(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 389 118 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
15.05.2019 Bulletin 2019/20

(21) Application number: **10702783.1**

(22) Date of filing: **26.01.2010**

(51) Int Cl.:
A61B 17/04 *(2006.01)* ***A61B 17/00*** *(2006.01)*
A61B 17/06 *(2006.01)*

(86) International application number:
PCT/US2010/022081

(87) International publication number:
WO 2010/085793 (29.07.2010 Gazette 2010/30)

(54) **BI-DIRECTIONAL SUTURE PASSER**

BIDIREKTIONALE NAHTDURCHGANGSVORRICHTUNG

PASSEUR DE SUTURE BIDIRECTIONNEL

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR

(30) Priority: **26.01.2009 US 147251 P**

(43) Date of publication of application:
30.11.2011 Bulletin 2011/48

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EP 2 389 118 B1

Printed by Jouve, 75001 PARIS (FR)

Description

BACKGROUND

[0001] Suture passing is utilized in the repair of soft tissue defects. A suture is typically attached to either free needles or uni-directional suture passing instruments (instruments that pass suture through tissue in only one direction) for use in surgery.

[0002] A bi-directional suture passing instrument, one which can pass suture through tissue in a forward direction (away from the user), and in a rearward direction (toward the user), can have several advantages over uni-directional suture passing instruments. Many uni-directional suture passers require an additional step to manually retrieve and pass the suture in a reverse direction, thus increasing the complexity of the surgical technique and procedural time. Some uni-directional suture passer designs allow for instrumented retrieval and reloading of the suture to pass the suture; however these designs require that the tissue be flexible enough that it can be lifted to expose both a first and second side of the tissue to the distal end of the instrument in order to pass suture in a reverse direction and also require an additional step to reload the suture. A bi-directional suture passing instrument eliminates the manual retrieval step, decreases the complexity of the surgical technique and the procedural time, enhances the variety of stitch configurations that can be utilized, and increases the number of bodily tissues that can be surgically repaired.

[0003] Some bi-directional suture passer designs known in the art require that a tissue defect is approached generally parallel to the tissue, which is difficult for many surgical procedures such as disc annulus repair, due to the surgical approach to the disc space. Thus, it may be desirable to construct a suture passing device that enables bi-directional suture passing using an instrument that approaches the tissue defect generally perpendicularly.

[0004] Yet other bi-directional suture passer designs require that a sharp needle tip be passed through tissue in both directions. This needle passing is visible in one direction and blind in the other direction, which may result in surgical complications when working in areas adjacent to nerve roots, blood vessels, bowel, or other sensitive anatomy. Thus it may also be desirable to construct a bi-directional suture passing instrument that enables a sharp needle to be visible every time it is passed through tissue, thereby increasing surgical safety when operating in the areas of sensitive anatomy.

[0005] Furthermore, current bi-directional suture passer designs do not effectively detachably couple the suture to the needle. Thus, it may be desirable to construct new features for detachably coupling the suture to the needle, thereby improving the efficiency of the instrument.

[0006] US 5,792,153 discloses a sewing device, which includes a hollow needle movably received within a needle receiving channel. The needle can be advanced towards a boom arm housing which is spaced from the needle receiving channel by a tissue receiving gap. A suture is carried by a carrier which is moved towards the boom arm housing by means of a wire in the hollow needle. Once the needle with the suture carrier has passed a portion of tissue, the carrier is coupled to the boom arm housing and decoupled from the wire by rotating the wire. The suture carrier may be coupled to the wire again by rotating the wire within the carrier and the needle.

SUMMARY

[0007] Various embodiments of a bi-directional suture passing instrument configured to approximate soft tissue defects are disclosed.

[0008] The embodiment of the invention is defined in claim 1. Preferred embodiment are defined in the dependent claims.

[0009] Methods of operating the different embodiments of the bi-directional suture passing instrument are also disclosed. For example, in one embodiment the needle may be rotated such that an engagement feature of the needle engages an engagement feature of the shuttling element to thereby detachably couple the shuttling element to the needle. The needle and shuttling element may then be passed through tissue and into the boom arm housing. By rotating the needle again, a locking mechanism of the shuttling element engages a locking interface of the boom arm housing to thereby detachably couple the shuttling element to the boom arm housing. Further rotation of the needle will disengage the needle from the shuttling element and the needle may be retracted while leaving the shuttling element in the boom arm housing. These steps may be repeated as many times as necessary.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The foregoing summary, as well as the following detailed description of preferred embodiments of the instrument of the present application, will be better understood when read in conjunction with the appended drawings. For the purposes of illustrating the suture passer instrument of the present application, there is shown in the drawings preferred embodiments. It should be understood, however, that the application is not limited to the precise arrangements and instrumentalities shown. In the drawings:

Fig. 1A is a top plan view of a bi-directional suture passing instrument in accordance with an embodiment of the present invention;

Fig. 1B is a side cross-sectional view of the bi-directional suture passing instrument shown in Fig. 1A, through the line 1B-1B;

Fig. 1C is an enlarged side cross-sectional view taken within window 1C of Fig. 1B showing a portion of

a boom arm and a body element of the instrument;
Fig. 2A is a side elevational view of a handle of the instrument shown in Figs. 1A-1B;
Fig. 2B is a top plan view of the handle shown in Fig. 2A;
Fig. 2C is a front elevational view of the handle shown in Fig. 2A;
Fig. 2D is a side cross-sectional view of the handle, taken along line 2D-2D of Fig. 2C;
Fig. 2E is a front cross-sectional view of the handle, taken along line 2E-2E of Fig. 2D;
Fig. 2F is a bottom cross-sectional view of the handle, taken along line 2F-2F of Fig. 2D;
Fig. 2G is a side cross-sectional view of the handle taken from within oval 2G of Fig. 2D;
Fig. 2H is a side cross-sectional view of the handle taken from within oval 2H of Fig. 2D;
Fig. 3A is a fragmented top plan view of an actuator element of the instrument shown in Figs. 1A-1B;
Fig. 3B is a fragmented side elevational view of the actuator element shown in Fig. 3A;
Fig. 3C is a front elevational view of the actuator element shown in Fig. 3A;
Fig. 3D is a rear elevational view of the actuator element shown in Fig. 3A;
Fig. 4A is a side elevational view of a thumb ring of the instrument shown in Figs. 1A-1B;
Fig. 4B is top plan view of the thumb ring shown in Fig. 4A;
Fig. 4C is a front elevational view of the thumb ring shown in Fig. 4A;
Fig. 5A is a side perspective view of an actuator stop element of the instrument shown in Figs. 1A-1B;
Fig. 5B is a front elevational view of the actuator stop element shown in Fig. 5A;
Fig. 5C is a side elevational view of the actuator stop element shown in Fig. 5A;
Fig. 6A is a front side elevational view of a thumb ring lock element of the instrument shown in Figs. 1A-1B;
Fig. 6B is a right plan view of the thumb ring lock element shown in Fig. 6A;
Fig. 7A is a top plan view of a thumb ring lock cap element of the instrument shown in Figs. 1A-1B;
Fig. 7B is a side elevational view of a thumb ring lock cap element shown in Fig. 7A;
Fig. 8A is a fragmented top plan view of a body element of the instrument shown in Figs. 1A-1B;
Fig. 8B is a front cross-sectional view of the body element shown in Fig. 8A, taken along the line 8B-8B;
Fig. 8C is a front elevational view of the body element shown in Fig. 8A;
Fig. 8D is a side cross-sectional view of the body element shown in Fig. 8C, taken along the line 8D-8D;
Fig. 9A is a front elevational view of a tip actuator element of the instrument shown in Figs. 1A-1B;
Fig. 9B is an enlarged front elevational view of the tip actuator element taken from within oval 9B of Fig. 9A;
Fig. 9C is a left side elevational view of the tip actuator element shown in Fig. 9A;
Fig. 9D is a right side elevational view of the tip actuator element shown in Fig. 9A;
Fig. 10A is a fragmented side elevational view of the instrument shown in Fig. 1A detailing the boom arm at its distal end;
Fig. 10B is a top plan view of the boom arm shown in Fig. 10A;
Fig. 10C is a side cross-sectional view of the boom arm shown in Fig. 10A;
Fig. 10D is a rear elevational view of the boom arm shown in Fig. 10A;
Fig. 10E is a front elevational view of the boom arm shown in Fig. 10A;
Fig. 10F is an enlarged rear view taken from within oval 10F of Fig. 10D;
Fig. 10G is a side cross-sectional view taken from within oval 10G of Fig. 10C;
Fig. 10H is an enlarged front view taken from within oval 10H of Fig. 10E;
Fig. 11A illustrates a fragmented top plan view of a needle of the instrument shown in Figs. 1A-1B;
Fig. 11B is a front cross-sectional view of the needle shown in Fig. 11A, taken along line 11B-11B;
Fig. 11C is a side elevational view of the needle, taken from within oval 11C of Fig. 11A;
Fig. 11D is an enlarged top plan view of the needle taken from within oval 11D of Fig. 11A detailing the distal end of the needle;
Fig. 11E is a partial side elevational view of the distal end of the needle shown in Fig. 11D;
Fig. 12A is a top plan view of a shuttling element of the instrument shown in Figs. 1A-1B;
Fig. 12B is a side elevational view of the shuttling element shown in Fig. 12A;
Fig. 12C is a cross-sectional view of the shuttling element shown in Fig. 12B, taken along line 12C-12C;
Fig. 12D is a front elevational view of the shuttling element shown in Fig. 12A;
Fig. 12E is a side cross-sectional view of the shuttling element shown Fig. 12C, taken along line 12E-12E;
Fig. 13 is a top plan view of a suture tensioner element of the instrument shown in Figs. 1A-1B;
Fig. 14A is a side perspective view of the bidirectional suture passing instrument illustrated in Figs. 1A-1B, showing the needle in a retracted position and the shuttling element coupled to the needle;
Fig. 14B is an enlarged side perspective view of a distal end of the instrument shown in Fig. 14A;
Fig. 14C is a side perspective view of the instrument shown in Fig. 14A, showing the needle in an advanced position and the shuttling element coupled to the needle;
Fig. 14D is an enlarged side perspective view of the

distal end of the instrument shown in Fig. 14C;
Fig. 14E is a side perspective view of the instrument shown in Fig. 14A, showing the needle in an advanced position and the shuttling element coupled to the boom arm;
Fig. 14F is an enlarged side perspective view of the distal end of the instrument shown in Fig. 14E;
Fig. 14G is a side perspective view of the instrument shown in Fig. 14A, showing the needle in a retracted position and the shuttling element coupled to the boom arm;
Fig. 14H is an enlarged side perspective view of the distal end of the instrument shown in Fig. 14G;
Fig. 14I is a side perspective view of the instrument shown in Fig. 14A, showing the needle in an advanced position and the shuttling element coupled to the boom arm;
Fig. 14J is an enlarged side perspective view of the distal end of the instrument shown in Fig. 14I;
Fig. 14K is a side perspective view of the instrument shown in Fig. 14A, showing the needle in an advanced position and the shuttling element uncoupled from the boom arm;
Fig. 14L is an enlarged side perspective view of the distal end of the instrument shown in Fig. 14K;
Fig. 14M is a side perspective view of the instrument shown in Fig. 14A, showing the needle in a retracted position and the shuttling element coupled to the needle;
Fig. 15A is a partial top elevational view of another embodiment of the bi-directional suture passing instrument, in which a series of grooves and traps are used to detachably couple the needle to the shuttling element, and to detachably couple the shuttling element to the boom arm housing;
Fig. 15B is a partial top elevational view of the instrument illustrated in Fig. 15A, showing the needle and shuttling element engaging the boom arm housing;
Fig. 15C is a perspective view of the shuttling element utilized with the instrument illustrated in Fig. 15A;
Fig. 15D is a front view of the shuttling element shown in Fig. 15C;
Fig. 15E is a side view of the shuttling element shown in Fig. 15C;
Fig. 16A is a partial side perspective view of another embodiment of the bi-directional suture passing instrument, in which threaded features are used to detachably couple the needle to the shuttling element, and to detachably couple the shuttling element to the boom arm housing;
Fig. 16B is a partial bottom cross-sectional view of the instrument illustrated in Fig. 16A, showing the needle in a fully advanced position;
Fig. 16C is a partial perspective view of the instrument illustrated in Fig. 16A, showing the needle and shuttling element in a fully retracted position;
Fig. 16D is a partial perspective view of the instrument illustrated in Fig. 16C, showing the needle advanced into the boom arm housing;
Fig. 16E is a partial perspective view of the instrument illustrated in Fig. 16D, showing the needle and the shuttling element being rotated to thereby selectively couple the shuttling element to the boom arm housing;
Fig. 16F is a partial perspective view of the instrument illustrated in Fig. 16E, showing the needle being further rotated to decouple the needle from the shuttling element;
Fig. 16G is a partial perspective view of the instrument illustrated in Fig. 16F, showing the needle being retracted while the shuttling element remains coupled to the boom arm housing;
Fig. 16H is a partial perspective view of the instrument illustrated in Fig. 16G, showing the needle fully retracted position;
Fig. 16I is a partial perspective view of the instrument illustrated in Fig. 16H, showing the needle being advanced into the boom arm housing;
Fig. 16J is a partial perspective view of the instrument illustrated in Fig. 16I, showing the needle being rotated to thereby couple the needle to the shuttling element;
Fig. 16K is a partial perspective view of the instrument illustrated in Fig. 16J, showing the needle and the shuttling element being rotated to thereby decouple the shuttling element from the boom arm housing;
Fig. 16L is a partial perspective view of the instrument illustrated in Fig. 16K, showing the needle and the shuttling element being retracted from the boom arm housing;
Fig. 17A is a partial cross-sectional view of another embodiment of the bi-directional suture passing instrument, in which the needle has external threads and the shuttling element has internal threads to detachably couple the needle to the shuttling element;
Fig. 17B is a partial cross-sectional view of the instrument illustrated in Fig. 17A, showing the needle and shuttling element in a fully advanced position;
Fig. 17C is a partial cross-sectional view of the instrument illustrated in Fig. 17B, showing the needle in a fully retracted position, and the shuttling element coupled to the boom arm housing;
Fig. 18A is a top side elevational view of a needle having wings;
Fig. 18B is a left side elevational view of the needle shown in Fig. 18A;
Fig. 18C is a top side elevational view of a shuttling element that is configured to be detachably coupled to the needle shown in Fig. 18A;
Fig. 18D is a left side elevational view of the shuttling element shown in Fig. 18C;
Fig. 18E is a back side plan view of the shuttling element shown in Fig. 18D;

Fig. 18F is a top side elevational view of a boom arm housing that is configured to receive the shuttling element shown in Fig. 18C;
Fig. 18G is a left side elevational view of the boom arm housing shown in Fig. 18F;
Fig. 18H is a back side plan view of the boom arm housing shown in Fig. 18G;
Fig. 18I is a partial top elevational view of the instrument illustrated in Figs. 18A-18H, showing the needle and shuttling element in a fully retracted position;
Fig. 18J is a partial top elevational view of the instrument illustrated in Fig. 18I, showing the needle and shuttling element advanced into the boom arm housing;
Fig. 18K is a partial top elevational view of the instrument illustrated in Fig. 18J, showing the needle and the shuttling element being rotated to thereby selectively couple the shuttling element to the boom arm housing;
Fig. 18L is a partial top elevational view of the instrument illustrated in Fig. 18K, showing the needle being retracted while the shuttling element remains coupled to the boom arm housing;
Fig. 18M is a partial top elevational view of the instrument illustrated in Fig. 18L, showing the needle advanced into the shuttling element;
Fig. 18N is a partial top elevational view of the instrument illustrated in Fig. 18M, showing the needle and shuttling element being rotated to decouple the shuttling element from the boom arm housing;
Fig. 19 is a perspective view of another embodiment of the bi-directional suture passing instrument that is similar to the instrument shown in Figs. 18A-18N, except that the structures defining the engagement features on the needle and the shuttling element are reversed;
Fig. 20A is a side perspective view of another embodiment of the bi-directional suture passing instrument, showing additional features that may be used;
Fig. 20B is a front perspective view of a driver that may be used with the instrument shown in Fig. 20A;
Fig. 20C is a side perspective view of a shuttling element that may be used with the instrument shown in Fig. 20A;
Fig. 20D is a rear perspective view of a boom arm that may be used with the instrument shown in Fig. 20A;
Fig. 21A is a side elevational view of another embodiment of the bi-directional suture passing instrument, configured to create a pathway in a bony structure through which the suture can be passed;
Fig. 21B is a side elevational view of the instrument shown in Fig. 21A, having an impact rod;
Fig. 21C is a side elevational view of the instrument shown in Fig. 21A, having an impact rod configured to grab the needle;
Fig. 21D is a front plan view of a grip associated with the impact rod shown in Fig. 21C;
Fig. 21E is a front plan view of the grip shown in Fig. 21D in a closed position;
Fig. 22A is a side elevational view of a simple stitch;
Fig. 22B is a side elevational view of a horizontal box mattress stitch;
Fig. 22C is a side elevational view of a horizontal mattress stitch;
Fig. 22D is a side elevational view of a reverse horizontal mattress stitch;
Fig. 22E is a side elevational view of a vertical mattress stitch;
Fig. 22F is a side elevational view of a reverse vertical mattress stitch; and
Figs. 22G-22I are side elevational views of a suturing method for soft tissue repair near a bony element.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

[0011] Certain terminology is used in the following description for convenience only and is not limiting. The words "right", "left", "lower" and "upper" designate directions in the drawings to which reference is made. The words "inwardly" or "distally" and "outwardly" or "proximally" refer to directions toward and away from, respectively, the patient's body, or the geometric center of the suture passer instrument and related parts thereof. The words, "anterior", "posterior", "superior," "inferior" and related words and/or phrases designate preferred positions and orientations in the human body to which reference is made and are not meant to be limiting. The terminology includes the above-listed words, derivatives thereof and words of similar import.

[0012] Referring to Figs. 1A-1C a bi-directional suture passing instrument 10 extends in a longitudinal direction L, and includes a proximal end P and a distal end D. As shown, the instrument 10 includes a handle 14, an elongated body 18 coupled to the handle 14, and a boom arm 22 coupled to the distal end of the elongated body 18. The boom arm 2 includes an arm 190 that is coupled to a distal end of the elongated body 18 and carries a boom arm housing 198, so as to define a tissue-receiving gap 202 between the elongated body 18 and the boom arm housing 198. The instrument 10 further includes, an actuator element 26, a needle 34 coupled to the distal end of the actuator element 26, and a grip 30 that is coupled to the proximal end of the actuator element 26. The actuator element 26 and the needle 34 are reciprocally translatable between a retracted (rearward) position and an extended or advanced (forward) position, within both the interior of the handle 14 and the interior of the elongated body 18. The instrument 10 further includes a needle like shuttling element 40 that is configured to carry a strand of suture to be inserted through a tissue defect, and the boom arm housing 198. As will be described in more detail below, when the shuttling element 40 is coupled to the needle 34, the shuttling element 40 may pass through a tissue defect. Once the shuttling element 40

has passed through the tissue defect, the shuttling element 40 may be detachably coupled to the boom arm housing 198.

[0013] As shown in Figs. 1A-1B, and 2A-2H, the handle 14 includes a body 50 having a grip 54 extending down from a bottom surface of the body 50. The body 50 is generally elongated and rectangular in shape. As shown in Fig. 2D, a first sized bore 58 extends distally, along the longitudinal direction L, through the body 50 from the proximal end of the body 50, and into a second sized bore 62. Second bore 62 continues to extend distally into a third sized bore 66, that extends through the distal end of the body 50. Each bore 58, 62, and 66 is sized to accommodate certain parts of the instrument 10. For example, actuator element 26 is translatable within bore 58, needle 34 is translatable within bore 62, and body member 18 is secured within bore 66.

[0014] In accordance with the illustrated embodiment, the first bore 58 is generally cylindrical and is capable of receiving the actuator element 26, as shown in Fig. 1B. In particular, the actuator element 26 is reciprocally translatable within the first bore 58. Referring back to Figs. 2D and 2H, a fourth bore 70 extends transverse to the longitudinal direction L, through the bottom surface of the body 50 and into the first bore 58. As shown, the fourth bore 70 contains a mating feature, such as ball plunger 74 that is adapted to engage either directly or indirectly the actuator element 26.

[0015] As shown in Figs. 3A-3D, the actuator element 26 includes a cylindrical body 76 having a first coupling element 78 at its distal end, and a second coupling element 82 at its proximal end. The body 76 of the actuator element 26 defines a mating feature, such as detent 86 that is configured to be engaged by a protrusion extending from a lock. The first coupling element 78 is configured to attach the actuator element 26 to the needle 34, and the second coupling element 82 is configured to attach the actuator element 26 to the thumb ring 30. Therefore, as the actuator element 78 is translated by the user, the needle 34 will be translated.

[0016] As shown in Figs. 4A-4C, the grip 30 may be a thumb ring that includes a body 98 having a bore 102 extending proximally into the body 98. The bore 102 is adapted to receive the second coupling element 82 of the actuator element 26. The body 98 defines a ring 106 that is capable of receiving a user's thumb, so that the user may easily apply a force to the thumb ring 30, to thereby cause the actuator element 26, and thus the needle 34 to translate forward or backward.

[0017] To limit the travel of the actuator element 26 and the needle 34, the suture passer 10 includes an actuator stop 110. As shown in Figs. 1B, and 5A-5C, the actuator stop 110 is a generally cylindrical body 114 disposed in the second bore 62 of the handle 14. As shown in Figs. 5A-5C, the body 114 of the actuator stop 110 includes an irregular shaped bore 118 for receiving and attaching to the needle 34. Irregular shaped means any shape, excluding a perfect cylinder.

[0018] The body 114 of the actuator stop 110 also defines two mating features, such as detents 122 formed in its outer surface for receiving a corresponding mating feature such as a ball plunger that may be disposed in the handle 14. As shown, the detents 122 are radially separated 90 degrees from each other with respect to a longitudinal axis of the actuator stop 110. The detents 122 are configured to receive a ball plunger 126 disposed in the handle 14 to limit or control the rotation of the needle 34, for embodiments of the instrument 10 that require rotation of the needle 34. Thus, the rotation of the needle 34 is limited to 90 degrees. It should be understood, that the actuator stop 110 is not limited to such a design, and that other designs are envisioned. For example, the actuator stop 110 may be embodied by a narrowing of the second bore 62 of the handle 14. In such a case, the narrowing portion will be configured to contact the distal end of the actuator element 26 near the coupling of the actuator 26 to the needle 34 upon a given translational value of the actuator 26 with respect to the handle 14.

[0019] The suture passer 10 may include a lock 130 that is operable to fix the longitudinal position of the actuator 26, and thus the needle 34, such that the actuator 26 and the needle 34 are no longer able to translate when locked. The lock 130 includes a locking element 134, as shown in Figs. 6A and 6B, and a locking cap 138, as shown in Figs. 7A and 7B that interacts with the locking element 134 so as to fix the position of the locking element 134. Referring to Figs. 6A and 6B the locking element 134 includes a head 142 and a body 146 extending from the head 142. The body 146 defines two large detents 148, three small detents 150, and a bore 152 extending into an end of the body 146. The body also defines a protrusion 153 that extends between the two large detents 148. When the locking element 134 is positioned such that the actuator is received into one of the large detents 148, the ball plunger 74 contained within the fourth bore 70 of the handle will engage one of the outer smaller detents 150, and the actuator 26 will be capable of translating forward and backward. However, when the ball plunger 74 contained within the fourth bore 70 of the handle engages the center smaller detent 150, the locking element 134 is positioned such that protrusion 153 engages the detent 86 of the actuator 26, and the actuator 26 will not be capable of movement, thereby locking the actuator 26 and needle 34 in place.

[0020] The locking cap 138 is configured to engage the bore 152 of the locking element 134. As shown in Figs. 7A and 7B, the locking cap 138 includes a head 154 and a body 156 extending from the head 154. The body 156 is cylindrical and is configured to engage the bore 152 of the locking element 134. When the body 156 of the locking cap 138 is engaging the bore 152 of the locking element 134, the position of the locking element will be fixed.

[0021] As shown in Figs. 1A, and 8A-8D, the body member 18 is longitudinally elongated, and defines a channel 160 that longitudinally extends through the entire

length of the body member 18. As shown in Fig. 1B, the needle 34 is translatable within the channel 160 of the body member 18. The channel 160 includes a first channel portion and a second channel portion 164 that is disposed distal of the first channel portion and has a larger diameter than the first channel portion. The channel 160 can be sized to accommodate the needle 34 so that the needle 34 can reciprocate between an extended or advanced (forward) position and a retracted (rearward) position. The second channel portion 164 preferably has a larger diameter than the first channel portion. The larger second channel portion 164 is thus capable of receiving the shuttling element 40 when the needle 34 is in a retracted position, to thereby act as a sheath for the needle and shuttling element.

[0022] As shown in Figs. 1A, 8A-8B, and 9A-9D, the body member 18 further defines an actuator slot 168 extending through the outer surface in a direction generally transverse to the channel 160. The actuator slot 167extends into the first channel section of the channel 160 at the proximal end of the body member 18. The suture passing instrument 10 includes a tip actuator 180 that is configured to actuate the needle 34 to thereby couple or decouple the shuttling element 40 to the needle 34. As shown in Figs. 1A, and 9A-9D, the tip actuator 180 extends through the actuator slot 168, and is attached to the needle 34. In particular, the tip actuator 180 includes a keyed bored 188 that receives the needle 34 at a location whereby the needle 34 includes a similarly keyed cross section, such that the tip actuator 180 is rotatably coupled to the primary needle 34. The tip actuator 180 extends out from the body member 18, and can be engaged by a user so as to rotate the needle 34 through a 90 degree angle range about the longitudinal axis L of the instrument 10 between a locked position and an unlocked position. When in the locked position, the shuttling element 40 is coupled to the boom arm housing 198. When in the unlocked position, the shuttling element 40 is disengaged from the boom arm housing 198. The tip actuator 180 also includes indicia 189 indicating the position of the needle tip. The indicia may state "tip unlocked" as shown in Fig. 9C or "tip locked" as shown in Fig. 9D. It should be understood, however, that in other embodiments of the instrument 10, the shuttling element 40 can be detachably coupled to the boom arm housing 198 through translation or actuation of an engagement feature or other like structure, as opposed to rotation of the tip actuator 180. Therefore, it will be appreciated that the tip actuator 180 may also be configured to enable translation of an engagement feature or other like structure.

[0023] As shown in Figs. 1A-1B, and 10A-10H, the boom arm 22 extends from the elongated body 18. In particular, the boom arm 22 includes an arm 190 that is coupled to a distal end of the elongated body member 18 and extends distally to a boom arm housing 198. The boom arm housing 198 extends generally perpendicularly out from the distal end of the boom arm 22, and is configured to receive the shuttling element 40. It can thus be said that the boom arm 22 includes a boom arm housing 198 supported at the distal end of the boom arm 22. A tissue-receiving gap 202 is disposed between the boom arm housing 198 and the distal end of the elongated body 18. The tissue receiving gap 202 is configured to receive a piece of tissue having a tissue defect, such as a laceration, that is to be repaired by the suturing instrument 10.

[0024] The boom arm housing 198 defines a cylindrical or alternatively shaped channel or bore 210 that is aligned with the channel 160 formed in the body member 18. The boom arm housing 198 includes a locking interface 214 configured to selectively detachably couple the shuttling element 40 within the boom arm housing 198 when the shuttling element 40 is to be retained within the boom arm housing 198. As shown, the locking interface 214 may be a flange 218 extending from an internal surface of the housing 198 that defines a slot shaped opening 222 into the housing 198.

[0025] As shown in Figs. 11A-11E, the primary needle 34 includes an elongated shaft 230, and a needle element 234 extending from a distal end of the shaft 230. As shown in Figs. 11A-B, the shaft 230 is generally cylindrical, and includes a keyed portion 238 that corresponds in shape to the keyed bore 188 of the tip actuator 180. The keyed portion 238 of the shaft 230 is aligned with the actuator slot 168. Accordingly, the keyed portion 238 is disposed at the location the actuator stop 110 and the tip actuator 180 are connected to the primary needle 34, and thus extends through the keyed bore 188 of the tip actuator 180. As a result, as the tip actuator 180 is rotated by a user, the needle 34 will also be rotated in the manner described above. The needle 34 further includes a coupling element 242 that extends rearward from the shaft 230, and is configured to attach the actuator element 26 to the primary needle 34. The coupling element 242 may be a hex or head portion that allows rotation of the needle 34 with respect to the actuator element 26. Thus, the needle 34 may be rotated, while the actuator element remains stationary.

[0026] As shown in Figs. 11D and 11E, the needle element 234 includes a cylindrical body 246 having a needle tip 250 and an engagement feature 252 defined by two fins 254 that extend radially outward from the cylindrical body 246. Each fin 254 includes an angled front surface 258 and an angled rear surface 262. The angled surfaces 258 and 262 allow the fins 254 and thus the needle element 234 to more easily engage and snap into and out of the shuttling element 40.

[0027] As shown in Figs. 12A-12E the shuttling element 40 includes a needle engaging portion 300, and a tissue engaging portion 304 extending forward of the needle engaging portion 300. The needle engaging portion 300 is configured to couple to the needle element 234 of the needle 34. In accordance with the illustrated embodiment, the needle engaging portion 300 defines a bore 308 that is configured to receive the needle element

234 of the needle 34. Grooves 312 are formed in the needle engaging portion 300 and extend into the bore 308. Grooves 312 form an engagement feature 314 that correspond to the engagement feature 252 of the needle 34. Thus, grooves 312 are configured to receive the fins 254 of the needle 34 to thereby detachably couple the needle 34 to the shuttling element 40. Forward of the grooves 312 is a bore 316 for securely holding an end of the suture. The bi-directional suture instrument 10 may come preassembled with the suture secured to the shuttling element 40 or the instrument 10 may be provided with a plurality of shuttling elements 40, each with a strand of suture secured thereto.

[0028] The tissue engaging portion 304 is oblong and is shaped to be received by the slot shaped opening 222 of the boom arm housing 198. As shown, the tissue engaging portion 304 includes a needle-like tip 318 and a locking mechanism 320. The locking mechanism 320 is a protrusion 324 that defines a recess 328 in the tissue engaging portion 304. The locking mechanism 320 is configured to lockingly engage the locking interface 214 formed in the boom arm housing 198. Thus, the shuttling element 40 may carry a suture through tissue, be locked and retained in the boom arm housing 198, and at a later time be reattached to the needle, to carry the suture back through the tissue.

[0029] To maintain tension in the suture strand, the suture instrument 10 may include a suture tensioner 350 coupled to the handle 14. As shown in Figs. 1A, and 13, the suture tensioner 350 may be configured to hold and secure a loose end of suture material and maintain tension in the suture strand, thereby allowing the suture strand to be drawn through the suture tensioner element 350 under tension. The suture tensioner 350 is configured to hold and secure suture material on either side of the handle 14 and may be disposed through the handle 14 or may be embodied by two suture tensioner elements 350, one disposed on either side of the handle 14. The tensioner 350 includes two slots, one on either side of the handle 14, and the strand of suture is passed through one of the two slots to hold the strand in tension.

[0030] In operation, an operator engages the shuttling element 40, with an attached strand of suture, onto the needle 34 by snapping the fins 254 of the needle into the grooves 312 of the shuttling element 40, and, optionally, places the suture through the suture tensioner 250, as shown in Fig. 14A. An operator then grasps the handle 14 with an index and middle finger and disposes a thumb through the thumb ring 30, with the actuator 26 in a position retracted proximally from the handle 14. Tissue including a tissue defect, such as a fissure through the annulus fibrosis of an intervertebral disc, is received within the tissue receiving gap 202 disposed between the boom arm housing 198 and body member 18. With the thumb ring lock 130 in an open or unlocked configuration via the actuation of the thumb ring lock cap 138, the thumb ring 30 is translated distally with respect to the handle 14, thereby advancing the actuator 26 and the needle 34 distally with respect to the handle 14 and causing the distal end of the needle 34 and the shuttling element 40 attached thereto, as well as the suture attached to the shuttling element 40, to pass through the tissue adjacent to the defect and force contact to be made between the shuttling element 40 and the distal end of the boom arm 22, as shown in Fig. 14C. The tip actuator 180 is then actuated, rotating the needle 34 90 degrees, thereby causing the locking mechanism 320 of the shuttling element 40 to engage the locking interface 214 of the boom housing 198, as shown in Fig. 14E.

[0031] When the needle 34 is retracted, the shuttling element 40 will be released from the needle 34 and remain selectively coupled to the boom arm housing 198, thereby maintaining the shuttling element 40 and connected suture strand on the underside of the tissue adjacent the defect. The needle 34 is then retracted into the protective sheath embodied by the body member 18, as shown in Fig. 14G. The boom arm 22 is then manipulated, e.g., rotated, with the needle 34 safely shielded, to another area on the underside of the tissue adjacent the defect, e.g., on an opposite underside of the defect, and, once optimally relocated, the needle 34 is translated distally again with respect to the handle 14 using the thumb ring 30 and maintaining the thumb ring lock 130 and thumb ring lock cap 134 in an unlocked position, thereby forcing the needle 34 to pass through from the top side to the underside of the tissue at a second site adjacent to the defect and cause the distal end of the needle 34 to re-engage or snap back into the shuttling element 40, as shown in Fig. 14K. The tip actuator 180 is then re-actuated or rotated 90 degrees in a rotational direction that is opposite to the first actuation of the tip actuator 198, thereby unlocking the shuttling element 40 from the boom housing 198. The thumb ring 30 is then retracted proximally with respect to the handle 14, causing the corresponding retraction of the actuator 26 and the needle 34, and thereby causing the distal end of the needle 34 and the shuttling element 40 with suture to disengage from the boom arm 22 and pass from the underside of the tissue adjacent the defect out through the topside of the tissue adjacent the defect, as shown in Fig. 14M. The steps can be repeated one or more times as desired, depending on the size of the defect and the characteristics of the tissue.

[0032] In another embodiment, and in reference to Figs. 15A-15E, a series of grooves and traps may be utilized to detachably couple the shuttling element to the needle, and detachably couple the shuttling element to the boom arm housing. As shown, the bi-directional suture instrument 10 may include a tube-like shuttling element 1600 having a body 1604 defining a bore 1608 that is engaged by a needle 1612. The needle 1612 includes a body 1616 having engagement features such as a plurality of external ribs 1620 extending up from the body 1616, and a plurality of triangular traps 1624 formed in the body 1616 proximal to the ribs 1620. The traps 1624 are spaced apart from the ribs 1620 a distance to allow

the shuttling element 1600 to rest on the body 1616. The body 1604 of the shuttling element 1600 includes axial slots 1628 that are configured to align with each rib 1620 of the needle 1612. A plurality of ribs 1632 extend from an external surface of the body 1604 and are aligned with the slots 1628. The shuttling element 1600 also includes triangular traps 1640 formed on the proximal and distal ends of the shuttling element body 1604. The traps 1640 on the distal end of the shuttling element 1600 are offset from the ribs 1620 of the needle 1612 and are biased to accept and capture the proximal tips of the ribs when it is desirable for the shuttling element 1600 to be coupled to the needle 1612. The needle 1612 and the coupled shuttling element 1600 may then be advanced to the boom arm housing.

[0033] The boom arm housing 1650 includes a body 1654 that defines a bore 1658. The bore 1658 defines axial slots that are configured to align with external ribs 1632 of the shuttling element 1604. Within the bore 1658 of the housing 1650 is a counter force element, such as a spring, that is configured to interact with the distal tip of the shuttling element 1600 and the distal tip of the needle 1612. The counterforce element includes a series of axial slots and triangular traps that are configured to interact with the external ribs 1620 of the needle 1612, and a preferably flat surface that is configured to interact with the distal end of the shuttling element 1604. Additionally, the boom arm housing 1650 includes a series of triangular traps that are located distal to the axial slots within the bore 1658 that are configured to interact with the triangular traps on the proximal end of the shuttling element 1604.

[0034] In operation, the shuttling element 1604 enters the bore 1658 of the boom arm housing 1650 by aligning the external ribs 1632 of the shuttling element 1604 with the axial slots of the housing 1650. As the needle 1612 is advanced further the external ribs 1620 on the needle 1612 align with the axial slots in the counterforce element, allowing the needle 1612 to advance through the counterforce element. Simultaneously the shuttling element 1604 is advanced past the axial slots within the boom housing 1650 and encounters the flat surface of the counter-force element, which pushes the shuttling element 1604 toward the proximal end of the boom tip, causing the shuttling element 1604 to rotate as the triangular traps 1640 on the proximal ends of the shuttling element 1604 interact with and are captured by the triangular traps on the distal end of the axial slots within the boom housing 1650. This rotation of the shuttling element 1604 aligns the axial slots 1628 within the shuttling element 1604 with the axial slots of the counterforce element and the external ribs 1620 of the needle 1612, allowing the needle 1612 to be freely retracted from the boom arm housing 1650 and retracted into the protective sheath embodied by the body, leaving the shuttling element 1604 detachably coupled to the distal boom housing 1650, thereby maintaining the shuttling element 1604 and connected suture strand on the underside of the tissue adjacent the defect.

[0035] The boom arm is then manipulated, e.g., rotated, with the needle 1612 safely shielded, to another area on the underside of the tissue adjacent the defect, e.g., on an opposite underside of the defect, and, once optimally relocated, the needle 1612 is translated distally again with respect to the handle using the thumb ring and maintaining the thumb ring lock and thumb ring lock cap in an unlocked position, thereby forcing the needle 1612 to pass through from the top side to the underside of the tissue at a second site adjacent to the defect and cause the distal end of the needle 1612 to re-engage the shuttling element 1604. The external ribs 1620 on the needle 1612 translate within the axial slots 1628 on the interior of the shuttling element 1604 in a distal motion. As the needle 1612 is further advanced the triangular traps 1624 on the proximal side of the distal end of the needle 1612 contact the triangular traps 1640 on the proximal end of the shuttling element 1604 and engage the shuttling element 1604, causing the shuttle 1604 to rotate. In this rotated position the external ribs 1620 on the needle 1612 are no longer aligned with the axial slots 1628 on the interior of the shuttling element 1604 and are instead aligned with the triangular traps 1640 on the distal end of the shutting element 1604, allowing the shuttling element 1604 to be recaptured by the needle 1612, thereby coupling the shuttling element 1604 to the needle 1612 upon retraction of the needle 1612.

[0036] In another embodiment, and in reference to Figs. 16A-16L, threaded engagement features and threaded locking interfaces may be utilized to detachably couple the shuttling element to the needle and detachably couple the shuttling element to the boom arm housing. As shown in Figs. 16A and 16B, the bi-directional suture instrument 10 may include a cannulated needle 1670, and a dual ended shuttling element 1674 that is selectively coupled to the needle 1670. The needle 1670 includes a body 1678 having a bore or channel 1682 extending through the body 1678. The distal end of the bore 1682 includes an engagement feature such as internal threads 1686. Detachably coupled to the distal end of the needle 1670 is the shuttling element 1674.

[0037] The shuttling element 1674 includes a body 1690 that defines a radial groove 1694 for fastening a suture to the shuttling element 1674, a first head 1698 extending rearward from the body 1690, and a second head 1702 extending forward from the body 1690. The first head 1698 includes an engagement feature such as external threads 1706 that are configured to engage the internal threads 1686 of the needle 1670. The second head 1702 includes a locking mechanism, such as external threads 1710 and a needle point 1714 forward of the external threads 1710. The external threads 1706 and the external threads 1710 have opposite threads. For example, external threads 1706 are left handed threads, and external threads 1710 are right handed threads, which will allow the needle 1670 to become detached from the shuttling element 1674. The internal and

external threads may have different pitches.

[0038] The shuttling element 1674 is preferably decoupleable from the needle 1670 within a boom arm housing, such as boom arm housing 1718, via actuation of a tip actuator. Boom arm housing 1718 includes a body 1722 having a bore 1726 that extends therethrough. The distal end of the bore 1726 includes a locking interface, such as internal threads 1730 that are configured to engage the external threads 1710 of the shuttling element 1674. The proximal end of the shuttling element 1674 includes a gap 1740 to create clearance for the suture that is attached to the shuttling element 1674.

[0039] In operation, an operator engages the shuttling element 1674 with attached suture onto the needle 1670 and, optionally, places the suture through a suture tensioner. An operator grasps the handle with his index and middle finger and disposes his thumb through the thumb ring, with the actuator in a position retracted proximally from the handle. The distal portion of the boom arm is placed through a tissue defect, such as a fissure through the annulus fibrosis of an intervertebral disc, from a top side of the tissue to an underside of the tissue, and is rotated or otherwise positioned adjacent the defect in an optimum configuration for passing a suture adjacent to the tissue defect for the purposes of approximating the defect. The thumb ring is translated distally with respect to the handle, thereby advancing the actuator and the needle 1670 distally with respect to the handle and causing the distal end of the needle 1670 and the shuttling element 1674 attached thereto, as well as the suture attached to the shuttling element 1674, to pass through the tissue adjacent to the defect and force contact to be made between the shuttling element 1674 and the boom arm housing 1718. When the distal tip of the shuttling element 1674 contacts the proximal end of the internal threads 1674 of the boom arm housing 1718, the tip actuator is actuated (i.e. right hand turning) causing the needle 1670 and shuttling element 1674 to be rotated, thereby engaging the external threads 1710 of the shuttling element 1674 with the internal threads 1674 of the boom arm housing 1718. Further rotation of the needle 1670 cause a decoupling of the threaded shuttling element 1674 from the needle 1670, leaving the shuttling element 1674 coupled to the boom arm housing 1718. In other words, at some point, as the needle 1670 is rotated, the shuttling element 1674 stops rotating in the boom arm housing 1718, and the needle 1670 continues to rotate causing the needle 1670 to disengage from the shuttling element 1674. This disengagement is enabled because of the opposite threading of the external threads 1706 and external threads 1710 of the shuttling element 1674.

[0040] The needle 1674 is then retracted into the protective sheath embodied by the body. The boom arm is then manipulated., e.g., rotated, with the needle 1670 safely shielded, to another area on the underside of the tissue adjacent the defect, e.g., on an opposite underside of the defect, and, once optimally relocated, the needle 1670 is translated distally again with respect to the handle using the thumb ring, thereby forcing the needle 1670 to pass through from the top side to the underside of the tissue at a second site adjacent to the defect and cause the distal end of the needle 1670 to contact the proximal edge of the external threads 1706 of the shuttling element 1674. The tip actuator is then re-actuated (i.e. left hand turning), causing the needle 1670 to rotate in the opposite direction, thereby engaging the internal threads 1686 of the needle 1670 with the external threads 1706 on the proximal end of the shuttling element 1674, and coupling the shuttling element 1674 to the needle 1670. Further rotation of the needle 1670 causes the shuttling element 1674 to decouple from the boom arm housing 1718. The thumb ring is then retracted proximally with respect to the handle, causing the corresponding retraction of the actuator and the needle 1670, and thereby causing the distal end of the needle 1670 and the shuttling element 1674 with suture to pass from the underside of the tissue adjacent the defect out through the topside of the tissue adjacent the defect. The steps can be repeated one or more times as desired, depending on the size of the defect and the characteristics of the tissue.

[0041] In another embodiment, and in reference to Figs. 17A - 17C, the needle includes external threads rather than internal threads. As shown in Fig. 17A, the bi-directional suture instrument 10 may include a needle 1750, and a shuttling element 1754 that is selectively coupled to an exterior surface of the needle 1750. The needle 1750 includes a body 1758 having an engagement feature such as external threads 1766 proximate to its distal end. Detachably coupled to the distal end of the needle 1750 is the shuttling element 1754.

[0042] The shuttling element 1754 includes a body 1770 having an axial bore 1774 extending therethrough. As shown, the bore 1774 includes an engagement feature, such as internal threads 1778 that are configured to engage the external threads 1766 of the needle 1750. The shuttling element body 1754 also includes a locking mechanism, such as external threads 1780. The internal threads 1778 and the external threads 1780 have opposite threads. For example, internal threads 1778 are left handed threads, and external threads 1780 are right handed threads, which will allow the needle 1670 to become detached from the shuttling element 1674.

[0043] The shuttling element 1754 is preferably decoupleable from the needle 1750 within a boom arm housing, such as boom arm housing 1784, via actuation of a tip actuator. Boom arm housing 1784 includes a body 1788 having a bore 1792 that extends therethrough. The bore 1792 includes a locking interface, such as internal threads 1796 that are configured to engage the external threads 1780 of the shuttling element 1754. The shuttling element 1754 may be coupled to the boom arm housing 1784, as shown in Figs. 17B and 17C in a similar manner as the embodiment described in reference to Figs. 16A-16L. It should be understood, that the shuttling element 1754 is not limited to the configuration described, and may be dual ended as described in Figs. 16A - 16L, with

the first head having a bore that defines internal threads configured to engage the external threads 1766 of the needle 1750.

[0044] In another embodiment, and in reference to Figs. 18A-18N, wings may be utilized rather than threads to detachably couple the needle to the shuttling element, and the shuttling element to the boom arm housing. As shown, the bi-directional suture instrument 10 may include a winged needle 1800 that is detachably coupled to a winged shuttling element 1804. As shown, the needle 1800 includes a body 1808 having an engagement feature, such as wings 1812 extending radially outward from an external surface of the body 1808 adjacent a distal top of the needle 1800. Each wing 1812 includes an angled front surface 1816. As shown, the wings 1812 extend on opposite sides of the needle body 1808 and are configured to engage the shuttling element 1804.

[0045] The shuttling element 1804 includes a body 1820 having a locking mechanism such as wings 1824 extending radially outward from an external surface of the body 1820 adjacent a needle like distal end 1828, and a bore 1832 extending into the body 1820 from the proximal end of the body 1820. Each wing 1824 includes an angled front surface 1830 to allow the shuttling element 1804 to easily pass through tissue. The shuttling element 1804 includes a bore 1832 having a pair of axial slots 1836 that lead into an engagement feature, such as radial slots 1840, which are configured to be engaged by wings 1812 of the needle 1800 to detachably couple the shuttling element 1804 to the needle 1800.

[0046] The shuttling element 1804 and needle 1800 may be advanced into a boom arm housing, such as boom arm housing 1850. As shown, the boom arm housing 1850 is similar to the proximal end of the shuttling element 1804. In other words, the boom arm housing 1850 includes a bore 1854 that defines axial slots 1858 to lead into a locking interface, such as radial slots 1862, which are configured to be engaged by wings 1824 of the shuttling element 1804.

[0047] In operation, the needle 1800 is coupled to the shuttling element 1804 by aligning the wings 1812 with the axial slots 1836 of the shuttling element 1804. The needle 1800 is then advanced through the slots 1836 and into the radial slots 1840. The needle is then rotated 180 degrees (right hand turning) and the interface between the wings 1812 and the radial slots 1840 couples the shuttling element 1804 to the needle 1800. The shuttling element 1804 and the needle 1800 are then translated toward the boom arm housing 1850. The shuttling element 1804 engages the boom arm housing 1850 by aligning the wings 1824 of the shuttling element 1804 with the axial slots 1858 of the boom arm housing 1850. The shuttling element 1804 is further advanced until the wings 1824 engage the radial slots 1862 of the boom arm housing 1850. The needle 1800 with the shuttling element 1804 are then rotated to thereby selectively couple the shuttling element 1804 to the boom arm housing 1850. The needle 1800 may then be retracted thereby leaving the shuttling element 1804 in the boom arm housing 1850. The steps can be repeated one or more times as desired, depending on the size of the defect and the characteristics of the tissue.

[0048] Alternatively the engagement features of the embodiment shown in Figs. 18A-18N may be reversed. For example, as shown in Fig. 19 the bi-directional suture passing instrument 10 may include a needle 1870, that is detachably coupled to a shuttling element 1874. As shown, the needle 1870 includes a body 1878 having an engagement feature, such as a recess 1882 extending radially inward from an external surface of the body 1878. The recess 1882 extends proximally to a radial slot 1886 that defines a back wall 1890. As shown, the recess 1882 is configured to engage the shuttling element 1874.

[0049] The shuttling element 1874 includes a body 1894 having a bore 1898 and a locking mechanism that is substantially identical to the engagement feature of the needle 1870. The bore 1898 includes an axial protrusion that define an engagement feature, such as a radial slot, that is configured to be engaged by the recess and back wall of the needle 1870 to thereby detachably couple the shuttling element 1874 to the needle 1870.

[0050] The shuttling element 1874 and needle 1870 may be advanced into a boom arm housing, such as boom arm housing 1906. As shown, the boom arm housing 1906 is similar to the proximal end of the shuttling element 1874. In other words, the boom arm housing 1906 includes a bore 1910 that defines an axial protrusion 1912 that define an engagement feature, such as a radial slot, that is configured to be engaged by the recess and back wall of the shuttling element 1874 to detachably couple the shuttling element 1874 to the boom arm housing 1906.

[0051] As shown in Figs. 20A-20D, the bi-directional suture passer 10 may include other features and designs. For example, as shown in Fig. 20A, the bi-directional suture passer 10 may include a handle 1920 a member 1924 extending through the handle 1920, and a boom arm 1928 extending from an end of the member 1924. The bi-directional suture passer 10 may also include a driver 1932 translatable within a bore of the member 1924. As shown in Fig. 20B, the driver 1932 includes a knob 1936, a shaft 1940 extending from the knob 1936, and a needle 1944 extending from a distal end of the shaft 1940. The needle 1944 is similar to the needle described in reference to Figs. 17A-17C and includes an engagement feature comprising externally extending threads 1948 for coupling the needle 1944 to a shuttling element such as shuttling element 1950 shown in Fig. 17C. The threads of the needle 1944 and shuttling element 1944 may engage each other either in a ratcheting type connection or a rotation type connection. **20**

[0052] As shown in Fig. 20C the shuttling element includes a body 1951 having a needle engaging portion 1952 and a tissue engaging portion 1953. As shown, the needle engaging portion 1953 includes a bore 1954 having an internal surface that defines an engagement fea-

ture such as threads. The threads of the needle engaging portion 1953 are configured to engage the threads 1948 of the needle 1944 to detachably couple the needle 1944 to the shuttling element 1950. As shown, the tissue engaging portion 1953 extends distally and includes a locking mechanism such as external threads 1955. Threads 1955 are configured to engage a locking feature defined by a boom arm housing 1956 (shown in Fig. 56D) of the boom arm 1928.

[0053] As shown in Fig. 20D, the boom arm housing 1956 has a bore 1960 extending therethrough. The bore 1960 has an internal surface that defines internal threads 1964. The boom arm 1928 also includes slots 1970 that extend through the body of the boom arm 1928. The slots 1970 allow the boom arm housing 1956 to separate slightly when the shuttling element 1950 is being disposed within the bore 1960. Therefore, for embodiments that utilize threads, the amount of turning may be reduced because the shuttling element may be ratcheted in. To remove the shuttling element from the boom arm housing 1956, the shuttling element may be turned or rotated to unthread the shuttling element form the boom arm housing 1956.

[0054] In reference to Fig. 21A-21E, the bi-directional suture passing instrument 10 may be configured to create a pathway in a bony structure through which the suture can be passed. As shown, the bi-directional suture instrument 10 may include a boom arm 2000 having an awl tip 2004 configured to allow the boom arm 2000 to create a pathway in a bony structure through which the suture can be passed. Alternatively, the bi-directional suture instrument 10 may include a needle 2008 having an awl tip 2012 configured to enable the tip of the needle 2008 to create a pathway in a bony structure through which the suture can be passed. It should be understood that both the boom arm and the needle can include an awl tip.

[0055] As shown in Fig. 21B, an impaction rod 2016 may be attached to the instrument 10, and may be configured to contact an impact wall formed on the boom arm 2000. Alternatively, the impaction rod 2016 may include grips 2020, as shown in Figs. 21C-21E, that are configured to grip and hold the needle 2008 when the needle 2008 is to be impacted. A bi-directional suture passing instrument 10 having such features may be used to repair annulus rim tears.

[0056] The bi-directional suture instrument 10 may be used to repair soft tissue defects using a variety of different suture passing configurations,such as those illustrated in Figs. 22A-22F. For example a simple stitch 2100 as shown in Fig. 22A, a box mattress stitch 2104 as shown in Fig. 22B, a mattress stitch 2108 as shown in Fig. 22C, a reverse mattress stitch 2112 as shown in Fig. 22D, a vertical mattress stitch 2116 as shown in Fig. 22E, and a reverse vertical mattress stitch 2120 as shown in Fig. 22F. The final configuration of suture surrounding the defect may be a single straight loop, a mattress stitch or combination of mattress stitches, or may include a loop comprising any of a number of stitch patterns for soft tissue repair known to the art of arthroscopic, laparoscopic, orthopedic, cardiovascular, or general surgery.

[0057] As shown in Fig. 22A, the simple stitch 2100 is formed by passing the suture through the full thickness of tissue on one side of a defect and retrieved through the full thickness of tissue on the other side of the defect. The suture may first be passed from inside to outside (i.e., a first side to a second side of the tissue), and then retrieved from outside to inside (i.e., a second side to a first side) of the tissue, or may first be passed from outside to inside then inside to outside of the tissue. Any combination of outside-to-inside and inside-to-outside passes may be used.

[0058] As shown in Fig. 22B, the box stitch 2104 is formed by passing the suture horizontally across the defect and then from the proximal side of the disc to the distal side of the disc. The suture is then passed back across the defect and the free end of the suture is then tied into a knot to complete the stitch. The knot sits on the outside of the annulus defect.

[0059] As shown in Fig. 22C, the mattress stitch 2108 is formed by passing the suture from the proximal side of the disc to the distal side of the disc, and then across the defect at an angle toward the proximal side of the disc. The steps are repeated and the free end of the suture is then tied into a knot to complete the stitch. The knot sits on the outside of the annulus defect. As shown in Fig. 22D, the knot sits o the inside of the annulus wall below the defect for a zero profile closure for the reverse mattress stitch 2112.

[0060] As shown in Figs. 22E and 22F, the vertical mattress stitch and the reverse vertical mattress stitch may be formed by passing the suture across the defect on the proximal side of the disc, and then across the defect at an angle toward a distal side of the disc. The steps are repeated and the stitch is completed. As shown, the knot may be either outside of the annulus defect, as shown in Fig. 22E, or inside of the defect as shown in Fig. 22F.

[0061] The bi-directional suture instrument 10 may also be configured to pass a suture for soft tissue repair near a bony element, such as a vertebral body, is shown in Figs. 22G-22I. As shown, a free end 2200 of the suture is passed through the full thickness of the annulus wall on the side of the defect furthest away from the vertebral body nearest the defect and then passed through a hole that is formed through the vertebral body via a transosseus approach next to the defect. The hole can be created using an awl tip or awl tipped needle as described above in reference to Fig. 21A-21D, or can be predrilled. The suture may first be passed through the vertebral body and then through the full thickness of the annulus. Such a method may also be configured for other soft tissues adjacent a bony element, such as reattachment of torn rotator cuff tendons to the lesser tuberosity of the humerus.

[0062] It will be appreciated by those skilled in the art that changes could be made to the embodiments de-

scribed above without departing from the broad inventive concept thereof. It is understood, therefore, that this invention is not limited to the particular embodiments disclosed, but it is intended to cover modifications within the scope of the present invention as defined by the present description. The scope of the invention is therefore defined by the claims. For example, other engagement features may be utilized to detachably connect the needle to the shuttling element and other mechanisms may be utilized to detachably connect the shuttling element to the boom arm housing, such as a Morse taper coupling, a magnetic hold, a press fit coupling, and a variety of other mechanical connections known in the art. Furthermore, any features of one described embodiment can be applicable to the other embodiments described herein. For example, each shuttling element described, may be tubular and capable of fitting over the needle, or each may include a needle like tip with a proximal end configured to be coupled to the needle.

Claims

1. A bi-directional suture passing instrument (10) configured to approximate soft tissue defects, the suture passing instrument comprising:

a body member (18) defining a needle receiving channel (160);
a boom arm (22) extending from the body member (18), the boom arm (22) having a boom arm housing (198; 1718; 1784; 1850) that is spaced from the body member (18), wherein a tissue-receiving gap (202) is disposed between the boom arm housing (198; 1718; 1784; 1850) and the body member (18);
a needle (34; 1670; 1750; 1800) reciprocally translatable within the channel (160) of the body member (18) between an advanced position in which a distal end of the needle (34; 1670; 1750; 1800) extends into the boom arm housing (198; 1718; 1784; 1850), and a retracted position in which the distal end of the needle (34; 1670; 1750; 1800) is retracted from the boom arm housing (198; 1718; 1784; 1850); and
a shuttling element (40; 1674; 1754; 1804) configured to detachably couple to the needle (34; 1670; 1750; 1800), and to the boom arm housing (198; 1718; 1784; 1850),
characterized in that (i) when the shuttling element (40; 1674; 1754; 1804) is detachably coupled to the needle (34; 1670; 1750; 1800), rotation of the needle (34; 1670; 1750; 1800) relative to the boom arm housing (198; 1718; 1784; 1850) causes the shuttling element (40; 1674; 1754; 1804) to detachably couple to the boom arm housing (198; 1718; 1784; 1850), and (ii) when the shuttling element (40; 1674; 1754; 1804) is detachably coupled to the boom arm housing (198; 1718; 1784; 1850), rotation of the needle (34; 1670; 1750; 1800) relative to the shuttling element (40; 1674; 1754; 1804) causes the needle (34; 1670; 1750; 1800) to detachably couple to the shuttling element (40; 1674; 1754; 1804).

2. The bi-direction suture passing instrument of claim 1, wherein (i) the needle (34; 1670; 1750; 1800) includes an engagement feature (252; 1686; 1766; 1812), (ii) the shuttling element (40; 1674; 1754; 1804) includes an engagement feature (314; 1706; 1778; 1840), and (iii) when the shuttling element (40; 1674; 1754; 1804) is detachably coupled to the boom arm housing (198; 1718; 1784; 1850), rotation of the needle (34; 1670; 1750; 1800) relative to the shuttling element (40; 1674; 1754; 1804) causes the engagement feature (252; 1686; 1766; 1812) of the needle (34; 1670; 1750; 1800) to engage the engagement feature (314; 1706; 1788; 1840) of the shuttling element (40; 1674; 1754; 1804) to detachably couple the needle (34; 1670; 1750; 1800) to the shuttling element (40; 1674; 1754; 1804).

3. The bi-directional suture passing instrument of claim 2, wherein (i) the shuttling element (40; 1674; 1754; 1804) includes a locking mechanism (320; 1710; 1780; 1824), (ii) the boom arm housing (198; 1718; 1784; 1850) includes a locking interface (214; 1730; 1796; 1862), and (iii) when the shuttling element (40; 1674; 1754; 1804) is detachably coupled to the needle (34; 1670; 1750; 1800), rotation of the needle (34; 1670; 1750; 1800) relative to the boom arm housing (198; 1718; 1784; 1850) causes the locking mechanism (320; 1710; 1780; 1824) of the shuttling element (40; 1674; 1754; 1804) to engage the locking interface (214; 1730; 1796; 1862) of the boom arm housing (198; 1718; 1784; 1850) to detachably couple the shuttling element (40; 1674; 1754; 1804) to the boom arm housing (198; 1718; 1784; 1850).

4. The bi-directional suture passing instrument of claim 3, wherein engagement feature (1706; 1778) of the shuttling element (1674; 1754) and the locking mechanism (1710; 1780) of the shuttling element (1674; 1754) are oppositely oriented threads.

5. The bi-directional suture passing instrument of any one of claims 2 to 4, wherein the engagement features (1686; 1766) of the needle (1670; 1750) and the shuttling element (1674; 1754) are threads, and the threads (1686; 1766) of the needle (1670; 1750) are configured to engage the threads (1706; 1778) of the shuttling element (1674; 1754).

6. The bi-directional suture passing instrument of claim 5, wherein the threads (1766) of the needle (1750)

extend from an external surface of the needle (1750).

7. The bi-directional suture passing instrument of claim 6, wherein (i) the shuttling element (1754) defines a bore (1774), (ii) the threads (1778) of the shuttling element (1754) extend from an internal surface of the bore (1774), and (iii) the bore (1774) is configured to receive the needle (1750).

8. The bi-directional suture passing instrument of claim 7, wherein the bore (1774) extends completely through the shuttling element (1754), and the needle (1750) is configured to extend through the bore (1774) of the shuttling element (1754).

9. The bi-directional suture passing instrument of claim 5, wherein the needle (1670) includes a bore (1682), and the threads (1686) of the needle (1670) extend from an internal surface of the bore (1682).

10. The bi-directional suture passing instrument of claim 9, wherein (i) the threads (1706) of the shuttling element (1674) extend from an external surface of the shuttling element (1674), and (ii) the bore (1682) of the needle (1670) is configured to receive the shuttling element (1674).

11. The bi-directional suture passing instrument of any one of claims 3 to 10, wherein (i) the locking mechanism (1710; 1780) of the shuttling element (1674; 1754) and the locking interface (1730; 1796) of the boom arm housing (1718; 1784) are threads, (ii) the threads (1710; 1780) of the shuttling element (1674; 1754) extend from an external surface of the shuttling element (1674; 1754), (iii) the threads (1730; 1796) of the boom arm housing (1718; 1784) extend from an internal surface of a bore (1726; 1792) that is defined by the boom arm housing (1718; 1784), and (iv) the threads (1710; 1780) of the shuttling element (1674; 1754) are configured to engage the threads (1730; 1796) of the boom arm housing (1718; 1784).

12. The bi-directional suture passing instrument of claim 3, wherein (i) the engagement feature (1812) of the needle (1800) includes a wing extending out from a body (1808) of the needle (1800), (ii) the shuttling element (1804) includes a bore (1832) that defines an axial slot (1836) configured to receive the wing (1812) of the needle (1800), (iii) the axial slot (1836) extends into the engagement feature (1840) of the shuttling element (1804), (iv) the engagement feature (1840) of the shuttling element (1804) includes a radial slot, and (v) rotation of the needle (1800) causes the wing (1812) of the needle (1800) to engage the radial slot (1840) of the shuttling element (1804) to thereby detachably couple the shuttling element (1804) to the needle (1800).

13. The bi-directional suture passing instrument of claim 12, wherein (i) the locking mechanism (1824) of the shuttling element (1804) includes a wing extending out from a body (1820) of the shuttling element (1804), (ii) the boom arm housing (1850) includes a bore (1854) that defines an axial slot (1858) configured to receive the wing (1824) of the shuttling element (1804), (iii) the axial slot (1858) extends into the locking interface (162) of the boom arm housing (1850), (iv) the locking interface (1862) of the boom arm housing (1850) includes a radial slot, and (v) rotation of the shuttling element (1804) causes the wing (1824) of the shuttling element (1804) to engage the radial slot (1862) of the boom arm housing (1850) to thereby detachably couple the shuttling element (1804) to the boom arm housing (1850).

14. The bi-directional suture passing instrument of any one of claims 1 to 13, further comprising a tip actuator (180) coupled to the needle, wherein rotation of the tip actuator (180) causes the needle to rotate.

15. The bi directional suture passing instrument of any one of claims 1 to 14, further comprising an actuation member (26) coupled to a proximal end of the needle, wherein translation of the actuation member (26) causes the needle to translate.

16. The bi-directional suture passing instrument of any one of claims 1 to 15, wherein either the boom arm housing or the needle include an awl tip.

Patentansprüche

1. Bidirektionales Nahtmaterial-Durchlaufinstrument (10), das zur Annäherung an Weichteil-Defekte konfiguriert ist, wobei das Nahtmaterial-Durchlaufinstrument umfasst:

ein Körperelement (18), das einen Nadelaufnahmekanal (160) definiert;
einen Auslegerarm (22), der sich von dem Körperelement (18) erstreckt, wobei der Auslegerarm (22) ein Auslegerarmgehäuse (198; 1718; 1784; 1850) aufweist, das vom Körperelement (18) beabstandet ist, wobei ein Gewebe-Aufnahmezwischenraum (202) zwischen dem Auslegerarmgehäuse (198; 1718; 1784; 1850) und dem Körperelement (13) angeordnet ist;
eine Nadel (34; 1670; 1750; 1800), die im Innern des Kanals (160) des Körperelements (18) zwischen einer vorgerückten Position, an der sich ein distales Ende der Nadel (34; 1670; 1750; 1800) in das Auslegerarmgehäuse (198; 1718; 1784; 1850) erstreckt, und einer zurückgezogenen Position, an der das distale Ende der Nadel (34; 1670; 1750; 1800) aus dem Auslegerarm-

gehäuse (198; 1718; 1784; 1850) zurückgezogen ist, hin und her verschiebbar ist; und
ein Pendelelement (40; 1674; 1754; 1804), das zum lösbaren Verbinden mit der Nadel (34; 1670; 1750; 1800) und dem Auslegerarmgehäuse (198; 1718; 1784; 1850) konfiguriert ist,
dadurch gekennzeichnet, dass (i) wenn das Pendelelement (40; 1674; 1754; 1804) lösbar mit der Nadel (34; 1670; 1750; 1800) verbunden ist, eine Drehung der Nadel (34; 1670; 1750; 1800) relativ zum Auslegerarmgehäuse (198; 1718; 1784; 1850) bewirkt, dass sich das Pendelelement (40; 1674; 1754; 1804) lösbar mit dem Auslegerarmgehäuse (198; 1718; 1784; 1850) verbindet, und (ii) wenn das Pendelelement (40; 1674; 1754; 1804) lösbar mit dem Auslegerarmgehäuse (198; 1718; 1784; 1850) verbunden ist, eine Drehung der Nadel (34; 1670; 1750; 1800) relativ zum Pendelelement (40; 1674; 1754; 1804) bewirkt, dass die Nadel (34; 1670; 1750; 1800) lösbar mit dem Pendelelement (40; 1674; 1754; 1804) verbunden ist.

2. Bidirektionales Nahtmaterial-Durchlaufinstrument nach Anspruch 1, wobei (i) die Nadel (34; 1670; 1750; 1800) ein Eingriffselement (252; 1686; 1766; 1812) umfasst, (ii) das Pendelelement (40; 1674; 1754; 1804) eine Eingriffseinrichtung (314; 1706; 1778; 1840) umfasst, und (iii), wenn das Pendelelement (40; 1674; 1754; 1804) lösbar mit dem Auslegerarmgehäuse (198; 1718; 1784; 1850) verbunden ist, eine Drehung der Nadel (34; 1670; 1750; 1800) relativ zum Pendelelement (40; 1674; 1754; 1804) bewirkt, dass das Eingriffselement (252; 1686; 1766; 1812) der Nadel (34; 1670; 1750; 1800) in das Eingriffselement (314; 1706; 1788; 1840) des Pendelelements (40; 1674; 1754; 1804) zum lösbaren Verbinden der Nadel (34; 1670; 1750; 1800) mit dem Pendelelement (40; 1674; 1754; 1804) eingreift.

3. Bidirektionales Nahtmaterial-Durchlaufinstrument nach Anspruch 2, wobei (i) das Pendelelement (40; 1674; 1754; 1804) einen Verriegelungsmechanismus (320; 1710; 1780; 1824) umfasst, (ii) das Auslegerarmgehäuse (198; 1718; 1784; 1850) eine Verriegelungsschnittstelle (214; 1730; 1796; 1862) umfasst, und (iii), wenn das Pendelelement (40; 1674; 1754; 1804) lösbar mit der Nadel (34; 1670; 1750; 1800) verbunden ist, eine Drehung der Nadel (34; 1670; 1750; 1800) relativ zum Auslegerarmgehäuse (198; 1718; 1784; 1850) bewirkt, dass der Verriegelungsmechanismus (320; 1710; 1780; 1824) des Pendelelements (40; 1674; 1754; 1804) in die Verriegelungsschnittstelle (214; 1730; 1796; 1862) des Auslegerarmgehäuses (198; 1718; 1784; 1850) zum lösbaren Verbinden des Pendelelements (40; 1674; 1754; 1804) mit dem Auslegerarmgehäuse (198; 1718; 1784; 1850) eingreift.

4. Bidirektionales Nahtmaterial-Durchlaufinstrument nach Anspruch 3, wobei das Eingriffselement (1706; 1778) des Pendelelements (1674; 1754) und der Verriegelungsmechanismus (1710; 1780) des Pendelelements (1674; 1754) entgegengesetzt ausgerichtete Gewinde sind.

5. Bidirektionales Nahtmaterial-Durchlaufinstrument nach einem der Ansprüche 2 bis 4, wobei die Eingriffselemente (1686; 1766) der Nadel (1670; 1750) und des Pendelelements (1674; 1754) Gewinde sind, und die Gewinde (1686; 1766) der Nadel (1670; 1750) zum Eingriff mit den Gewinden (1706; 1778) des Pendelelements (1674; 1754) konfiguriert sind.

6. Bidirektionales Nahtmaterial-Durchlaufinstrument nach Anspruch 5, wobei sich die Gewinde (1766) der Nadel (1750) von einer Außenfläche der Nadel (1750) erstrecken.

7. Bidirektionales Nahtmaterial-Durchlaufinstrument nach Anspruch 6, wobei (i) das Pendelelement (1754) eine Bohrung (1774) definiert, (ii) sich die Gewinde (1778) des Pendelelements (1754) von einer Innenfläche der Bohrung (1774) erstrecken, und (iii) die Bohrung (1774) zum Aufnehmen der Nadel (1750) konfiguriert ist.

8. Bidirektionales Nahtmaterial-Durchlaufinstrument nach Anspruch 7, wobei sich die Bohrung (1774) vollständig durch das Pendelelement (1754) erstreckt, und die Nadel (1750) zum Erstrecken durch die Bohrung (1774) des Pendelelements (1754) konfiguriert ist.

9. Bidirektionales Nahtmaterial-Durchlaufinstrument nach Anspruch 5, wobei die Nadel (1670) eine Bohrung (1682) umfasst, und sich die Gewinde (1686) der Nadel (1670) von einer Innenfläche der Bohrung (1682) erstrecken.

10. Bidirektionales Nahtmaterial-Durchlaufinstrument nach Anspruch 9, wobei (i) sich die Gewinde (1706) des Pendelelements (1674) von einer Außenfläche des Pendelelements (1674) erstrecken, und (ii) die Bohrung (1682) der Nadel (1670) zum Aufnehmen des Pendelelements (1674) konfiguriert ist.

11. Bidirektionales Nahtmaterial-Durchlaufinstrument nach einem der Ansprüche 3 bis 10, wobei (i) der Verriegelungsmechanismus (1710; 1780) des Pendelelements (1674; 1754) und die Verriegelungsschnittstelle (1730; 1796) des Auslegerarmgehäuses (1718; 1784) Gewinde sind, (ii) sich die Gewinde (1710; 1780) des Pendelelements (1674; 1754) von einer Außenfläche des Pendelelements (1674; 1754) erstrecken, (iii) sich die Gewinde (1730; 1796) des Auslegerarmgehäuses (1718; 1784) von einer

Innenfläche einer Bohrung (1726; 1792) erstrecken, die durch das Auslegerarmgehäuse (1718; 1784) definiert ist, und (iv) die Gewinde (1710; 1780) des Pendelelements (1674; 1754) zum Eingriff mit den Gewinden (1730; 1796) des Auslegerarmgehäuses (1718; 1784) konfiguriert sind.

12. Bidirektionales Nahtmaterial-Durchlaufinstrument nach Anspruch 3, wobei (i) das Eingriffselement (1812) der Nadel (1800) einen Flügel aufweist, der sich aus einem Körper (1808) der Nadel (1800) heraus erstreckt, (ii) das Pendelelement (1804) eine Bohrung (1832) umfasst, die einen axialen Schlitz (1836) definiert, der zum Aufnehmen des Flügels (1812) der Nadel (1800) konfiguriert ist, (iii) sich der axiale Schlitz (1836) in das Eingriffselement (1840) des Pendelelements (1804) erstreckt, (iv) das Eingriffselement (1840) des Pendelelements (1804) einen radialen Schlitz umfasst, und (v) eine Drehung der Nadel (1800) bewirkt, dass der Flügel (1812) der Nadel (1800) in den radialen Schlitz (1840) des Pendelelements (1804) zum lösbaren Verbinden des Pendelelements (1804) mit der Nadel (1800) eingreift.

13. Bidirektionales Nahtmaterial-Durchlaufinstrument nach Anspruch 12, wobei (i) der Verriegelungsmechanismus (1824) des Pendelelements (1804) einen Flügel umfasst, der sich von einem Körper (1820) des Pendelelements (1804) erstreckt, (ii) das Auslegerarmgehäuse (1850) eine Bohrung (1854) umfasst, die einen axialen Schlitz (1858) definiert, der zum Aufnehmen des Flügels (1824) des Pendelelements (1804) konfiguriert ist, (iii) sich der axiale Schlitz (1858) in die Verriegelungsschnittstelle (162) des Auslegerarmgehäuses (1850) erstreckt, (iv) die Verriegelungsschnittstelle (1862) des Auslegerarmgehäuses (1850) einen radialen Schlitz umfasst, und (v) eine Drehung des Pendelelements (1804) bewirkt, dass der Flügel (1824) des Pendelelements (1804) in den radialen Schlitz (1862) des Auslegerarmgehäuses (1850) zum lösbaren Verbinden des Pendelelements (1804) mit dem Auslegerarmgehäuse (1850) eingreift.

14. Bidirektionales Nahtmaterial-Durchlaufinstrument nach einem der Ansprüche 1 bis 13, ferner umfassend einen mit der Nadel verbundenen Spitzenaktuator (180), wobei eine Drehung des Spitzenaktuators (180) eine Drehung der Nadel bewirkt.

15. Bidirektionales Nahtmaterial-Durchlaufinstrument nach einem der Ansprüche 1 bis 14, ferner umfassend ein Betätigungselement (26), das mit einem proximalen Ende der Nadel verbunden ist, wobei eine Verschiebung des Betätigungselements (26) ein Verschieben der Nadel bewirkt.

16. Bidirektionales Nahtmaterial-Durchlaufinstrument nach einem der Ansprüche 1 bis 15, wobei entweder das Auslegerarmgehäuse oder die Nadel eine Ahlenspitze aufweist.

Revendications

1. Instrument de passage de suture bidirectionnel (10) configuré de manière à ce qu'il réalise une approche par rapport à des défauts d'un tissu mou, l'instrument de passage de suture comprenant :

un élément de corps (18) qui définit un canal de réception d'aiguille (160) ;
un bras en porte-à-faux (22) qui s'étend depuis l'élément de corps (18), le bras en porte-à-faux (22) comportant un logement de bras en porte-à-faux (198 ; 1718 ; 1784 ; 1850) qui est espacé de l'élément de corps (18), dans lequel un espace de réception de tissu (202) est disposé entre le logement de bras en porte-à-faux (198 ; 1718 ; 1784 ; 1850) et l'élément de corps (18) ;
une aiguille (34 ; 1670 ; 1750 ; 1800) qui peut être translatée en va-et-vient à l'intérieur du canal (160) de l'élément de corps (18) entre une position avancée dans laquelle une extrémité distale de l'aiguille (34 ; 1670 ; 1750 ; 1800) s'étend à l'intérieur du logement de bras en porte-à-faux (198 ; 1718 ; 1784 ; 1850) et une position rétractée dans laquelle l'extrémité distale de l'aiguille (34 ; 1670 ; 1750 ; 1800) est rétractée par rapport au logement de bras en porte-à-faux (198 ; 1718 ; 1784 ; 1850) ; et
un élément de navette (40 ; 1674 ; 1754 ; 1804) qui est configuré de manière à ce qu'il soit couplé de façon amovible à l'aiguille (34 ; 1670 ; 1750 ; 1800) et au logement de bras en porte-à-faux (198 ; 1718 ; 1784 ; 1850) ;
caractérisé en ce que, (i) lorsque l'élément de navette (40 ; 1674 ; 1754 ; 1804) est couplé de façon amovible à l'aiguille (34 ; 1670 ; 1750 ; 1800), une rotation de l'aiguille (34 ; 1670 ; 1750 ; 1800) par rapport au logement de bras en porte-à-faux (198 ; 1718 ; 1784 ; 1850) a pour effet que l'élément de navette (40 ; 1674 ; 1754 ; 1804) est couplé de façon amovible au logement de bras en porte-à-faux (198 ; 1718 ; 1784 ; 1850) et (ii) lorsque l'élément de navette (40 ; 1674 ; 1754 ; 1804) est couplé de façon amovible au logement de bras en porte-à-faux (198 ; 1718 ; 1784 ; 1850), une rotation de l'aiguille (34 ; 1670 ; 1750 ; 1800) par rapport à l'élément de navette (40 ; 1674 ; 1754 ; 1804) a pour effet que l'aiguille (34 ; 1670 ; 1750 ; 1800) est couplée de façon amovible à l'élément de navette (40 ; 1674 ; 1754 ; 1804).

2. Instrument de passage de suture bidirectionnel selon la revendication 1, dans lequel (i) l'aiguille (34 ; 1670 ; 1750 ; 1800) inclut une caractéristique d'engagement (252 ; 1686 ; 1766 ; 1812), (ii) l'élément de navette (40 ; 1674 ; 1754 ; 1804) inclut une caractéristique d'engagement (314 ; 1706 ; 1778 ; 1840) et (iii) lorsque l'élément de navette (40 ; 1674 ; 1754 ; 1804) est couplé de façon amovible au logement de bras en porte-à-faux (198 ; 1718 ; 1784 ; 1850), une rotation de l'aiguille (34 ; 1670 ; 1750 ; 1800) par rapport à l'élément de navette (40 ; 1674 ; 1754 ; 1804) a pour effet que la caractéristique d'engagement (252 ; 1686 ; 1766 ; 1812) de l'aiguille (34 ; 1670 ; 1750 ; 1800) engage la caractéristique d'engagement (314 ; 1706 ; 1788 ; 1840) de l'élément de navette (40 ; 1674 ; 1754 ; 1804) de manière à coupler de façon amovible l'aiguille (104 ; 1670 ; 1750, 1800) à l'élément de navette (40 ; 1674 ; 1754 ; 1804).

3. Instrument de passage de suture bidirectionnel selon la revendication 2, dans lequel (i) l'élément de navette (40 ; 1674 ; 1754 ; 1804) inclut un mécanisme de blocage (320 ; 1710 ; 1780 ; 1824), (ii) le logement de bras en porte-à-faux (198 ; 1718 ; 1784 ; 1850) inclut une interface de blocage (214 ; 1730 ; 1796 ; 1862) et (iii) lorsque l'élément de navette (40 ; 1674 ; 1754 ; 1804) est couplé de façon amovible à l'aiguille (34 ; 1670 ; 1750 ; 1800), une rotation de l'aiguille (34 ; 1670 ; 1750 ; 1800) par rapport au logement de bras en porte-à-faux (198 ; 1718 ; 1784 ; 1850) a pour effet que le mécanisme de blocage (320 ; 1710 ; 1780 ; 1824) de l'élément de navette (40 ; 1674 ; 1754 ; 1804) engage l'interface de blocage (214 ; 1730 ; 1796 ; 1862) du logement de bras en porte-à-faux (198 ; 1718 ; 1784 ; 1850) de manière à coupler de façon amovible l'élément de navette (40 ; 1674 ; 1754 ; 1804) au logement de bras en porte-à-faux (198 ; 1718 ; 1784 ; 1850).

4. Instrument de passage de suture bidirectionnel selon la revendication 3, dans lequel une caractéristique d'engagement (1706 ; 1778) de l'élément de navette (1674 ; 1754) et le mécanisme de blocage (1710 ; 1780) de l'élément de navette (1674 ; 1754) sont des filets orientés de façon opposée.

5. Instrument de passage de suture bidirectionnel selon l'une quelconque des revendications 2 à 4, dans lequel les caractéristiques d'engagement (1686 ; 1766) de l'aiguille (1670 ; 1750) et de l'élément de navette (1674 ; 1754) sont des filets, et les filets (1686 ; 1766) de l'aiguille (1670 ; 1750) sont configurés de manière à ce qu'ils engagent les filets (1706 ; 1778) de l'élément de navette (1674 ; 1754).

6. Instrument de passage de suture bidirectionnel selon la revendication 5, dans lequel les filets (1766) de l'aiguille (1750) s'étendent depuis une surface externe de l'aiguille (1750).

7. Instrument de passage de suture bidirectionnel selon la revendication 6, dans lequel (i) l'élément de navette (1754) définit un alésage (1774), (ii) les filets (1778) de l'élément de navette (1754) s'étendent depuis une surface interne de l'alésage (1774) et (iii) l'alésage (1774) est configuré de manière à ce qu'il reçoive l'aiguille (1750).

8. Instrument de passage de suture bidirectionnel selon la revendication 7, dans lequel l'alésage (1774) s'étend complètement au travers de l'élément de navette (1754) et l'aiguille (1750) est configurée de manière à ce qu'elle s'étende au travers de l'alésage (1774) de l'élément de navette (1754).

9. Instrument de passage de suture bidirectionnel selon la revendication 5, dans lequel l'aiguille (1670) inclut un alésage (1682) et les filets (1686) de l'aiguille (1670) s'étendent depuis une surface interne de l'alésage (1682).

10. Instrument de passage de suture bidirectionnel selon la revendication 9, dans lequel (i) les filets (1706) de l'élément de navette (1674) s'étendent depuis une surface externe de l'élément de navette (1674) et (ii) l'alésage (1682) de l'aiguille (1670) est configuré de manière à ce qu'il reçoive l'élément de navette (1674).

11. Instrument de passage de suture bidirectionnel selon l'une quelconque des revendications 3 à 10, dans lequel (i) le mécanisme de blocage (1710 ; 1780) de l'élément de navette (1674 ; 1754) et l'interface de blocage (1730 ; 1796) du logement de bras en porte-à-faux (1718 ; 1784) sont des filets, (ii) les filets (1710 ; 1780) de l'élément de navette (1674 ; 1754) s'étendent depuis une surface externe de l'élément de navette (1674 ; 1754), (iii) les filets (1730 ; 1796) du logement de bras en porte-à-faux (1718 ; 1784) s'étendent depuis une surface interne d'un alésage (1726 ; 1792) qui est défini par le logement de bras en porte-à-faux (1718 ; 1784) et (iv) les filets (1710 ; 1780) de l'élément de navette (1674 ; 1754) sont configurés de manière à ce qu'ils engagent les filets (1730 ; 1796) du logement de bras en porte-à-faux (1718 ; 1784).

12. Instrument de passage de suture bidirectionnel selon la revendication 3, dans lequel (i) la caractéristique d'engagement (1812) de l'aiguille (1800) inclut une aile qui s'étend vers l'extérieur depuis un corps (1808) de l'aiguille (1800), (ii) l'élément de navette (1804) inclut un alésage (1832) qui définit une fente axiale (1836) qui est configurée de manière à ce qu'elle reçoive l'aile (1812) de l'aiguille (1800), (iii)

la fente axiale (1836) s'étend à l'intérieur de la caractéristique d'engagement (1840) de l'élément de navette (1804), (iv) la caractéristique d'engagement (1840) de l'élément de navette (1804) inclut une fente radiale et (v) une rotation de l'aiguille (1800) a pour effet que l'aile (1812) de l'aiguille (1800) engage la fente radiale (1840) de l'élément de navette (1804) de manière à ainsi coupler de façon amovible l'élément de navette (1804) à l'aiguille (1800).

13. Instrument de passage de suture bidirectionnel selon la revendication 12, dans lequel (i) le mécanisme de blocage (1824) de l'élément de navette (1804) inclut une aile qui s'étend vers l'extérieur depuis un corps (1820) de l'élément de navette (1804), (ii) le logement de bras en porte-à-faux (1850) inclut un alésage (1854) qui définit une fente axiale (1858) qui est configurée de manière à ce qu'elle reçoive l'aile (1824) de l'élément de navette (1804), (iii) la fente axiale (1858) s'étend à l'intérieur de l'interface de blocage (162) du logement de bras en porte-à-faux (1850), (iv) l'interface de blocage (1862) du logement de bras en porte-à-faux (1850) inclut une fente radiale et (v) une rotation de l'élément de navette (1804) a pour effet que l'aile (1824) de l'élément de navette (1804) engage la fente radiale (1862) du logement de bras en porte-à-faux (1850) de manière à ainsi coupler de façon amovible l'élément de navette (1804) au logement de bras en porte-à-faux (1850).

14. Instrument de passage de suture bidirectionnel selon l'une quelconque des revendications 1 à 13, comprenant en outre un actionneur de pointe (180) qui est couplé à l'aiguille, dans lequel une rotation de l'actionneur de pointe (180) a pour effet que l'aiguille est entraînée en rotation.

15. Instrument de passage de suture bidirectionnel selon l'une quelconque des revendications 1 à 14, comprenant en outre un élément d'actionnement (26) qui est couplé à une extrémité proximale de l'aiguille, dans lequel une translation de l'élément d'actionnement (26) a pour effet que l'aiguille réalise une translation.

16. Instrument de passage de suture bidirectionnel selon l'une quelconque des revendications 1 à 15, dans lequel soit le logement de bras en porte-à-faux, soit l'aiguille inclut une pointe d'alène.

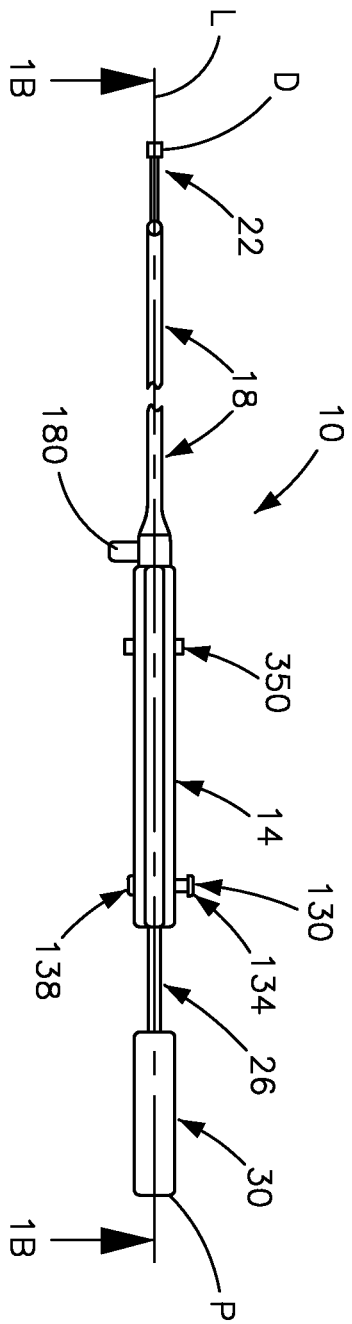

L
D
1B
22
18
10
180
350
14
130
138
134
26
30
1B
P

Fig. 1A

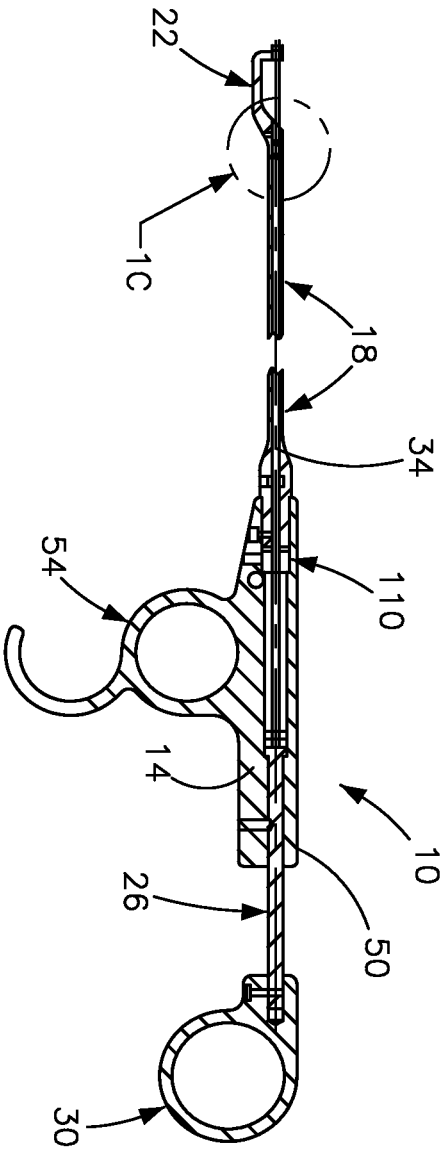

22
1C
18
34
110
54
14
10
26
50
30

Fig. 1B

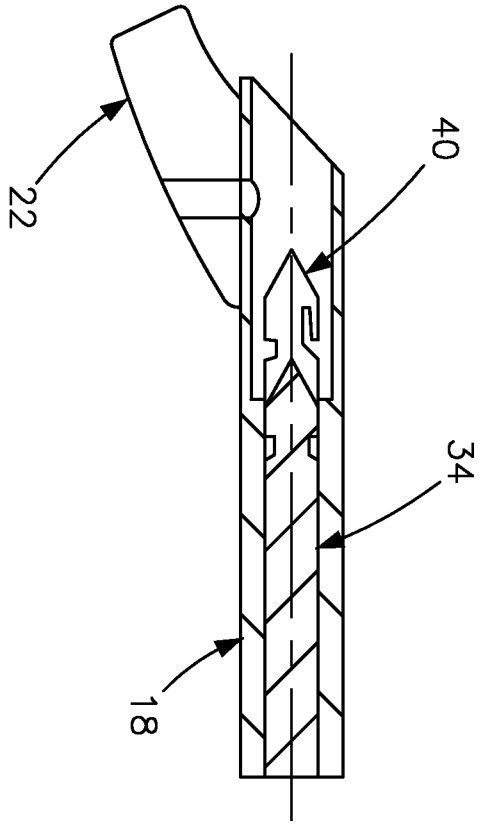


Fig. 1C

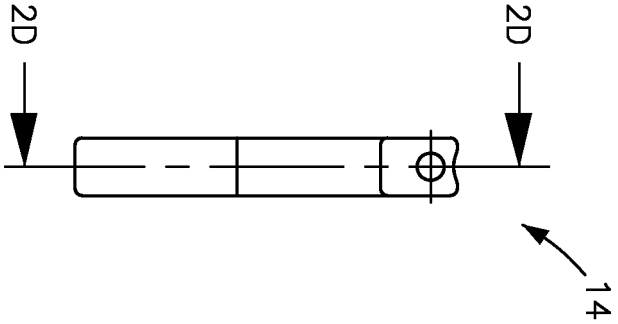


Fig. 2C

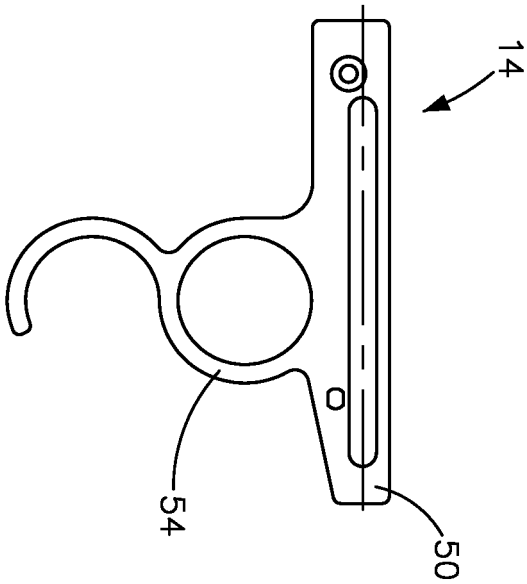


Fig. 2A

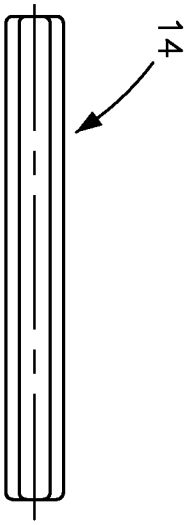


Fig. 2B

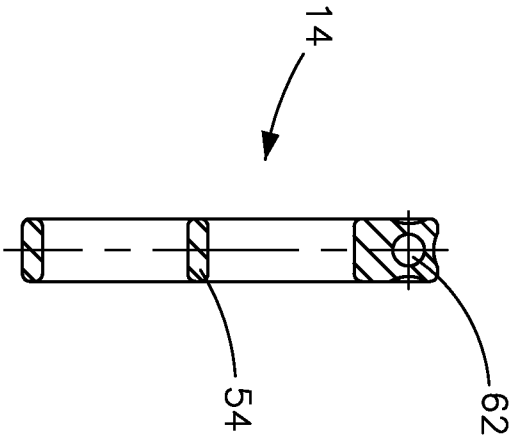


Fig. 2E

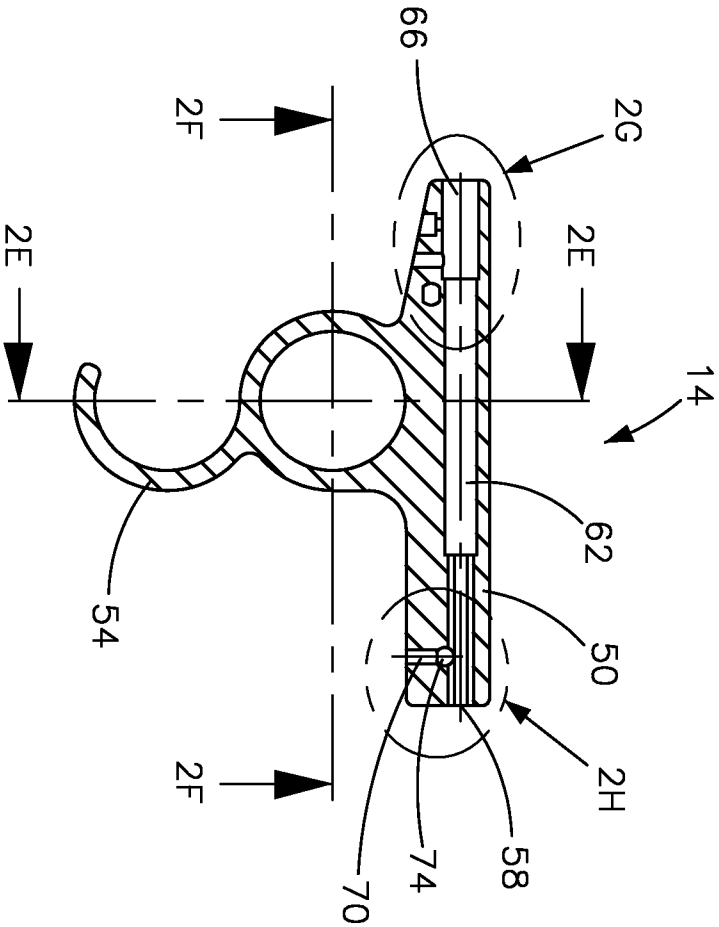


Fig. 2D

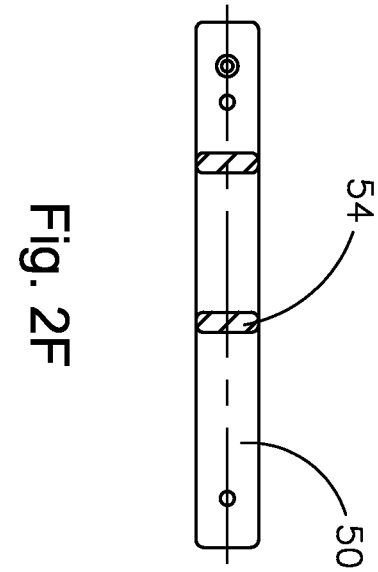


Fig. 2F

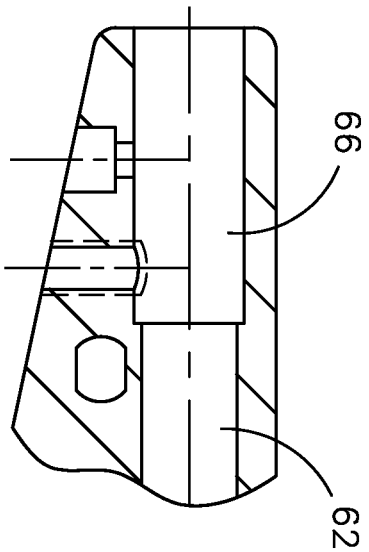


Fig. 2G

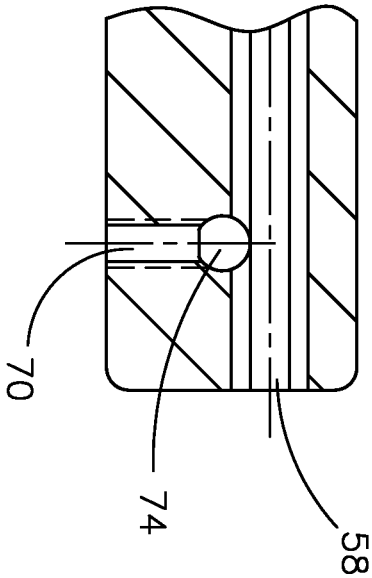


Fig. 2H

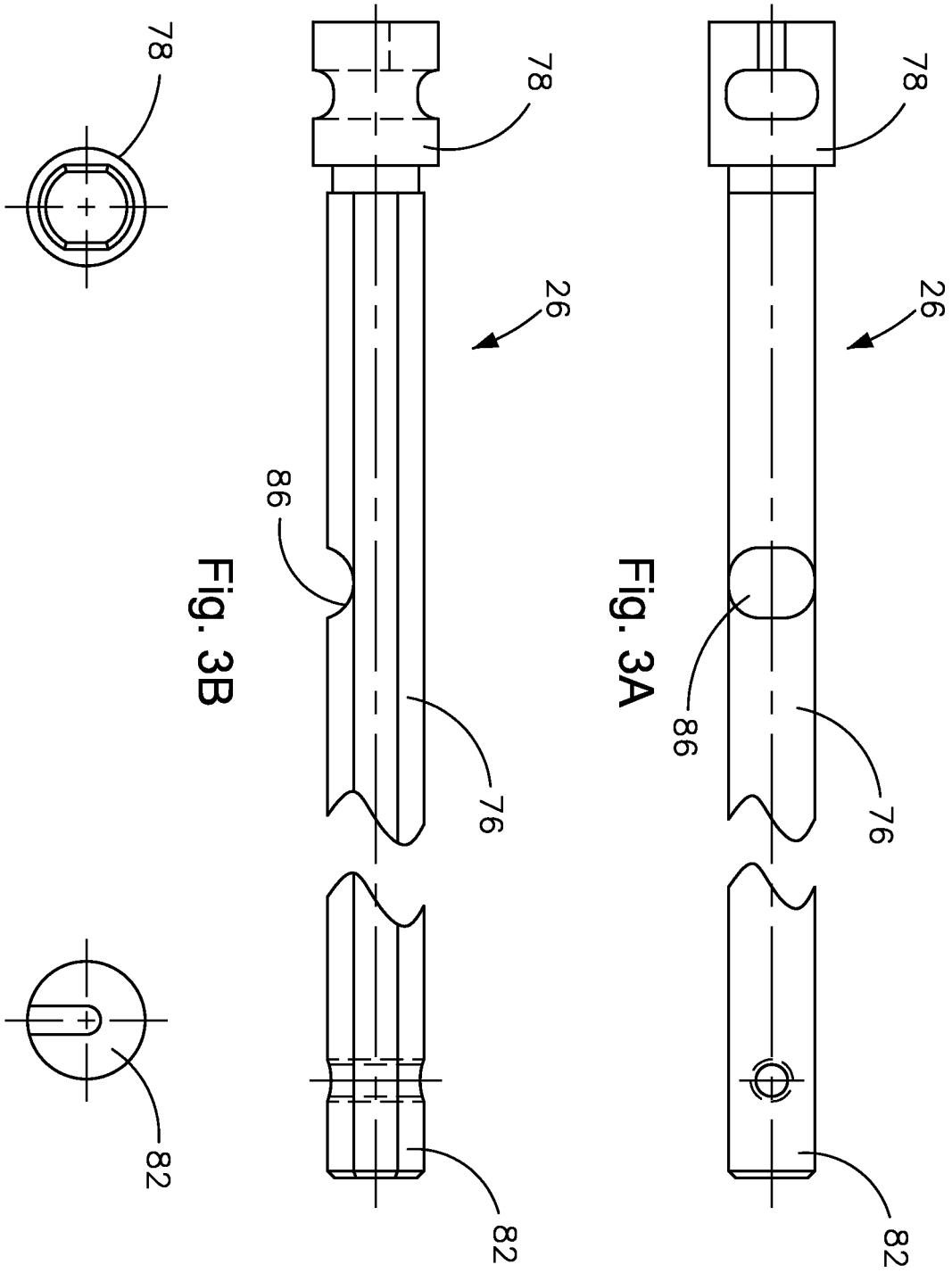


Fig. 3A

Fig. 3B

Fig. 3C

Fig. 3D

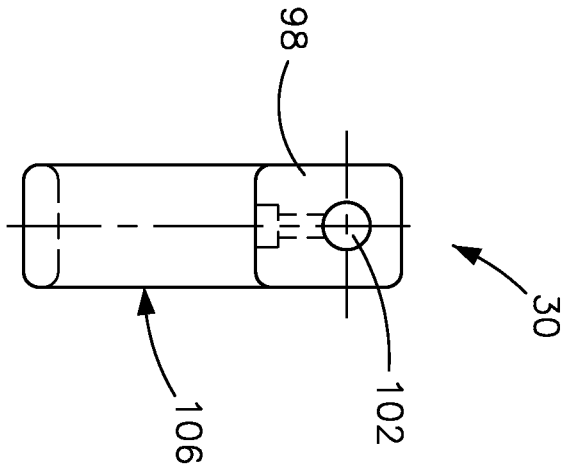


Fig. 4C

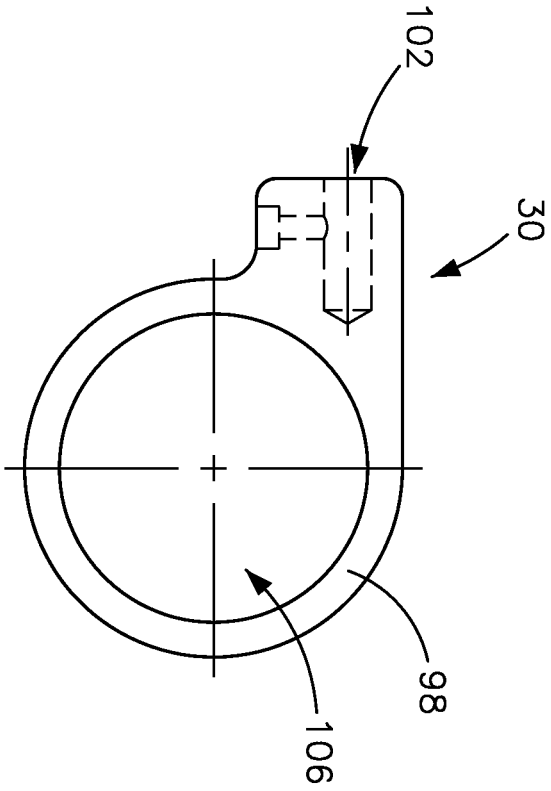


Fig. 4A

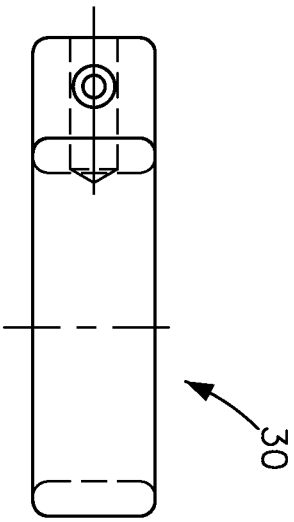


Fig. 4B

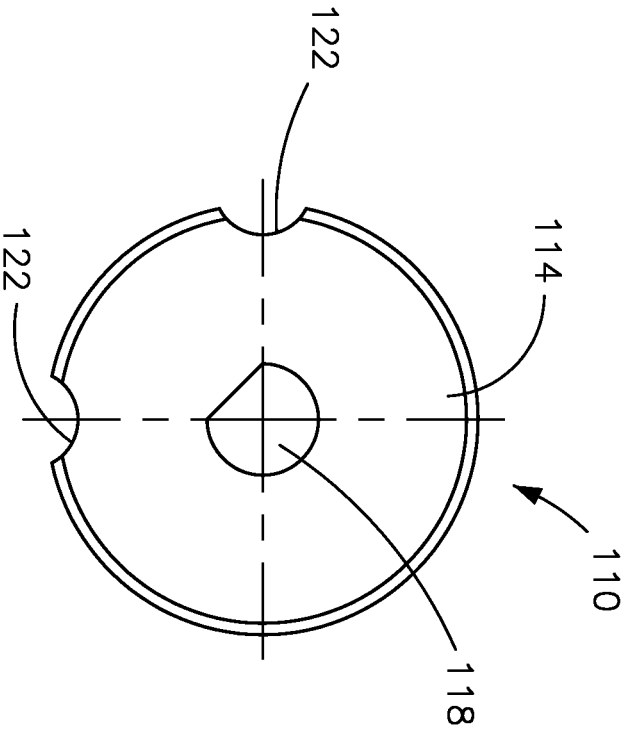


Fig. 5B

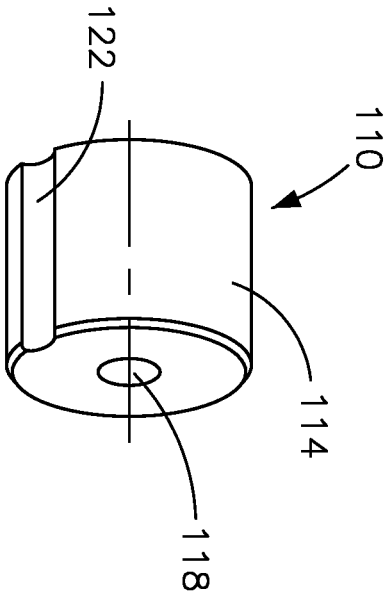


Fig. 5A

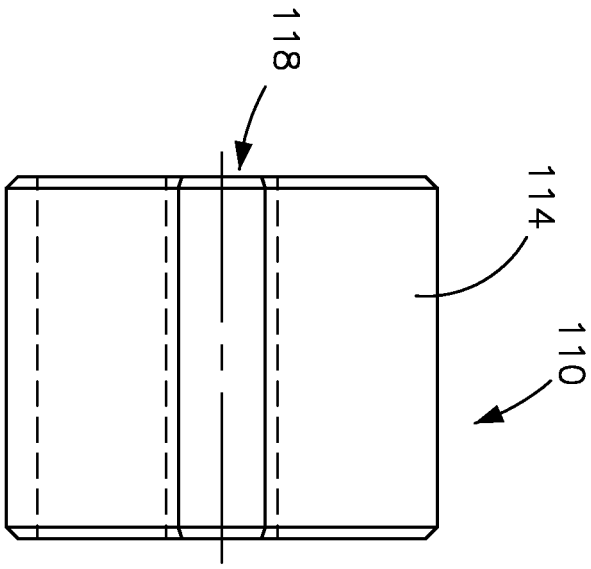


Fig. 5C

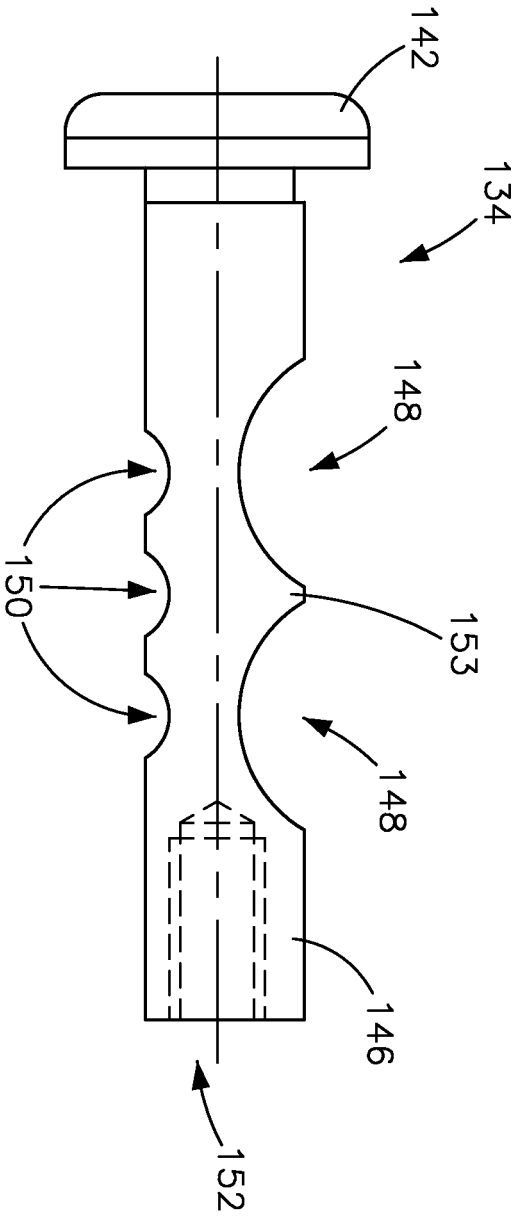


Fig. 6A

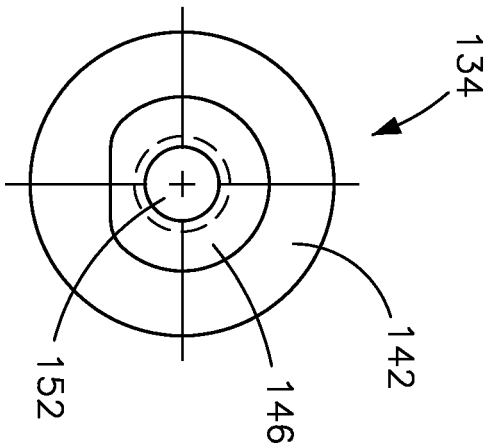


Fig. 6B

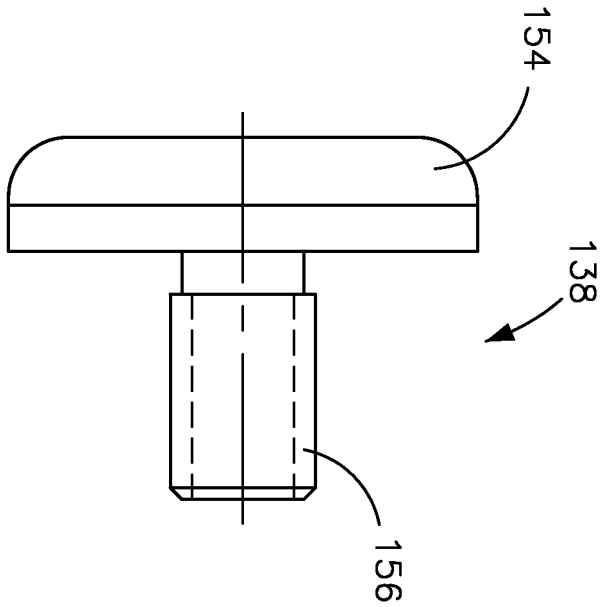


Fig. 7A

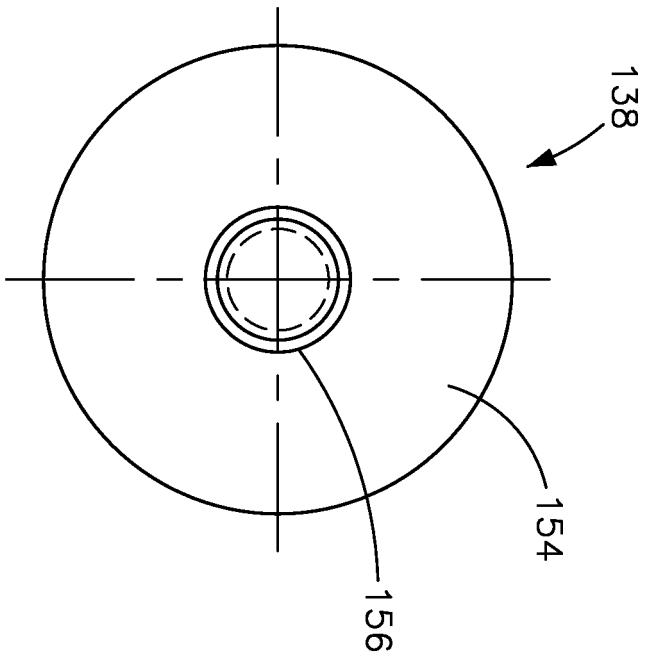


Fig. 7B

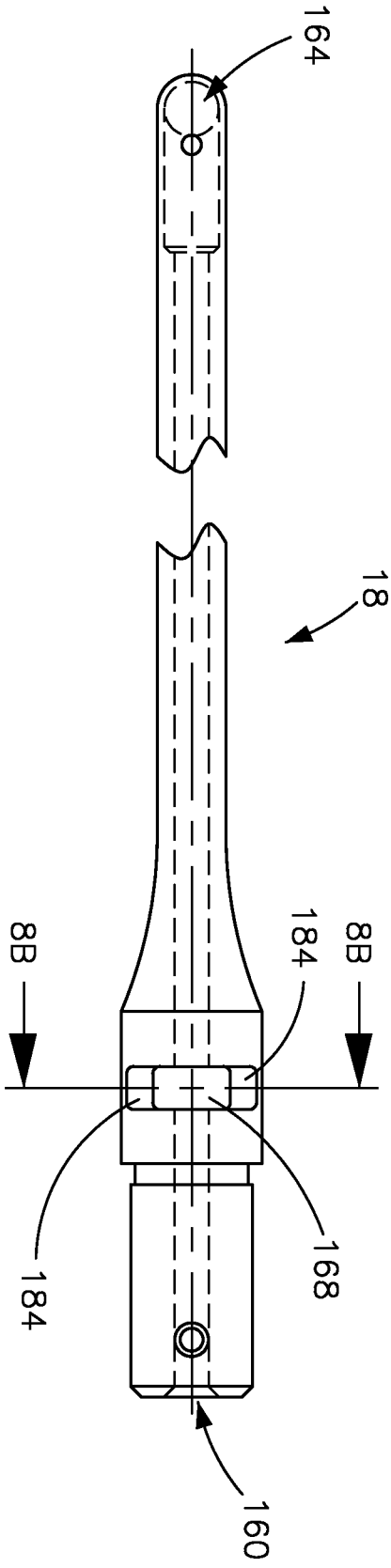


Fig. 8A

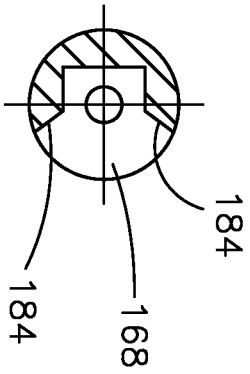


Fig. 8B

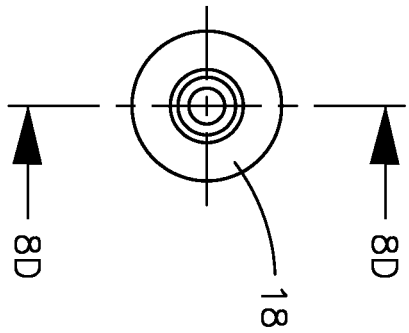


Fig. 8C

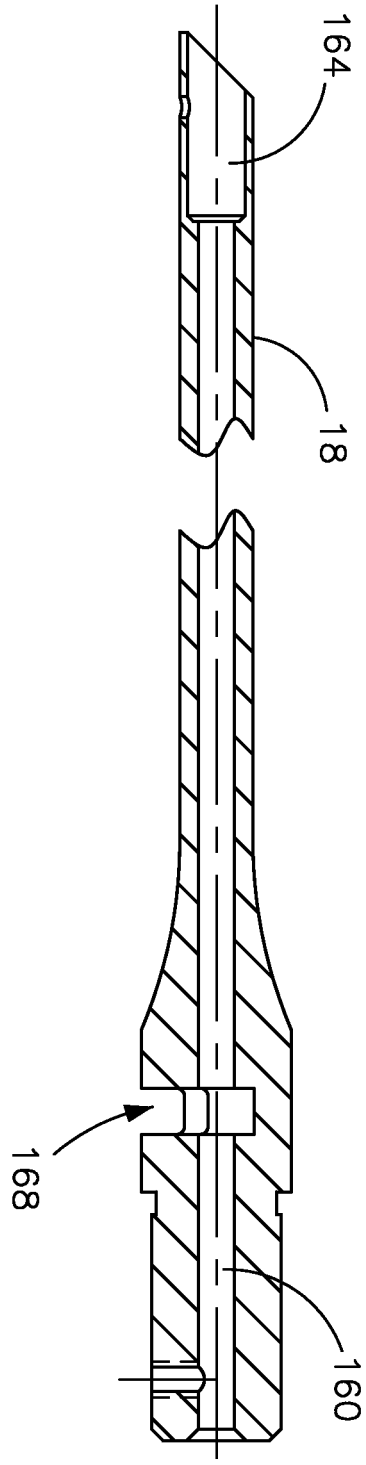


Fig. 8D

Fig. 9A

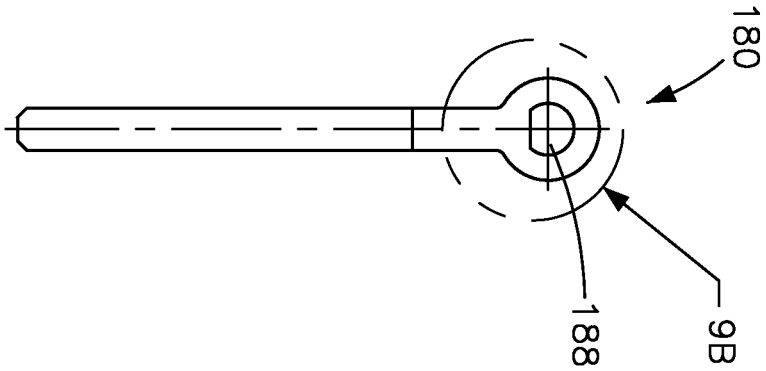


Fig. 9B

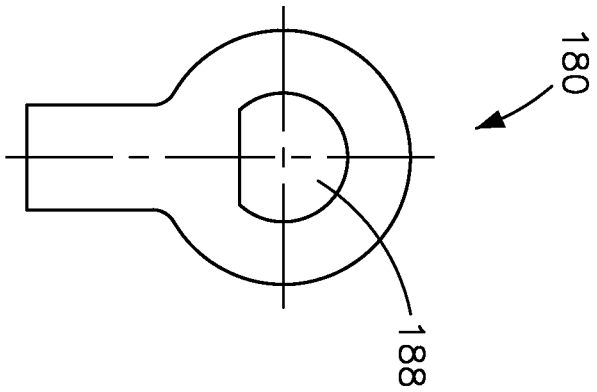


Fig. 9C

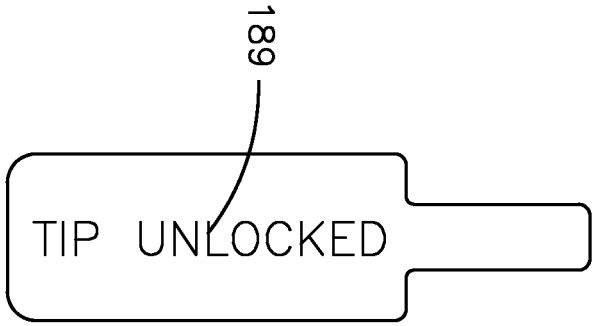
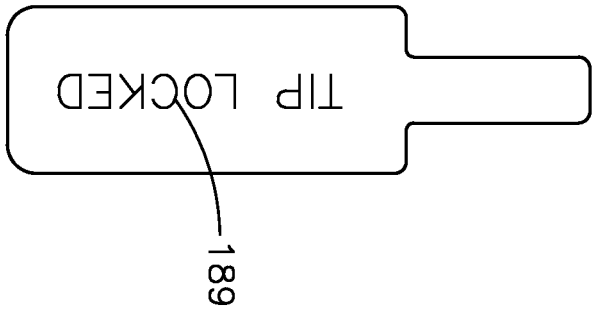


Fig. 9D



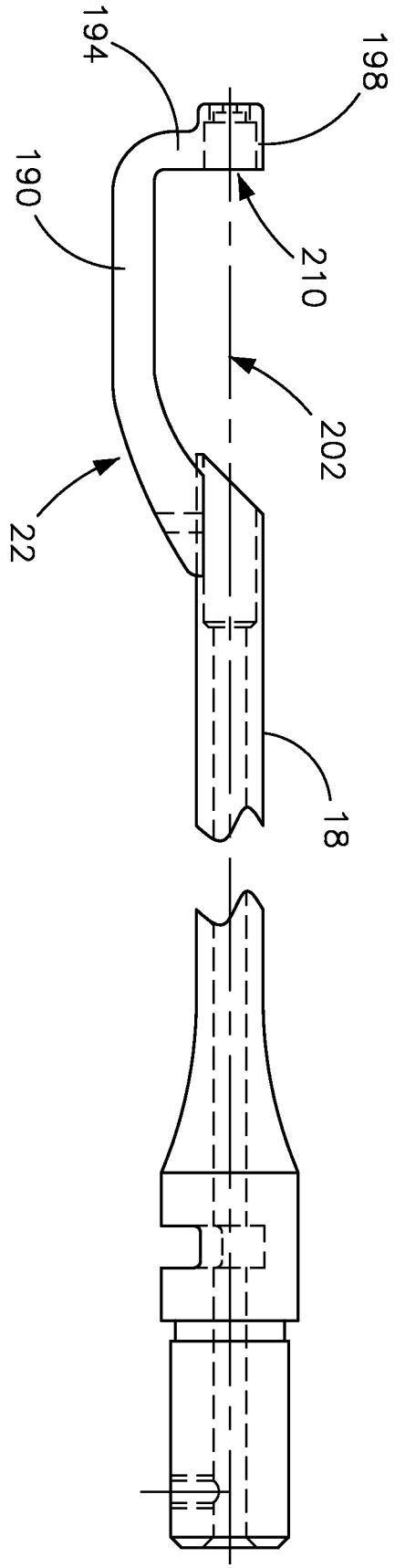


Fig. 10A

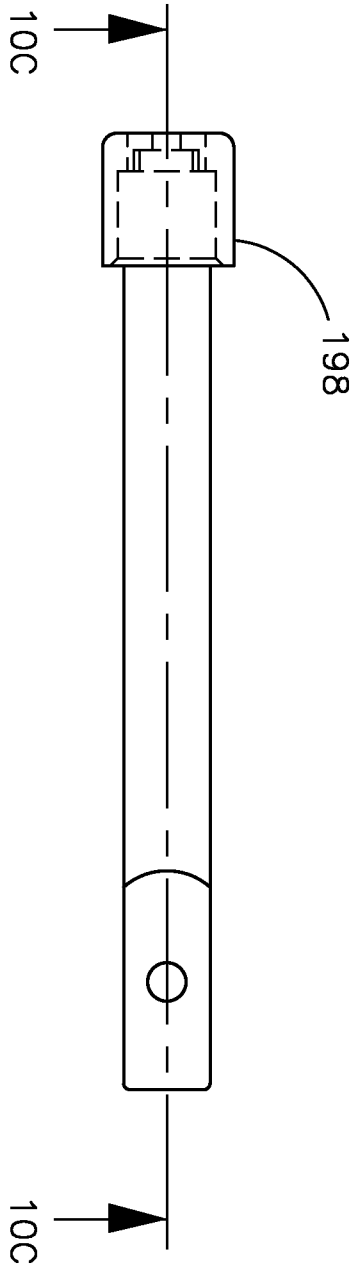
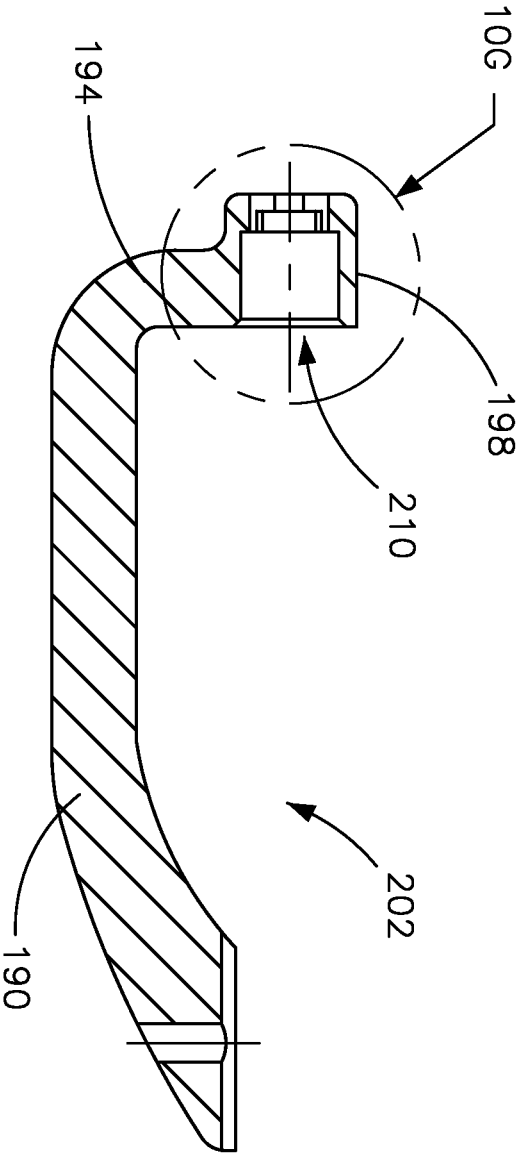


Fig. 10B



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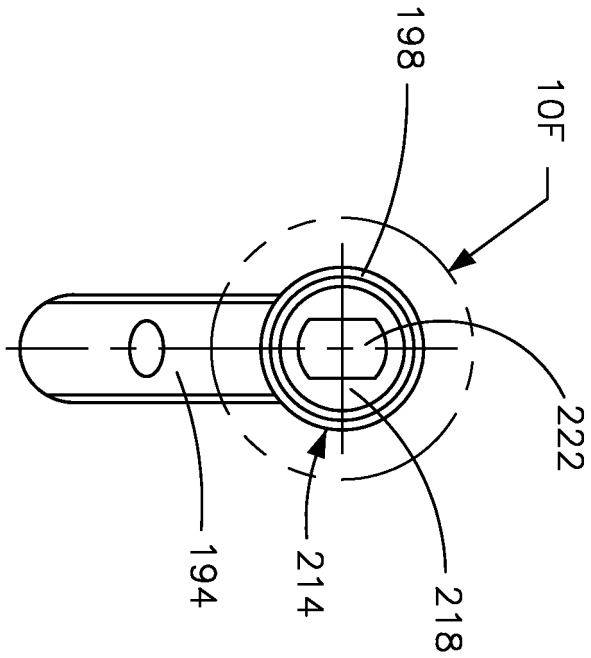

Fig. 10D

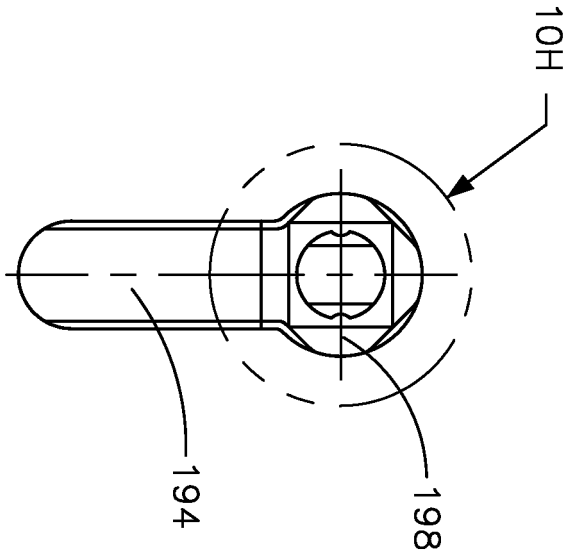

Fig. 10E

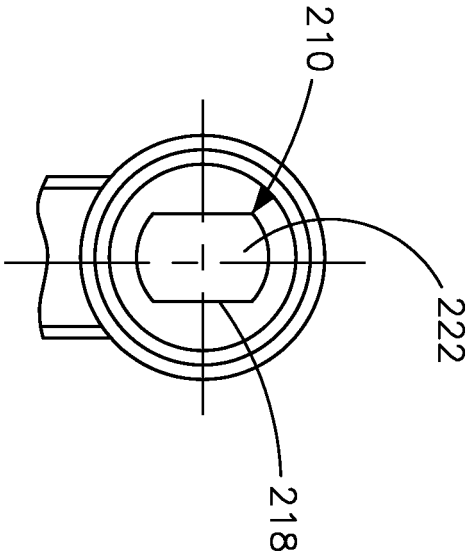

Fig. 10F

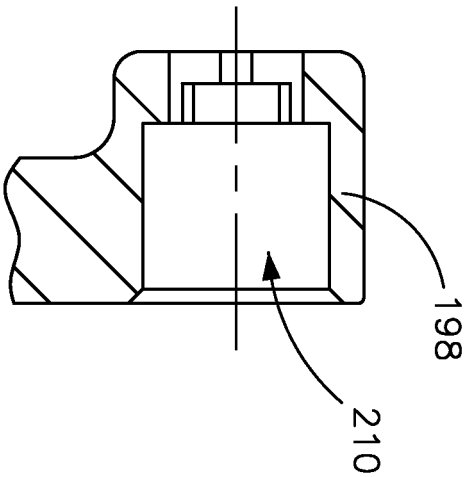

Fig. 10G

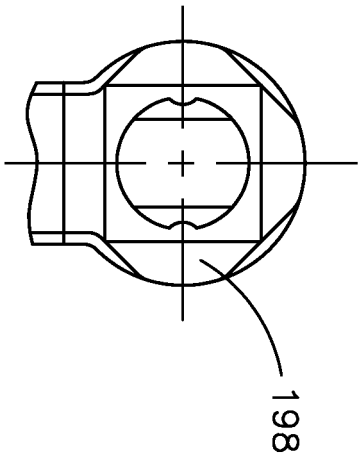

Fig. 10H

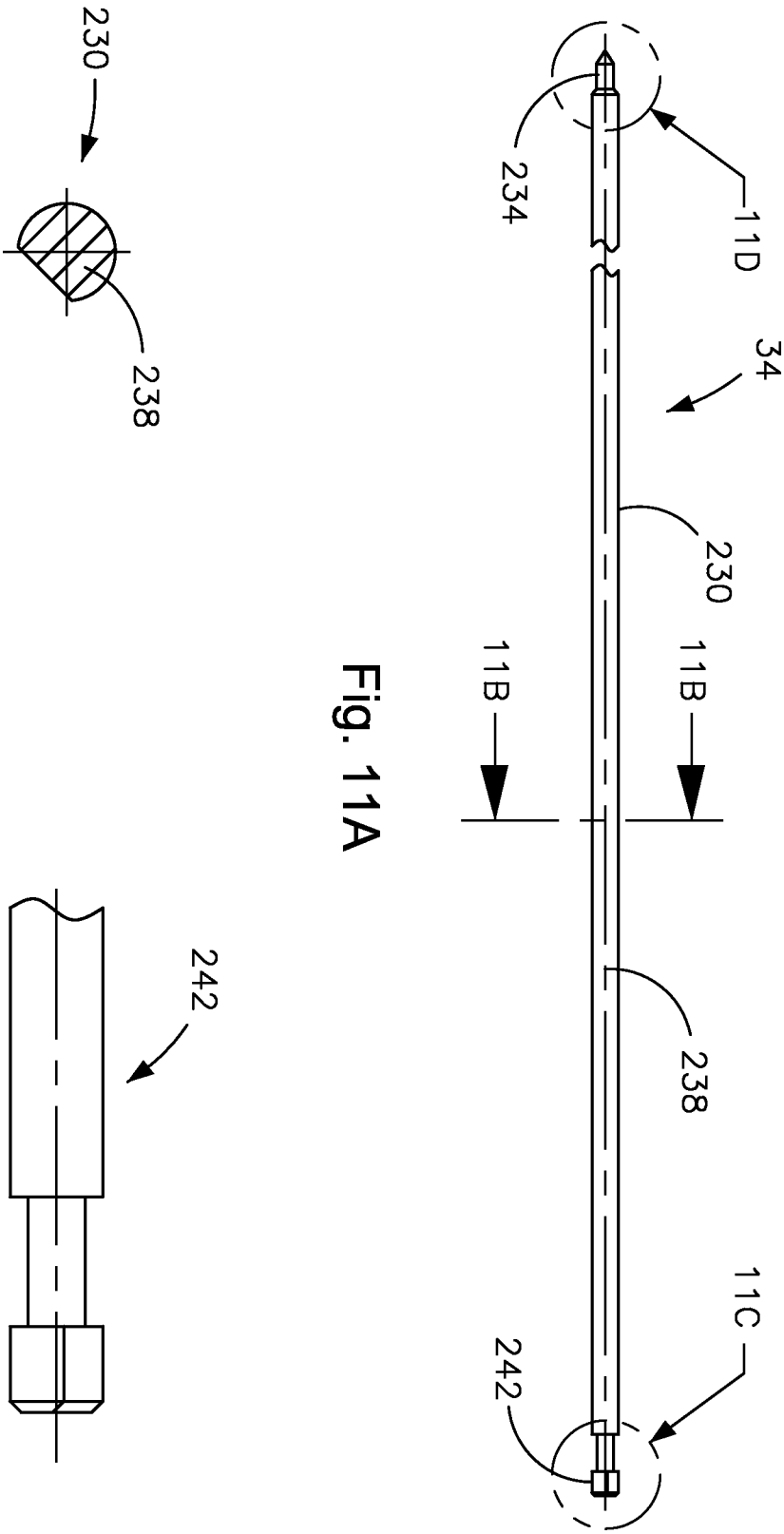

Fig. 11A

Fig. 11B

Fig. 11C

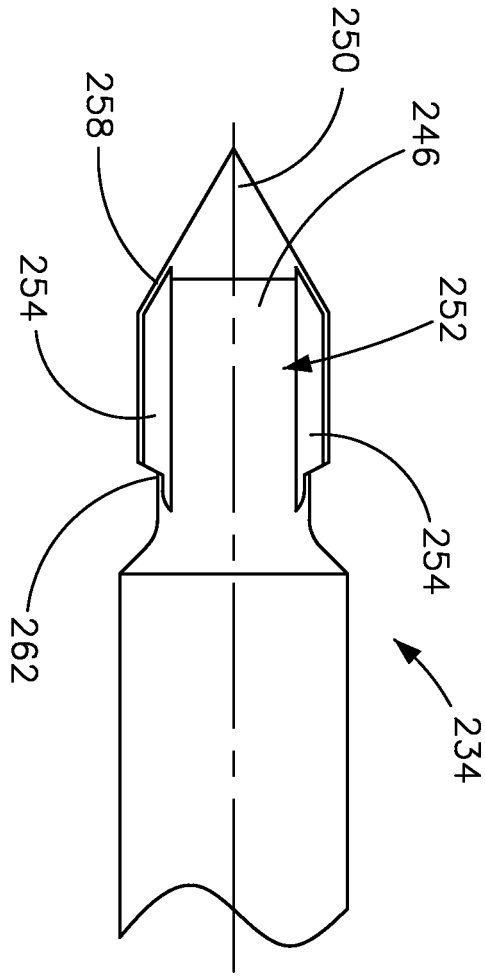

Fig. 11D

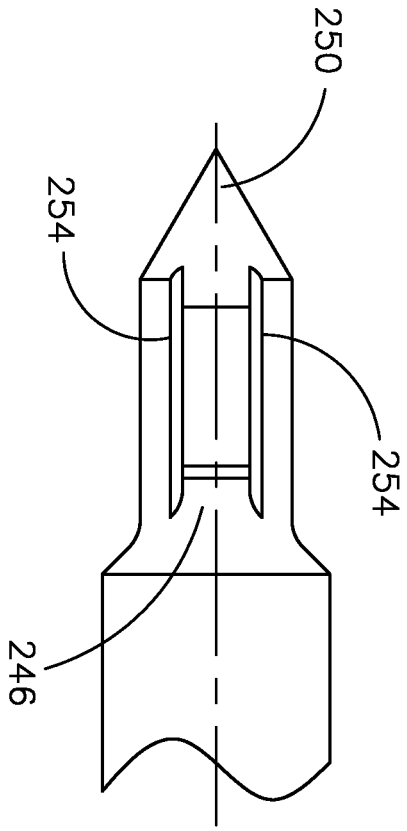

Fig. 11E

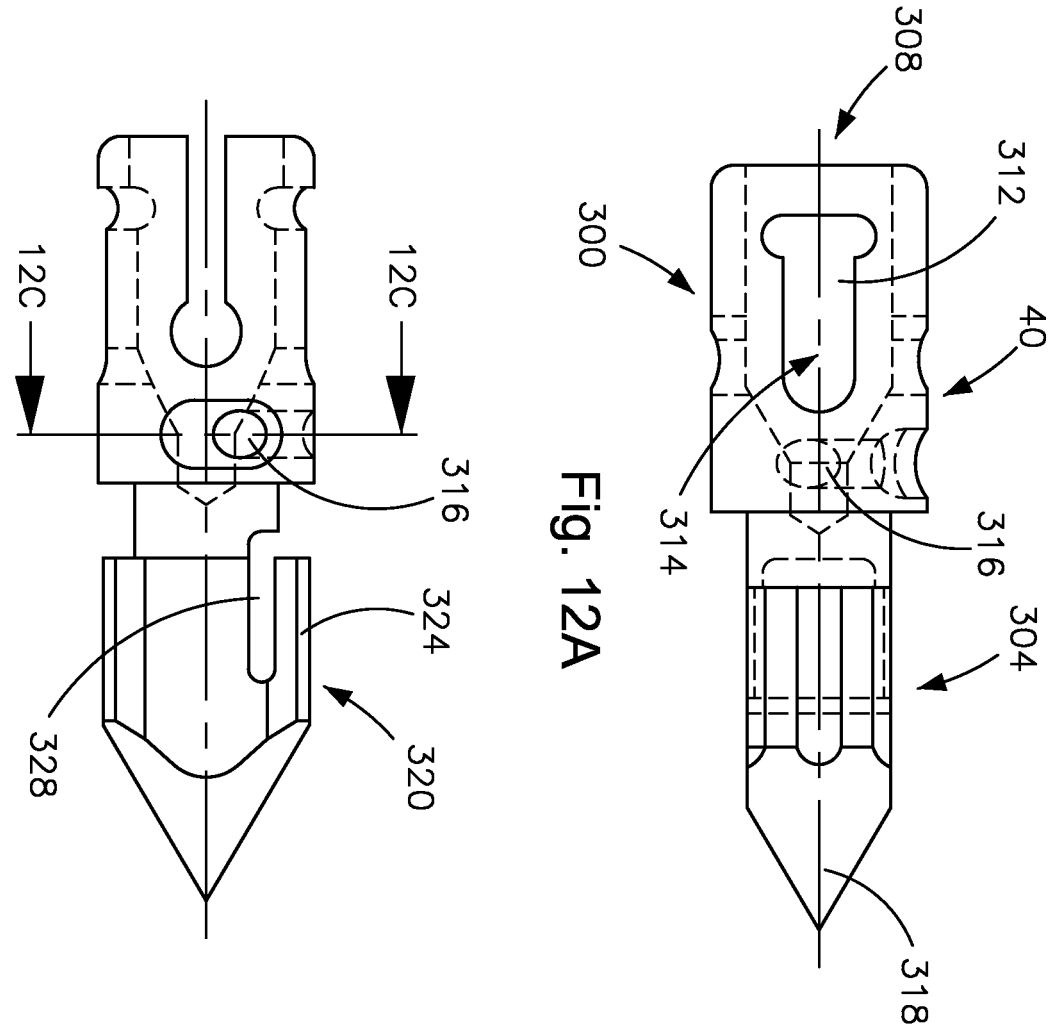

Fig. 12A

Fig. 12B

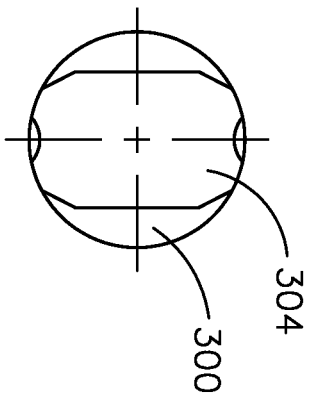

Fig. 12D

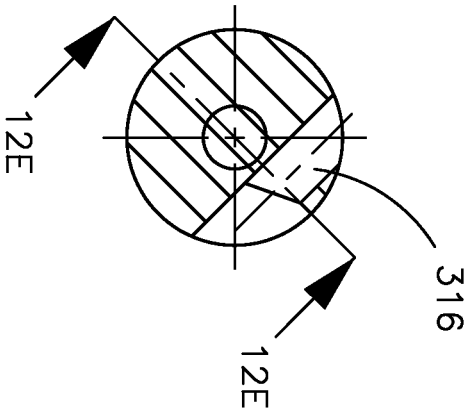

Fig. 12C

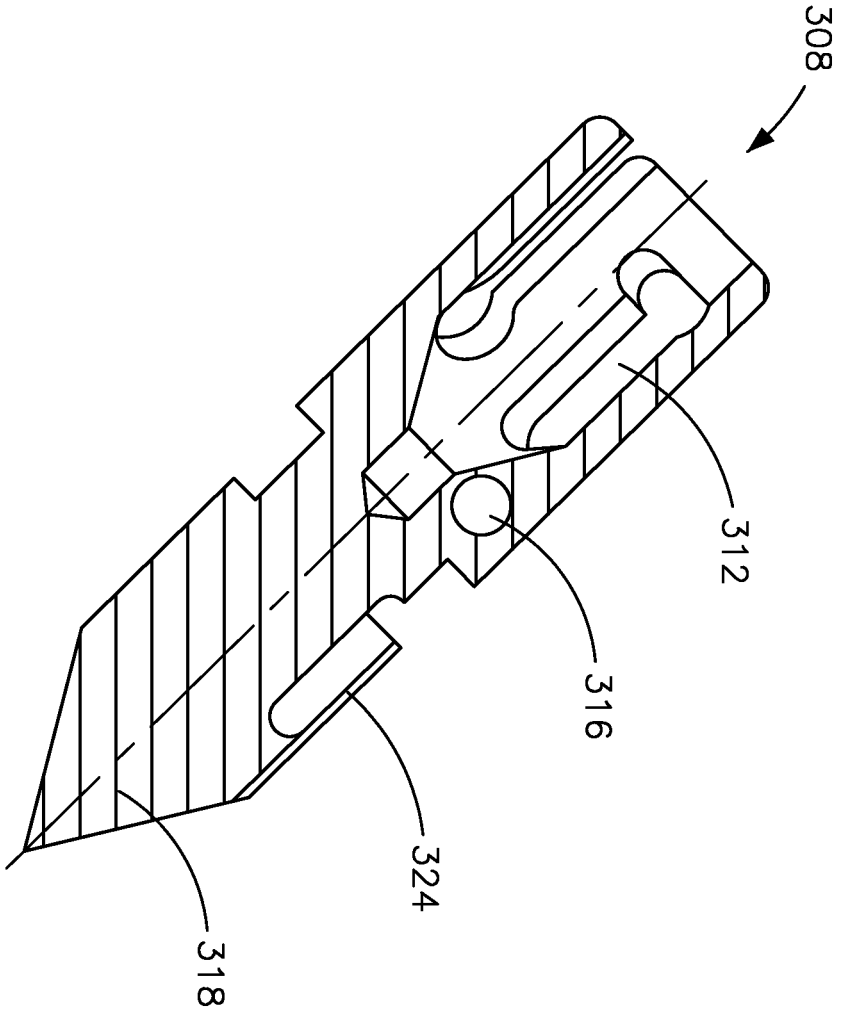

Fig. 12E

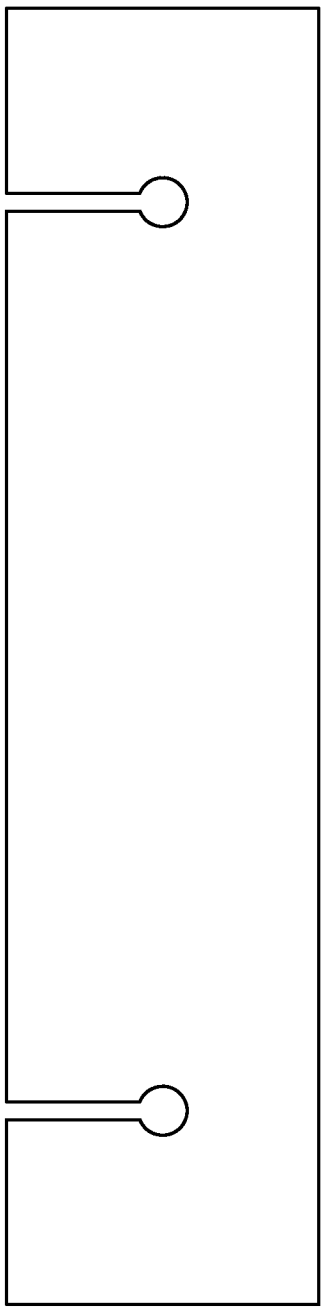

Fig. 13

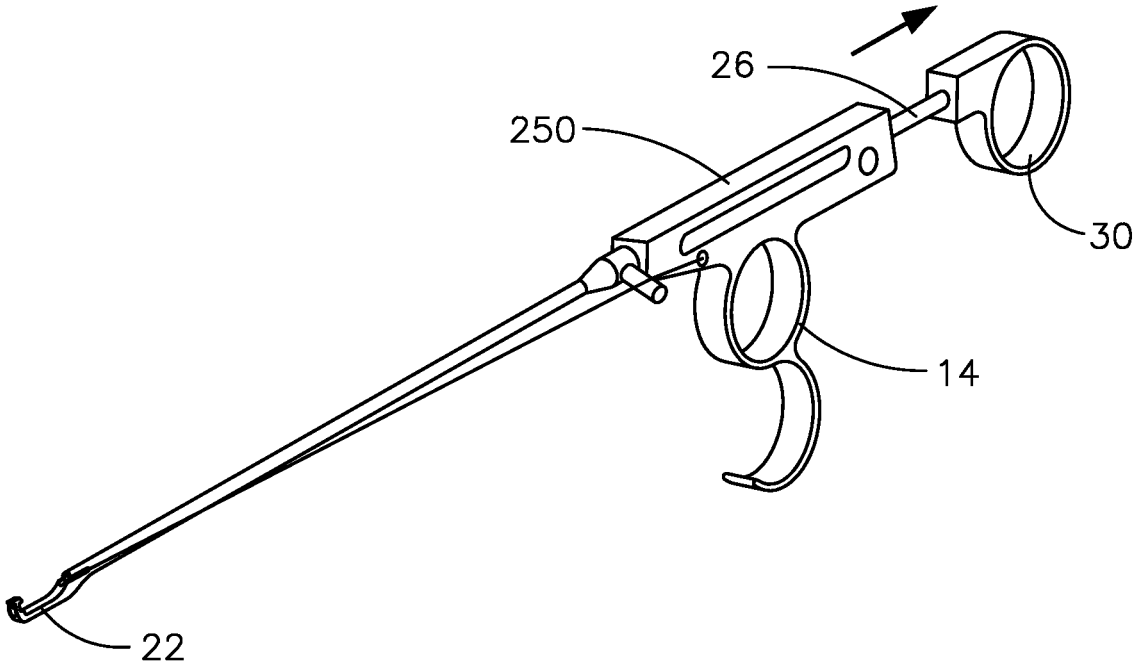

Fig. 14A

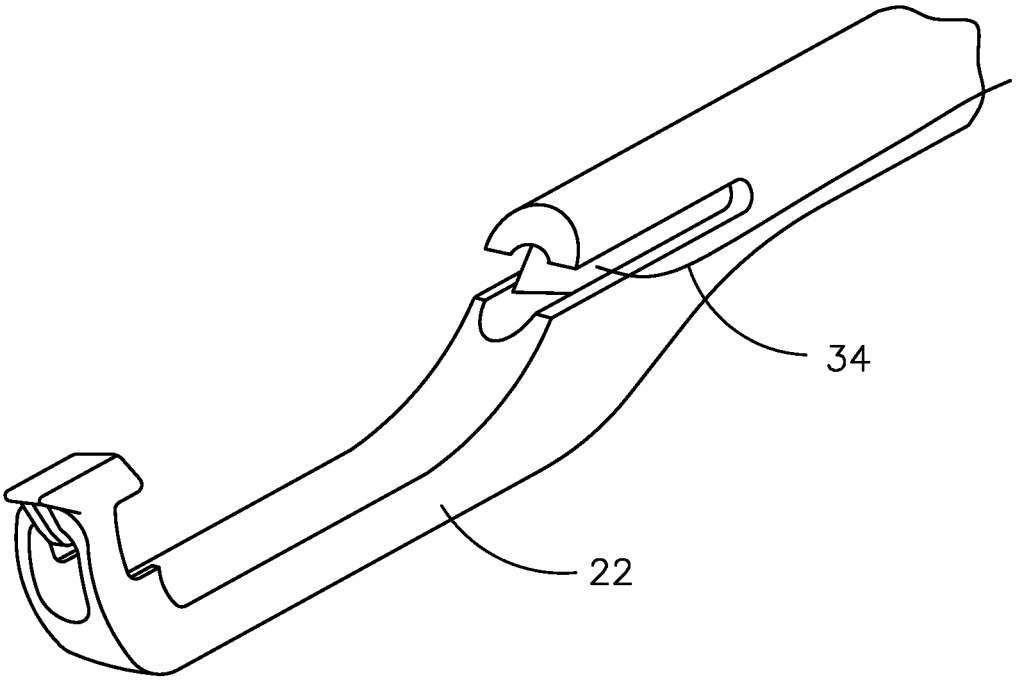

Fig. 14B

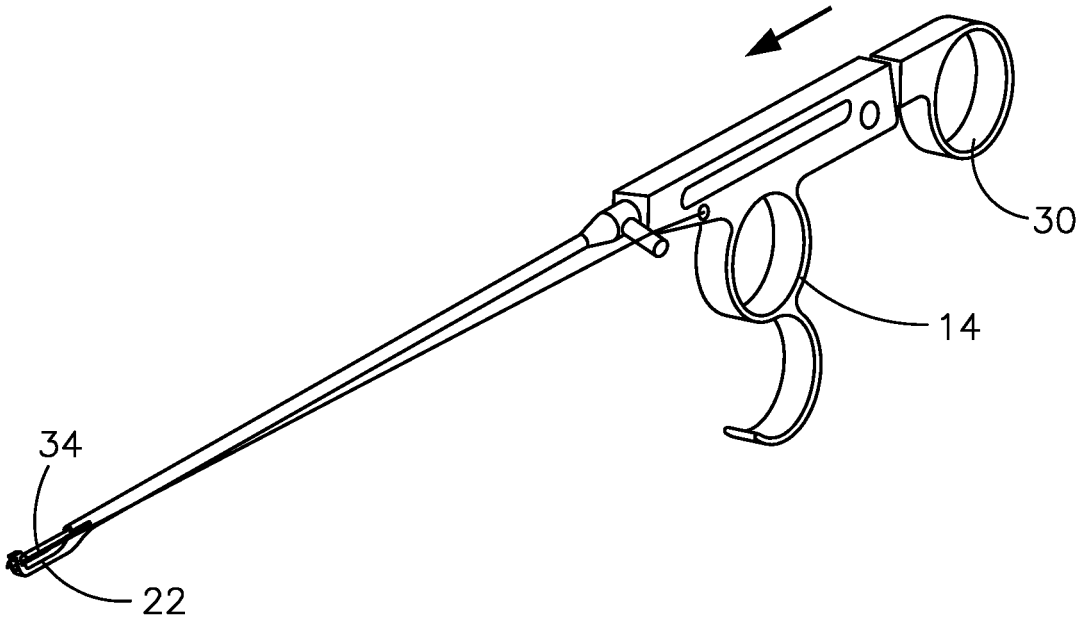

Fig. 14C

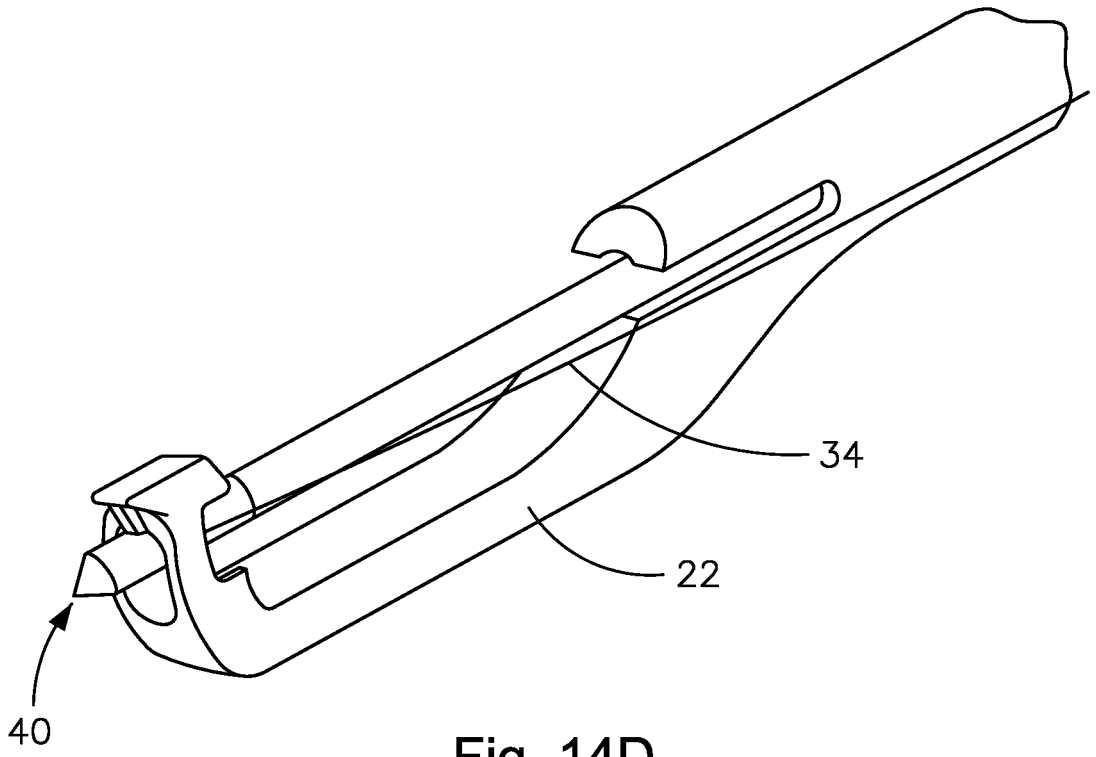

Fig. 14D

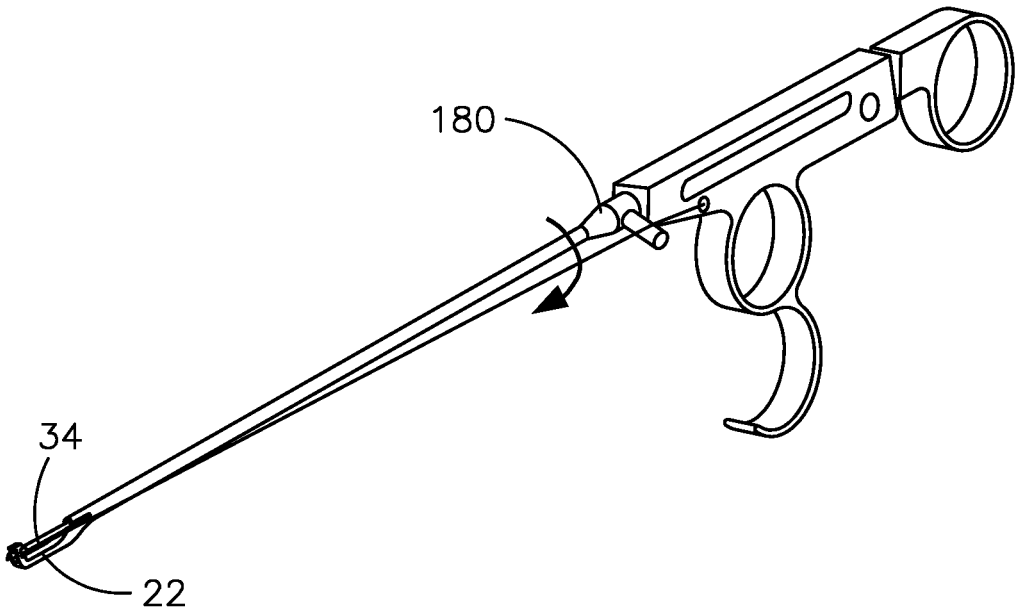

Fig. 14E

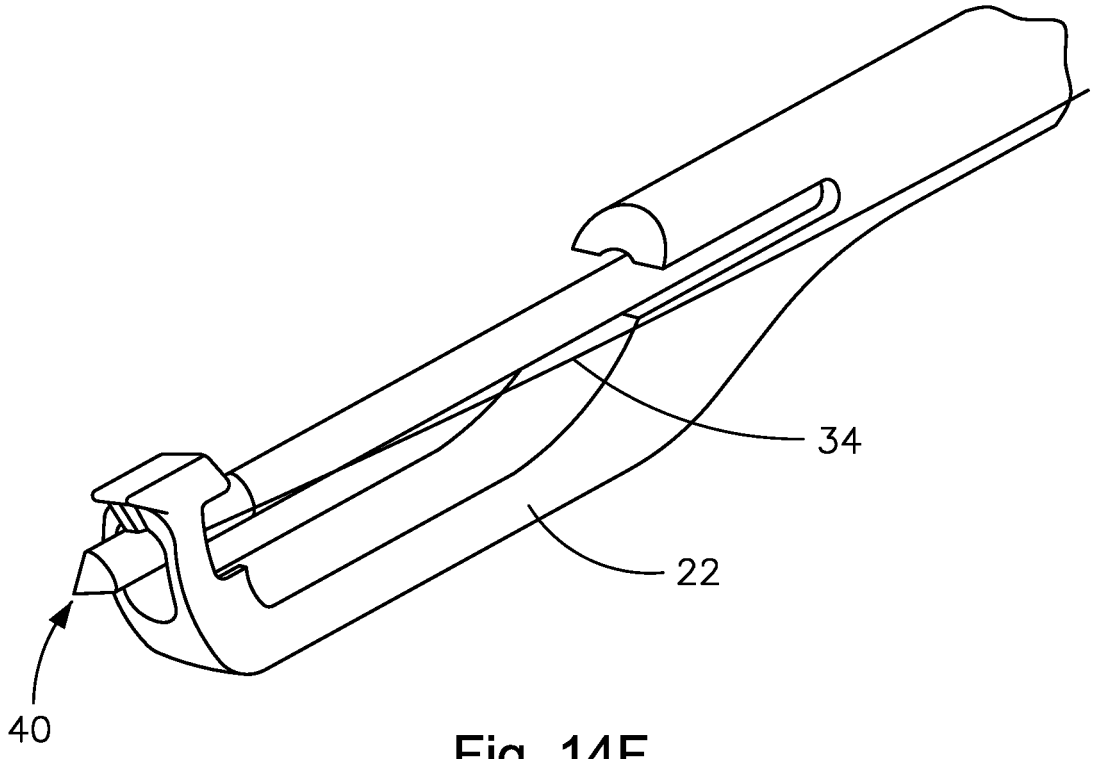

Fig. 14F

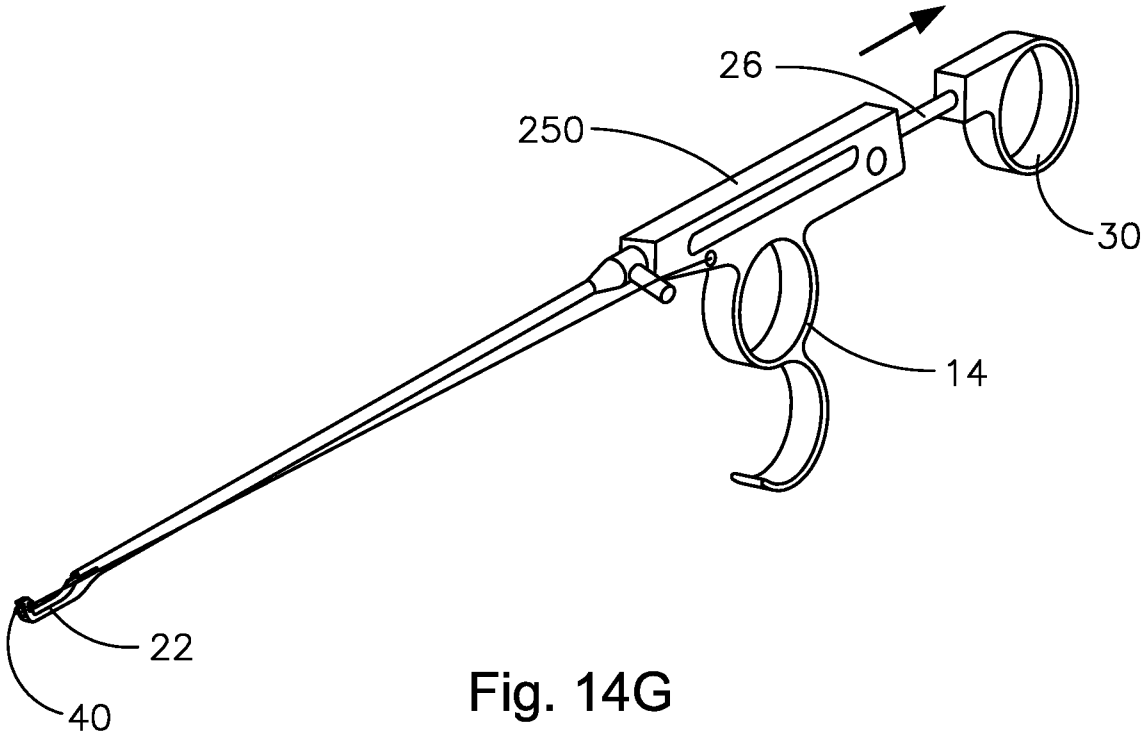

Fig. 14G

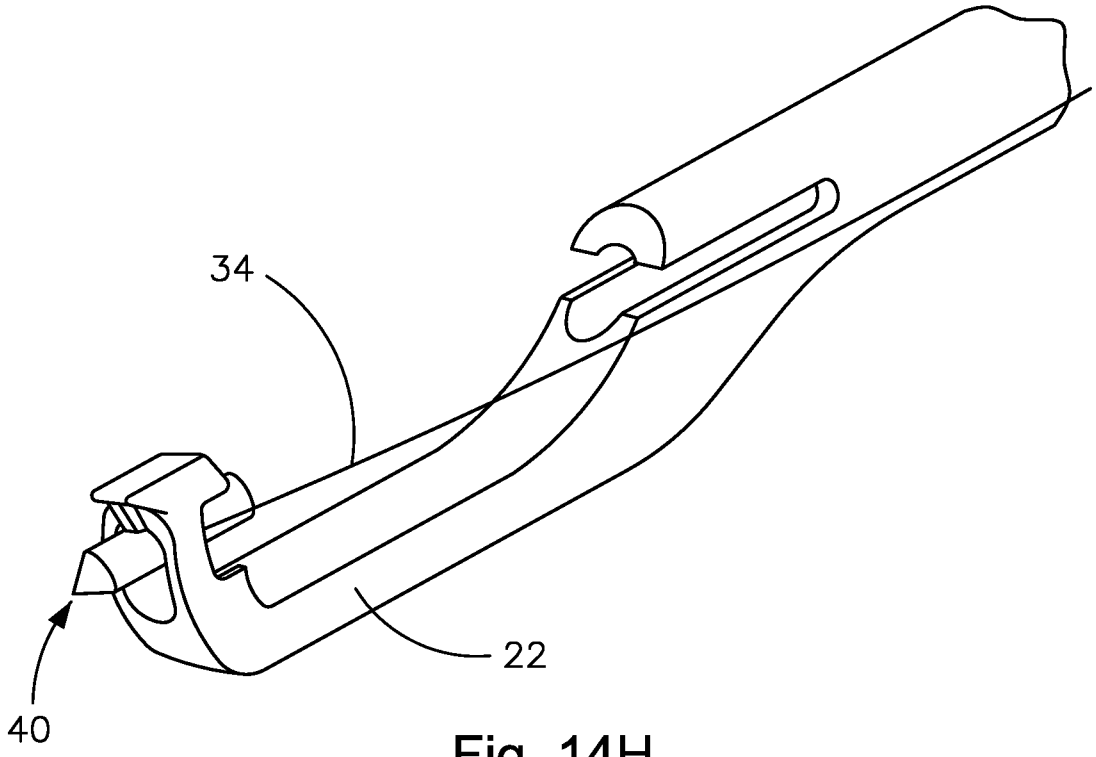

Fig. 14H

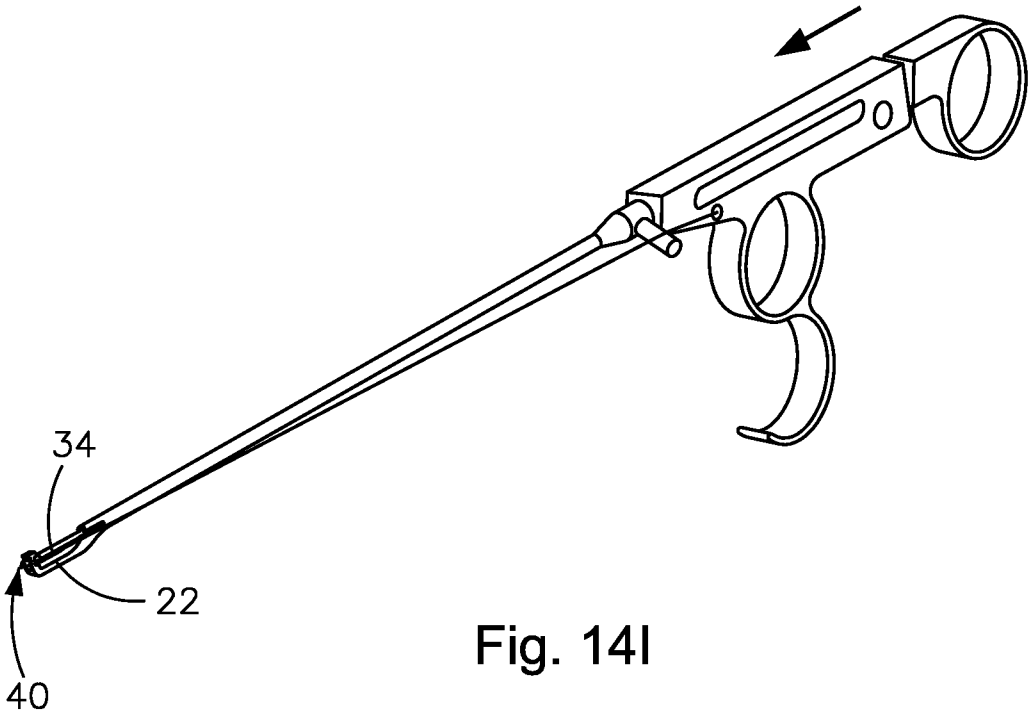

Fig. 14I

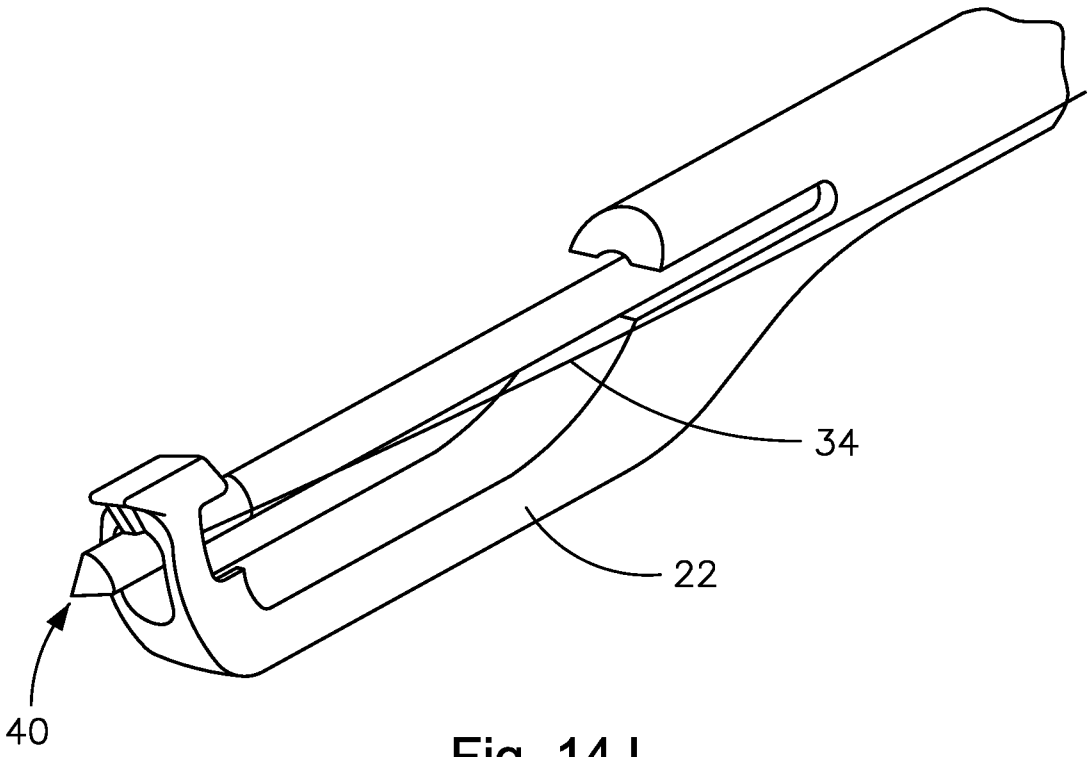

Fig. 14J

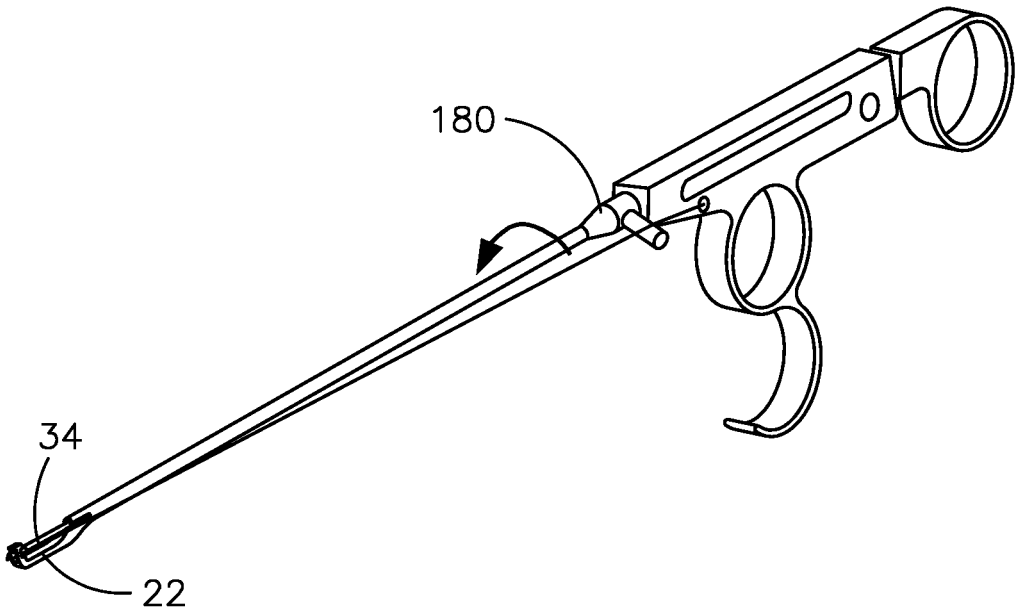

Fig. 14K

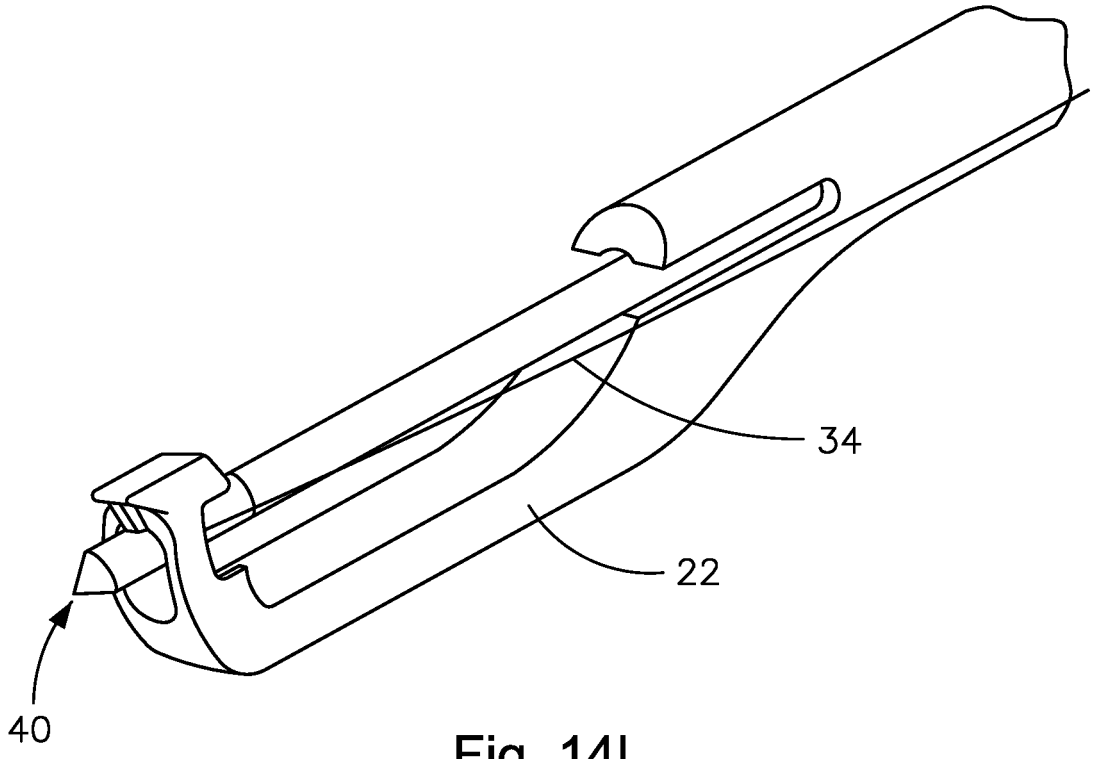

Fig. 14L

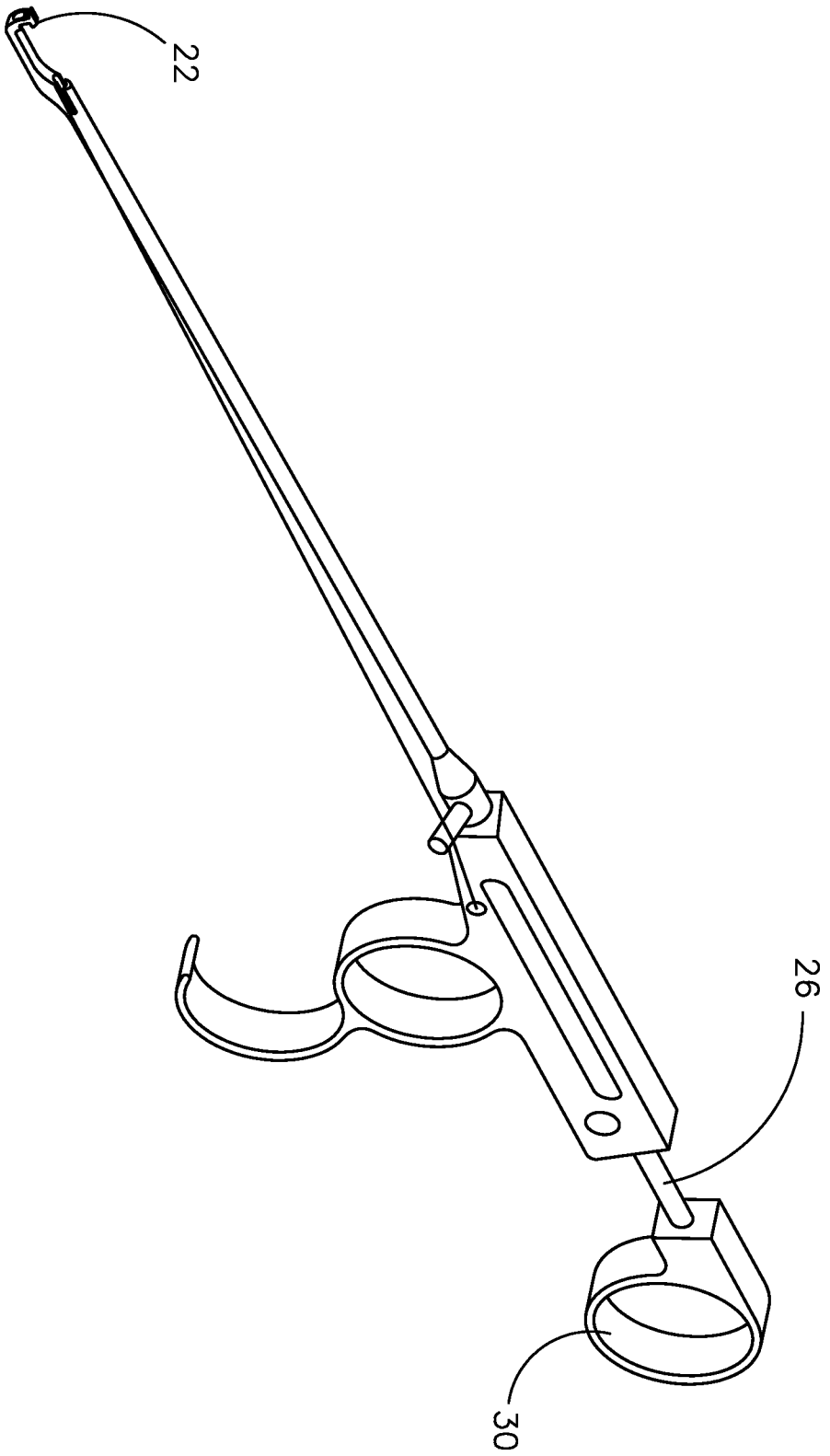

Fig. 14M

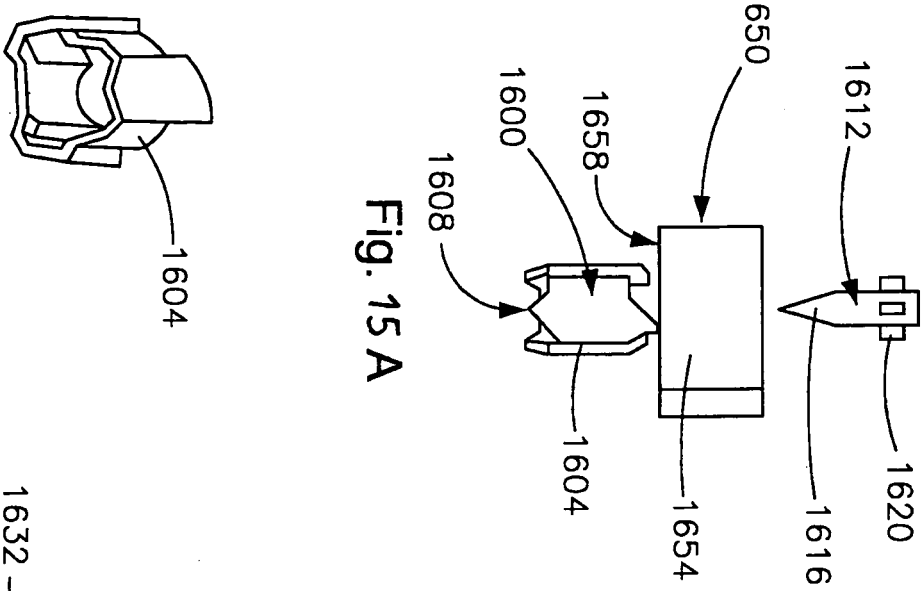

Fig. 15 A

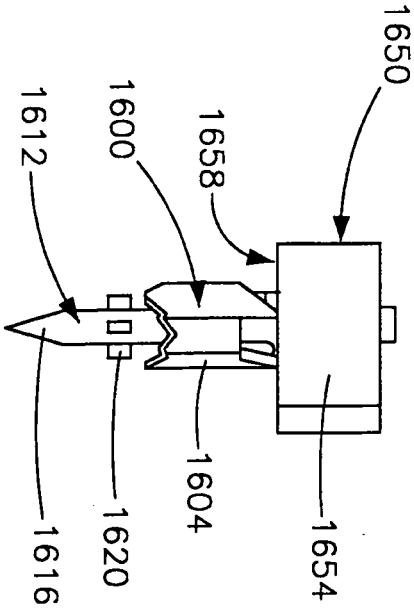

Fig. 15 B

Fig. 15 C

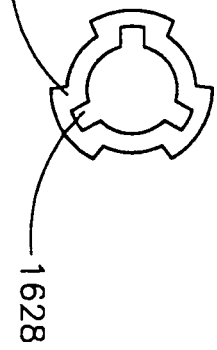

Fig. 15 D

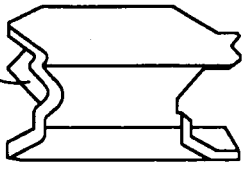

Fig. 15 E

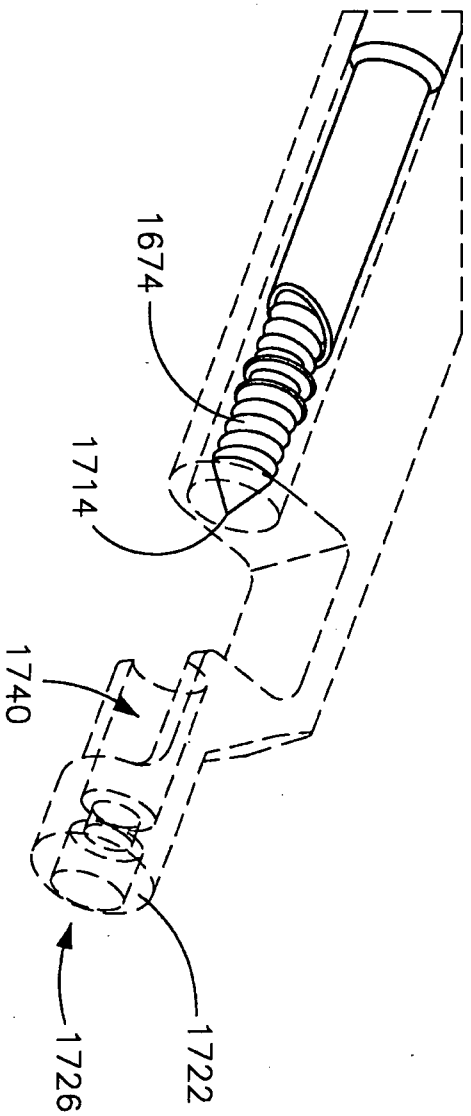

Fig. 16A

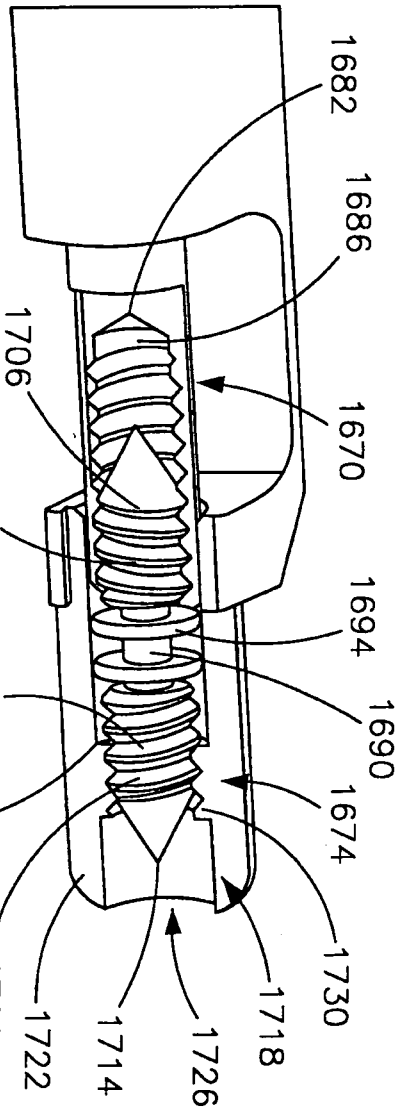

Fig. 16B

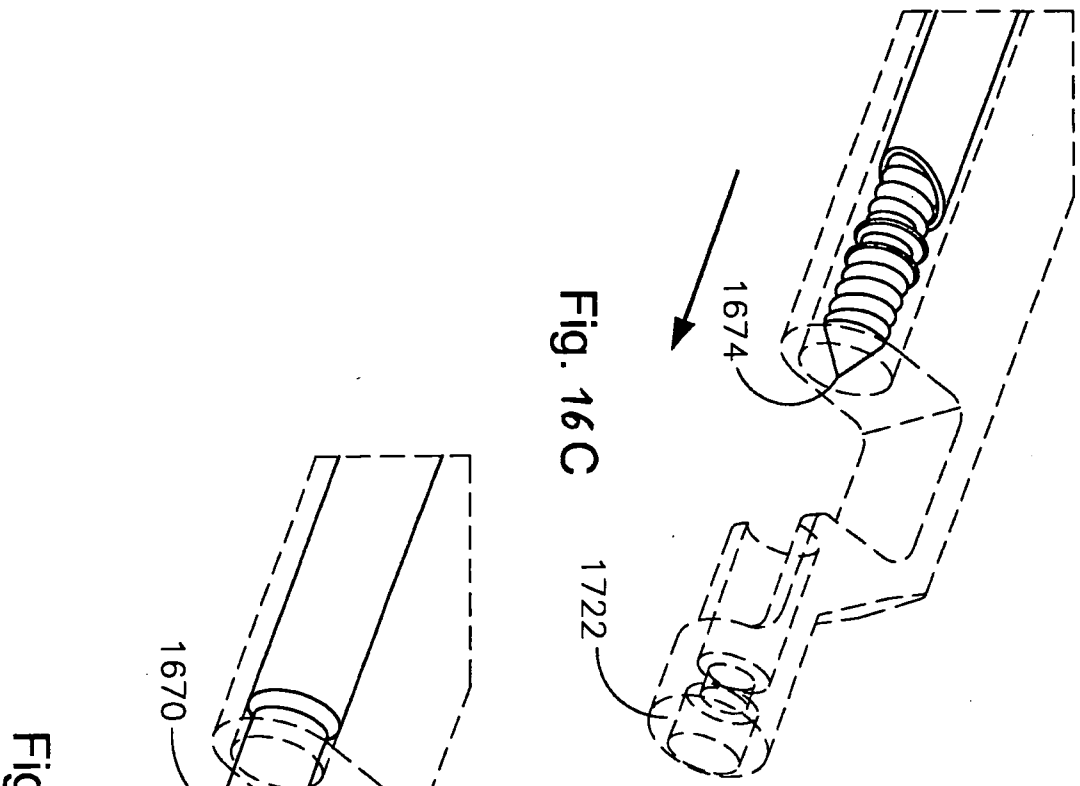

Fig. 16C

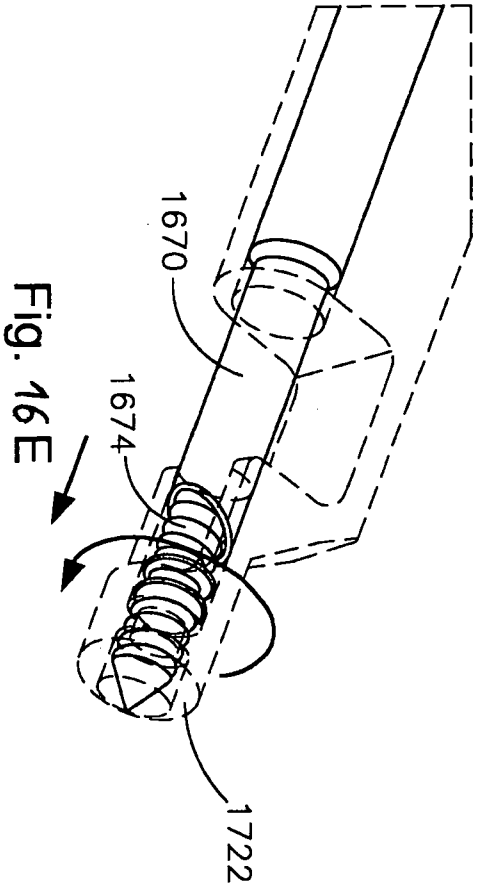

Fig. 16E

Fig. 16D

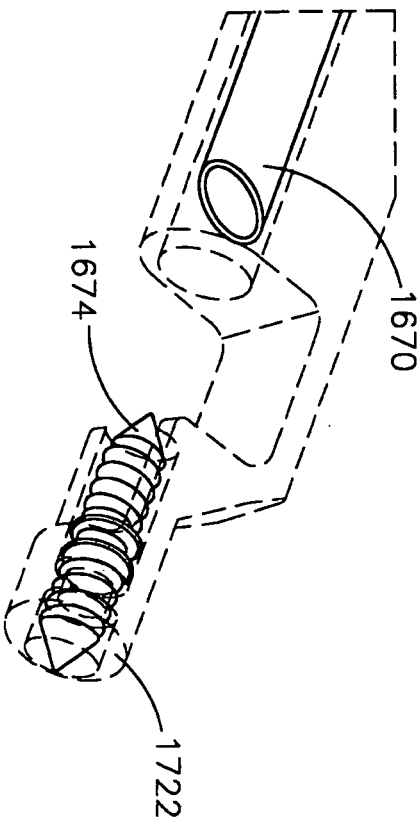

Fig. 16H

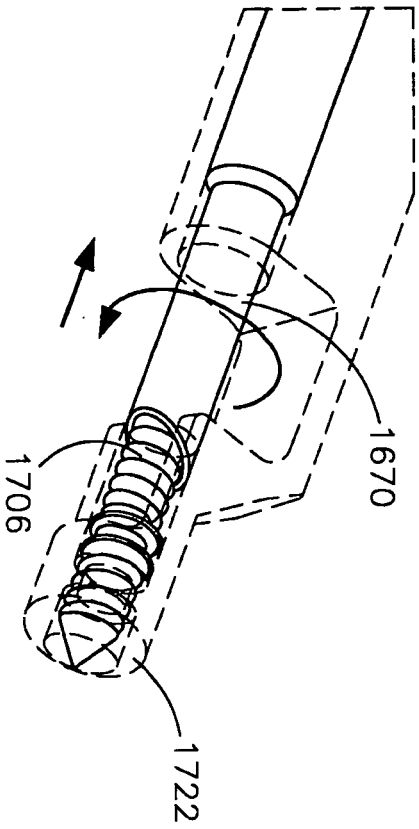

Fig. 16F

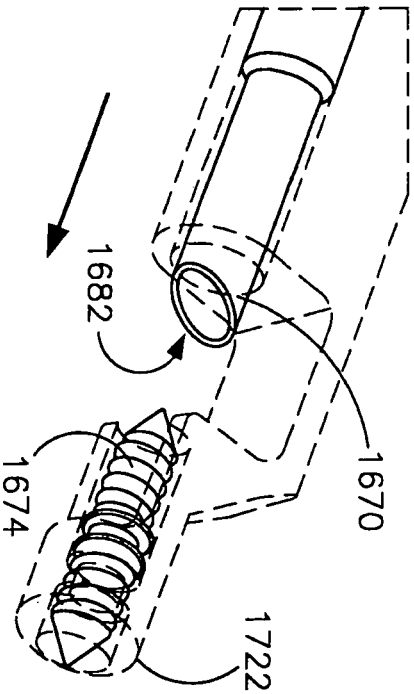

Fig. 16I

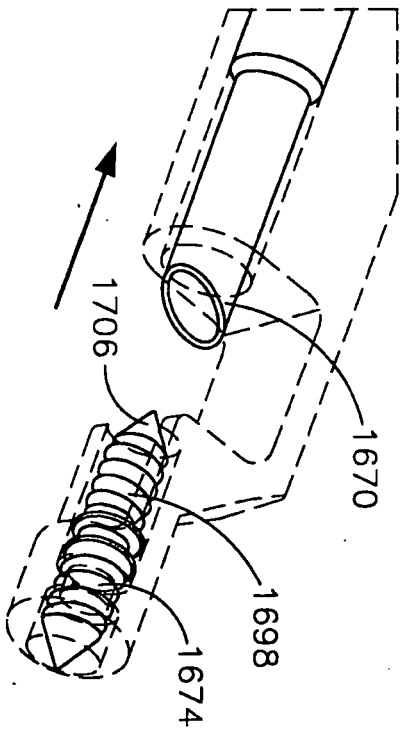

Fig. 16G

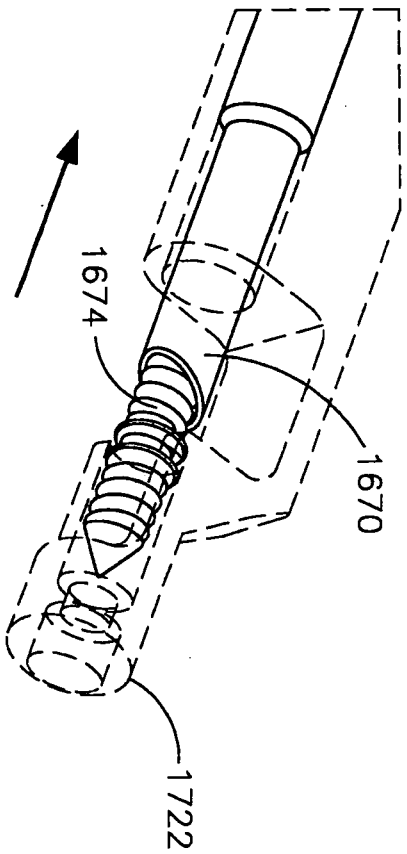

Fig. 16 L

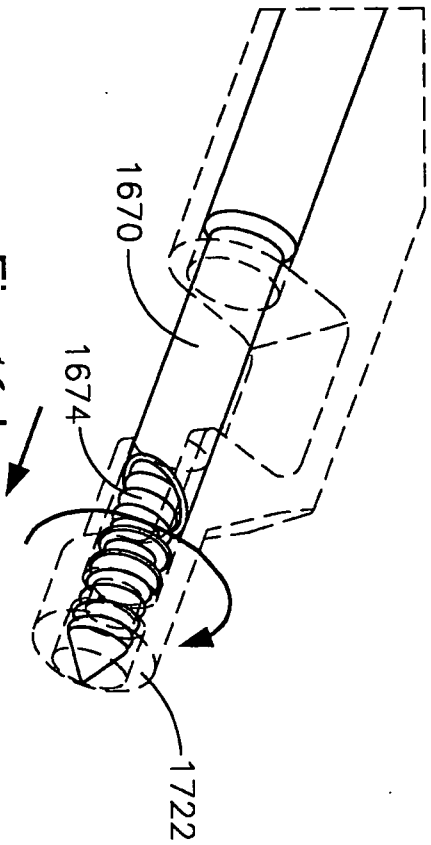

Fig. 16 J

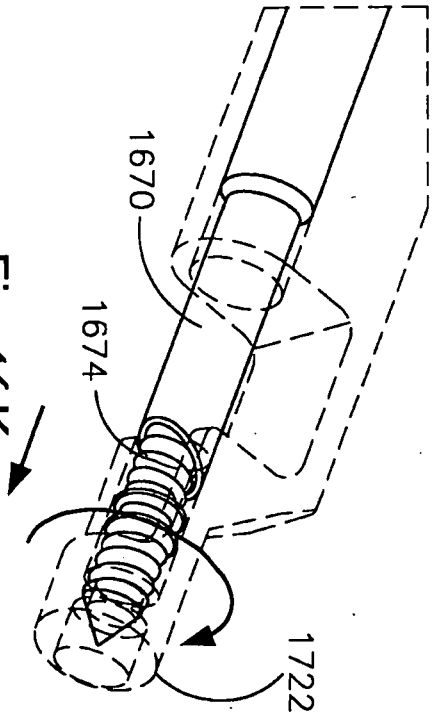

Fig. 16 K

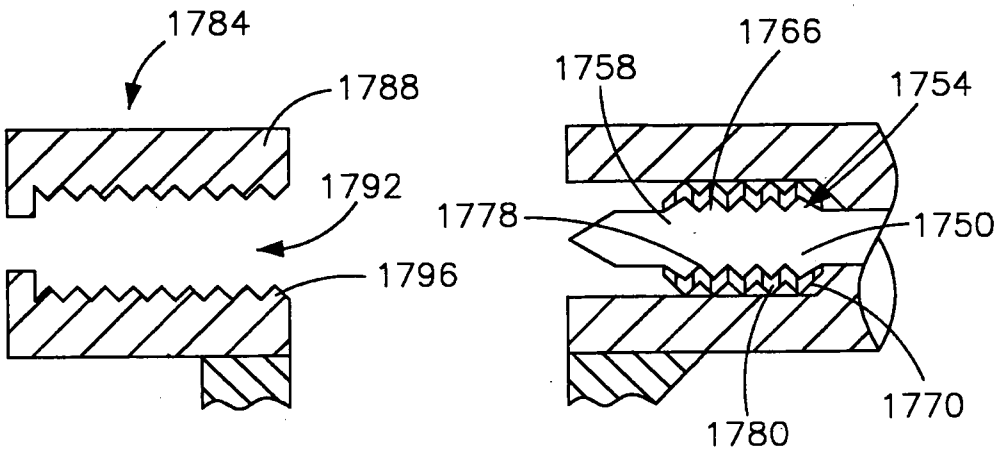

Fig. 17 A

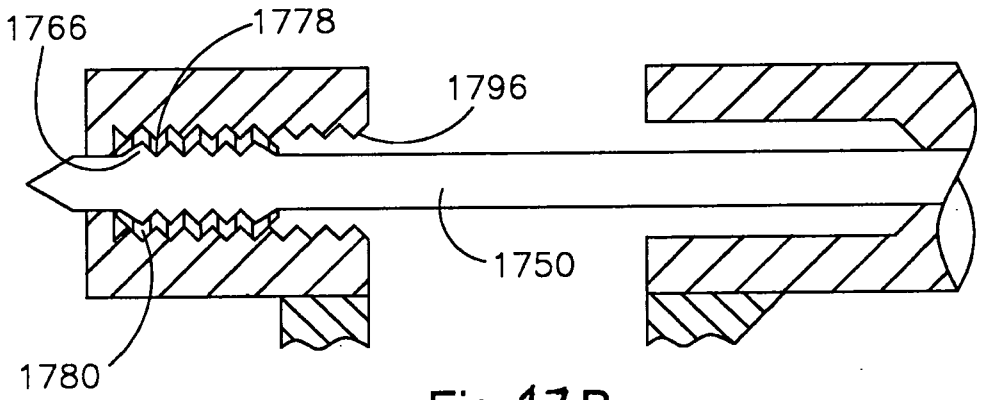

Fig. 17 B

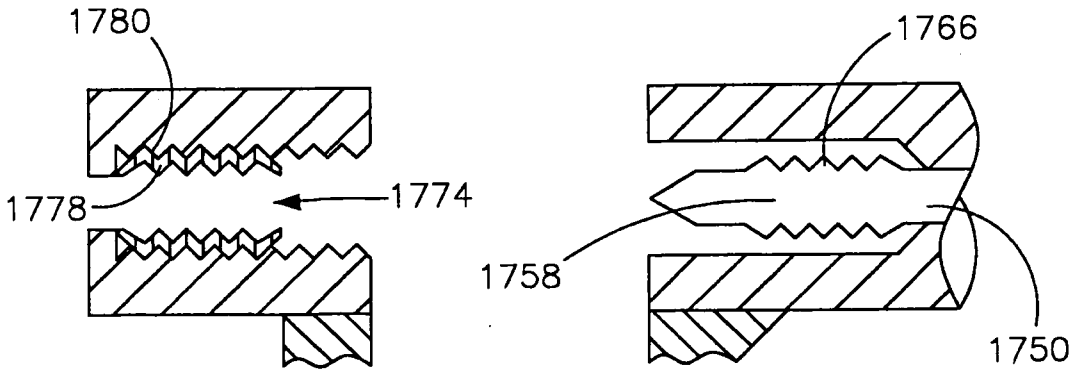

Fig. 17 C

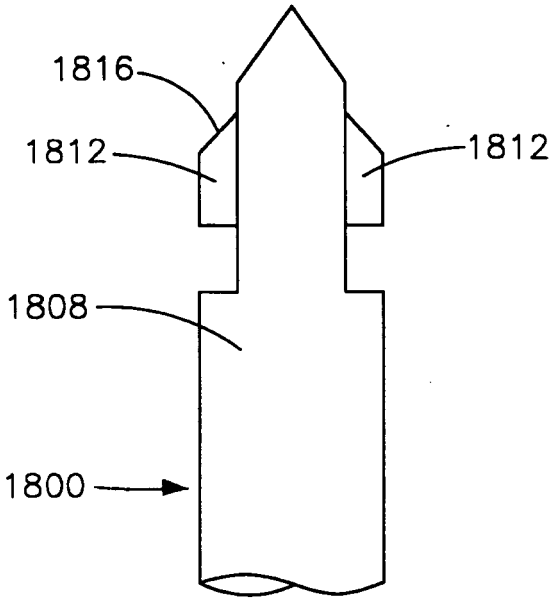

Fig. 18 A

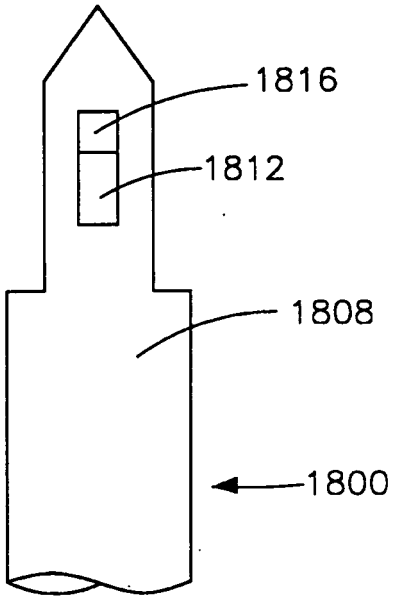

Fig. 18 B

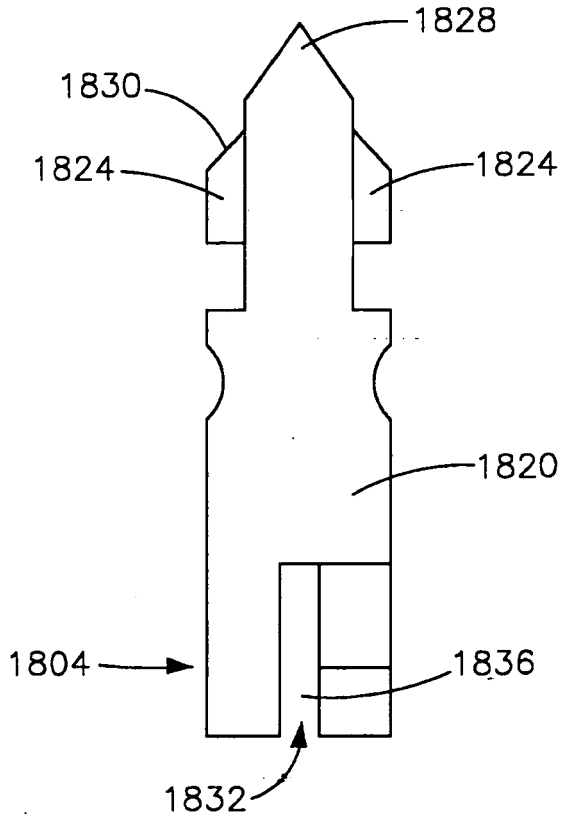

Fig. 18 C

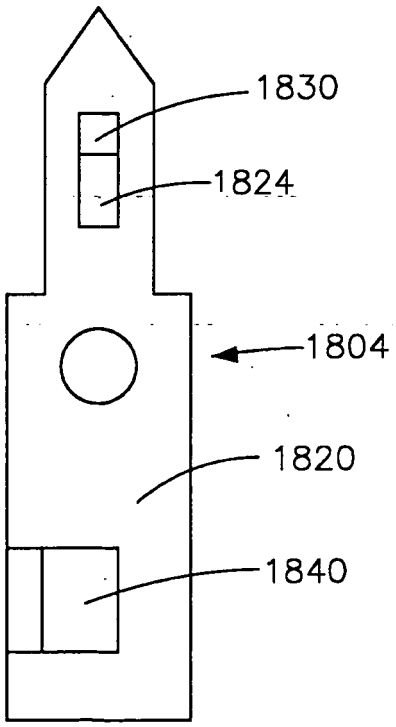

Fig. 18 D

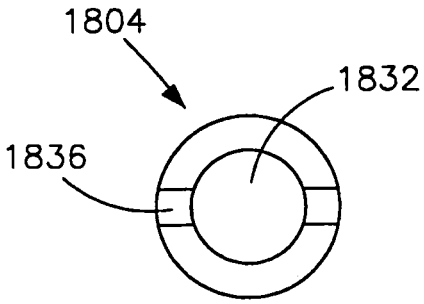

Fig. 18 E

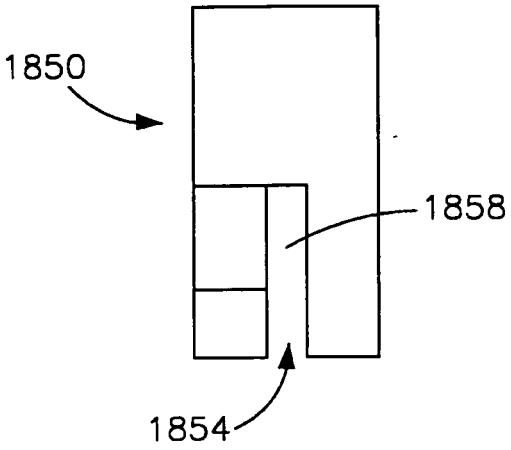

Fig. 18 F

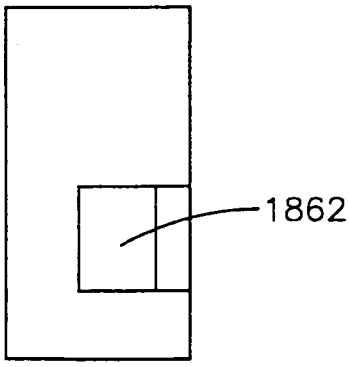

Fig. 18 G

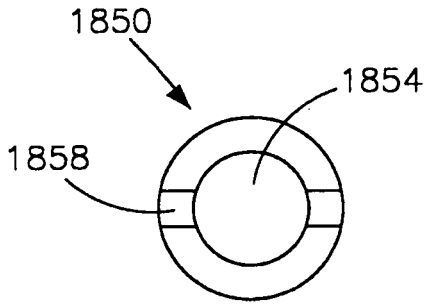

Fig. 18 H

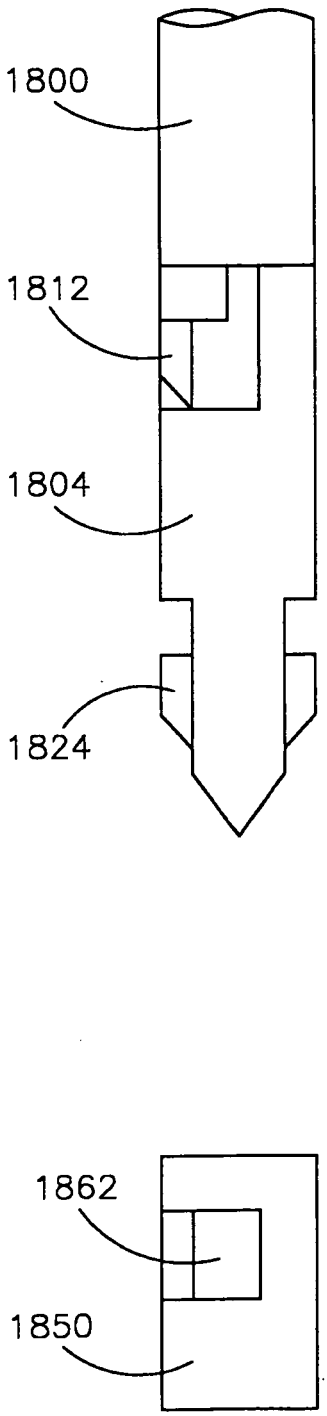

Fig. 18I

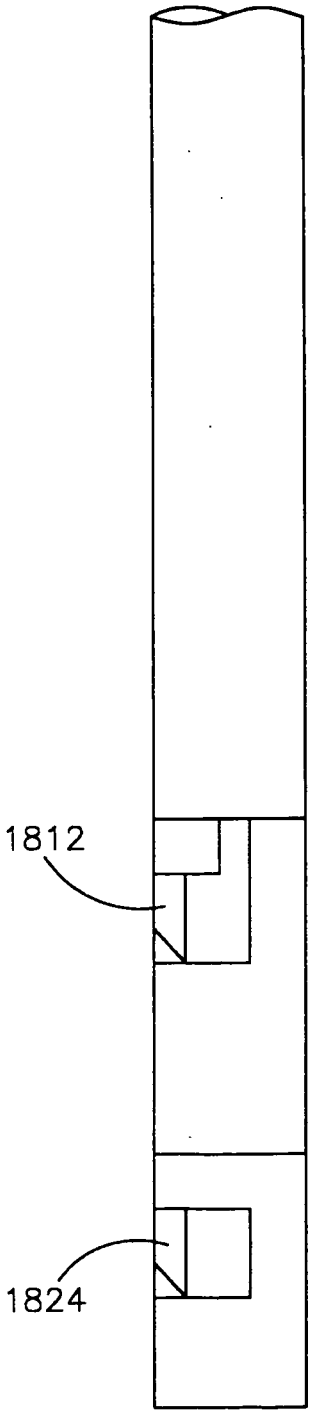

Fig. 18J

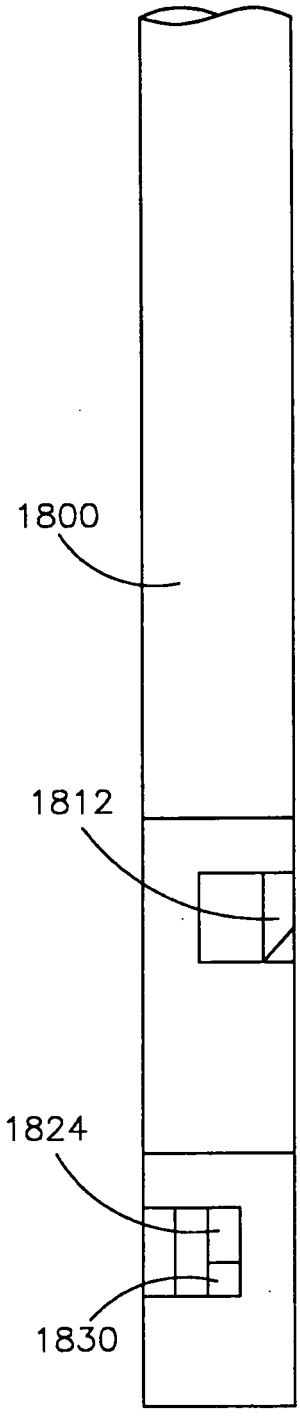

Fig. 18K

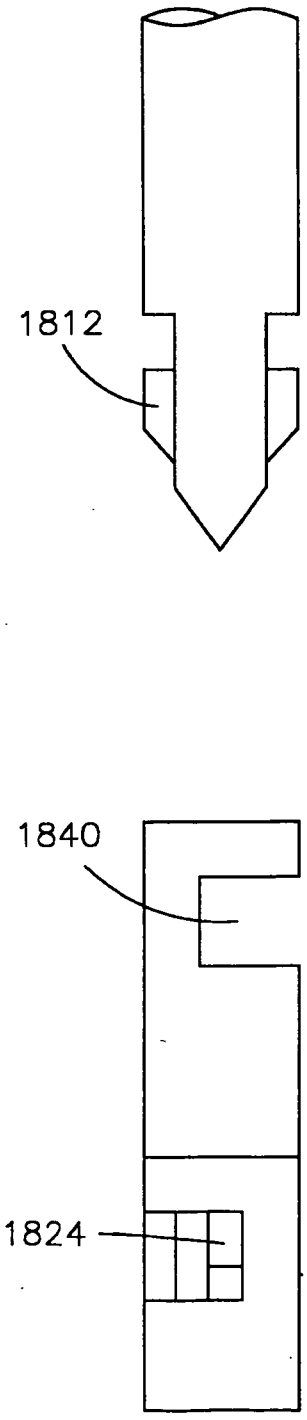

Fig. 18L

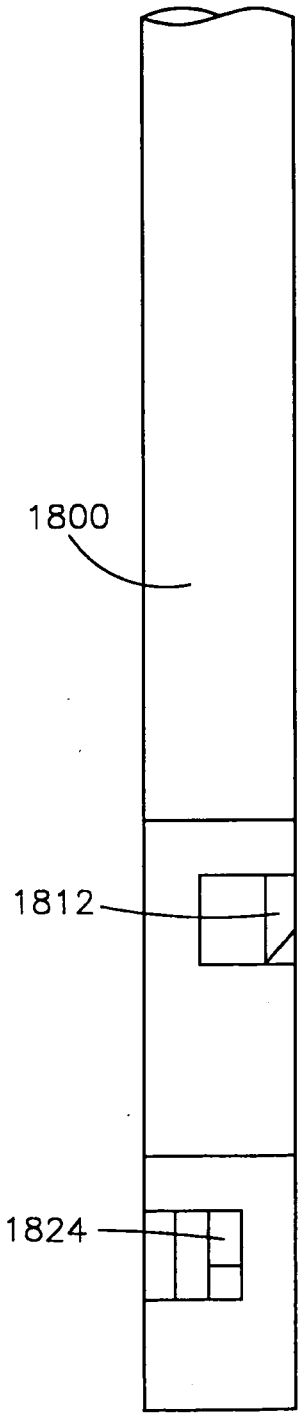

Fig. 18M

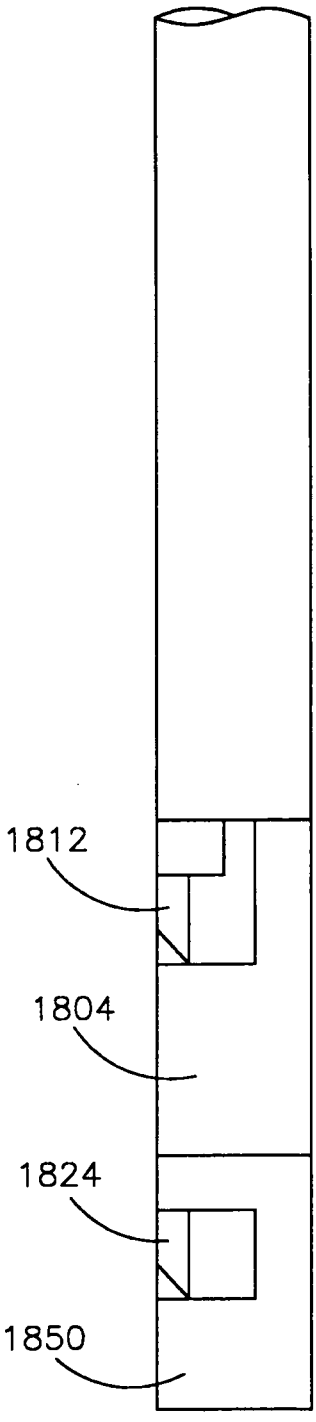

Fig. 18N

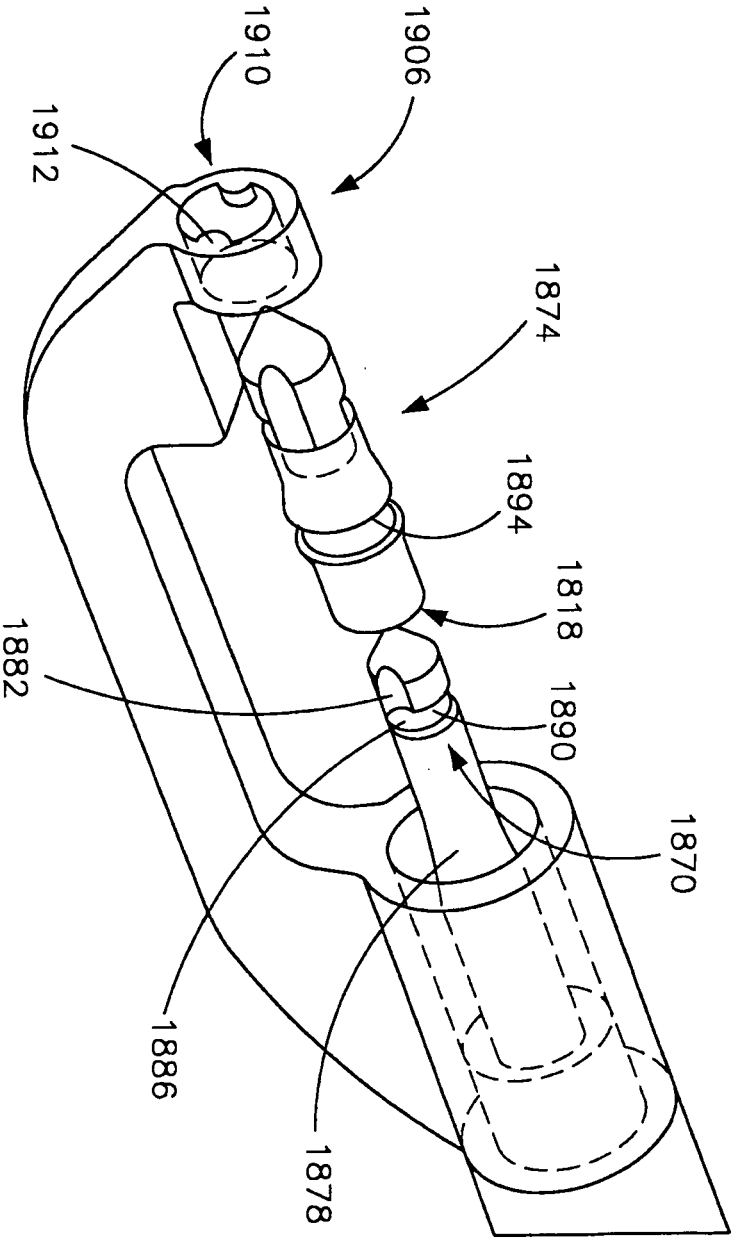

Fig. 19

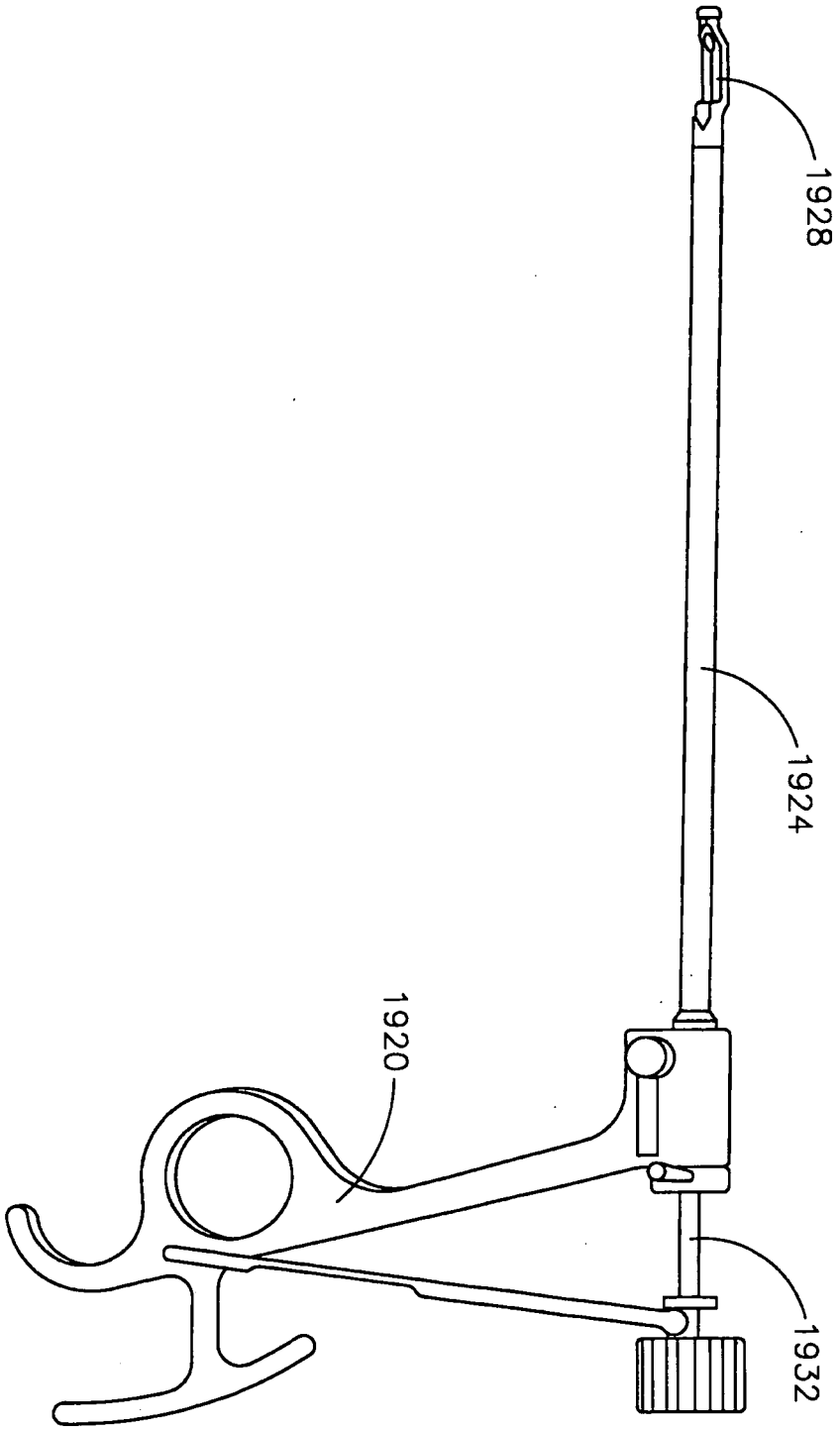

Fig. 20A

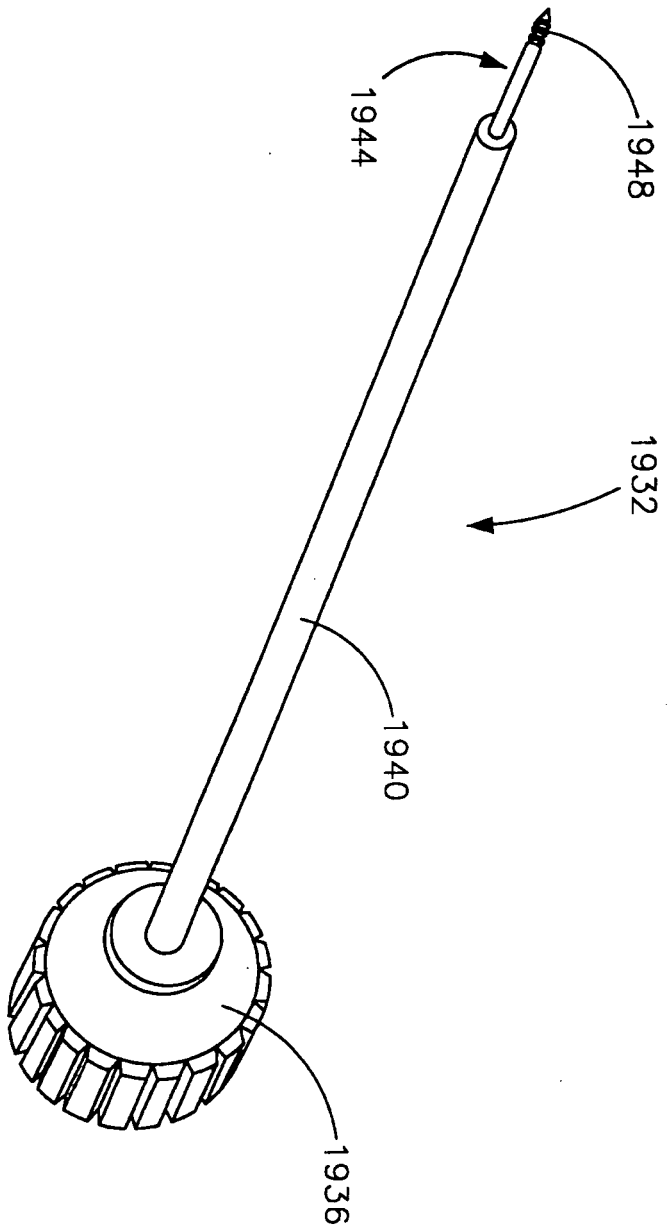

Fig.20 B

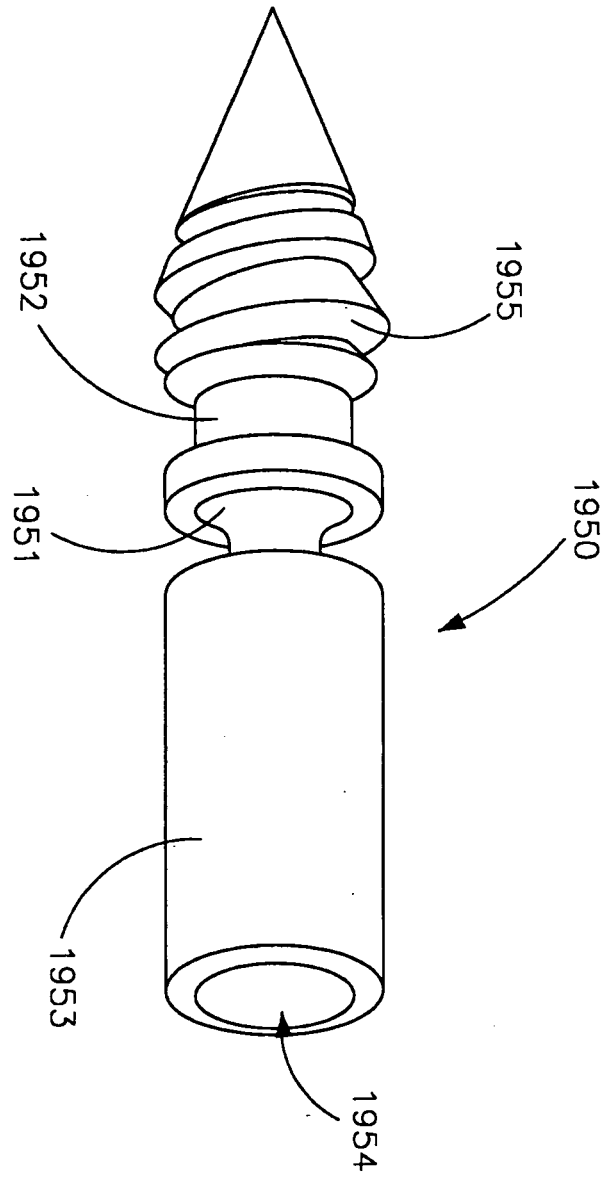

Fig. 20 C

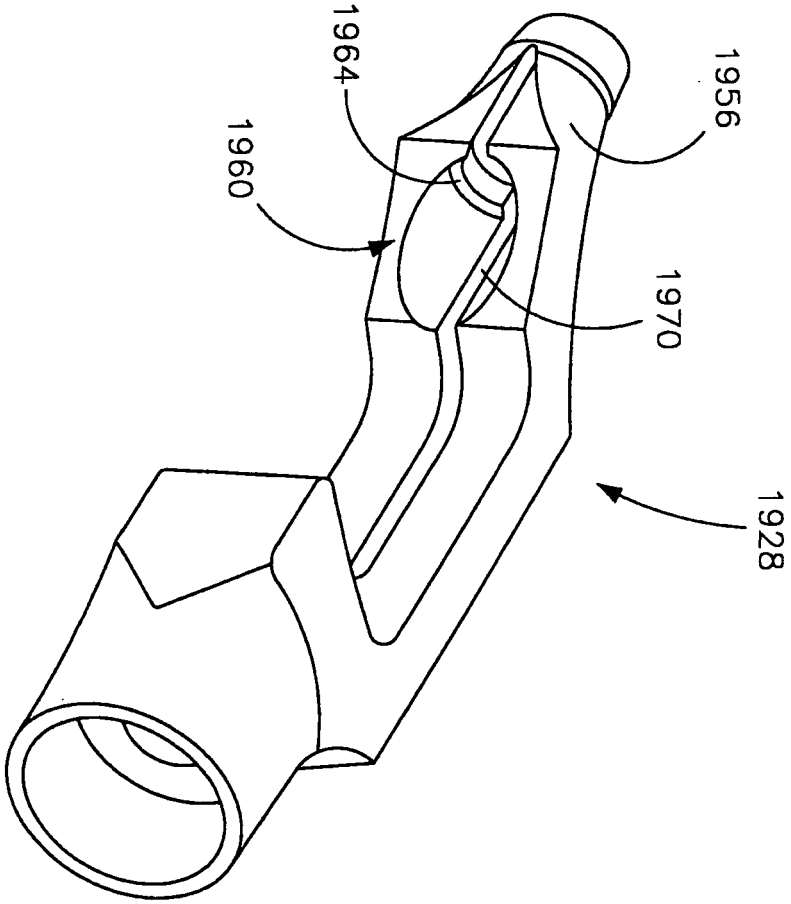

Fig.20 D

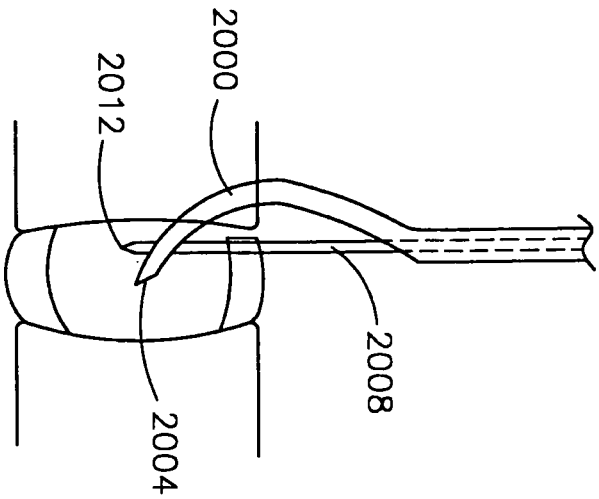

Fig. 21A

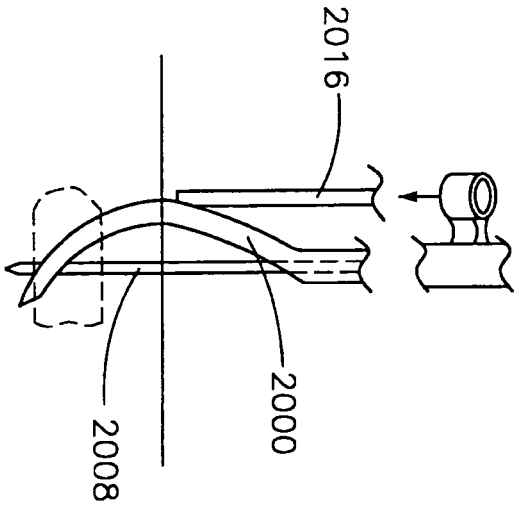

Fig. 21B

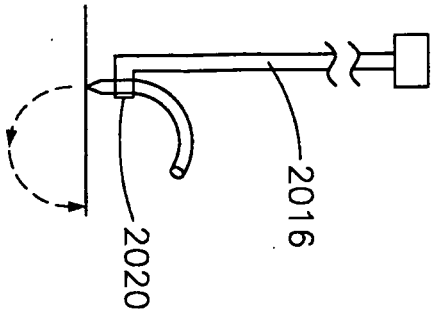

Fig. 21C

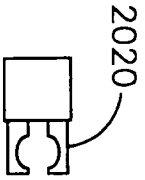

Fig. 21D

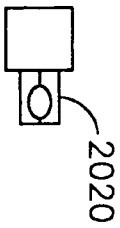

Fig. 21E

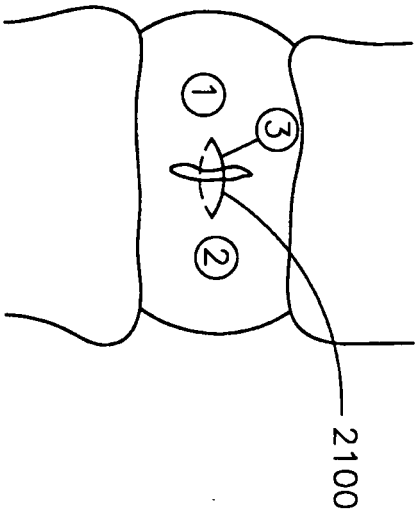

Fig. 22A

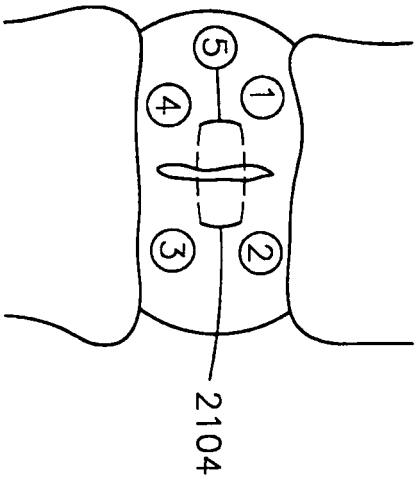

Fig. 22B

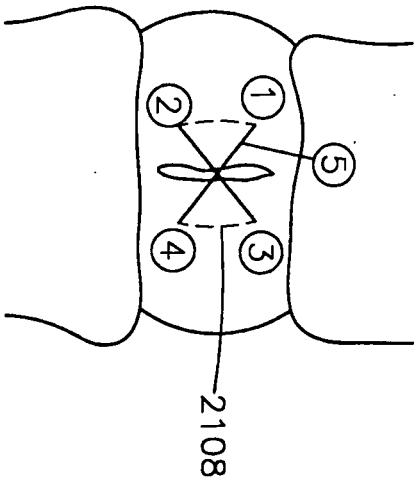

Fig. 22C

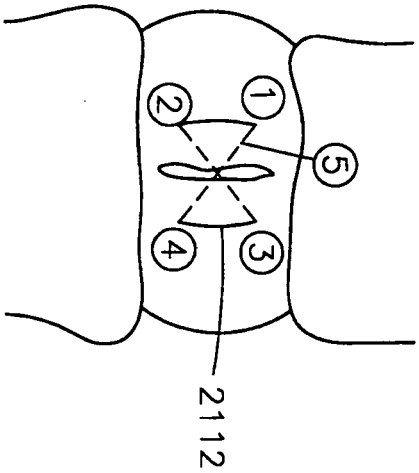

Fig. 22D

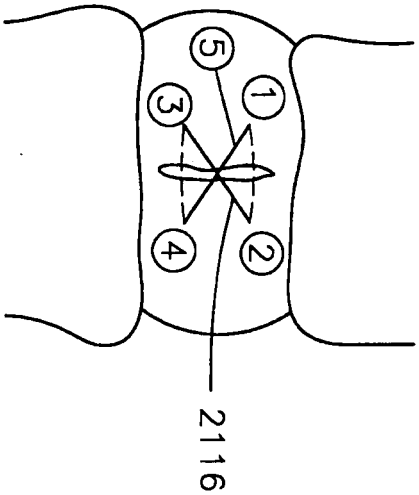

Fig. 22E

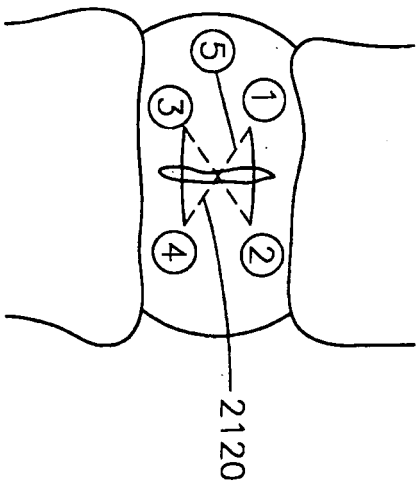

Fig. 22F

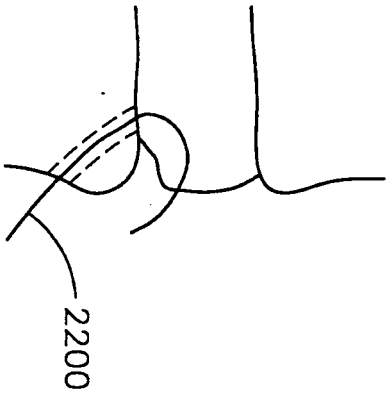

Fig. 22 G

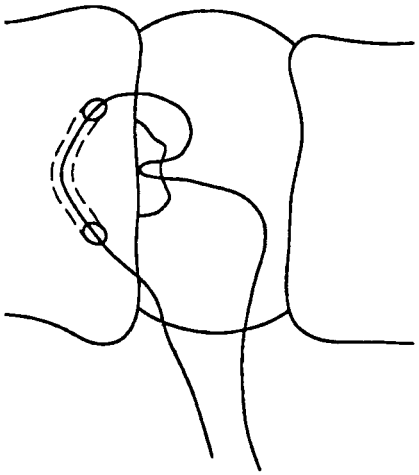

Fig. 22 I

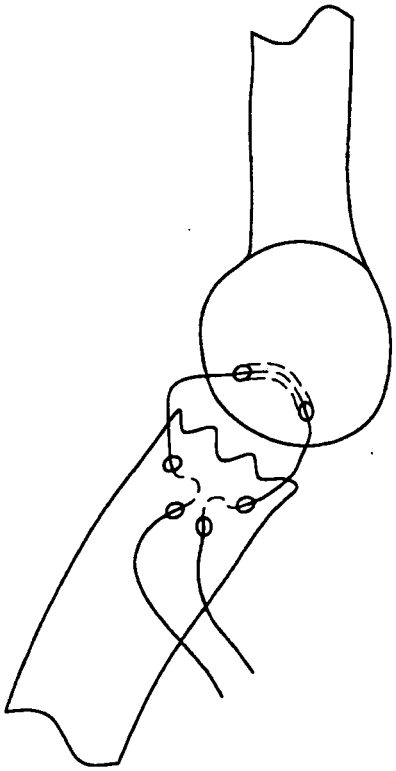

Fig. 22 H

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 5792153 A **[0006]**

专利名称(译)	双向缝线穿刺器		
公开(公告)号	EP2389118B1	公开(公告)日	2019-05-15
申请号	EP2010702783	申请日	2010-01-26
[标]申请(专利权)人(译)	斯恩蒂斯有限公司		
申请(专利权)人(译)	SYNTHES GMBH		
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IPC分类号	A61B17/04 A61B17/00 A61B17/06		
CPC分类号	A61B17/0482 A61B17/0469 A61B17/06066 A61B17/0625 A61B2017/00477 A61B2017/00867 A61B2017/0496		
优先权	61/147251 2009-01-26 US		
其他公开文献	EP2389118A2		
外部链接	Espacenet		

摘要(译)

双向缝合线传递仪器被配置为垂直接近软组织，使得能够使用更安全和更有效的外科修复和微创技术，在环状修复，半月板修复，肩关节镜检查，疝修复，腹腔镜修复和伤口闭合。

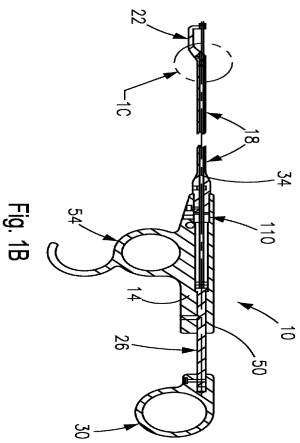

Fig. 1B

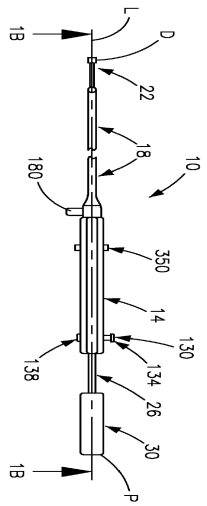

Fig. 1A