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(54) Expandable Counter-torque wrench

(57) A counter-torque wrench (100) includes a tubular outer body (110) having distal and proximal ends (112,114) and an inner shaft (130) disposed within the outer body. The inner shaft has a proximal end (135) and a distal end (132) and is axially displaceable relative to the outer body. The distal end of the inner shaft has a gripping end portion (132) disposed proximate to the distal end of the outer body. The gripping end portion comprises a plurality of branches (134) extending distally of the outer body. The branches are radially displaceable between a relatively open position, in which the branches are displaced radially outwardly from one another, and a relatively closed position, in which the branches are displaced radially inwardly toward one another. The distance between the branches is greater in the open position than in the closed position.

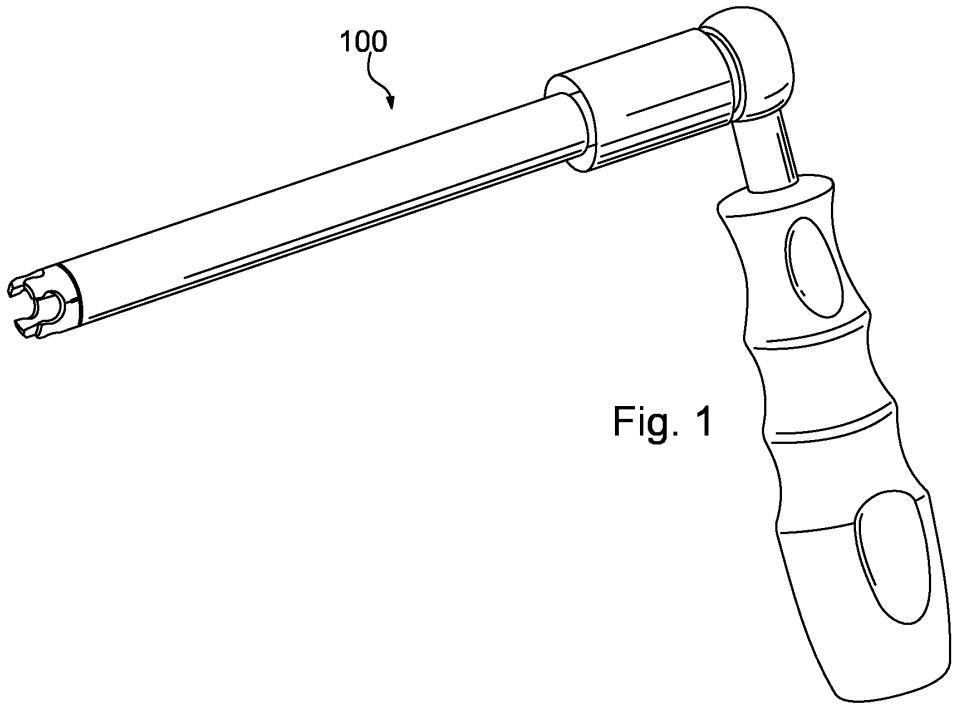

Fig. 1

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Description

FIELD OF THE INVENTION

[0001] The present invention relates generally to spinal fixation systems and more specifically to instruments for positioning and securing spinal fixation rods to screw and hook implants.

BACKGROUND OF THE INVENTION

[0002] A number of pedicle screw systems in the state of the art include a screw or hook implant attached to a receiver body for receiving a spinal rod. The receiver body typically includes a channel for receiving and seating the rod. A locking element, such as a set screw, is inserted into the channel to lock the rod in place in the receiver body. The set screw is secured in place by rotating the set screw relative to the receiver body.

[0003] In order to keep the receiver body and rod from rotating as the set screw is being screwed to the receiver body, a counter-torque wrench may be placed around the receiver body to counter the torque generated as the set screw is screwed into the receiver body. In some instances, however, as the set screw is being screwed into the receiver body, the receiver body may splay open, causing the receiver body to jam or bind inside the counter-torque wrench, and making it difficult to remove the counter-torque wrench from the receiver body after the set screw has been inserted.

[0004] In view of the foregoing, known counter-torque wrenches leave much to be desired in terms of ergonomics and functionality.

SUMMARY OF THE INVENTION

[0005] Briefly, the present application provides a counter-torque wrench comprising a tubular outer body having distal and proximal ends and an inner shaft disposed within the tubular outer body. The inner shaft has a proximal end and a distal end and is axially displaceable relative to the tubular outer body. The distal end of the inner shaft has a gripping end portion disposed proximate to the distal end of the tubular outer body. The gripping end portion comprises a plurality of branches extending distally of the distal end of the tubular outer body. The branches are radially displaceable between a relatively open position, in which the branches are displaced radially outwardly from one another, and a relatively closed position, in which the branches are displaced radially inwardly toward one another. The distance between the branches is greater in the open position than in the closed position.

[0006] In another aspect, the present invention provides a counter-torque wrench comprising an elongate tubular outer body and an elongate tubular inner shaft disposed within the outer body and axially moveable with respect to the outer body. The inner shaft has a gripping end portion including a plurality of branches extending distally from the outer body. The inner shaft is operable with respect to the tubular outer body between a gripping position wherein the branches are in a closed position, in which the branches are displaced radially inwardly toward one another to form a cylinder, and a release position, in which the branches are displaced radially outwardly from one another. The distance between the branches is greater in the release position than in the gripping position. A torque-applying handle is operatively connected to the tubular inner shaft. The outer body is rotatable relative to the inner shaft to move the tubular inner shaft relative to the outer body between the gripping position and the release position.

[0007] In yet another aspect, the present invention provides a method of tightening a set screw in a rod implant. The method comprises the steps of inserting a rod implant having a screw cap and a rod positioned in the screw cap into a patient; inserting a counter-torque wrench over the screw cap such that the counter-torque wrench engages the rod implant, the counter-torque wrench having a tubular inner shaft; inserting a set screw through the tubular inner shaft and into the screw cap in engagement with the rod; applying torque to the set screw in a first direction to tighten the set screw in the screw cap; applying torque to the screw cap in a second direction opposite the first direction with the counter-torque wrench to stabilize the screw cap against rotation while the set screw is tightened in the screw cap; radially expanding the inner shaft to release the inner shaft from the screw cap of the rod implant; and removing the counter-torque wrench from the screw cap.

[0008] In particular, in accordance with the present invention it is advantageous to provide a counter-torque wrench comprising:

a tubular outer body having a distal end and a proximal end; and

an inner shaft disposed within the tubular outer body, the inner shaft having a proximal end and a distal end and being axially displaceable relative to the tubular outer body, the distal end of the inner shaft having a gripping end portion disposed proximate to the distal end of the tubular outer body, wherein the gripping end portion comprises a plurality of branches extending distally of the distal end of the tubular outer body, the branches being radially displaceable between a relatively open position, in which the branches are displaced radially outwardly from one another, and a relatively closed position, in which the branches are displaced radially inwardly toward one another, the distance between the branches being greater in the open position than in the closed position.

[0009] It is expedient if the tubular outer body includes an internal thread and wherein the inner shaft includes an external thread in cooperative engagement with the

internal thread.

[0010] It is advantageous if the outer body is rotatable in a first direction to move the gripping end portion of the inner shaft proximally relative to the outer body and move the branches to the relatively closed position, the outer body being rotatable in a second direction to move the gripping end portion of the inner shaft distally relative to the outer body and move the branches to the relatively open position.

[0011] It is expedient if the inner shaft comprises a generally tubular body extending between the gripping end portion and the proximal end.

[0012] It is advantageous if the plurality of branches comprises an even number of branches.

[0013] It is expedient if the counter-torque wrench further comprises a torque-applying handle operatively connected to the tubular inner shaft.

[0014] It is advantageous if the outer body is rotatable relative to the inner shaft to move the inner shaft relative to the outer body between the relative closed position and the relatively open position.

[0015] It is expedient if the inner shaft further comprises a handle end portion, and wherein the torque-applying handle is fixedly coupled to the handle end portion.

[0016] It is advantageous if the inner shaft is cannulated, forming a bore extending between the gripping end portion and the handle end portion.

[0017] It is expedient if the outer body comprises a conically shaped inner surface.

[0018] It is advantageous if the gripping end portion of the inner shaft comprises a tapered outer surface disposed proximally of the branches.

[0019] It is expedient if the conically shaped inner surface comprises a nub extending radially inwardly in slidable engagement with the tapered outer surface on the inner shaft.

[0020] It is advantageous if the plurality of branches comprises a collet.

[0021] It is expedient if the plurality of branches comprises a pair of diametrically opposed cut outs for receiving a fixation rod.

[0022] Moreover, the following preferred embodiments are described in further detail below, in particular, in connection with the drawings:

1. A counter-torque wrench comprising:

   a tubular outer body having a distal end and a proximal end; and
   an inner shaft disposed within the tubular outer body, the inner shaft having a proximal end and a distal end and being axially displaceable relative to the tubular outer body, the distal end of the inner shaft having a gripping end portion disposed proximate to the distal end of the tubular outer body, wherein the gripping end portion comprises a plurality of branches extending distally of the distal end of the tubular outer body, the branches being radially displaceable between a relatively open position, in which the branches are displaced radially outwardly from one another, and a relatively closed position, in which the branches are displaced radially inwardly toward one another, the distance between the branches being greater in the open position than in the closed position.

2. The counter-torque wrench according to embodiment 1, wherein the tubular outer body includes an internal thread and wherein the inner shaft includes an external thread in cooperative engagement with the internal thread.

3. The counter-torque wrench according to embodiment 2, wherein the outer body is rotatable in a first direction to move the gripping end portion of the inner shaft proximally relative to the outer body and move the branches to the relatively closed position, the outer body being rotatable in a second direction to move the gripping end portion of the inner shaft distally relative to the outer body and move the branches to the relatively open position.

4. The counter-torque wrench according to embodiment 1, further comprising a torque-applying handle attached to the proximal end of the inner shaft.

5. The counter-torque wrench according to embodiment 1, wherein the inner shaft comprises a generally tubular body extending between the gripping end portion and the proximal end.

6. The counter-torque wrench according to embodiment 1, wherein the distal end of the tubular outer body comprises a conically-shaped inner surface and wherein the gripping end portion of the inner shaft comprises a tapered outer surface disposed proximally of the branches.

7. The counter-torque wrench according to embodiment 6, wherein the conically-shaped inner surface comprises a nub extending radially inwardly in slidable engagement with the tapered outer surface on the inner shaft.

8. The counter-torque wrench according to embodiment 1, wherein the plurality of branches comprises an even number of branches.

9. The counter-torque wrench according to embodiment 1, wherein the plurality of branches comprises a pair of diametrically opposed cut outs for receiving a fixation rod.

10. A counter-torque wrench comprising:

   an elongate tubular outer body;
   an elongate tubular inner shaft disposed within the outer body and axially moveable with respect to the outer body, the inner shaft having a gripping end portion including a plurality of branches extending distally from the outer body, the inner shaft being operable with respect to the tubular outer body between a gripping position wherein

the branches are in a closed position, in which the branches are displaced radially inwardly toward one another to form a cylinder, and a release position, in which the branches are displaced radially outwardly from one another, the distance between the branches being greater in the release position than in the gripping position; and

a torque-applying handle operatively connected to the tubular inner shaft, wherein the outer body is rotatable relative to the inner shaft to move the tubular inner shaft relative to the outer body between the gripping position and the release position.

11. The counter-torque wrench according to embodiment 10, wherein the tubular inner shaft further comprises a handle end portion, and wherein the torque-applying handle is fixedly coupled to the handle end portion.

12. The counter-torque wrench according to embodiment 11, where in the tubular inner shaft is cannulated, forming a bore extending between the gripping end portion and the handle end portion.

13. The counter-torque wrench according to embodiment 10, wherein the tubular outer body comprises a conically shaped inner surface and wherein the gripping end portion of the inner shaft comprises a tapered outer surface disposed proximally of the branches.

14. The counter-torque wrench according to embodiment 13, wherein the conically shaped tapered surface comprises a nub extending radially inwardly in slidable engagement with the tapered outer surface on the inner shaft.

15. The counter-torque wrench according to embodiment 1, wherein the plurality of branches comprises a collet.

16. The counter-torque wrench according to embodiment 1, wherein the plurality of branches comprises a pair of diametrically opposed cut outs for receiving a fixation rod.

17. A method of tightening a set screw in a rod implant, the method comprising the steps of:

a) inserting a rod implant having a screw cap and a rod positioned in the screw cap into a patient;

b) inserting a counter-torque wrench over the screw cap such that the counter-torque wrench engages the rod implant, the counter-torque wrench having a tubular inner shaft;

c) inserting a set screw into the screw cap in engagement with the rod;

d) applying torque to the set screw in a first direction to tighten the set screw in the screw cap;

e) applying torque to the screw cap in a second direction opposite the first direction with the counter-torque wrench to stabilize the screw cap against rotation while the set screw is tightened in the screw cap;

f) radially expanding the inner shaft to release the inner shaft from the screw cap of the rod implant; and

g) removing the counter-torque wrench from the screw cap.

18. The method according to embodiment 17, wherein the tubular inner shaft comprises a plurality of branches operable in a locked position, in which the branches engage each other forming a cylinder, and wherein step f) further comprises the step of moving the branches out of engagement with each other.

19. The method according to embodiment 17, wherein step f) comprises axially translating the tubular inner shaft relative to the tubular outer body.

20. The method according to embodiment 19, wherein the axial translation comprises allowing the branches to disengage from each other.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] The foregoing summary, as well as the following detailed description of preferred embodiments of the invention, will be better understood when read in conjunction with the appended drawings, which are incorporated herein and constitute part of this specification. For purposes of illustrating the invention, there are shown in the drawings exemplary embodiments of the present invention. It should be understood, however, that the invention is not limited to the precise arrangements and instrumentalities shown. In the drawings, the same reference numerals, are employed for designating the same elements throughout the several figures. In the drawings:

FIG. 1 is a perspective view of a counter-torque wrench according to an exemplary embodiment of the present invention, with the counter-torque wrench in a gripping position;

FIG. 2 is an enlarged view of the distal end of the counter-torque wrench of FIG. 1;

FIG. 3 is a perspective view of the counter-torque wrench of Fig. 1 in a release position;

FIG. 4 is an enlarged view of the distal end of the counter-torque wrench of FIG. 3;

FIG. 5 is a side elevational view of the counter-torque wrench of FIG. 1, with an implant affixed thereto;

FIG. 6 is a side elevational view of an outer body of the counter-torque wrench of FIG .1;

FIG. 7 is a sectional view of the outer body of FIG. 6, taken along line 7--7 of Fig. 6;

FIG. 8 is an enlarged view of the distal end of the outer body shown in FIG. 7;

FIG. 9 is a side elevational view of an inner shaft of the counter-torque wrench of FIG. 1;

FIG. 10 is a sectional view of a distal end of the inner

shaft of FIG. 9, taken along line 10--10 of FIG. 9;
FIG. 11 is an enlarged view of the distal end of the inner shaft shown in FIG. 10;
FIG. 12 is a sectional view of the inner shaft of FIG. 9, taken along line 12--12 of FIG. 9;
FIG. 13 is a side elevational view of a drive nut of the counter-torque wrench of FIG .1;
FIG. 14 is a sectional view of the drive nut of FIG. 13, taken along line 14--14 of Fig. 13;
FIG. 15 is a sectional view of a portion of the counter-torque wrench of FIG. 1 including the outer body of FIG. 6, the inner shaft of FIG. 9, and the drive nut of FIG. 13;
FIG. 16 is an enlarged view of the proximal end of the assembly shown in FIG. 15;
FIG. 17 is an enlarged view of the distal end of the assembly shown in FIG. 15;
FIG. 18 is an enlarged view of an engagement point of the outer body and the inner shaft of FIG. 15;
FIG. 19 is a side elevational view of a handle of the counter-torque wrench of FIG. 1; and
FIG. 20 is a flowchart illustrating exemplary steps for operating the counter-torque wrench of the present invention.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS OF THE INVENTION

[0024] Certain terminology is used herein for convenience only and is not to be taken as a limitation on the present invention. The terminology includes the words specifically mentioned, derivatives thereof and words of similar import. As used herein, the term "proximal" is intended to define a direction closer to an operator of a counter-torque wrench according to the present invention, and the term "distal" is intended to define a direction closer to a patient on which the counter-torque wrench according to the present invention is used.

[0025] The following describes an exemplary embodiment of the present invention. It should be understood based on this disclosure, however, that the invention is not limited by this exemplary embodiment. A counter-torque wrench according to an exemplary embodiment of the present invention is used to provide a surgeon with a tool capable of constraining an implant with the added advantage of a release mechanism that aids in removing the counter-torque wrench from the implant after the implant has been inserted into the patient. An exemplary implant for which the present invention may be used is the Aesculap Implant Systems, Inc. S-4 5.5 millimeter rod implant, although those skilled in the art will recognize that other implant designs may be used with the counter-torque wrench of the present invention.

[0026] Referring to the drawing figures generally, a counter-torque wrench 100 in accordance with an exemplary embodiment of the present invention is shown. Counter-torque wrench 100 is operable between a closed or gripping position, as shown in FIGS. 1 and 2, and an open or release position, as shown in FIGS. 3 and 4.

[0027] Counter-torque wrench 100 is used to stabilize the position of a rod implant as the rod is being secured in its rod receiver. Referring to FIG. 5, in which an exemplary implant 50 is shown affixed to counter-torque wrench 100, implant 50 includes a rod receiver in the form of a screw cap 52 through which a polyaxial screw 54 extends. Screw cap 52 includes a pair of diametrically opposed slots (not shown in FIG. 5) extending partially therethrough. A rod 60 is seated within the slots. A set screw 62 is inserted into screw cap 52 and is screwed into screw cap 52 by a screw driver 70 to secure rod 60 to screw cap 52.

[0028] In many circumstances, a surgeon must apply a significant amount of torque on set screw 62 to drive set screw 62 in screw cap 52 and advance rod 60 into a fully seated position. This torque is transferred from set screw 62 to screw cap 60. If screw cap 62 is not restrained, screw cap 62 and rod 60 will be allowed to rotate with set screw 62. Counter-torque wrench 100 is inserted over the proximal end of implant 50 such that counter-torque wrench 100 engages rod 60 to prevent rod 60 from rotating as set screw 62 is screwed into place.

[0029] Counter-torque wrench 100 includes a tubular outer body 110 and an inner shaft 130 co-axially disposed within outer body 110. Outer body 110 is axially translatable with respect to inner shaft 130 to move counter-torque wrench 100 between the gripping position of FIGS. 1 and 2 and the release position of FIGS. 3 and 4. Referring back to FIG. 5, a drive nut 150 is coupled to inner shaft 130 and a torque-applying handle 170 extends from drive nut 150.

[0030] Counter-torque wrench 100 includes a proximal end 102 and a distal end 104, with a linear axis 106 extending between proximal end 102 and distal end 104. Linear axis 106 extends through both outer body 110 and inner shaft 130 when inner shaft 130 is disposed within outer body 110, as is shown in FIG. 5. Handle 170 extends from proximal end 102, generally orthogonally relative to linear axis 106.

[0031] Referring now to FIGS. 6-8, outer body 110 includes a proximal end 112 and a distal end 114. Proximal end 112 of outer body 110 includes a knurled gripping portion 116. As shown in FIG. 6, knurled gripping portion 116 has a larger outer diameter than a remainder of outer body 110, although those skilled in the art will recognize that knurled gripping portion 116 may have an outer diameter approximately the same as the remainder of outer body 110.

[0032] As shown in FIG. 7, proximal end 112 of outer body 110 also includes an internal thread 118. Internal thread engages inner shaft 130 (shown in FIGS. 15 and 16) and provides for axial translation of outer body 110 with respect to inner shaft 130. Proximal end 112 of outer body 110 further includes a recessed cylindrical bore 119 located proximal of internal thread 118. Bore 119 is slightly larger than the outer diameter of drive nut 150 where the nut contacts the bore to allow proximal end 112 of

outer body 110 to slide along drive nut 150 (shown in FIGS. 15 and 16) when outer body 110 is translated relative to inner shaft 130.

[0033] Distal end 114 of outer body 110 includes a conically shaped inner surface 120. In an exemplary embodiment, inner surface 120 is angled at an included angle α of about 40 degrees. Referring to the enlargement of conically tapered surface 120 in FIG. 8, inner surface 120 comprises a radially extending nub 122 extending around the entire inner perimeter of inner surface 120 (*i.e.* 360 degrees), generally toward longitudinal axis 106. While an exemplary embodiment of counter-torque wrench 100 includes nub 122 extending 360 degrees around inner surface 120, those skilled in the art will recognize that nub 122 may extend less than 360 degrees around inner surface 120 and that a plurality of nubs 122 may be used.

[0034] Referring now to FIGS. 9-12, inner shaft 130 includes a generally tubular body 131 that is sized to allow a driving tool, such as screw driver 70 (shown in FIG. 5), or other implement, to be inserted therethrough. Referring also to FIGS. 2 and 4, inner shaft 130 further includes a distal, or gripping end portion 132, disposed proximate to distal end 114 of outer body 110 and a proximal, or handle end, portion 135 (shown in FIG. 9). Inner shaft 130 is cannulated, forming a bore extending between gripping end portion 132 and handle end portion 135.

[0035] Gripping end portion 132 includes a collet 133 having a plurality of branches 134 extending distally of distal end 114 of outer body 110. Branches 134 are radially displaceable between a relatively open position, in which the branches are naturally displaced radially outwardly from one another (as shown in FIG. 4), and a biased, or closed position, in which the branches are displaced radially inwardly toward one another by outer body 110 to form a cylinder (as shown in FIG. 2). The distance between branches 134 is greater in the open position than in the closed position. In the embodiment shown, branches 134 extend away from longitudinal axis 106 at an angle of about 0.4 degrees in the open position. That is, the inner surface of each branch 134 tapers radially outwardly from longitudinal axis 106, from the proximal end of the branch to the distal end. In this arrangement, the inner surfaces of branches 134 form a cylindrical socket when the branches converge inwardly into the closed position. If desired, the angle of taper inside branches 134 can be adjusted so that the internal profile of the branches in the closed position assumes a tapered or conical shape to match an anticipated amount of radial splaying exhibited by a receiver body.

[0036] In the illustrated exemplary embodiment of counter-torque wrench 100, four branches 134 are used. While four branches 134 are used in the illustrated exemplary embodiment, those skilled in the art will recognize that two or possibly even six branches 134 could be used. In an exemplary embodiment, an even number of branches 134 is used so that rod 60 on implant 50 may be inserted within diametrically opposed cutouts 136 between adjacent branches 134, as shown in FIG. 5.

[0037] Each branch 134 includes an arcuate portion 138 formed along either side of branch 134. As shown in FIG. 10, arcuate portions 138 of two adjacent branches 134 form a cutout 136 between adjacent branches 134. Arcuate portions 138 are curved to approximately the same radius of curvature as rod 60 such that, when counter-torque wrench 100 is disposed over implant 50 as shown in FIG. 5, rod 60 is seated within cutouts 136 with linear contact between rod 60 and arcuate portions 138.

[0038] Adjacent branches 134 are separated from each other by a longitudinal gap 140. At a distal end portion 142, gap 140 may be about 0.1 millimeters across, while a length of gap 140 extending proximally of distal end portion 142 may be about 0.3 millimeters across. A proximal end 144 of gap 140 may be enlarged to a circle having a diameter of about 1 millimeter to provide stress relief to branches 134.

[0039] Gripping end portion 132 of inner shaft 130, proximal of branches 134, also includes a tapered outer surface 148 that is angled at an included angle f3 that is approximately the same value as angle α, which, in an exemplary embodiment, may extend about 40 degrees.

[0040] Referring now to FIGS. 13-16, drive nut 150 is disposed over and coupled to handle end portion 135 of inner shaft 130. Drive nut 150 may be fixedly coupled to inner shaft 130 such as, for example, by welding drive nut 150 to inner shaft 130. Drive nut 150 includes a generally cylindrical body 152 that has a proximal end 154, a distal end 156, and a longitudinal axis 158 extending between proximal end 154 and distal end 156. When drive nut 150 is coupled to inner shaft 130 and inserted into outer body, as is shown in FIG. 15, longitudinal axis 158 is coaxial with longitudinal axis 106.

[0041] Distal end 156 includes an external thread 160 that engages internal thread 118 on outer body 110 to provide axial translation of outer body 110 with respect to inner shaft 130. Drive nut 150 also includes an annular portion 162 that is disposed between proximal end 154 and distal end 156. As described above, annular portion 162 has an outer diameter equal to the inner diameter of bore 119 of outer body 130 such that annular portion 162 may slide within and support proximal end 112 of outer body 110 as inner shaft 130 axially translates with respect to outer body 110.

[0042] Referring to FIGS. 14 and 19, proximal end 154 of drive nut 150 includes a handle insert opening 164 into which an insert portion 172 of torque-applying handle 170 is inserted. Torque-applying handle 170 is fixedly coupled to drive nut 150, such as, for example, by welding so that, torque-applying handle 170 is fixedly coupled to inner shaft 130.

[0043] FIGS. 15-18 illustrate inner shaft 130 having been inserted through outer body 110. FIGS. 15 and 16 illustrate the cooperative engagement of internal thread 118 of outer body 110 with external thread 160 of drive nut 150. Outer body 110 is rotatable in a first direction to move gripping end portion 132 of inner shaft 130 proxi-

mally relative to outer body 110 and move branches 134 to the relatively closed, or gripping, position. Outer body 110 is also rotatable in a second direction to move gripping end portion 132 of inner shaft 130 distally relative to outer body 110 and move branches 134 to the relatively open, or release, position.

[0044] In FIGS. 15-18, outer body 110 and inner shaft 130 are disposed relative to each other such that counter-torque wrench 100 is in the gripping position, as shown in FIGS. 1 and 2. When counter-torque wrench 100 is moved to the gripping position, inner surface 120 of outer body 110, and particularly nub 122, engages outer surface 148 of inner shaft 130, compressing branches 134 toward longitudinal axis 106 such that branches 134 form or approximate a cylinder. In an exemplary embodiment, outer body 110 may be rotated about inner shaft 130 approximately 540 degrees (*i.e.* one and one-half rotations) in order to move from the gripping position of FIGS. 1 and 2 to the release position of FIGS. 3 and 4.

[0045] FIGS. 17 and 18 illustrate engagement of conically-shaped inner surface 120 of outer body 110 and tapered outer surface 148 of inner shaft 130 when counter-torque wrench 100 is in the gripping position. Nub 122 slidably engages inner shaft 130 to reduce the engagement area of inner shaft 130 with respect to outer body 110 in order to reduce the force required to disengage outer body 110 from inner shaft 130. In the exemplary embodiment, nub 122 is rounded as shown to reduce the amount of friction that must be overcome when disengaging outer body 110 from inner shaft 130.

[0046] As shown in FIG. 19, handle 170 includes a contoured gripping portion 174 that allows a user to grip the handle. Referring back to FIG. 5, handle 170 extends generally orthogonally relative to longitudinal axis 106 in order to allow a user to provide a counter-torque to the receiver body 52 and restrict or prevent movement of rod 70 as set screw 62 is being tightened into the receiver body.

[0047] Referring now to FIGS. 1-5, as well as the flow chart 500 of FIG. 20, to use counter-torque wrench 100, in STEP 502, implant 50 is inserted into the patient (not shown). To fixate a rod 60 in implant 50, rod 60 is inserted into screw cap 52. In STEP 504, with counter-torque wrench 100 in the gripping position, counter-torque wrench 100 is inserted over screw cap 52, aligning diametrically opposed slots 136 on counter-torque wrench 100 with rod 60 such that counter-torque wrench 100 engages implant 50 and rod 60 is seated within slots 136. While STEP 504 describes counter-torque wrench 100 being inserted over screw cap 52 in the gripping position, those skilled in the art will recognize that counter-torque wrench 100 could also be inserted over screw cap 52 in the release position, and then moved to the gripping position prior to securing set screw 62 into screw cap 52.

[0048] Next, set screw 62 may be placed on a distal end of screw driver 70. In STEP 506, set screw 62 and screw driver 70 are inserted into handle end portion 135 of inner shaft 130 and through the length of inner shaft 130 toward distal end 132 of inner shaft 130 such that set screw 62 engages screw cap 52. Counter-torque wrench 100 is rotated slightly in a counter-clockwise direction when looking from proximal end 102 toward distal end 104 such that arcuate portion 138 engages rod 60 to restrict movement of rod 60 as set screw 62 is tightened. Alternatively, prior to STEP 504, set screw 62 may be inserted directly into screw cap 52 and initially threaded onto screw cap 52, with STEP 506 then including only the step of inserting the distal end of screw driver 70 through the length of inner shaft 130 until screw driver 70 engages set screw 62.

[0049] In STEP 508, torque is then applied with screw driver 70 to set screw 62 in a first direction such that set screw 62 is tightened in screw cap 52. Simultaneously, in STEP 510, a counter-torque is applied to screw cap 52 in a second direction, opposite the first direction, with counter-torque wrench 100 to stabilize screw cap 50 against rotation while set screw 62 is tightened in screw cap 52. Those skilled in the art will note that counter-torque may not be necessary during the entire course of tightening the set screw 62, and may only be needed in the latter stages of tightening (*e.g.*, the last turn of the screw driver) when torque on the set screw begins to transfer to the receiver body and the rod (*i.e.*, when the entire construct begins to rotate with the tightened set screw). In STEP 512, after set screw 62 is tightened, screw driver 70 is removed from inner shaft 130.

[0050] As set screw 62 is threaded into screw cap 52 in STEPS 508 and 510 above, screw cap 52 may have a tendency to expand, or "splay out." This expansion may cause screw cap 52 to impinge against the inside of branches 134 such that, when the user attempts to remove counter-torque wrench 100 from screw cap 52 after set screw 62 is tightened, counter-torque wrench 100 may stick to screw cap 52, making it difficult to remove counter-torque wrench 100.

[0051] In order to release counter-torque wrench 100 from screw cap 52, in STEP 514, gripping end portion 132 of inner shaft 130 may be radially expanded to release inner shaft 130 from screw cap 52. This is done by moving branches 134 out of engagement with each other by axially translating outer body 110 in a proximal direction relative to inner shaft 130, allowing branches 134 to disengage from each other, moving branches 134 from the gripping position to the release position. In STEP 516, after branches 134 have disengaged from each other, counter-torque wrench 100 may be removed from screw cap 52.

[0052] Although the invention is illustrated and described herein with reference to specific embodiments, the invention is not intended to be limited to the details shown. Rather, various modifications may be made in the details within the scope and range of equivalents of the claims and without departing from the invention.

Claims

1. A counter-torque wrench comprising:

   a tubular outer body having a distal end and a proximal end; and
   an inner shaft disposed within the tubular outer body, the inner shaft having a proximal end and a distal end and being axially displaceable relative to the tubular outer body, the distal end of the inner shaft having a gripping end portion disposed proximate to the distal end of the tubular outer body, wherein the gripping end portion comprises a plurality of branches extending distally of the distal end of the tubular outer body, the branches being radially displaceable between a relatively open position, in which the branches are displaced radially outwardly from one another, and a relatively closed position, in which the branches are displaced radially inwardly toward one another, the distance between the branches being greater in the open position than in the closed position.

2. The counter-torque wrench according to claim 1, wherein the tubular outer body includes an internal thread and wherein the inner shaft includes an external thread in cooperative engagement with the internal thread.

3. The counter-torque wrench according to any of claims 1 and 2, wherein the outer body is rotatable in a first direction to move the gripping end portion of the inner shaft proximally relative to the outer body and move the branches to the relatively closed position, the outer body being rotatable in a second direction to move the gripping end portion of the inner shaft distally relative to the outer body and move the branches to the relatively open position.

4. The counter-torque wrench according to any of the preceding claims, wherein the inner shaft comprises a generally tubular body extending between the gripping end portion and the proximal end.

5. The counter-torque wrench according to any of the preceding claims, wherein the plurality of branches comprises an even number of branches.

6. The counter-torque wrench according to any of the preceding claims, further comprising a torque-applying handle operatively connected to the tubular inner shaft.

7. The counter-torque wrench according to the preceding claims, wherein the outer body is rotatable relative to the inner shaft to move the inner shaft relative to the outer body between the relative closed position and the relatively open position.

8. The counter-torque wrench according to any of claims 6 and 7, wherein the inner shaft further comprises a handle end portion, and wherein the torque-applying handle is fixedly coupled to the handle end portion.

9. The counter-torque wrench according to claim 8, wherein the inner shaft is cannulated, forming a bore extending between the gripping end portion and the handle end portion.

10. The counter-torque wrench according to any of the preceding claims, wherein the outer body comprises a conically shaped inner surface.

11. The counter-torque wrench according to any of the preceding claims, wherein the gripping end portion of the inner shaft comprises a tapered outer surface disposed proximally of the branches.

12. The counter-torque wrench according to claim 11, wherein the conically shaped inner surface comprises a nub extending radially inwardly in slidable engagement with the tapered outer surface on the inner shaft.

13. The counter-torque wrench according to any of the preceding claims, wherein the plurality of branches comprises a collet.

14. The counter-torque wrench according to any of the preceding claims, wherein the plurality of branches comprises a pair of diametrically opposed cut outs for receiving a fixation rod.

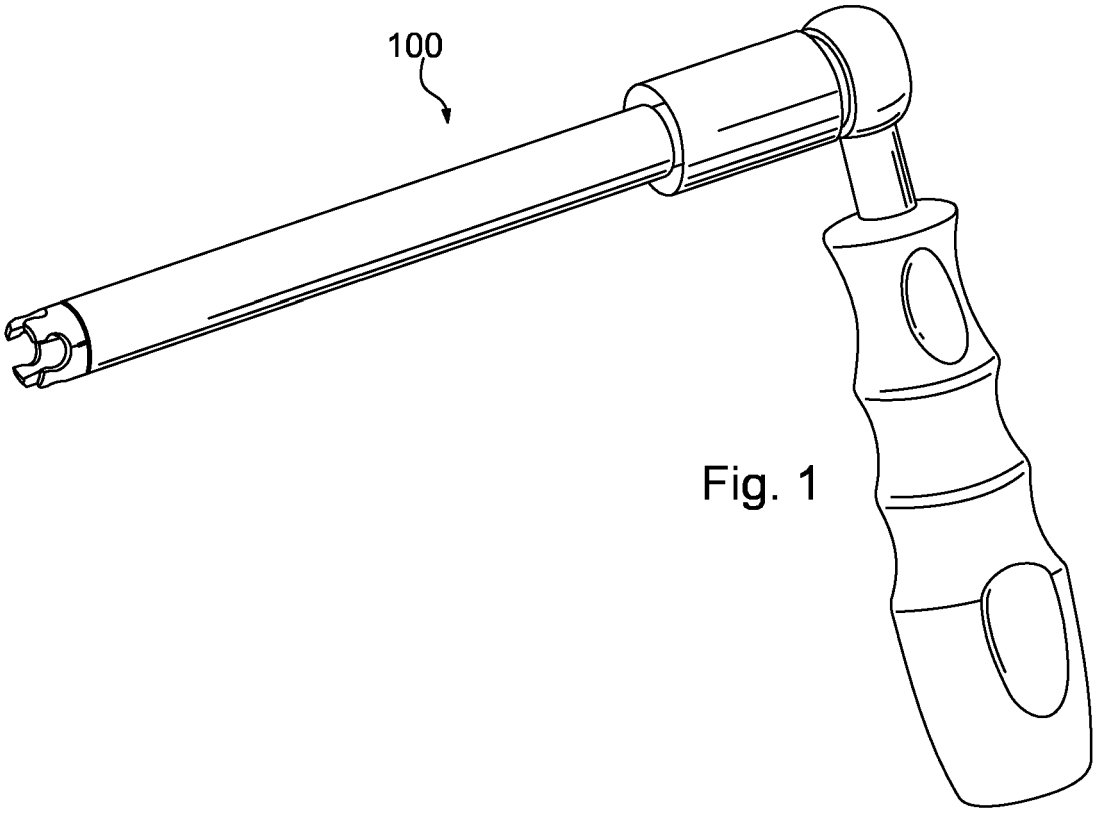

Fig. 1

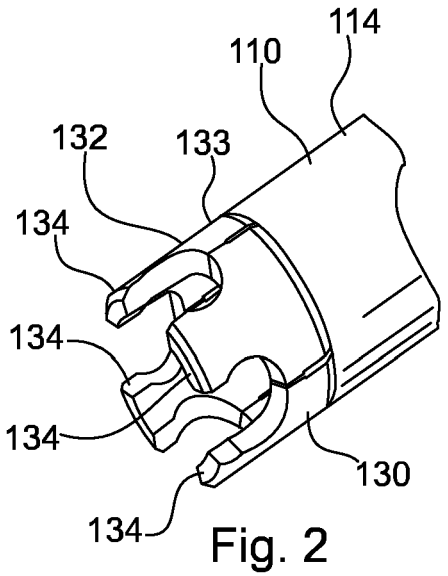

Fig. 2

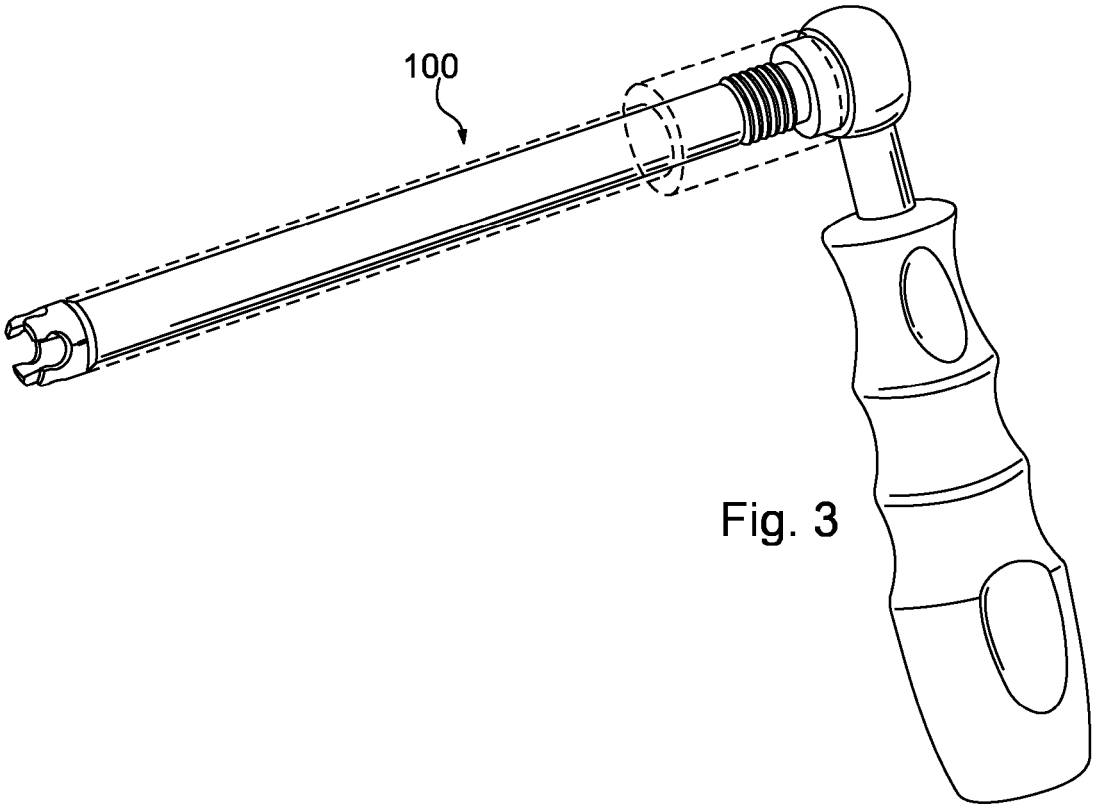

Fig. 3

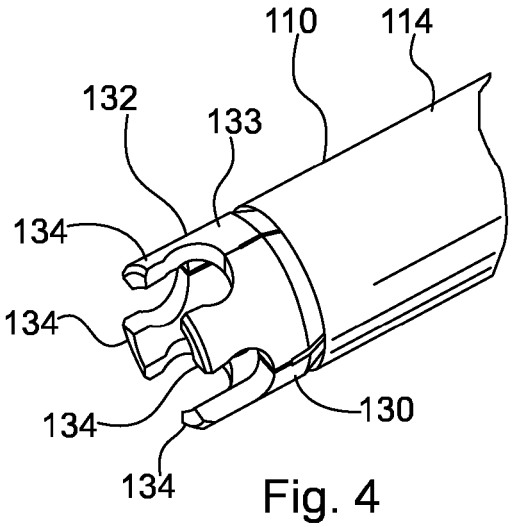

Fig. 4

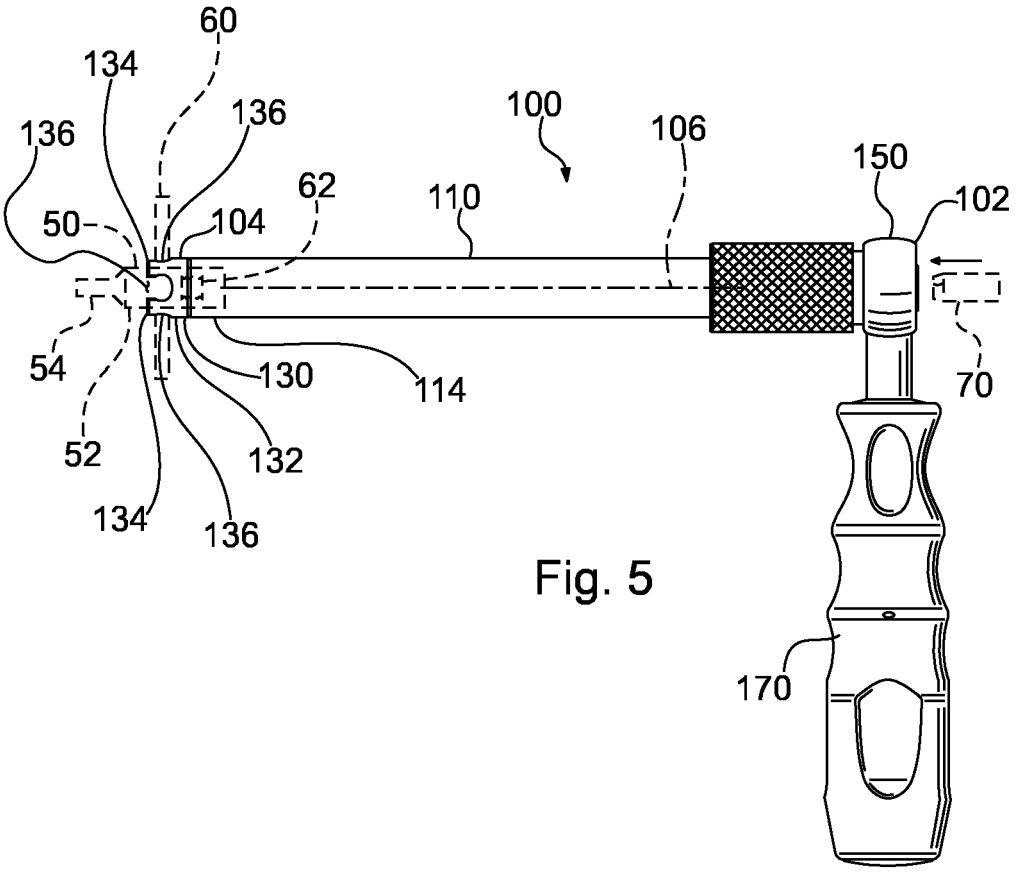
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Fig. 5

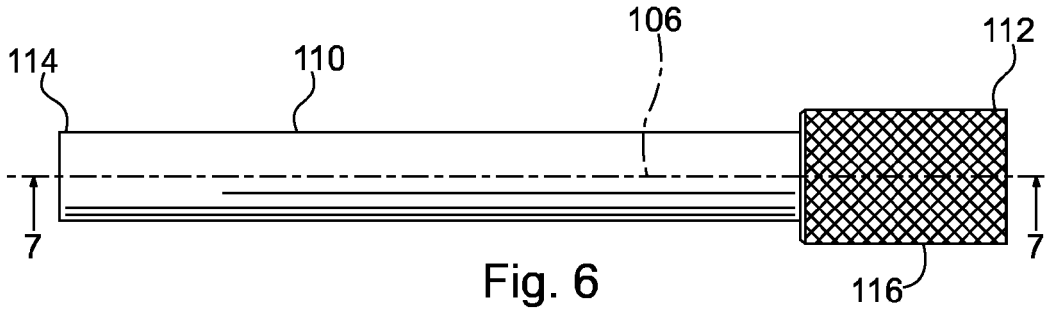


Fig. 6

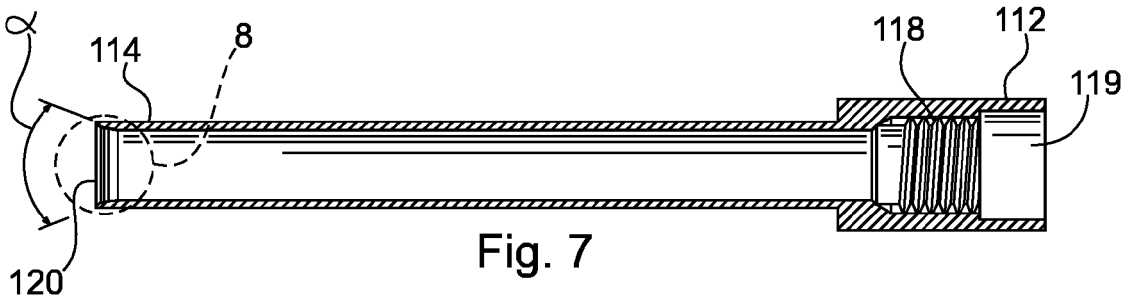


Fig. 7

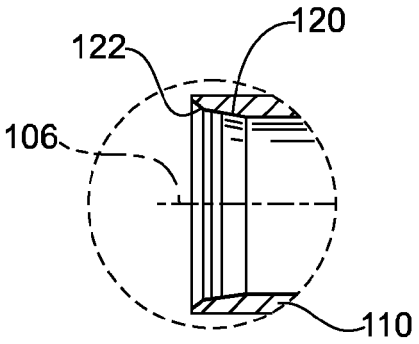
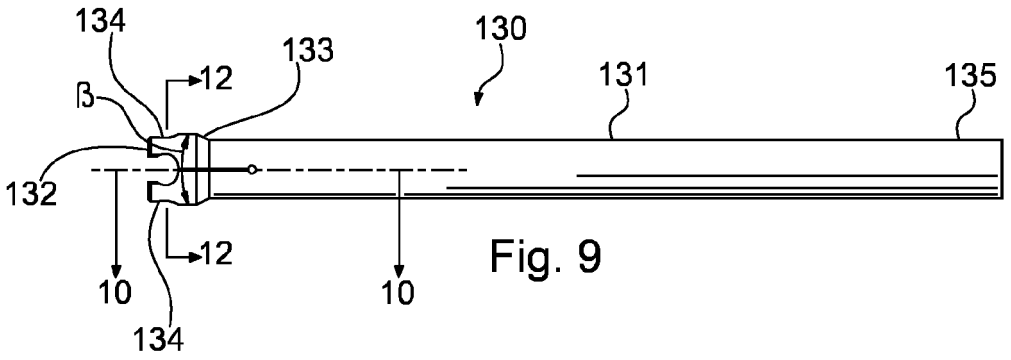


Fig. 8



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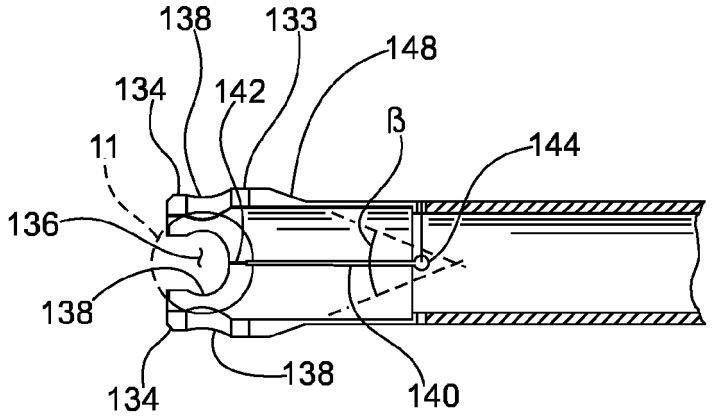


Fig. 10

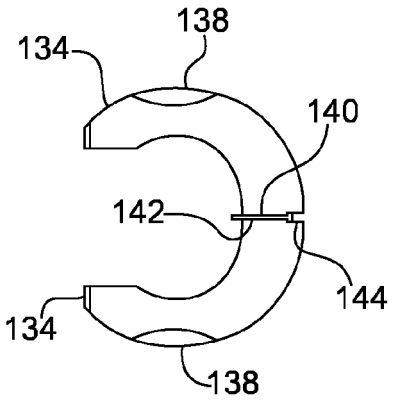


Fig. 11

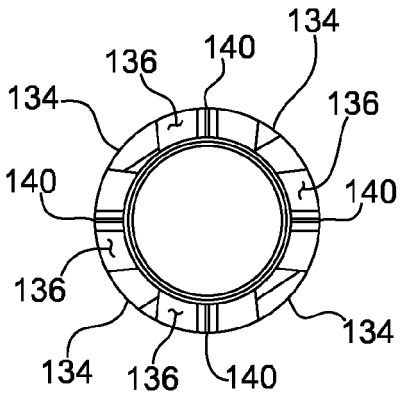


Fig. 12

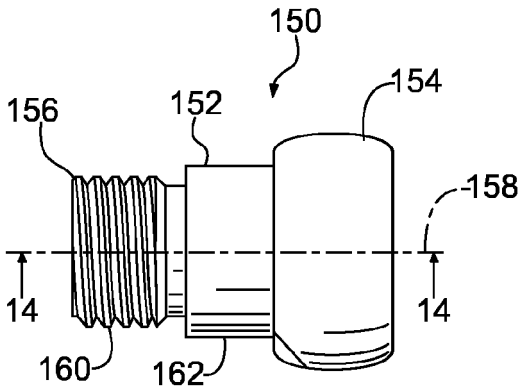


Fig. 13

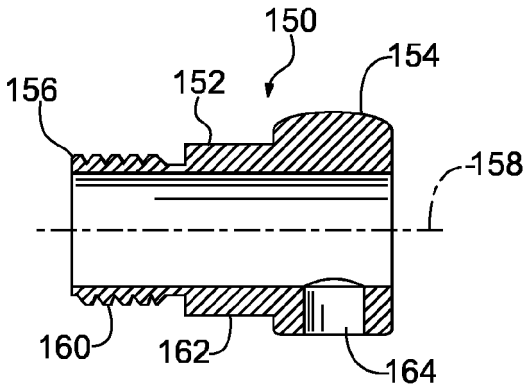


Fig. 14

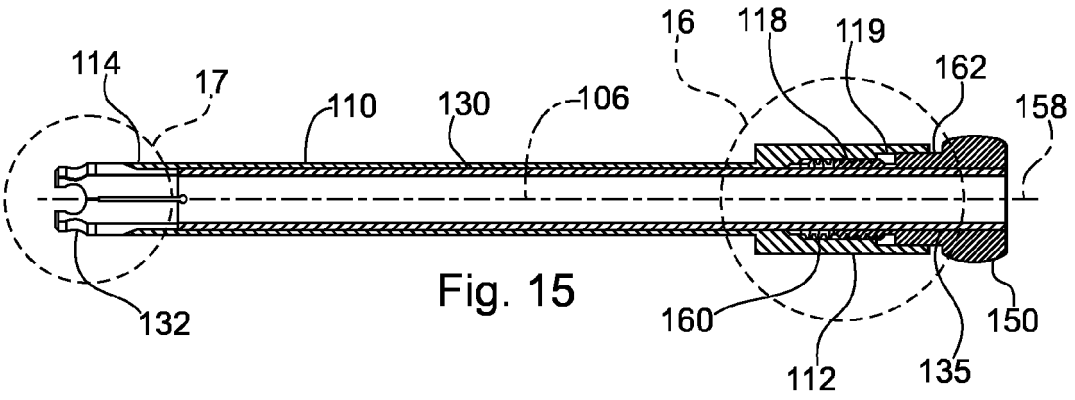


Fig. 15

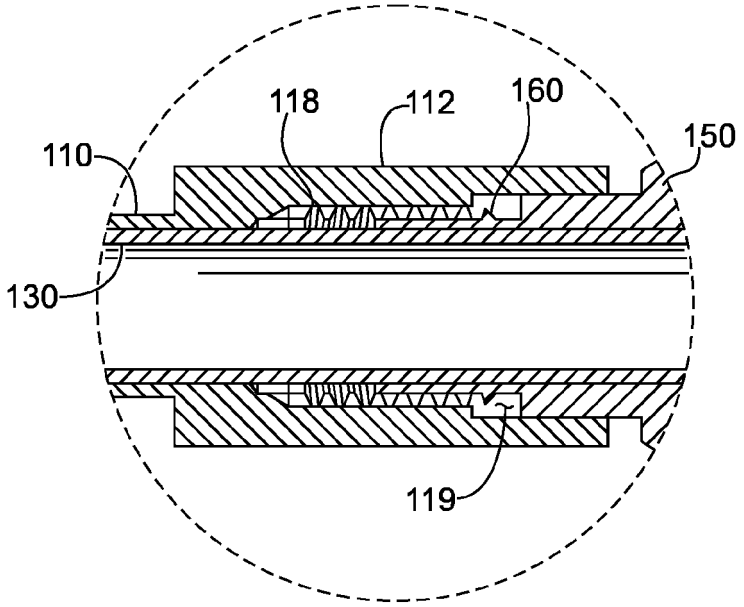


Fig. 16

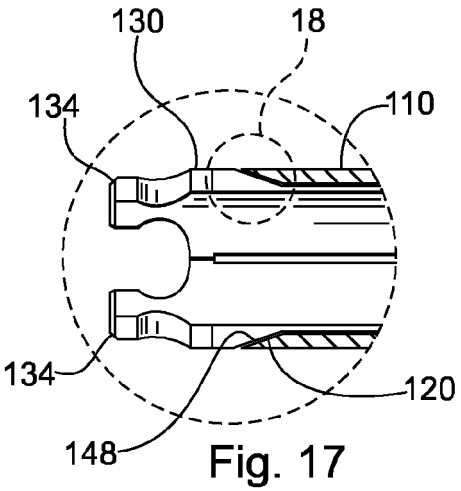


Fig. 17

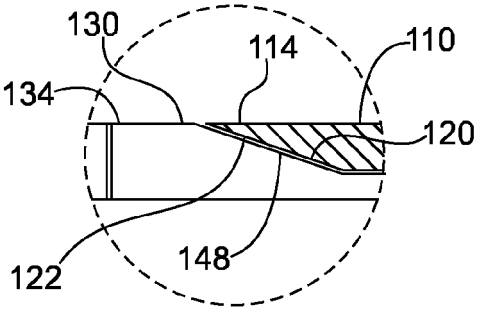


Fig. 18

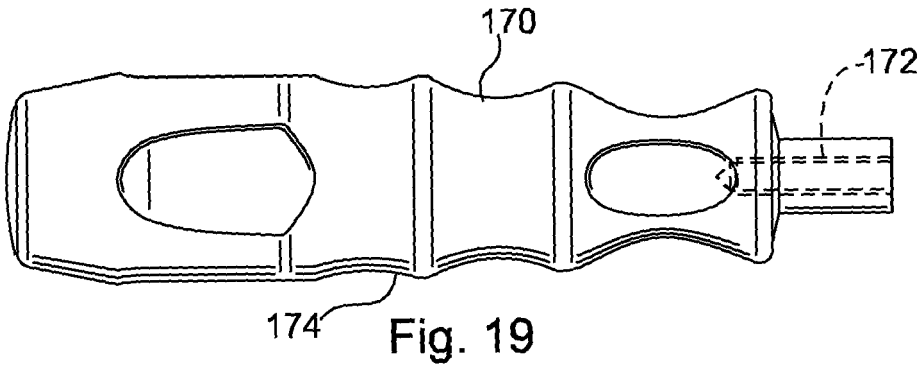
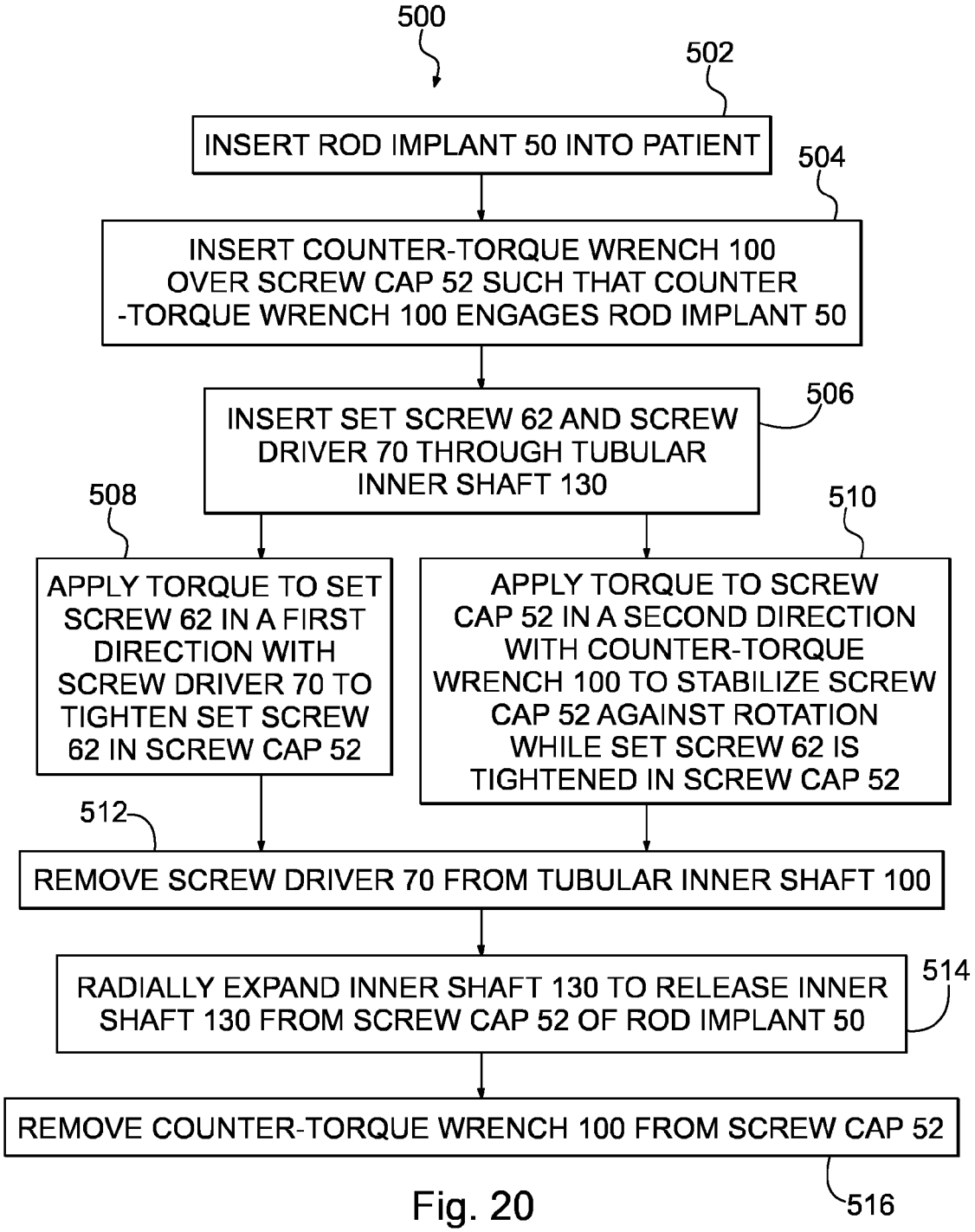


Fig. 19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INSERT ROD IMPLANT 50 INTO PATIENT
504
INSERT COUNTER-TORQUE WRENCH 100 OVER SCREW CAP 52 SUCH THAT COUNTER -TORQUE WRENCH 100 ENGAGES ROD IMPLANT 50
506
INSERT SET SCREW 62 AND SCREW DRIVER 70 THROUGH TUBULAR INNER SHAFT 130
508
APPLY TORQUE TO SET SCREW 62 IN A FIRST DIRECTION WITH SCREW DRIVER 70 TO TIGHTEN SET SCREW 62 IN SCREW CAP 52
510
APPLY TORQUE TO SCREW CAP 52 IN A SECOND DIRECTION WITH COUNTER-TORQUE WRENCH 100 TO STABILIZE SCREW CAP 52 AGAINST ROTATION WHILE SET SCREW 62 IS TIGHTENED IN SCREW CAP 52
512
REMOVE SCREW DRIVER 70 FROM TUBULAR INNER SHAFT 100
514
RADIALLY EXPAND INNER SHAFT 130 TO RELEASE INNER SHAFT 130 FROM SCREW CAP 52 OF ROD IMPLANT 50
REMOVE COUNTER-TORQUE WRENCH 100 FROM SCREW CAP 52
516

Fig. 20

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EUROPEAN SEARCH REPORT

Application Number
EP 10 15 4357

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y A	US 2006/111712 A1 (JACKSON ROGER P [US]) 25 May 2006 (2006-05-25) * page 1, paragraph 13 * * page 7, paragraph 85 - page 11, paragraph 119 * * figures 3,25,27,28,32-37 * -----	1,2,4,5, 11,14 6,8,9 3	INV. A61B17/88
X A	US 2008/172062 A1 (DONAHUE JAMES R [US] ET AL) 17 July 2008 (2008-07-17) * page 2, paragraph 27 - page 6, paragraph 63 * * figures 1-4B,5B,12 * -----	1,4,5, 11,14 9	
Y A	US 2006/260440 A1 (ABDELGANY MAHMOUD F [US]) 23 November 2006 (2006-11-23) * page 5, paragraph 51-52 * * page 1, paragraph 7 * * figures 16-18 * -----	6,8,9 1	

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A61B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Berlin	4 June 2010	Kakoullis, Marios

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04-06-2010

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