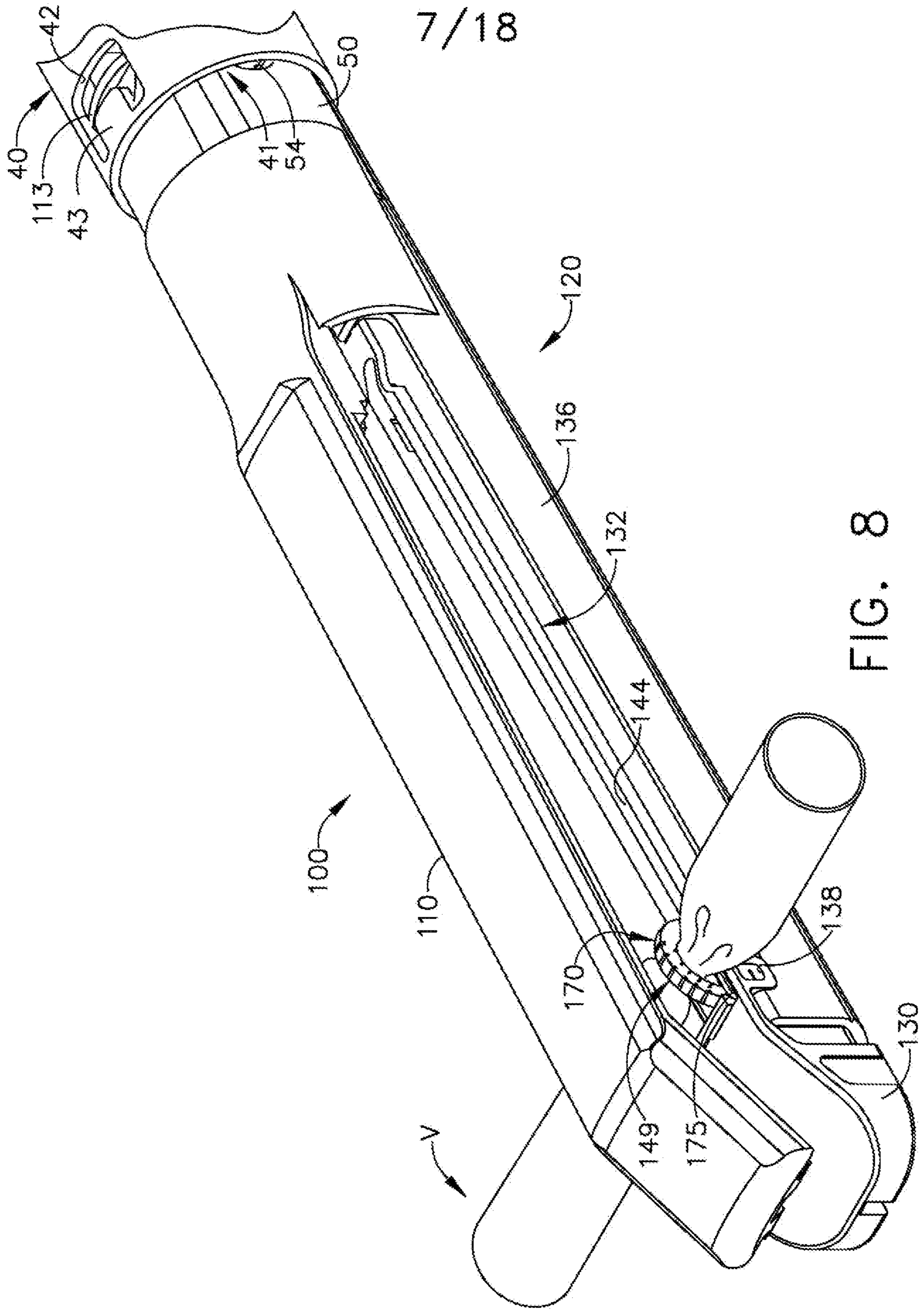

FIG. 8

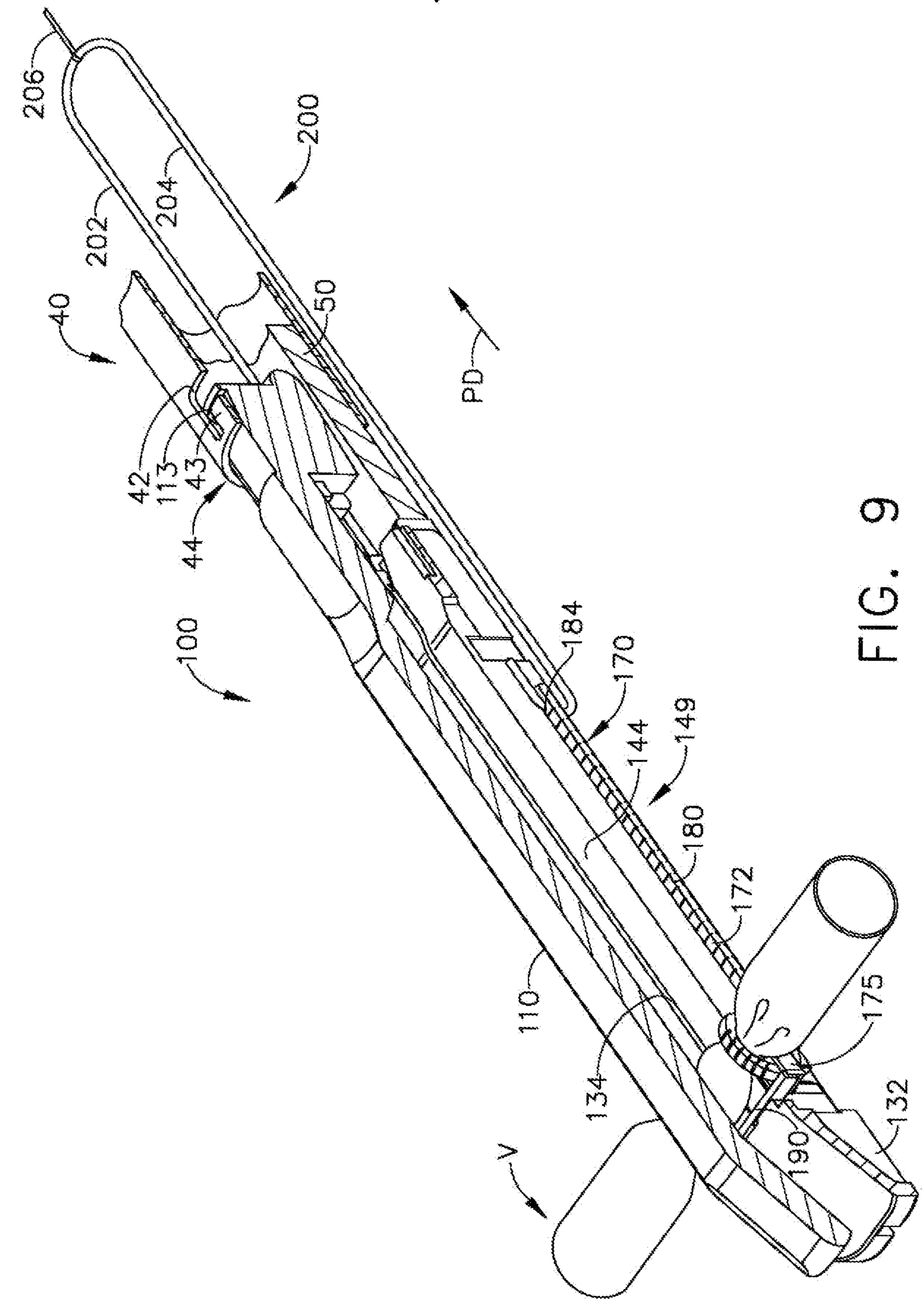
206
202
204
200
40
50
PD
42
113
43
44
100
184
170
144
149
180
172
110
175
134
160
132
V

FIG. 9

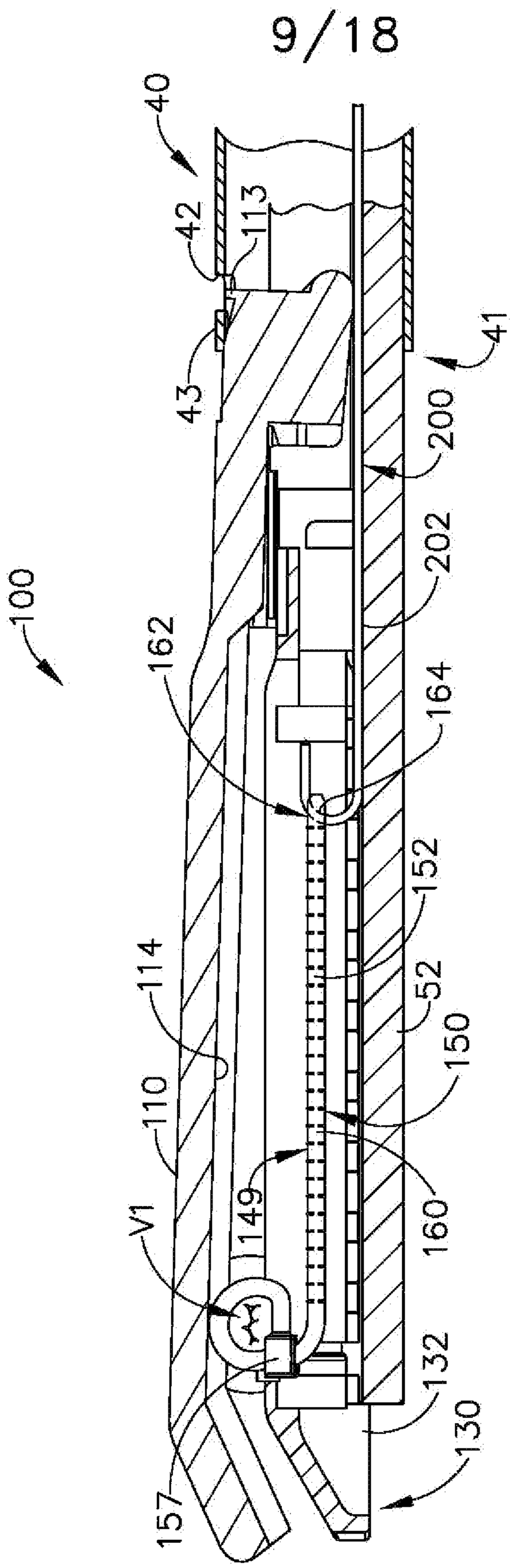
40
42
113
43
41
200
202
100
162
164
152
114
52
150
110
160
V1
149
132
130
157

FIG. 10

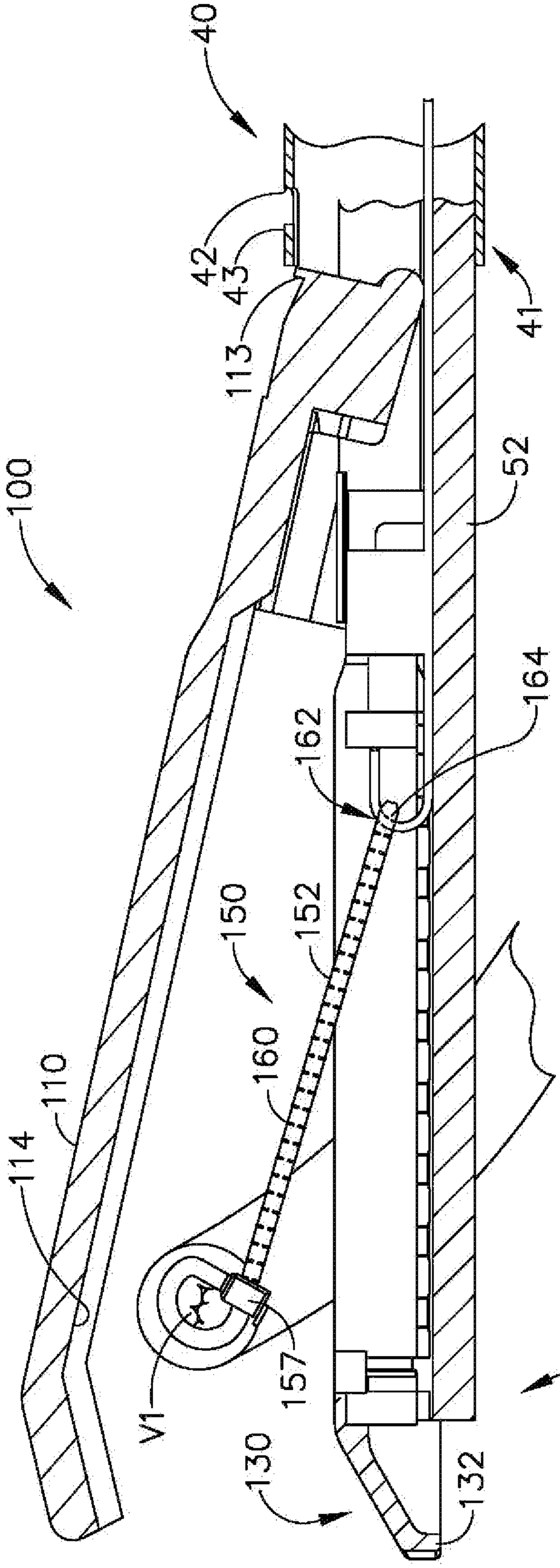
40
42
43
113
41
100
52
164
162
150
152
160
110
114
V1
157
130
132
120

FIG. 11

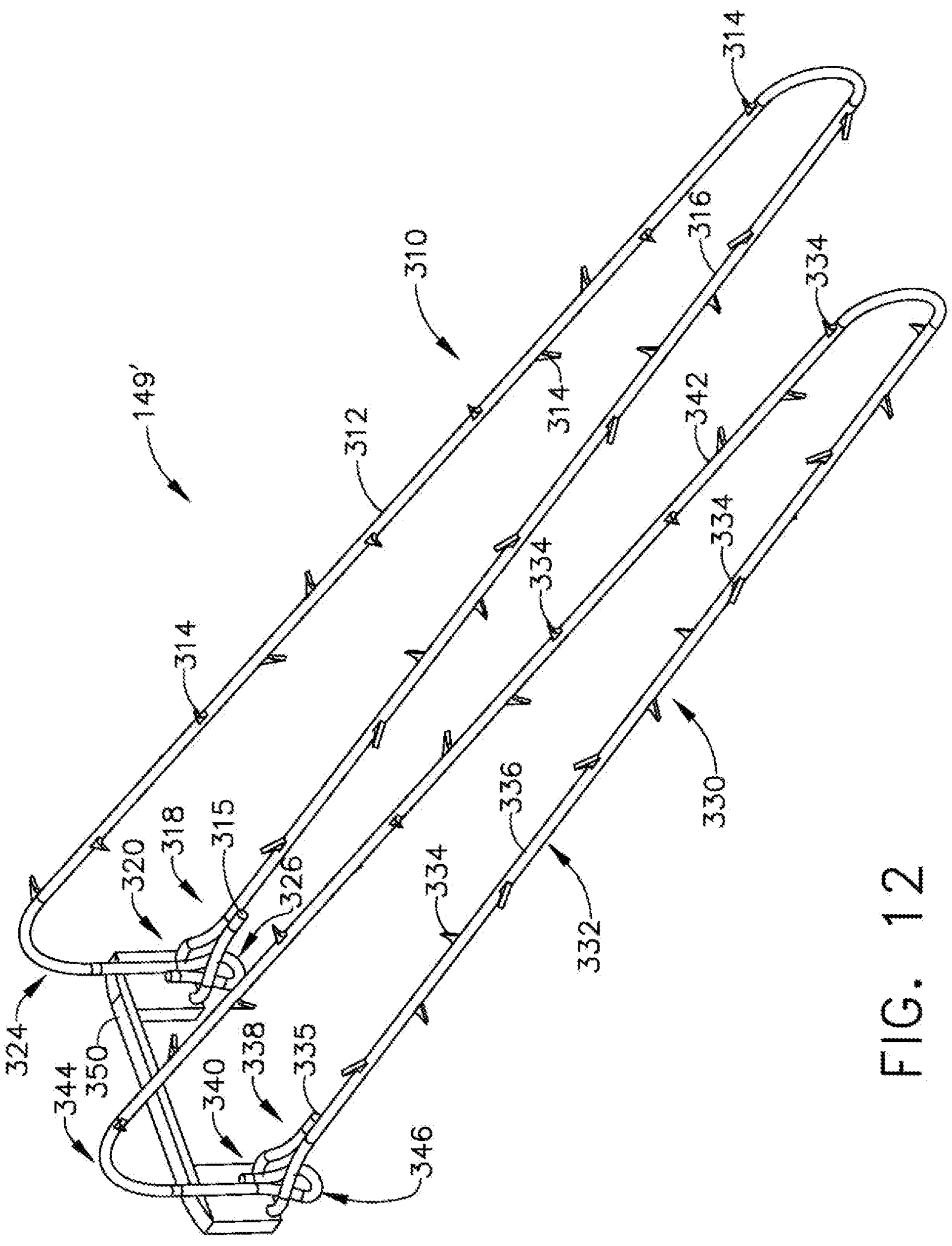
149'
310
312
314
316
318
315
320
326
324
344
350
340
338
335
346
342
334
336
330
332

FIG. 12

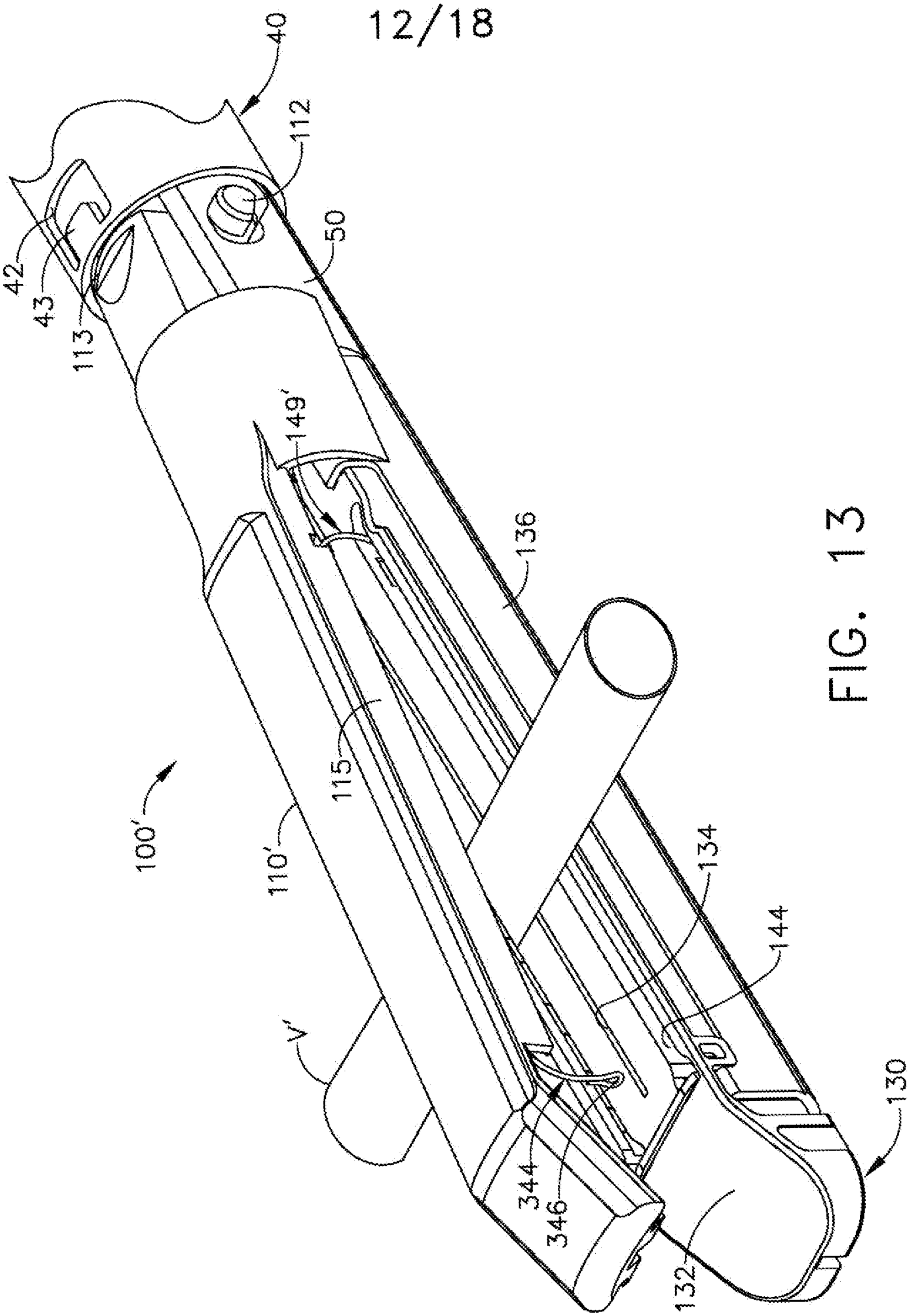

FIG. 13

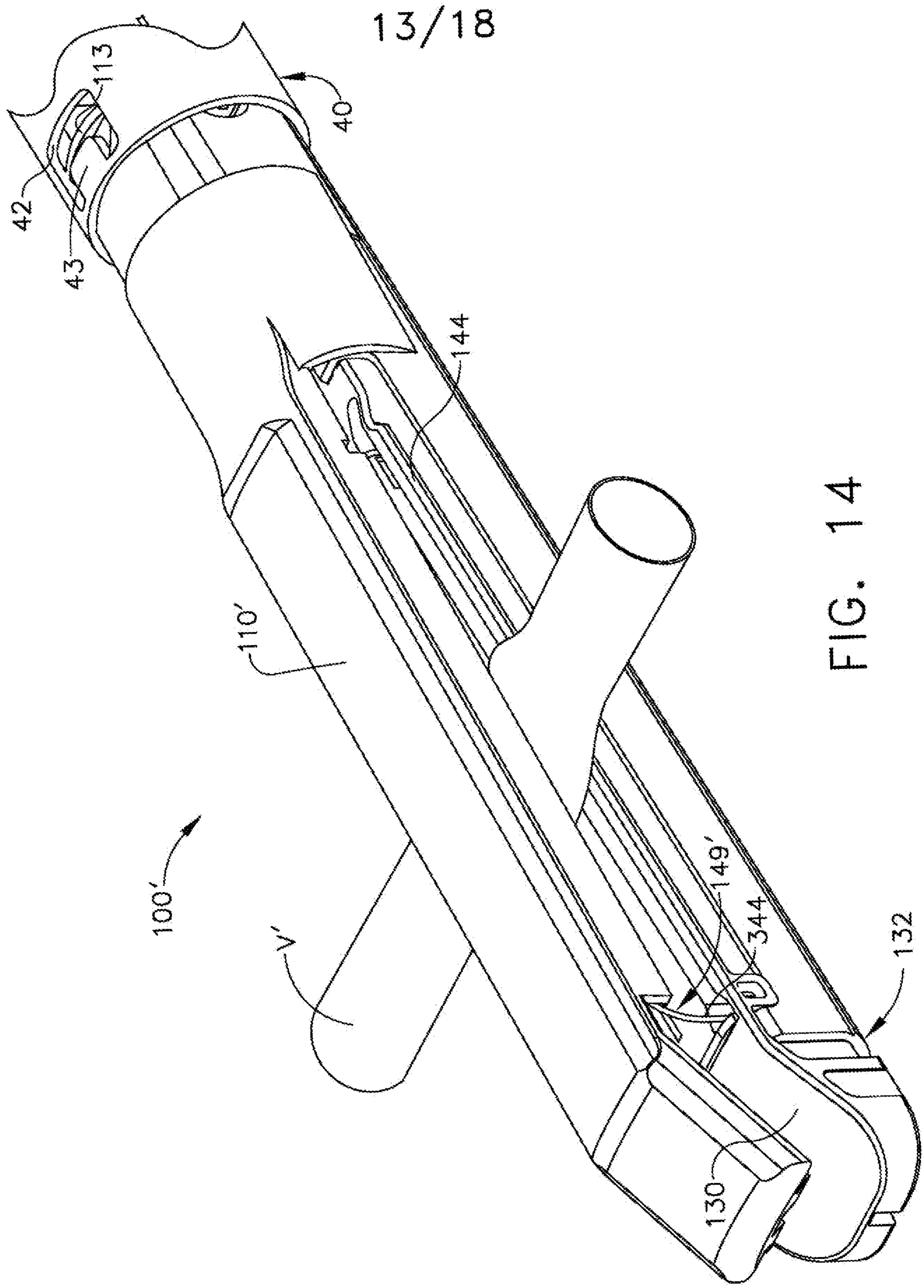

FIG. 14

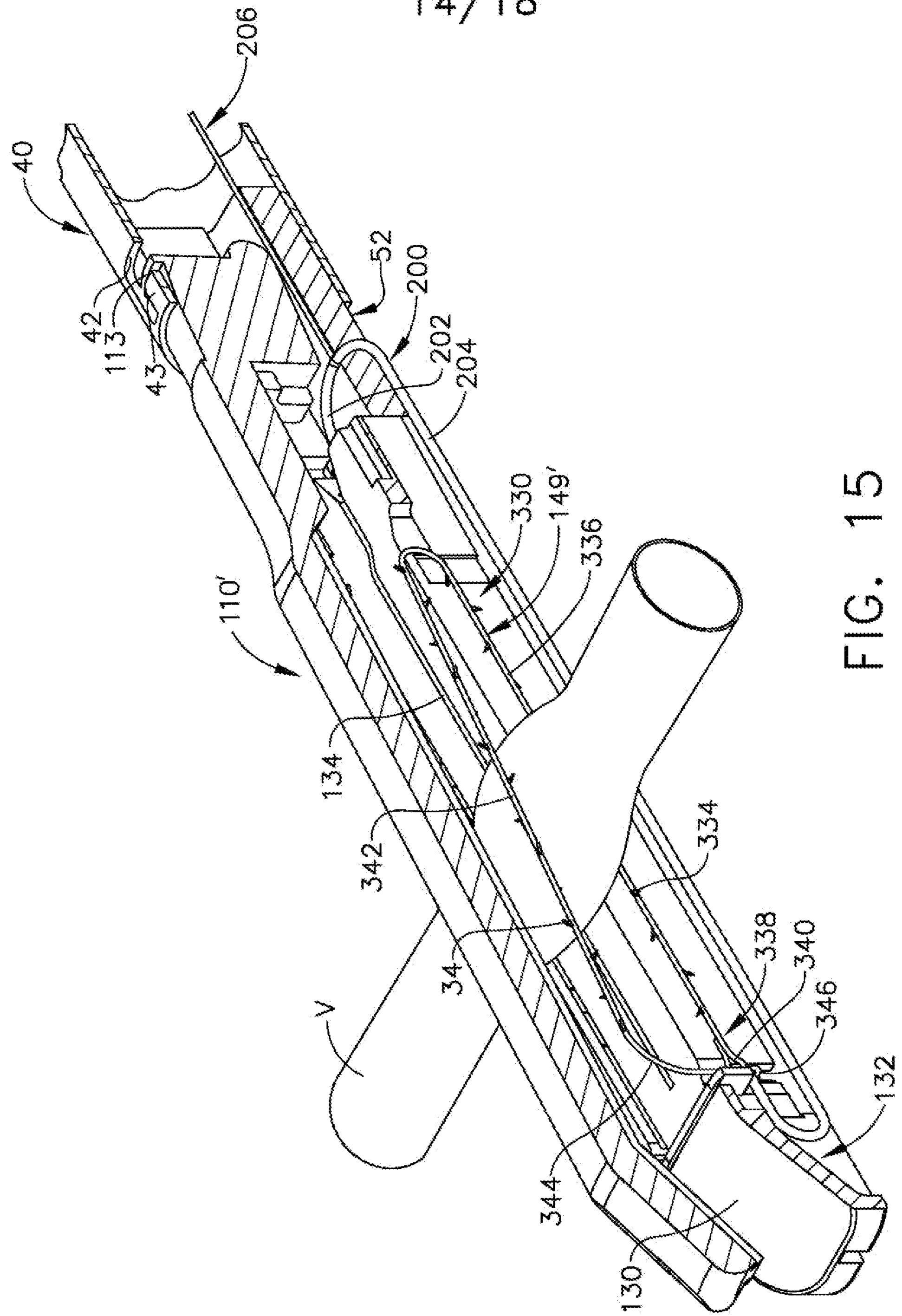
206
40
42
113
43
52
200
202
204
330
149'
336
110'
134
342
334
338
340
346
132
344
130
V

FIG. 15

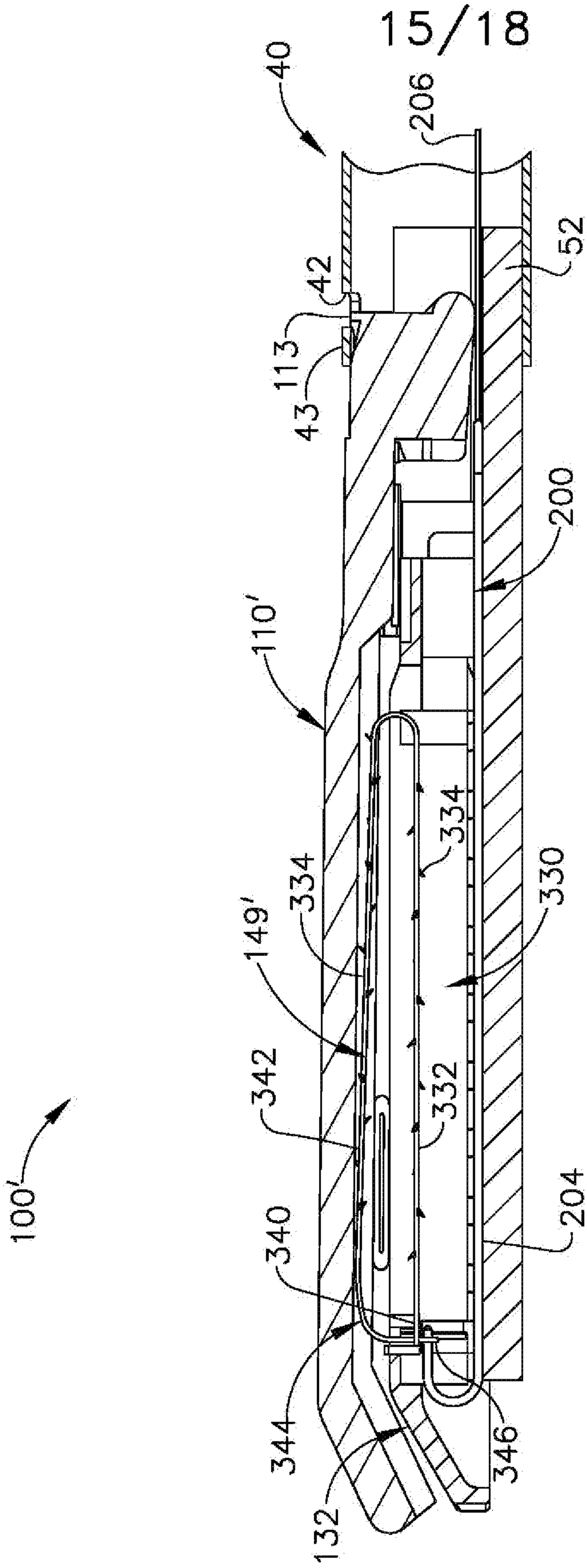
100'
40
206
52
42
113
43
200
110'
149'
334
330
342
332
340
204
344
346
132

FIG. 16

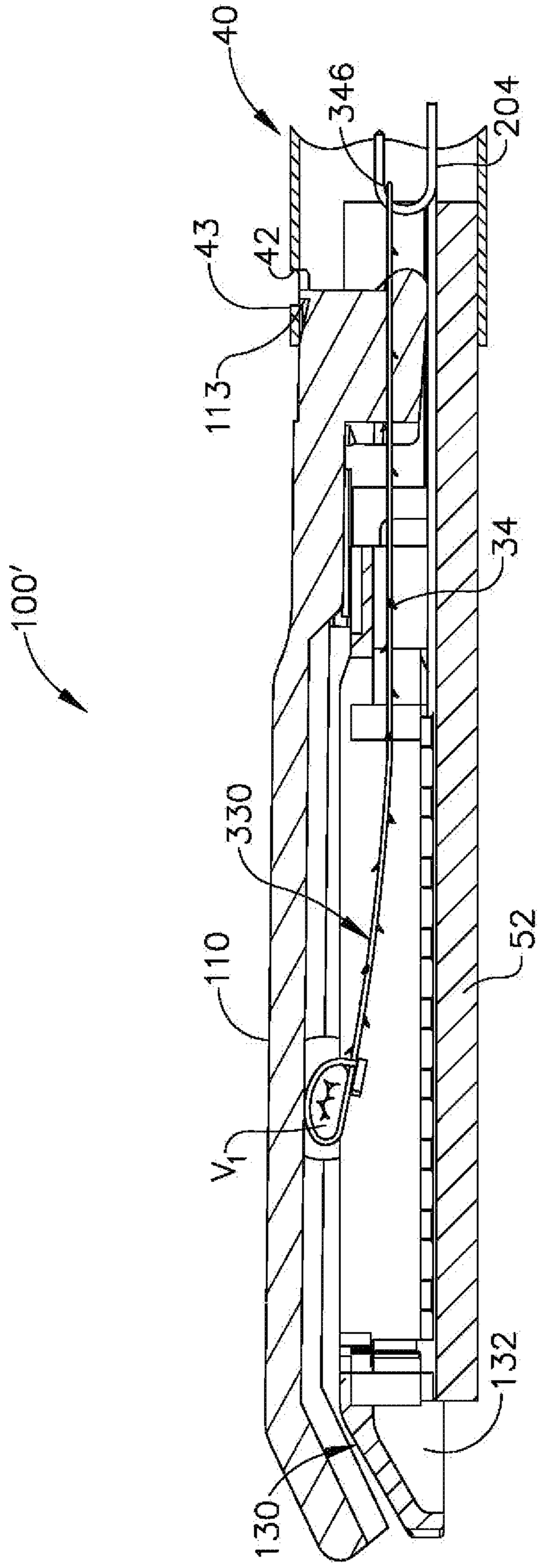

FIG. 17

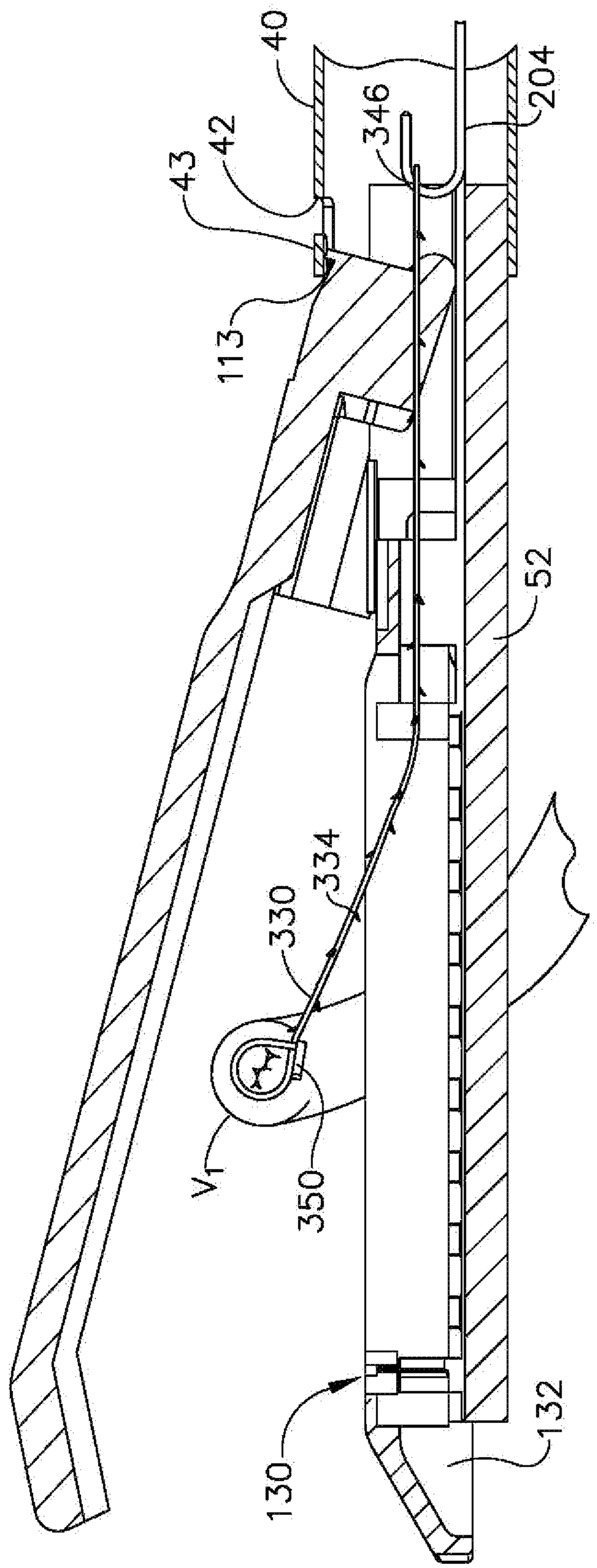

FIG. 18

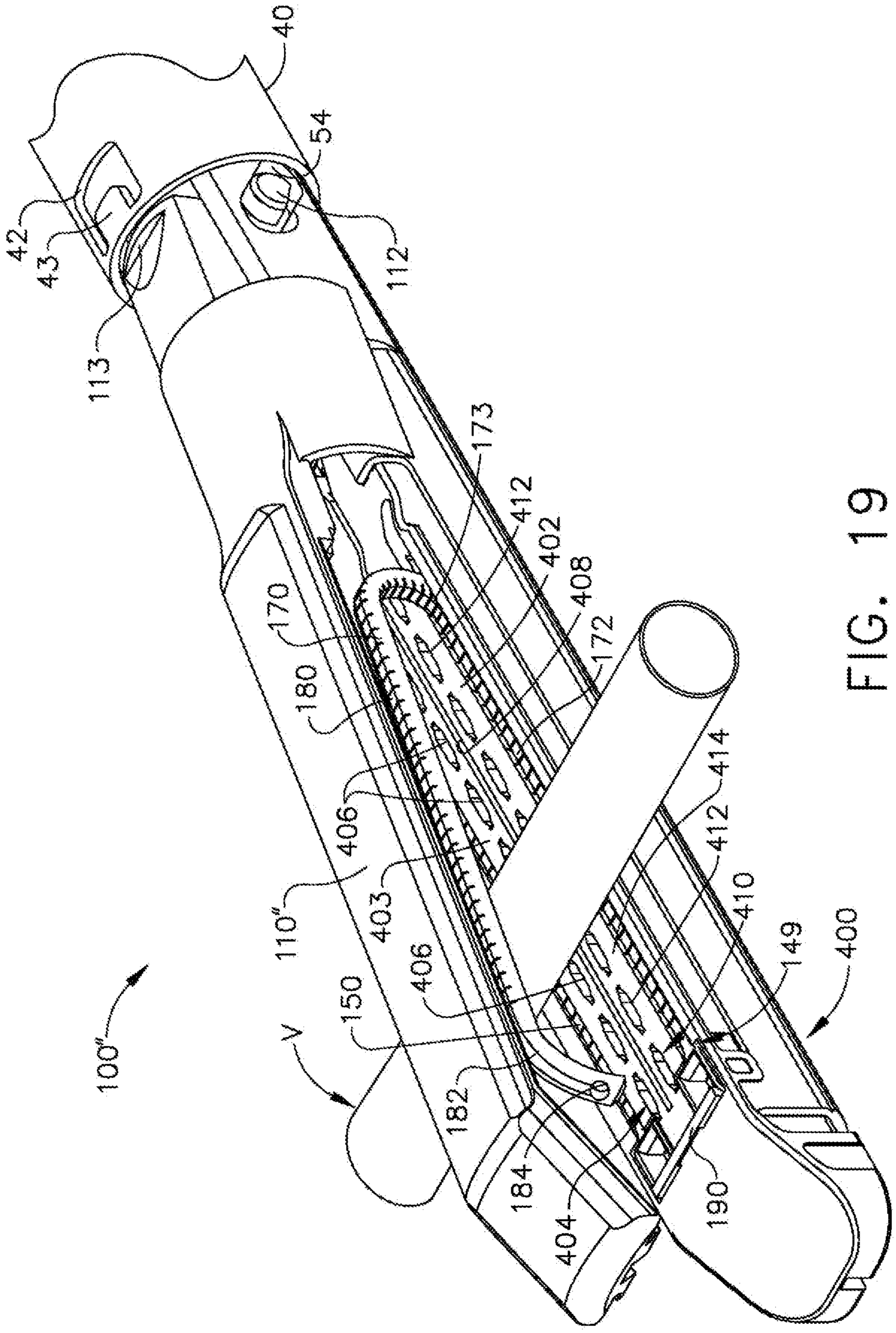
100"
110"
V
40
54
42
43
113
112
173
412
402
408
172
170
180
406
403
150
182
184
404
190
414
410
149
400

FIG. 19

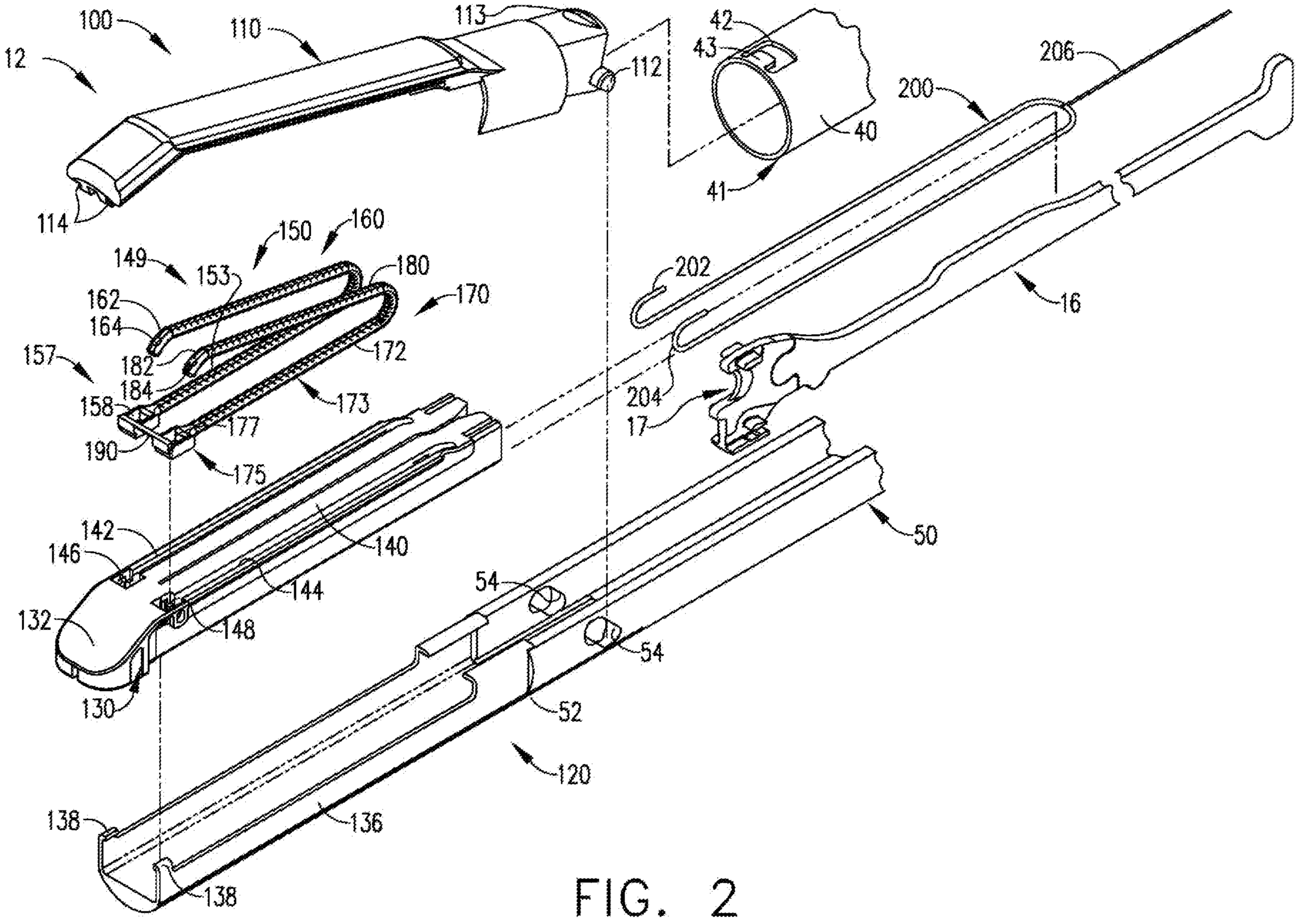
100
110
113
12
112
114
42
43
40
41
206
200
202
16
204
17
50
150
160
149
153
180
170
162
164
172
157
182
184
173
158
177
190
175
142
146
140
144
132
148
130
54
54
52
120
138
136
138

FIG. 2