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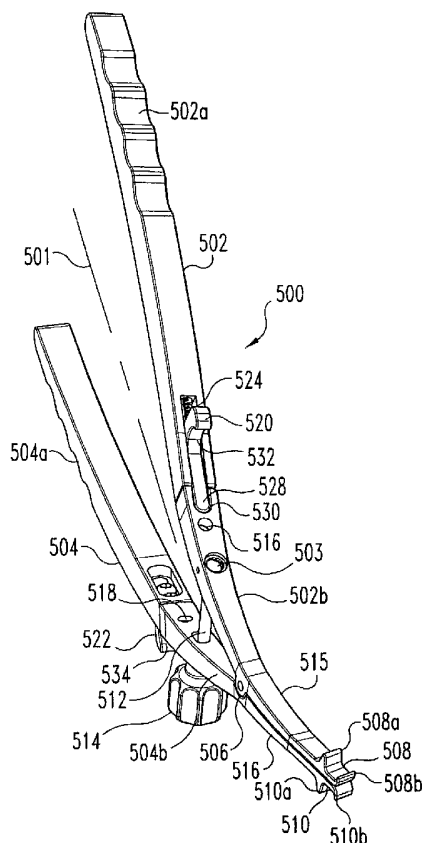
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(54) Title: DEVICES AND TECHNIQUES FOR A POSTERIOR LATERAL DISC SPACE APPROACH

(57) Abstract: This invention relates to devices and instruments for implant insertion through a posterior lateral opening to the disc space. The instruments include an implant inserter, and the devices include a spinal fusion implant engageable by the implant inserter. The implant provides bilateral support of the adjacent vertebrae when inserted into the disc space from a postero-lateral approach.



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DEVICES AND TECHNIQUES FOR A POSTERIOR LATERAL DISC SPACE APPROACH

5 Cross-Reference to Related Applications:

The present application is a continuation-in-part of Patent Application Serial No. 09/858,197 filed May 15, 2001, which is a continuation-in-part of U.S. Patent Application No. 09/694,521, filed on October 23, 2000, which claims the benefit of the filing date of Provisional Application No. 60/160,667, filed October 21, 1999.

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BACKGROUND OF THE INVENTION

The present invention relates to techniques for use in interbody fusion procedures, instruments for performing such procedures, and implants insertable in the spinal disc space. More specifically, but not exclusively, the present invention relates to implants, methods and instruments for use in a posterior lateral approach to the disc space, including a transforaminal approach.

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Normally intervertebral discs, which are located between endplates of adjacent vertebrae, stabilize the spine and distribute forces between the vertebrae and cushion vertebral bodies. The spinal discs may be displaced or damaged due to trauma, disease or aging. A herniated or ruptured annulus fibrosis may result in nerve damage, pain, numbness, muscle weakness, and even paralysis. Furthermore, as a result of the normal aging processes, discs dehydrate and harden, thereby reducing the disc space height and producing instability of the spine and decreased mobility. Most typically surgical correction of a collapsed disc space includes a discectomy (surgical removal of a portion or the entire intervertebral disc). The discectomy is often followed by restoration of normal disc space height and bony fusion of the adjacent vertebrae to maintain the disc space height.

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Access to a damaged disc space may be accomplished from several approaches to the spine. One approach is to gain access to the anterior portion of the spine through a patient's abdomen. However, extensive vessel retraction is often required and many vertebral levels are not readily accessible from this approach. A posterior approach may also be utilized. However, this typically requires that both sides of the disc space on either

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side of the spinal cord be surgically exposed. This may require a substantial incision or multiple access locations, as well as extensive retraction of the spinal cord. To alleviate problems associated with both anterior and posterior approaches to the spine, a posterior lateral approach, such as a transforaminal approach, to the disc space may be utilized.

5 While it is desirable to place one or more implants in the disc space so that the load of the spinal column is evenly distributed, accurate placement of implants in the disc space from a single posterior lateral approach has heretofore been extremely difficult. Thus, this approach to the spine is seldom used in practice.

10 Therefore, there remains a need for improved instruments, implants and techniques for use in a posterior lateral approach to the disc space that allows unilateral disc space preparation and implant insertion to provide bilateral stability to the subject disc space.

SUMMARY OF THE INVENTION

15 The present invention provides implants, instruments and methods particularly adapted for disc space preparation and implant insertion from a posterior lateral approach to the disc space.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view of a lamina spreader according to the present invention.

20 Fig. 2 is a perspective view of the lamina spreader of Fig. 1 with the handle portions rotated to a folded position.

Fig. 3 is an elevational view of a spinal column segment showing the distal portion of the lamina spreader of Fig. 1 engaged to the lamina on either side of a disc space.

Fig. 4 is a perspective view of a disc space spreader according to the present invention.

25 Fig. 4(a) is a plan view of the distal end of an alternate embodiment disc space spreader.

Figs 5(a) and 5(b) are perspective views of the disc space spreader of Fig. 4 with a lever arm and a perspective view of the lever arm, respectively.

30 Fig. 6 shows the sequence of the insertion of the disc space spreader of Fig. 4 into a disc space.

Fig. 7 is a perspective view of a distractor according to the present invention.

Fig. 8 is a perspective view of an alternative distractor having application in the present invention.

Fig. 9 is a top plan view of a vertebra with the distractor of Fig. 7 inserted in the disc space.

5 Fig. 10 is a perspective view of a straight reamer according to the present invention having the outer shaft partially cut-away to show the inner shaft.

Fig. 11 is a perspective view of a curved reamer according to the present invention having the outer shaft partially cut-away to show the inner shaft.

10 Fig. 12 is an end view of the reamer cutting head used with the reamers of Figs. 10 and 11.

Fig. 13 is a top plan view of a vertebra with the straight reamer of Fig. 10 inserted in the disc space.

Fig. 14 is a top plan view of a vertebra with the curved reamer of Fig. 11 inserted in the disc space.

15 Fig. 15 is a perspective view of a guided rotary cutter according to the present invention.

Fig. 16 is an enlarged view of the distal end portion of the cutter of Fig. 15.

Fig. 17 is a top plan view of a vertebra with the cutter of Fig. 15 inserted in the disc space.

20 Fig. 18 is a perspective view of a guided rotary cutting tool according to the present invention.

Fig. 19 is an enlarged perspective view of the distal end portion of the cutting tool of Fig. 18.

Fig. 20 is a top plan view of a vertebra with the cutting tool of Fig. 18 in the disc space.

25 Fig. 21 is a perspective view of an alternative cutting tool head.

Fig. 22 is a further perspective view of the cutting tool head of Fig. 21.

Fig. 23 is a perspective view of a push scraper according to the present invention.

Fig. 23(a) is section view taken through line 23(a)-23(a) of Fig. 23.

Fig. 24 is a perspective view of a pull scraper according to the present invention.

30 Fig. 24(a) is section view taken through line 24(a)-24(a) of Fig. 24.

Fig. 25 is a top plan view of a vertebra with the push scraper of Fig. 23.

Fig. 26 is a top plan view of a vertebra with the pull scraper of Fig. 24.

Fig. 27 is a perspective view of a straight chisel according to the present invention.

Fig. 28 is a lateral elevational view of a spinal column segment with the chisel of Fig. 27 inserted in the disc space.

5 Fig. 29 is a posterior elevational view of a spinal column segment showing the disc space entrance created by the chisel of Fig. 27.

Fig. 30 is a perspective view of an alternate embodiment guided chisel according to the present invention.

10 Fig. 31 is an enlarged perspective view of the chisel head and shaft with the chisel head in the position of Fig. 30.

Fig. 32 is a top plan view of a vertebra with the chisel of Fig. 30.

Fig. 33 is a perspective view an implant sizing guide according to one aspect of the present invention.

Fig. 34 is the implant sizing guide of Fig. 33 with the handle detached.

15 Fig. 35 shows a perspective view of an implant insertion guide according to the present invention.

Fig. 35(a) is an enlarged view of the distal end portion of the implant insertion guide of Fig. 35.

20 Fig. 36 is a perspective view of a straight implant inserter according to the present invention having the outer shaft partially cut-away to show the inner shaft.

Fig. 37 is a perspective view of a curved implant inserter according to the present invention having the outer shaft partially cut-away to show the inner shaft.

Fig. 38 is a perspective view of an impaction tool according to the present invention.

25 Fig. 39 is a top plan view of the disc space showing the sequence of the curved inserter of Fig. 37 inserting an implant into the disc space.

Fig. 40 is a perspective view of an alternate embodiment guided implant inserter according to the present invention.

Fig. 41 is an enlarged perspective view of the distal portion of the implant inserter of Fig. 40.

30 Fig. 42 is an enlarged plan view of the distal portion of the implant inserter of Fig. 40 and an implant.

Fig. 43 is the view of Fig. 42 showing the implant and insertion tool moved distally along the guide shaft.

Fig. 44 is a top plan view of a vertebra with the implant inserter of Fig. 40 in the disc space.

5 Fig. 45 is a top plan view of a vertebra with an implant inserted into the distal portion of the disc space.

Fig. 46 is a top plan view of a vertebra with a pair of implants bi-laterally positioned in the disc space to provide bi-lateral support to the spinal column segment.

10 Fig. 47 is a top plan view of a vertebra with a single implant positioned in the disc space to provide bi-lateral support to the spinal column segment.

Fig. 48 is a perspective view of an alternate embodiment implant inserter.

Fig. 49 is a perspective view of a still a further embodiment of an implant inserter.

Fig. 50 is a plan view of an intradiscal rasp according to another aspect of the present invention.

15 Fig. 50(a) is an enlarged view of an alternate embodiment head for the intradiscal rasp of Fig. 50.

Fig. 51 is a side elevational view of the intradiscal rasp of Fig. 50.

Fig. 51(a) is an elevational view of the head of Fig. 50(a) looking in the direction of arrows 51(a)-51(a).

20 Fig. 52 is a top plan view of an implant and instrument set for inserting the implant into the disc space.

Fig. 53 is a top plan view of the implant and instrument set of Fig. 52 with the implant partially inserted in the disc space.

25 Fig. 54 is an end elevational view of an implant according to another aspect of the present invention.

Fig. 55 is a top plan view of the implant of Fig. 54.

Fig. 56 is a perspective of the implant of Fig. 54 oriented towards the posterior face.

Fig. 57 is another perspective view of the implant of Fig. 54 oriented towards the anterior face.

30 Fig. 58 is an elevational view of the implant of Fig. 54 looking towards the posterior face.

Fig. 59 is a perspective view looking toward the posterior wall of another embodiment implant of the present invention.

Fig. 60 is a perspective view looking toward the anterior wall of the implant of Fig. 59.

Fig. 61 is an elevation view looking at the posterior wall of the implant of Fig. 59.

5 Fig. 62 is an elevation view looking at the anterior wall of the implant of Fig. 59.

Fig. 63 is a plan view of the plant of Fig. 59.

Fig. 64 is an end elevation view of the implant of Fig. 59.

10 Fig. 65 is a sectional plan view of another embodiment implant insertion instrument according to the present invention engaged to the implant of Fig. 59, the sectional view illustrating first and second positions of a proximal portion of the implant insertion instrument.

Fig. 65a is a perspective view of a pusher instrument.

Fig. 66 is an enlarged sectional plan view of the implant insertion instrument and implant of Fig. 65.

15 Fig. 67 is a side elevation view of the implant insertion instrument and implant of Fig. 65.

Fig. 68 is an enlarged plan view of the implant insertion instrument and implant of Fig. 65 prior to engaging the implant to the implant insertion instrument.

20 Fig. 69 is an enlarged plan view of the implant insertion instrument and implant of Fig. 65 after engagement of the implant to the implant insertion instrument.

Fig. 70 is a partial elevation view the proximal portion of another embodiment inserter instrument and alignment instrument.

Fig. 71 is a section view through line 71-71 of Fig. 70 showing the attachment of the alignment instrument to the proximal portion of the inserter instrument.

25 Fig. 72 is an enlarged section view shown an alternate connection arrangement between the proximal portion and the implant engaging portion of the insertion instrument of Fig. 65.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

30 For the purposes of promoting an understanding of the principles of the present invention, reference will now be made to the embodiments illustrated in the drawings, and specific language will be used to describe the same. It will nevertheless be understood that

no limitation of the scope of the invention is intended thereby. Any alterations and further modification in the described processes, systems, or devices, and any further applications of the principles of the invention as described herein are contemplated as would normally occur to one skilled in the art to which the invention relates.

5 In a posterior lateral approach to the disc space, such as is provided with a transforaminal approach, it is often difficult to prepare the proper locations in the disc space to receive an implant. The instruments and techniques of the present invention provide for improved unilateral disc space preparation in both the distal and proximal portions of the disc space through a single opening. Another difficulty in posterior lateral approaches to the disc
10 space is related to the proper positioning of the implant in the portion of the disc space most distal from the posterior lateral opening. While it is desirable that the implant be positioned in the distal portion of the disc space, it is often too difficult to move the implant across the disc space to the distal portion. Thus, the present invention further provides implant inserters, implant templates, implant insertion guides, and implants that facilitate implant
15 positioning in the distal and proximal portions of the disc from a posterior lateral approach.

Referring now to FIG. 1, there is provided a lamina spreader 500 according to one aspect of the present invention. Lamina spreader 500 includes a first arm 502 pivotally joined to a second arm 504 by pin 506. Arms 502, 504 extend generally along a central axis
20 501 when in a first spreading position. Extending distally from pin 506 are distal portions 515 and 516 of arms 502 and 504, respectively. Distal portions 515 and 516 include lamina engaging portions 508 and 510, respectively. Lamina engaging portions 508 and 510 are generally U-shaped and configured to engage the lamina of an upper vertebra V2 and the lamina of a lower vertebra V1, respectively, on either side of the subject disc space, as shown
25 in FIG. 3. Spreading portion 508 includes an outer portion 508a configured to reside on the outer side of the lamina connected to an inner portion 508b configured to reside on the inner side of the lamina. Spreading portion 510 similarly includes an outer portion 510a configured to reside on the outer side of the lamina connected to an inner portion 510b configured to reside on the inner side of the lamina.

The lamina can be spread by the surgeon grasping handle 502a of arm 502 and handle
30 504a of arm 504, and forcing arms 502, 504 towards one another in the direction towards axis 501. There is also provided a mechanism to force and/or maintain spreading portions 508

and 510 apart. The spreading mechanism includes an externally threaded rod 512 threadingly engaged to branch 502 and a hand nut 514 received on rod 512. Arms 502 and 504 may be forced together by action of threading nut 514 to force rod 512 into threaded opening 503 in arm 502, thereby forcing spreading portions 508 and 510 apart and separating the lamina to open access to the disc space. Nut 514 can also be used to thread rod 512 into opening 503 after manually spreading the lamina via handles 502a, 504a, until nut 514 contacts arm 504 to maintain the engaging portions 508, 510 in a spread condition.

In a preferred form, arm 502 has handle portion 502a that is hinged to rotate with respect to a non-rotating portion 502b about a pin 516, and arm 504 has handle portion 504a hinged to rotate with respect to a non-rotating portion 504b about a pin 518. A first spring loaded locking mechanism 520 resides in cut-out 524 formed in handle portion 502a, and a second spring loaded locking mechanism 522 resides in a similar cut-out (not shown) formed in handle portion 504a. Locking mechanism 520 includes a finger 528 spring-biased into notch 530 formed in non-rotating portion 502b. The surgeon or attendant can release handle portion 502a by pulling proximally on grasping portion 532 to pull finger 528 out of notch 530, and then rotate handle portion 502a transversely to axis 501 about pin 516 to a position oriented about 90 degrees with respect to non-rotating portion 502b. Similarly, locking mechanism 522 includes a finger spring-biased into a notch formed in non-rotating portion 504b. The surgeon or attendant can release handle portion 504a by pulling proximally on grasping portion 534 to pull the finger out of the notch, and then rotate handle portion 504a transversely to axis 501 about pin 518 to a position oriented about 90 degrees with respect to non-rotating portion 504b. Rotating handle portions 502a, 504a moves this portion of lamina spreader out of the way of the surgeon and avoids interference with other instruments to be inserted in the disc space.

It is contemplated that spreader 500 can be used to assist the surgeon in gaining access to the disc space. The rotating handles allow lamina spreader 500 to remain in place during subsequent procedures. It is further contemplated that the surgeon may not desire to use lamina spreader 500, and therefore proceed with disc space distraction after gaining access to the disc space.

Referring to Figs. 4 and Figs. 5(a) and 5(b), a disc space spreader according to the present invention is shown. Disc space spreader 70 has a proximal portion that includes a

first branch 72 pivotally joined to a second branch 74 by pin 76. Extending distally from pin 76 are distal portions 85 and 86 of branches 72 and 74, respectively. Distal portions 85 and 86 have a distal working end that includes spreading portions 80 and 78 that contact the endplates of the adjacent vertebrae to apply a distraction force thereto. Distal portions 85 and 86 further include lateral offset portions 81 and 79, respectively, that laterally offset the branches 72, 74 from the spreading portions 80, 78. Offset portions 79 and 81 have a straight portion extending generally parallel to central axis 88 extending between branches 72, 74 and a bend forming a first offset angle A2 with axis 88. Spreading portions 78 and 80 form a second overall offset angle A21 with axis 88. In a preferred embodiment, offset angle A2 is about 120 degrees, but it is contemplated that offset angle A2 can range from 90 degrees to 160 degrees. Offset angle A21 is about 110 degrees. The offset portions 79, 81 laterally offset branches 72, 74 from spreading portions 78, 80, allowing branches 72, 74 to be further pivoted across the spinous process S, as shown by disc space spreader 70 in Fig. 6, than would be possible without offset portions 79, 81. In one form, the lateral offset distance d between axis 88 and the center of the straight portion is between 10 to 20 millimeters. This allows the distal tip of spreader 70 to be properly oriented into posterior lateral opening 35 formed in disc space D1.

To separate spreading portions 78, 80 a force can be applied to the proximal ends of branches 72, 74. In a preferred embodiment, disc space spreader 70 includes a mechanism to force and/or maintain the separation of spreading portions 78 and 80. The spreading mechanism includes an externally threaded rod 82 pivotally joined to branch 72 and positionable in notch 83 formed in the proximal end of branch 74. The spreading mechanism has an internally threaded hand nut 84 threadedly received on rod 82. Branches 72 and 74 may be forced together by action of internally threaded nut 84 on branch 74 forcing it towards branch 72, thereby forcing spreading portions 78 and 80 apart. A spring blade 89 attached to branches 72, 74 biases branches 72, 74 apart.

Branches 72 and 74 also define opposing grooves 92 and 94 adjacent pin 76. A lever arm or pusher 90 may be provided having an elongated shaft 96 with a handle 98 on one end and an opposing spreader engaging portion 99. Engaging portion 99 is configured for removable engagement with opposing grooves 92 and 94 formed in branches 72 and 74, respectively. In se, removal of bony structures to gain access to the disc space and resection

of disc material may be conducted by known methods. As shown in Fig. 6, the distal end of spreader 70 is positioned at opening 35, and pusher 90 can be used to provide a pushing force in the direction of arrow P into the disc space during the steps of inserting the spreading portions 78 and 80 into opening 35. Disc space spreader 70 is pivoted sequentially in the direction of arrow R about spinous process S via the proximal end of branches 72, 74. This pivotal and distal movement from proximal portion 41 to distal portion 37 of disc space D1 is indicated by the relative sequential positions of spreader 70, 70', 70'', and 70''' and spreader portions 78, 78', 78'', and 78'''. Thus, branches 72, 74 and pusher 90 enable the surgeon to have simultaneous two-handed control of spreader 70, with one hand controlling insertion movement with pusher 90 and the other hand controlling pivotal movement with branches 72, 74. This positions spreading portions 78, 80 across the disc space, and provides uniform disc space distraction so that the vertebral endplates will be parallel when distracted. The location of spreading portions 78, 80 in the disc space may be checked by any known visualization techniques before proceeding to tissue removal.

It should be understood that pusher 90 is engaged to disc space spreader 70 during the steps indicated by spreaders 70', 70'' and 70''', but is not shown for purposes of clarity. The S-shaped connecting portions 79, 81 provide a lateral offset to branches 72, 74 to laterally offset branches 72, 74 from spreader portions 78, 80. This allows branches 72, 74 of disc space spreader 70 to avoid interference with the spinous process S when inserting the distal portions spreader portions 78, 80 through opening 35 into disc space D1. Enlarged stops (not shown) can be formed on distal portions 85 and 86 in order to engage the adjacent vertebra during insertion and limit advancement of spreaders 78 and 80 into disc space D1. After the spreader is inserted into the disc space, lever arm 90 may be removed.

Disc space spreader 70 is manipulated as described above to spread or distract disc space D1 to the desired height. In one procedure, it is contemplated that lamina spreader 500 is first used to spread the lamina. Since this tends to tilt the disc space and make the vertebral endplates non-parallel, spreader 70 can then be used to distract the distal portion of the disc space to provided parallel endplates. Disc space spreader 70 can remain in the disc space during subsequent procedures. It is further contemplated that lamina spreader 500, pedicle screw fixation with rods or plates on the other side of spinous process S may be used to maintain the distracted disc space height so that disc space spreader 70 can be removed.

Distraction shims may also be used to maintain disc space distraction, such as disclosed in co-pending application entitled METHODS AND INSTRUMENTATION FOR DISTRACTION OF A DISC SPACE, filed October 20, 1999, U.S. Patent Application Serial No. 09/421,709, which application is incorporated herein by reference in its entirety. In
5 another form, lamina spreader 500 is not used by the surgeon, and the surgeon only uses disc space spreader 70 to restore the normal disc space height.

In Fig. 4(a) there is shown an alternate form for the distal portions of disc space spreader 70 which facilitates spreader insertion through opening 35. The proximal portion of the spreading instrument is similar to spreader 70 discussed above and will not be repeated
10 here. Further, specific references are made to one alternate distal portion in this description, it being understood that the second distal portion is identical thereto. In addition, a spreader utilizing these alternate distal portions can be used in the same manner as discussed above with respect to disc space spreader 70. Central axis 88 between branches 72, 74 is provided in Fig. 4(a) to orient distal portions 785, 786 with respect thereto. Distal portions 785, 786
15 each have a distal working end that includes spreading portion 778 that contacts the endplate of the adjacent vertebrae to apply a distraction force thereto. Distal portions 785, 786 further include branch extension 777 extending from a respective one of the branches 72, 74 along axis 88.

A first lateral inset 779 extends from proximal portion 777 and has a central axis 780
20 forming an angle A4 with respect to axis 88 such that first lateral inset 779 extends in a first direction away from axis 88. A lateral offset 781 extends from first lateral inset 779 and has a central axis 781 forming an angle A6 with central axis 88 and an angle A5 with central axis 780 such that lateral offset 781 extends in a second direction with respect to axis 88 opposite the first direction, positioning the distal end of lateral offset 781 on the side of axis 88
25 opposite first lateral inset 779. A second lateral inset 783 extends from lateral offset 781 and has a central axis 784 forming an angle A5 with central axis 782 and an angle A4 with central axis 88 such that second lateral inset 783 extends in the first direction towards axis 88. Thus, first lateral inset 779 and second lateral inset 783 are parallel to one another. Spreading portion 778 extends from second lateral inset 783 in the second direction away from axis 88
30 and has a central axis 787 forming an angle A5 with central axis 88. Central axis 787 is not parallel to central axis 782 of lateral offset 781.

In one specific embodiment, it is contemplated that angle A4 is about 10 degrees, angle A5 is about 125 degrees and angle A6 is about 45 degrees. In this specific embodiment, the length d1 along central axis 88 of first lateral inset 779 is about 21 millimeters, the length d2 of lateral offset 781 along axis 88 is about 11 millimeters, and the length d3 of second lateral inset 783 along axis 88 is about 15 millimeters.

Referring now to Fig. 7, another alternate embodiment disc space spreader/distracting mechanism is shown. Distractor 10 includes an elongated shaft 12 having a longitudinal axis 34. On the proximal end, distractor 10 includes a tool coupling 14 having a pair of opposed driving surfaces 16 and 18. On the opposite distal end, distractor 10 includes a distraction head 20 with a straight section 31 joined to shaft 12 by bend 32. Straight section 31 has a longitudinal axis 29 disposed at an angle A1 with respect to longitudinal axis 34. In a preferred embodiment angle A1 is between 120 and 160 degrees. Distraction head 20 is joined to straight section 31 and has a longitudinal axis 33 at an angle A11 with respect to axis 29. In one embodiment, angle A11 is between 20 and 60 degrees. Distraction head 20 includes a pair of opposed distraction flats 26 and 28 separated by a first height. A second pair of opposed flats 22 and 24 is separated by a second height, the second height being greater than the first height.

In an alternative embodiment to distractor 10 shown in Fig. 8, distractor 50 may include a lever arm 62 to assist in rotation of the distractor head after insertion into the disc space. Distractor 50 includes a shaft 52 having a handle 54 opposite distractor head 56. As with the previous embodiment, distractor head 56 is joined to shaft 50 a lateral offset that includes a bend 58 and a straight section 59. Additionally, shaft 53 includes multiple holes 60, which preferably include an internal thread. Lever arm 62 has a connection end 66 adapted to be removably received in a selected one of the holes 60. Handle 64 tends to allow the surgeon to generate a substantial torque on head 56 to rotate head 56 in the disc space.

Referring to Fig. 9, distractor 10 may be utilized to distract adjacent vertebrae. Distractor head 20 may be inserted into disc space D1 through opening 35. Distractor head 20 may be inserted into the disc space D1 until the distal tip is positioned adjacent the distal portion 37 and straight section 31 is disposed in disc space D1 adjacent proximal portion 41. Distractor 10 is oriented during insertion in a reduced height configuration such that surface 26 of head 20 engages the endplate of vertebra V1. In a similar manner,

surface 28 engages upper adjacent vertebra V2. Thus, distractor head 20 creates a distraction height approximating the distance between surfaces 26 and 28. Distractor shaft 12 is then moved to cause rotation about axis 33 of the distraction head 20 bringing surfaces 22 and 24 into contact with the opposing endplate surfaces, thereby distracting the disc space to the second, greater height between surfaces 22, 24. Lamina spreader 500, pedicle screw fixation with rods or plates may be used to maintain disc space height. Distraction shims may also be used to maintain disc space distraction.

According to a further aspect of the invention, various reamers are provided with the present invention to remove soft tissues from the disc space and the cartilage layer from the adjacent vertebral endplates. A straight reamer is illustrated in Fig. 10 and a curved reamer is illustrated in Fig. 11. Straight reamer 200 includes a hollow outer shaft 202 with a handle 204 attached to the proximal portion thereof. A rotatable inner shaft 206 is disposed within outer shaft 202. Rotary cutting head 210 having a cavity 213 is coupled to inner shaft 206. A Hudson type tool coupler 208 is provided at the proximal portion of inner shaft 206. It will be understood that a manual handle, such as a T-handle, may be attached to tool coupler 208. Application of rotation force on the inner shaft turns cutting head 210. Straight reamer 200 is inserted through opening 35 to remove material from proximal portion 41 of disc space D1, as shown in Fig. 13. Cutting head 210 of curved reamer 200 may be moved to various locations in the proximal portion 41 of disc space D1 and the cutting head reinserted to widen or alter a previously formed channel. A powered rotary driver may also be coupled to tool coupler 208 to mechanically drive inner shaft 206 and rotate cutting head 210.

Referring now to Fig. 11, curved reamer 220 includes a hollow outer shaft 222 with a handle 224 attached to the proximal portion thereof. A rotatable inner shaft 226 is disposed within outer shaft 222. Rotary cutting head 210 (identical to the head provided on reamer 200) having a cavity 213 is coupled to inner shaft 206. Outer shaft 222 includes a bend 221 angled at offset angle A3, permitting insertion of cutting head 210 through opening 35 and into distal portion 37 of disc space D1, as shown in Fig. 14. It is contemplated that A3 may range from 100 to 150 degrees. In one specific embodiment, angle A3 is about 125 degrees. Further, while a fixed bend is shown for the purpose of illustration in Fig. 11, it is contemplated that outer shaft 222 may include a flexible portion or mechanical coupling permitting a plurality of angles for bend 221. Inner shaft 226 is preferably flexible at least

through bend 221 so that rotary torque can be transmitted through bend 221. The flexible inner shafts used with the instruments of the present invention can be made from, for example, stainless steel coiled wire or nitinol.

A Hudson type tool coupler 228 is provided at the proximal portion of inner shaft 226. It will be understood that a manual handle, such as a T-handle, may be attached to tool coupler 228 to permit application of rotation force on the inner shaft and turn cutting head 210. Alternatively, a powered rotary driver may be coupled to tool coupler 228 to mechanically drive inner shaft 226 and rotate cutting head 210. As shown in Fig. 14, cutting head 210 of curved reamer 220 may be moved to various locations in the distal portion 37 of disc space D1 and the cutting head reinserted to widen or alter a previously formed channel. Thus, straight reamer 200 and curved reamer 220 allow the surgeon to remove disc material, cartilage and other tissue in both proximal portion 41 and distal portion 37 of disc space D1 through opening 35.

As shown in Fig. 12, cutting head 210 includes cutting edges 211a, 211b, 211c, and 211d. Cutting head 210 has a smooth, non-cutting profile between edges 211a, 211d and between edges 211b, 211c. It is contemplated that head 210 is inserted with the non-cutting profiles oriented towards the vertebral endplates to provide smooth insertion and positioning of cutting head 210 in the disc space. The location of cutting head 210 in the disc space may be checked by any known visualization techniques before proceeding to tissue removal. When cutting head 210 is rotated in direction R1, edges 211a and 211c cut tissue and cartilage, while edges 211b and 211d pass over the tissue without cutting. The cut material is deposited in cavity 213, where it may then be extracted from the disc space. Cutting head 210 provides a safe and efficient discectomy tool that preserves the bony endplate surface and quickly collects the soft tissue.

Other embodiments of cutting instruments are provided that include a guide member for controlled cutting within the proximal and distal portions of the disc space. Referring to Figs. 15 and 16, a guided rotary cutter is disclosed. Cutter 100 includes a guiding shaft 102 having an interconnected handle 109 disposed on the proximal end and a stop 106 disposed on the opposing distal end. Stop 106 may be substantially radiopaque to provide an indication of inner shaft location on x-ray images. Distal portion 103 is joined to shaft 102

by bend 104. Bend 104 is preferably a substantially uniform curve creating angle A3 between axis 105 of shaft 102 and axis 107 of distal portion 103.

Disposed on guide shaft 102 between handle 109 and stop 106 is an outer shaft 108. Outer shaft 108 includes a handle 110 on a proximal end and a flexible drive 112 on the
5 opposing distal end. A cutting head 114 is interconnected with flexible drive 112. As shown more clearly in Fig. 16, cutting head includes a number of cutting blades configured for rotary cutting. Flexible drive 112 is designed to transmit both longitudinal force to advance cutting head along guiding shaft 102 in the direction arrow 116 and also transmit rotation
10 force in the direction of arrow 118 to move cutting head 114 in a circular manner about shaft 102, thereby engaging cutting blades 120 with adjacent tissues. While other flexible drives, such as, for example but without limitation, cables and mechanical couplings may be utilized, in a preferred embodiment flexible drive 112 is a helically wound cable.

Referring to Fig. 17, cutter 100 may be inserted into disc space D1 through opening 35. Preferably, stop 106 is positioned adjacent distal disc space portion 37 and bend 104 may be
15 positioned centrally in the disc space. The location of guide shaft 102 in the disc space may be checked by any known visualization techniques before proceeding to tissue removal. Once the proper positioning of the guide shaft 102 has been established, force is applied to handle 110 to advance cutting head 114 into contact with structures adjacent the disc space. Forward pressure in the direction of arrow 116 may be maintained as rotational force in the
20 direction of arrow 118 is transmitted to cutting head 114. As tissue is removed cutting head 114 may cuttingly advance along guide shaft 102 until it reaches stop 106. Cutting head 114 has an internal channel (not shown) sized to receive shaft 102 but limited in size and shape such that the cutting head may not extend beyond stop 106. As will be understood by the illustrations, cutting tool 100 forms an arcuate channel through the disc space by following
25 guiding shaft 102. Guide shaft 102 may be moved to one or more new locations in the disc space and the cutting head reinserted to widen or alter a previously formed channel in disc space D1.

A further embodiment of a rotary cutting device is disclosed in Figs. 18 through 20. Shaver 150 includes a guide rod 152 with a handle 158 disposed at the proximal end and a
30 stop 156 disposed on the distal end. Guide rod 152 includes bend 154 adjacent the distal end. Outer shaft 160 is slidably mounted on guide rod 152. Outer shaft 160 includes a handle 162

on its proximal end and is coupled to flexible drive 164 on its distal end. A shaving head 166 is mounted on flexible drive 164. Preferably, shaving head 166 has a plurality of cutting blades adapted to shave tissue as the head is rotated. In one aspect, individual blades of head 166 are elongated and include a forward cutting blade 168 and backward cutting blade 170 and a cavity 169 for deposit of material. Still more preferably, shaving head 166 has sufficiently flexibility to allow it to conform at least partially to bend 154 as it is advanced along guide rod 152 towards stop 156.

In use, shaver 150 may be positioned in disc space D1 with stop 156 disposed adjacent distal disc space portion 37 as shown in Fig. 20. Preferably, shaver 150 will follow use of cutter 100 to further define and expand the arcuate channel defined in the disc space. As shaver head 166 is advanced in the direction of arrow 174, handle 162 may be rotated thereby rotating head 166 in the direction of arrow 173 to cut tissue, and cut tissue can be accumulated between the blades and in cavities 169 for removal from disc space D1. Shaver head 166 preferably cuts in both directions, however it is also contemplated that the shaver may be unidirectional.

Referring now to Figs. 21 and 22, an alternative shaver head 180 is illustrated. Shaver head 180 is slidably disposed on inner shaft 182 and may be advanced along the shaft until it reaches stop 186. Shaver head 180 includes a flexible drive portion 190 and a helical cutting blade 188 disposed on the distal portion of the flexible drive. Thus, as flexible drive 190 rotates, helical blade 188 cuts the tissue and accumulates tissue between the blades for removal from the disc space.

Referring to Figs. 23-26, further cutting instruments according to the present invention are shown. In Fig. 23 there is illustrated a push scraper 260. Push scraper 260 includes an elongated shaft 262 with a handle 264 on the proximal end and a push scraper head 265 on the distal end. Scraper head 265 is joined to and is substantially perpendicular to shaft 262. As shown in Fig. 23(a), scraper head 265 includes distally facing upper and lower cutting blades 266 having a distal concave face 267 with a hole 268 formed therein. Concave face 267 forms a trough around hole 268. The proximal face 269 of scraper head 265 has a smooth, convex non-cutting profile to facilitate proximal movement of scraper head 265 through the disc space. As shown in Fig. 25, push scraper 260 is inserted through opening 35 with scraper head 265 initially positioned towards proximal portion 41 of disc space D1.

Push scraper 260 is then pivoted and pushed distally through disc space D1, as indicated by push scraper 260', to position scraper head 265' towards distal portion 37 of disc space D1. Distally facing blades 266 remove disc material and can deposit at least some of the material in the trough between blades 266 during this distal pivotal movement for subsequent removal.

5 A pusher as described herein can be used to facilitate this distal pivotal movement.

In Fig. 24 there is illustrated a pull scraper 270 includes an elongated shaft 272 with a handle 274 on the proximal end and a pull scraper head 275 on the distal end. Scraper head 275 is joined to and extends substantially perpendicular to shaft 272. Scraper head 275 includes proximally facing cutting blades 276 and a concave proximal face 277 with a hole 10 278 formed therein. Concave face 277 forms a trough around hole 278. The distal face 279 of scraper head 275 has a smooth, convex non-cutting profile to facilitate distal movement of scraper head 275 through the disc space. As shown in Fig. 26, pull scraper 270 is inserted through opening 35 and scraper head 275 is pushed through disc space D1 to initially position scraper head 275 towards distal portion 37 of disc space D1. Pull scraper 270 is then pivoted 15 and pulled proximally through disc space D1, as indicated by pull scraper 270', to position scraper head 275' towards proximal portion 41 of disc space D1. Proximally facing blades 276 remove any remaining disc material and can deposit at least some of the material in the trough between blades 276 during this proximal pivotal movement for subsequent extraction.

When the desired amount material has been removed from disc space D1 using the 20 instruments described above, a straight chisel 540 as shown in Fig. 27 is provided for preparing a square entrance port into disc space D1 for implant insertion. Chisel 540 includes shaft 542 having a handle 544 coupled to the proximal end of shaft 542. A chisel head 546 is provided at the distal end of shaft 542. Chisel head 546 includes a body portion 547 having a pair of non-cutting extensions 548 extending distally therefrom. Extensions 548 have an 25 upper surface 548a for contacting vertebra V2 and a lower surface 548b for contacting lower vertebra V1. Extensions 548 guide chisel head 546 into the disc space, ensuring equal amounts of material are removed from the endplates of the upper and lower vertebrae by upper cutting edge 550 and lower cutting edge 551. V-shaped portions 552, 553 distally offset edges 550, 551, respectively, with respect to body portion 547. A chamber 554 is 30 formed in body portion 547, and body portion 547 has upper and lower openings positioned

proximally of the upper and lower cutting edges 550, 551. Cut material can be deposited through these upper and lower openings and into chamber 554.

Referring now to Fig. 28, chisel 540 is shown with extensions 548 in disc space D1. Chisel head 546 is impacted into the disc space, with cutting edges 550, 551 removing bone material and osteophytes from the vertebral endplates. This provides, as shown in Fig. 29, an enlarged squared entrance to disc space D1 is formed at the proximal portion of the disc space that is larger than the opening created by spreading the lamina and distracting disc space D1. This enlarged entrance facilitates implant insertion into the disc space. The material removed to form the enlarged entrance is indicated by cut-away portions C in vertebra V1 and V2.

Referring now to Figs. 30 through 32, there is shown a guided chisel which can be used, if desired, to remove material from distal portion 37 of disc space D1. Chisel 230 includes an inner shaft 232 with a handle 238 connected to the proximal end and a stop 236 formed on the distal end. As shown in Fig. 31, inner shaft 232 preferably has a non-circular cross section 233 adjacent the distal portion. The non-circular cross section, preferably square, inhibits rotation of the chisel cutting head as it is impacted along inner shaft 232. Outer shaft 240 is slidably disposed about inner shaft 232. Outer shaft 240 includes a drive region 242 with an impact shoulder 244. Outer shaft 232 is coupled to chisel head 248 by flexible drive 246. Chisel head 248 includes an upper cutting edge 254 and a lower cutting edge 252. The cutting blades are spaced by extensions 249 and 251 that control and limit the depth of penetration of the cutting edged into the endplates.

As shown in Fig. 32, inner shaft 234 is positioned in disc space D1 through opening 35. Stop 236 is position adjacent the distal portion 37 of disc space D1. Visualization of the placement of inner shaft 234 may be made to confirm proper positioning. Once the position is confirmed, chisel head 248 is advanced along inner shaft 232 in the direction of arrow 250. If necessary, a forked slap hammer or pusher may be positioned with the forks extending on either side of drive region 242. The slap hammer may then be forcibly urged against impact shoulder 244 to drive chisel head 248 into the disc space. The chisel head is advanced until it engages stop 236. This action forms a substantially square or rectangular arcuate channel extending into each of the adjacent vertebral endplates.

Referring now to Figs. 33 through 34 there is provided an implant template inserter 560 according to another aspect of the present invention. Template inserter 560 includes a shaft 562 having a handle 564 detachably secured to the proximal end of shaft 562. A bend 566 is secured to the distal end of shaft 562 and forms offset angle A3. A template 568 is secured at the distal end of bend 566. A notch 567 is provided in shaft 562 that is engageable by a pusher, such as pusher 670 described below, to facilitate placement of template 568 into disc space D1. Template 568 is positionable through opening 35 into the distal portion of disc space D1 to determine if enough material has been removed from the disc space to accommodate the implant to be inserted therein, or to determine the size of implant required. Handle 564 is removable for fluoroscopic or radiographic imaging of template 568 in disc space D1, allowing the surgeon to confirm the fit and positioning of template 568 in disc space D1. Templates 568 of various heights h1 having various sized bends 566 can be provided so the surgeon can perform multiple trials to obtain information as to the proper implant size.

Referring now to Figs. 35 and 35(a), there is shown an implant insertion guide 600 according to another aspect of the present invention. Insertion guide 600 has a proximal portion that includes a first branch 602 pivotally joined to a second branch 604 by pin 606. Extending distally from pin 606 are distal portions 615 and 616 of branches 602 and 604, respectively. Distal portions 615 and 616 have a distal working end that includes guide members 608 and 610 extending from lateral offsets 609 and 611, respectively. Offset portions 609 and 611 have a straight portion extending generally parallel to and offset by distance d from axis 618, and a bend forming a first offset angle A2 with axis 618. Guide members 608 and 610 have an arcuate form extending from offset portions 609, 611 to the distal tip insertion guide 600. This shape generally corresponds to the shape of the implant insertion path P, as discussed below. Guide members 608, 610 preferably have a length and shape such that the distal tip of inserter guide 600 is positionable in the desired location in distal portion 37 of disc space D1. These offset portions 609, 611 laterally offset branches 602, 604 from guide members 608, 610. This provides room for placement of an implant insertion instrument, such as those described below, or the implant template inserter 560 described above, alongside branches 602, 604. The implant can be slid along guide members

608, 610 and into the disc space, and guide members 608, 610 provide a barrier that protects the anterior portion of the disc space during implant insertion.

In a preferred embodiment branches 602 and 604 of inserter guide 600 can be manipulated to separate guide portions 608, 610 and place guide portions 608, 610 in contact with the vertebral endplates. This contact allows the desired position of guide members 608, 610 to be maintained during implant insertion. Further, such separation capabilities might be required in order to further distract disc space D1 to facilitate implant insertion or removal. Inserter guide 600 includes a mechanism to force and/or maintain the separation of guide members 608 and 610. The spreading mechanism includes an externally threaded rod 612 joined to branch 602 and extending through hole 613 formed in the proximal end of branch 604. The spreading mechanism has an internally threaded hand nut 614 threadedly received on rod 612. Branches 602 and 604 may be forced together by action of internally threaded nut 614 on branch 604 forcing it towards branch 602, thereby forcing guide members 608 and 610 apart and into contact with the vertebral endplates.

Referring now to Fig. 36, there is shown a straight implant inserter 630. Inserter 630 includes a rigid hollow outer shaft 632 secured to a handle 634 at the proximal end of shaft 632. An inner shaft 636, either rigid or flexible, extends through outer shaft 632 and includes an implant connector 638 at its distal end extending distally from the distal end of outer shaft 632. Implant connector 638 is preferably threaded, but can include other attachment means for engaging the implant. Inner shaft hand nut 642 is coupled to inner shaft 636, and can be rotated to in turn rotate connector 638 to secure or release the implant thereto as desired. A bearing member 640 is secured to outer shaft 636, and contacts the wall of implant to direct an insertion force to the implant.

Referring now to Figs. 37-38, there is shown a curved inserter 650 and a pusher 670 adapted for use with the curved inserter 650 and other instruments of the present invention. Inserter 650 includes a rigid hollow outer shaft 652 secured to a handle 654 at the proximal end of shaft 652. Outer shaft 652 includes a bend 655 adjacent its distal end forming offset angle A3. A flexible inner shaft 656 extends through outer shaft 652 and bend 655. Inner shaft 656 includes an implant connector 658 at its distal end extending distally from the distal end of outer shaft 652. Implant connector 658 includes threads or other attachment means for engaging an implant. Inner shaft hand nut 662 is coupled to inner shaft 656, and can be

rotated to in turn rotate connector 658 to secure or release the implant thereto as desired. A bearing member 660 is secured to outer shaft 656, and contacts the wall of the implant to direct the insertion force thereto. An impaction tool engaging portion 664 in the form of a notch formed around outer shaft 664 is provided in outer shaft 652.

5 An impaction tool or pusher 670 includes a shaft 672 having a bulb handle 674 secured to the proximal end of shaft 672. A shaft engaging portion 674 is secured to and extends from the distal end of shaft 672. In the illustrated embodiment, shaft engaging portion 674 is a U-shaped prong, and is positionable in notch 664 to apply a pushing force to curved inserter 650 to facilitate placement the implant secured to inserter 650 into distal portion 37 of disc
10 space D1.

Insertion of implant I with curved inserter 650 is shown in Fig. 39. Implant I is attached to inserter 650, and implant I is then positioned in opening 35 with inserter 650 oriented such that it extends across spinous process S. As implant I is advanced from proximal portion 41 to distal portion 37 of disc space D1, inserter 650 is pivoted around
15 spinous process S to the position indicated by inserter 650'. Pusher 670 can be used to facilitate insertion by allowing the surgeon to use pusher 670 to apply the insertion force with one hand while the other hand is used to pivot inserter 650.

An alternate embodiment implant insertion device is shown in Figs. 40 through 44. The implant inserter 300 includes an inner guiding shaft 302 having a handle 308 attached to
20 one end and a stop 306 disposed on the opposite end. Guiding shaft 302 includes a bend 304 adjacent the distal portion. Insertion sleeve 310 is slidably disposed about inner shaft 302. As previously described with respect to chisel 230, insertion sleeve 310 includes a drive portion 314 and impact shoulder 316 for use with a slap hammer, if necessary. Insertion sleeve 310 is connected at its distal end to an implant driver 318 by a flexible drive member
25 312. Implant driver 318 includes an arcuate cavity 322 having a substantially concave surface. The concave surface terminates adjacent the inner shaft 302.

As shown in Figs. 42 through 43, an implant 330 is engaged to implant driver 318 with a portion of the implant positioned in arcuate cavity 322. Driver 318 urges implant 330 in the direction of arrow 320. It will be understood that driver 318 and guide rod 302 cooperate to
30 guide the implant along an arcuate path through the disc space formed by guide rod 302. Implant 300 is one example of an implant that may be inserted with instruments according to

the present invention. Further suitable implants are disclosed in U.S. Patent No. 5,897,556 and also in PCT International Application PCT/US00/41392 entitled IMPACTED ORTHOPEDIC BONE SUPPORT IMPLANT, each of which is incorporated herein by reference in its entirety. The implant inserted with the instruments and techniques of the present invention could also be a spacer, a disc prosthesis or disc nucleus prosthesis.

As shown in Fig. 44, inner shaft 302 of implant inserter is positioned in disc space D1 with stop 306 positioned adjacent distal portion 37. Implant 330 is positioned in opening 35 and implant driver 318 is urged forwardly along guide shaft 304 to drive the implant to distal portion 37 of disc space D1 as shown in Fig. 45. Once implant 330 is positioned in the desired location, bone ingrowth promoting material may be positioned around implant 330 using guide rod 302 as a guide for placement. Bone ingrowth promoting material 331 can also be placed in the interior portions of implant 330 prior to placement. Additionally, bone ingrowth promoting material 342 may be positioned in the anterior portion 39 of the disc space. As shown in Fig. 46, a second implant 349 may be placed in the proximal portion 41 of the disc space to complete a bilateral placement of implants to provide balanced structural support in disc space D1. Second implant 349 may also be filled with bone growth promoting material 351.

While some of the above-described instruments illustrate a separate guide rod for each instrument, it is contemplated that a single guide rod may be positioned in the disc space and multiple instruments advanced over the guide rod to complete disc space preparation and implant insertion. Further, the stop on the guide rod may include selectively engageable portions that may be engaged with the vertebral endplates to maintain the position of the guide rod in the disc space.

In a further alternative embodiment implant shown in Fig. 47, the disc space is prepared using the any combination of instruments described above. The anterior portion 39 of the disc space may be packed with bone ingrowth promoting material 342. A dual lobe implant 370, which can have features such as those described below with respect to implant 1000, is placed in the disc space D1 and has a length sufficient to span the disc space from the distal portion 37 to the proximal portion 41. Implant 370 includes a first distal lobe 372 and a second proximal lobe 374. A central opening 376 is provided that may be filled with bone

ingrowth material. Implant 370 may be positioned by using any of the implant inserters described herein. .

Fig. 48 illustrates one example another embodiment implant inserter according to the present invention. Implant inserter 400 includes an elongated shaft 402 with a handle 404 at its proximal end and an implant-gripping end at the opposite end. The implant-gripping end includes bifurcated branches 408 and 410 separated by a space 412. The bifurcated branches each include a bend 406 to accommodate implant placement through opening 35 and into disc space D1. Branch 408 includes an inclined surface 414 and an implant engagement block 418. Similarly, branch 410 includes inclined surface 416 and an implant engagement block 420. Each engagement block includes at least one projection (not shown) for insertion into a wall opening of implant 422 having a bearing surface to engage implant 422. An outer sleeve 424 is slidably disposed on inner shaft 402 with an internal channel 426. It will be understood that as sleeve 424 is advanced toward implant 422, sleeve 424 will engage inclines 414 and 416 thereby urging branches 408 and 410 towards each other. The projections on engagement blocks 418 and 420 will then firmly engage implant 422.

In a further embodiment illustrated in Fig. 49, implant inserter 450 has an implant engagement end 456 offset from shaft 452 by a bend 454. A pusher 460 includes a handle 464 at one end and a projection (not shown) at the opposite end 462 for engagement with a corresponding opening (not shown) on shaft 452. Pusher 460 provides a mechanism for the surgeon to use one hand to urge implant 458 across disc space D1, while the other hand of the surgeon pivots implant 458 with inserter 450 as it is moved across disc space D1. The longitudinal axis of pusher 460 is in relatively substantial alignment with the longitudinal axis of implant engagement end 456. Thus, longitudinal force applied on pusher 460 may be directly transmitted as longitudinal force to advance implant 458 into the disc space.

Referring to Figs. 50-51, an intradiscal rasp 700 according to the present invention is shown that is useful for disc space preparation with the approaches discussed herein. It is further contemplated that rasp 700 also has application with approaches and intradiscal procedures other than those discussed herein. Rasp 700 includes an elongated shaft 702 with a handle 704 on the proximal end of shaft 702 and a rasping head 705 on the distal end of shaft 702. Shaft 702 has a distal portion 708 laterally offset from a proximal portion 706 to facilitate insertion of rasping head 705 into the disc space. Rasping head 705 is joined to and

extends laterally from distal portion 708 and has a leading end wall 722 that is laterally offset from proximal portion 708 in the same direction as but to a greater extent than distal portion 708. The configuration of shaft 702 also allows the surgeon to place rasping head 705 in contact with the vertebral endplates to prepare distal portion 37 of disc space D1 for implant insertion. Shaft 702 and rasping head 705 are configured in a manner that further allows preparation via a posterior lateral approach of at least a portion of the anterior third of the disc space for receipt of an implant. In order to match the endplate area prepared to the implant, rasping head 705 can have a size and shape, when viewed in the direction of the vertebral endplates, that generally corresponds to the size and shape of the implant to be inserted. In the illustrated embodiment, rasping head 705 has a generally banana or boomerang shape that generally corresponds to the shape of the vertebral endplate contacting surfaces of the implant 1000 discussed below. However, it should be understood that rasping head 705 can also be used for implants having other shapes, including circular, semi-circular, square, rectangular, or ovoid shapes, to name a few.

Further details regarding shaft 702 and rasping head 705 will now be discussed. Shaft 702 has proximal portion 706, distal portion 708, and an intermediate connecting portion 710 extending between and joining proximal portion 706 and distal portion 708. Proximal portion 706 extends along a central axis 707, distal portion 708 extends along a central axis 709, and connecting portion 710 extends along a central axis 711. Shaft 702 forms an angle A2 between central axis 707 and central axis 711, and an angle A22 between central axis 711 and central axis 709. Thus, connecting portion 710 laterally offsets distal portion 708 from proximal portion 706 a distance d. In one specific embodiment, this distance d is about 10 millimeters. Rasping head 705 extends from shaft 702 such that its leading end wall 722 is positioned even further laterally offset from proximal portion 706 than distal portion 708. This configuration allows shaft 702 to be initially positioned across spinous process S (such as shown with respect to inserter 1000 in Fig. 53) and then pivoted in the direction of arrow R away from spinous process S as rasping head 705 is inserted into disc space D1. Rasping head 705 can thus be used by the surgeon to create a rasped endplate portion on each vertebral endplate that generally corresponds to the implant insertion path.

As shown in Fig. 51, rasping head 705 includes a first rasping surface 712 and an opposite second rasping surface 714. Rasping head 705 further includes an anterior wall 718,

a posterior wall 720, leading end wall 722 and a trailing end wall 724. Rasping head 705 is connected, mounted, integrally formed with, or otherwise attached to shaft 702 at trailing end wall 724. Each of these walls 718, 720, 722, and 724 has a smooth surface finish, and leading end wall 722 is rounded to provide a smooth transition between anterior wall 718 and posterior wall 720. Anterior wall 718 has a convex profile that, in addition to generally matching the shape of the anterior wall of implant 1000, also generally corresponds to the shape of the anterior inner annulus wall and can contact this annulus wall to limit insertion depth of rasping head 705. Posterior wall 720 has a slightly concave profile of less curvature than anterior wall 718, and posterior wall is shorter than anterior wall 718 between leading end 722 and trailing end 724. Posterior wall 724 generally corresponds to the shape of the posterior edge of the vertebral endplate.

In an alternate embodiment shown in Figs. 50(a) and 51(a), rasp 700 has a rasping head 705' with a leading end wall 722' that is bulleted or tapered to facilitate entry of rasping head 705' into the disc space. This alternate embodiment further includes a rasping surface on the anterior wall 718' that can scrape material in the anterior portion of the disc space. First and second rasping surfaces 712', 714' can be used to rasp material from the vertebral endplates. In this embodiment, posterior wall 702', leading end wall 722' and trailing end wall 724' have a smooth surface finish.

Rasping surfaces of rasp 700 are provided with a surface configuration that allows that surgeon to scrape endplate material as the rasp is moved across the endplate. In one form, this rasping surfaces includes a plurality of pyramid-shaped teeth each having their upper most point positioned to contact the vertebral endplate. It is further contemplated that other rasping surfaces known to those skilled in the art could be provided, such as, for example, a plurality of frusto-conical projections, spikes, diamond-shaped projections, or wedge-shaped projections that each extend across the width of the rasping surface. Rasping surfaces 712, 714 can simultaneously contact the adjacent upper or lower vertebral endplates, or rasp 700 can be manipulated in the disc space to selectively contact one of the upper endplate or the lower endplate. In one specific embodiment, rasping head 705 has a height 716 between the outermost ends of the rasping surfaces 712, 714 of 8 millimeters. In another specific embodiment, height 716 is 6 millimeters. However, it should be understood that other

heights are also contemplated so long as rasping head 705 can be positioned in the intradiscal space.

Referring now to Figs. 52-53, another embodiment implant and instrument set for inserting the implant into disc space D1 through opening 35 are provided. The instrument set includes an implant insertion tool in the form of inserter 1100, an impaction tool in the form of pusher 1200, and driver 1300. Inserter 1100 has a proximal portion with a shaft 1106 and a handle 1108 secured to the proximal end of shaft 1106. Shaft 1106 includes a distal working end having a rotatable connecting portion 1102 with a threaded distal end portion 1104 for engaging a threaded opening on implant 1000. A male protrusion member 1105 extends from end portion 1104, and is positionable in a slot formed in implant 1000 as described further below. Driver 1300 is engageable to the proximal end of connecting portion 1102 to thereby rotate connecting portion 1102 to threadingly engage implant 1000 to threaded end portion 1104 of inserter 1100. Shaft 1106 further includes a lateral offset 1110 having a bend forming angle A2 with shaft 1106 and an angle A22 with distal shaft portion 1111, and is configured similar to the shaft of rasp 700 discussed above. Distal portion 1111 is thus offset from the proximal portion of shaft 1106 by distance d. In one specific embodiment, this offset distance is about 10 millimeters. This allows shaft 1106 to be initially positioned across spinous process S, as shown in Fig. 53, and then pivoted in the direction of arrow R away from spinous process S as implant 1000 is positioned in disc space D1. Pusher 1200 has a shaft 1202 and handle 1204 at the proximal end of shaft 1202. Pusher 1200 further includes a reduced diameter distal end portion 1206 positionable in an impaction tool engaging portion in the form of bore 1112 formed in shaft 1106.

The surgeon can use pusher 1200 to apply a pushing force to implant 1000 in the direction of arrow P while inserter 1100 is pivoted in the direction of arrow R to pivot the leading end of implant 1000 towards distal portion 37 of disc space D1. It should be understood that inserter 1100 does not pivot with respect to implant 1000, but rather inserter 1100 follows the proximal end of implant 1000 as the distal end of implant 1000 is pivoted to move implant 1000 non-linearly into and across the disc space along insertion path P. The inserter 1100 and pusher 1200 provide the surgeon the ability to use two-handed control to insert implant 1000 into the disc space along non-linear path P since the surgeon controls

inserter 1100 with one hand while the other hand provides a pushing or impaction force on implant 1000 with pusher 1200.

Referring now to Figs. 54-58, various views of implant 1000 are shown and will now be described in further detail. Implant 1000 is an interbody fusion device or cage that can be packed with bone growth material or other known substance and inserted into disc space D1 to promote bony fusion between vertebrae V1 and V2. Furthermore, the structural features of implant 1000 can have application for a disc prosthesis or a disc nucleus prosthesis that is to be inserted into disc space D1 through opening 35. Implant 1000 has a boomerang or banana shape that is suited for insertion to provide bi-lateral support in disc space D1 through a unilateral approach, after the disc space D1 has been accessed and prepared using the above described instruments and techniques. It is also contemplated that disc space D1 can be accessed and prepared for implant insertion using any other known techniques and instruments and other approaches to the disc space, such as lateral, anterior or antero-lateral approaches, for inserting implant 1000. However, a particular problem exists providing bilateral support to the intradiscal space in instances where the disc space is accessed from a posterior lateral approach, such as a transforaminal approach, due to the difficulty in accessing and inserting the implant into distal portion 37 of disc space D1. Implant 1000 addresses this problem by providing a design that is suited for insertion into opening 35 and for subsequent pivotal movement and impaction movement through disc space D1 into distal portion 37.

Implant 1000 includes a concave posterior wall 1002 and an opposite convex anterior wall 1004. Implant 1000 further includes an arcuate leading end wall 1006 and an arcuate trailing end wall 1008. Each of the end walls 1006, 1008 extend between and connect posterior wall 1002 and anterior wall 1004, and provide a smooth transition therebetween to facilitate passage of implant 1000 through disc space D1. Implant 1000 further includes an upper bearing member 1010 and a lower bearing member 1012 extending between and connecting walls 1002, 1004, 1006 and 1008.

Implant 1000 has a height H1 at the medial portion of posterior wall 1002 and a second height H2 at the medial portion of anterior wall 1004. Upper bearing member 1010 and lower bearing member 1012 have a slight convexity between the anterior and posterior walls 1002, 1004 and height H2 is preferably greater than H1 in order to correspond to the anatomy

of the vertebral endplates at the posterior portion of disc space D1. Leading end wall 1006 and trailing end wall 1008 further have a height H3 that is less than H1 and H2, and upper bearing member 1010 and lower bearing member 1012 have a slight convexity between leading end 1006 and trailing end 1008 as best shown in Fig. 56. This double convexity preferably matches the double concavity of the adjacent vertebral endplate. Furthermore, the difference in heights between the upper and lower bearing members at the anterior and posterior walls can be provided so as to establish lordosis when implant 1000 is inserted in the disc space. Implant 1000 thus has application in restoring and maintaining spinal lordosis from a postero-lateral approach.

Upper bearing member 1010 can further be provided with a number of grooves 1014 and lower bearing member 1012 can be provided with a number of grooves 1016. Grooves 1014 and 1016 can engage the vertebral endplates to resist posterior and anterior migration of implant 1000 in the disc space.

In order to promote fusion, the walls and bearing members of implant 1000 are provided with a number of openings. Upper bearing member 1010 includes upper openings 1018a and 1018b separated by an upper strut 1019. Lower bearing member 1012 includes lower openings 1020a and 1020b separated by a lower strut 1021. An upper bar 1022 forming the perimeter of upper bearing member 1010 has a boomerang shape, and surrounds upper openings 1018a, 1018b and is connected to strut 1019. Similarly, a lower bar 1024 forming the perimeter of lower bearing member 1012 has a boomerang shape, and surrounds lower openings 1020a, 1020b and is connected to strut 1021. Posterior wall 1002 includes a pair of posterior lateral openings 1026a and 1026b adjacent to the posterior side of leading end wall 1006 and trailing end wall 1008, respectively. Posterior vertical struts 1030a and 1030b extend between and are connected to upper bar 1022 and lower bar 1024 on the medial side of openings 1026a and 1026b, respectively. A posterior middle opening 1028 that is larger than posterior lateral openings 1026a, 1026b is defined between vertical struts 1030a, 1030b.

Anterior wall 1004 includes a pair of anterior lateral openings 1032b and 1032a adjacent to the anterior side of leading end wall 1006 and trailing end wall 1008, respectively. Anterior vertical struts 1034a and 1034b extend between and are connected to upper bar 1022 and lower bar 1024 on the medial side of openings 1032a and 1032b, respectively. An

anterior middle opening 1036 that is larger than anterior lateral openings 1032a, 1032b is defined between vertical struts 1034a, 1034b. An offset strut 1038 is provided at the middle of opening 1036, and extends between and is connected with upper bar 1022 and lower bar 1024. Since offset strut 1038 is offset toward posterior wall 1002, and offset strut 1038 is also connected with upper strut 1019 and lower strut 1021. As best shown in Fig. 54, offset strut 1038 and middle opening 1036 provide upper member 1010 with an upper cantilevered portion 1040 and lower member 1012 with a lower cantilevered portion 1042. The cantilevered portions 1040, 1042 facilitate x-ray assessment of fusion in the middle of disc space D1 since there is no structural member blocking an x-ray image taken from a lateral view.

Implant 1000 is also provided with an inserter engaging portion 1048 at trailing end 1008 and an identical inserter engaging portion 1044 at leading end 1006 so that implant 1000 is insertable into disc space D1 from a unilateral approach taken on either side of the spinous process. Inserter engaging portions 1044, 1048 are preferably internally threaded and engageable with a distal end of an implant inserter, such as threaded end portion 1104 of inserter 1100 described above. A slot 1046 extends upwardly and downwardly from inserter engaging portion 1044 to upper bearing member 1010 and lower bearing member 1012. A slot 1050 extends upwardly and downwardly from inserter engaging portion 1048 to upper bearing member 1010 and lower bearing member 1012. Slots 1046, 1050 receive male member 1105 of inserter 1100 to prevent rotation of implant 1000 with respect to inserter 1100 when implant 1000 is engaged thereto. The cooperation between slots 1046, 1050 and male member 1105 also properly orients inserter 1100 with respect to implant 1000 when implant 1000 is engaged thereto.

Referring now specifically to Fig. 55, implant 1000 has an axis C extending through its center longitudinally. Axis C extends generally in the direction between the leading end and the trailing end of implant 1000, and is equal distance from the most posterior point A on leading end wall 1006 and the most posterior point B on trailing end wall 1008. Leading end wall 1006 is offset to the posterior side of axis C, and trailing end wall 1008 and engaging portions 1044, 1048 are also offset to the posterior side of axis C. The offset in the leading end and trailing ends of implant 1000 facilitates the controlled insertion of implant 1000 along curved insertion path P.

One method for inserting implant 1000 will now be described with reference to Figs. 52 and 53. Driver 1300 is used to connect implant 1000 to connecting portion 1104 of inserter 1100. Distal end portion 1206 of pusher 1200 is positioned in bore 1112 in shaft 1106. The leading end 1106 of implant 1100 is placed at the opening 35. A manual or mechanical
5 impaction force is applied to pusher 1200 to push implant 1000 a desired amount into proximal portion 41 of disc space D1. Inserter 1100 is pivoted in the direction of arrow R, thereby pivoting leading end 1106 in the disc in the posterior direction. Pusher 1200, pivoted along with inserter 1200, is then used to apply a further impaction force to push implant 1000 further into the disc space. However, due to the pivoting of inserter 1100 and pusher 1200,
10 the direction of insertion is now oriented more towards distal portion 37 of disc space D1. This alternating pivotal and pushing movement of implant 1000 is continued until implant 1000 is placed in the proper position in disc space D1.

Implant 1000 provides many further advantages. The shape and location of the bars, struts and walls positions the load bearing members at the strong bony surfaces of the
15 vertebral endplates to provide maximum load support capacity and avoid implant subsidence into the vertebral endplates. The double convexity of the upper and lower bearing members in combination with the boomerang shape provides an intimate fit in the disc space and a profile that matches the concavity of the endplates, providing implant stability and promoting fusion. The openings and hollow interior maximize the volume available to receive bone
20 growth material and also maximize the contact surface area between the bone growth material and the adjacent bony structure. Implant 1000 can be made from titanium, surgical grade stainless steel, or other bio-compatible material using fabricating techniques known in the art.

Referring now to Figs. 59-64, there is shown another embodiment implant according to
25 the present invention. Implant 1400 is an interbody fusion device or cage that can be packed with bone growth material or other known substance and inserted into disc space D1 to promote bony fusion between adjacent vertebrae V1 and V2. Implant 1400 has a boomerang or banana shape that is suited for insertion from a postero-lateral or uni-lateral approach into disc space D1, after the disc space D1 has been accessed and prepared using the above
30 described instruments and techniques. Implant 1400 is insertable through opening 35 and pivotally moved and impacted through disc space D1 into distal portion 37. It is also

contemplated that disc space D1 can be accessed and prepared for implant insertion using any other known techniques and instruments and other approaches to the disc space, such as lateral, anterior or antero-lateral approaches, for insertion of implant 1400.

Implant 1400 includes a body having a leading end portion 1450, a trailing end portion 1452, and a middle portion 1454 therebetween. A concave posterior wall 1402 and an opposite convex anterior wall 1404 extend along middle portion 1454, and also along at least part of the corresponding side of leading end portion 1450 and trailing end portion 1452. Implant 1400 further includes an arcuate leading end wall 1406 extending along leading end portion 1450 between posterior wall 1402 and anterior wall 1404. Implant 1400 also includes an arcuate trailing end wall 1408 extending along trailing end portion 1452 between posterior wall 1402 and anterior wall 1404. Implant 1400 further includes an upper bearing surface 1410 and a lower bearing surface 1412 extending between walls 1402, 1404, 1406 and 1408.

Implant 1400 has a height H1' at the medial portion of posterior wall 1402 and a second height H2' at the medial portion of anterior wall 1404. Upper bearing surface 1410 and lower bearing surface 1412 have a slight convexity between the posterior and anterior walls 1402, 1404, and height H2' is greater than H1' in order to correspond to the anatomy of the vertebral endplates on each side of disc space D1. Leading end wall 1406 and trailing end wall 1408 each have a height H3' that is less than H1' and H2', and upper bearing surface 1410 and lower bearing surface 1412 have a slight convexity between leading end 1406 and trailing end 1408 as best shown in Figs. 61-64. This double convexity substantially matches the double concavity of the adjacent vertebral endplates. Furthermore, the difference in heights between the upper and lower bearing surfaces at the anterior and posterior walls can be provided so as to establish lordosis when implant 1400 is inserted in the disc space. In one specific application, implant 1400 can be inserted from a postero-lateral approach to restore and maintain spinal lordosis.

Upper bearing surface 1410 can further be provided with a number of first grooves 1414a along anterior wall 1404 and second grooves 1414b along leading and trailing end walls 1406, 1408. Lower bearing surface 1412 can be provided with a number of grooves 1416a along anterior wall 1404 and second grooves 1416b along leading and trailing end walls 1406, 1408. Grooves 1414a, 1414b and 1416a, 1416b increase frictional resistance

between the adjacent vertebral endplate and the bearing surfaces 1410, 1412 to resist posterior and anterior migration of implant 1400 in the disc space.

In order to provide avenues for bone growth through implant 1400, the walls of implant 1400 form a number of chambers opening at upper bearing surface 1410 and lower bearing surface 1412. In particular, leading end portion 1450 includes first chamber 1418 and trailing end portion 1452 includes second chamber 1420. Middle portion 1454 includes a middle chamber 1422. A first strut 1424 is located between first chamber 1418 and third chamber 1422 and extends between posterior wall 1402 and anterior wall 1404. A second strut 1426 is located between second chamber 1420 and third chamber 1422 and extends between posterior wall 1402 and anterior wall 1404.

Posterior wall 1402 includes a posterior opening 1427 along middle portion 1454, and anterior wall 1404 includes an anterior opening 1428 along middle portion 1454. In the illustrated embodiment, posterior wall opening 1427 is circular and anterior wall opening 1428 is oval or racetrack shaped and elongated in the direction between upper bearing surface 1410 and lower bearing surface 1412; however, other shapes for openings 1427, 1428 are also contemplated. Leading end portion 1450 includes first and second wall openings 1430a, 1430b in anterior wall 1404, and trailing end portion 1452 includes first and second wall openings 1432a, 1432b in anterior wall 1404. In the illustrated embodiment, openings 1430a, 1430b and 1432a, 1432b are oval or racetrack shaped and elongated in the direction between upper bearing surface 1410 and lower bearing surface 1412; however, other shapes for openings 1430a, 1430b and 1432a, 1432b are also contemplated.

Anterior wall 1404 includes an offset portion 1434 that is offset anteriorly with respect to the remaining portions of anterior wall 1404 extending from either side thereof. Anterior offset portion 1434 provides additional support of the vertebrae and strength to the body of implant 1400. A number of radiographic markers 1438 can also be provided in implant 1400 to facilitate X-ray assessment of the locating and positioning of implant 1400 in the patient's body. Such markers are particularly useful for an implant 1400 made from radiolucent material. In the illustrated embodiment, markers 1438 are provided at the midline of anterior wall 1404 at the anterior most point defined by offset portion 1434. Markers 1438 are also provided at the posterior-most points of trailing end wall 1408 and leading end wall 1406. Positioning markers 1438 at these locations provides an indication of the anterior and

posterior placement of implant 1400 in the disc space, and also an indication of the lateral placement of implant 1400 in the disc space. Alignment of the end wall markers 1438 in a lateral X-ray indicates proper orientation of implant 1400 in the disc space in the A-P direction.

5 Implant 1400 includes a recessed area 1446 extending along leading end wall 1406 and a portion of anterior wall 1404. Implant 1400 also includes a recessed area 1442 extending along trailing end wall 1408 and a portion of anterior wall 1404. Recessed areas 1442, 1446 are located in the respective wall portions mid-height between upper bearing surface 1410 and lower bearing surface 1412. Recessed surfaces 1442, 1446 are configured to receive a
10 portion of an implant insertion instrument and to facilitate grasping of the implant, as discussed further below.

 The symmetrical shape of implant 1400 allows implant 1400 to be inserted into disc space D1 from a unilateral approach taken on either side of the spinous process, and by grasping either of leading end portion 1450 or trailing end portion 1452 with an insertion
15 instrument. Implant 1400 is provided with a first inserter instrument engaging receptacle 1448 at trailing end portion 1452 and a second inserter instrument engaging receptacle 1444 at leading end portion 1450. Each of the engaging receptacles 1444, 1448 are configured along with adjacent recessed area 1442, 1446 for engagement with an implant inserter instrument, such as inserter instrument 1500 described below. Trailing end wall 1408 and
20 leading end wall 1406 could also include a threaded hole for engagement with an inserter, such as inserter 1100 described above. In the illustrated embodiment, engaging receptacles 1444, 1448 are in the form of grooves that extend between upper bearing surface 1410 and lower bearing surface 1412. Each of the grooves is aligned with a corresponding one of the first strut 1424 and second strut 1426. First strut 1424 and second strut 1426 provide bearing
25 support to resist application of forces applied to the implant wall by an insertion instrument positioned in the respective engaging receptacle 1444, 1448.

 Implant 1400 has an axis C1 extending through its center longitudinally. Axis C1 extends generally in the direction between the leading end and the trailing end of implant 1400, and is equal distance from the most posterior point on leading end wall 1406 and the
30 most posterior point on trailing end wall 1408. Leading end wall 1406 is offset to the posterior side of axis C1, and trailing end wall 1408 is offset to the posterior side of axis C1.

The offset in the leading end and trailing ends of implant 1400 facilitates the controlled insertion of implant 1400 along curved insertion path P.

Referring now to Figs. 65-69, there are shown instruments suited for inserting an implant through a postero-lateral opening in a spinal disc space. Inserter instrument 1500 provides the surgeon the ability to control insertion of an implant into the spinal disc space from a postero-lateral approach. Inserter instrument 1500 facilitates positioning of the implant in the disc space such that the implant extends across the disc space to provide bi-lateral support of the adjacent vertebrae. Inserter instrument 1500 also facilitates positioning of the implant in the disc space along a non-linear insertion path. Inserter instrument 1500 can also be used to position multiple implants at various locations in the disc space, and also for insertion of one or more implants from other approaches to the disc space.

Inserter instrument 1500 includes a proximal portion 1501 pivotally coupled to a distal portion 1512. Proximal portion 1501 extends along axis 1520 when in a first position, and is pivotal relative to distal portion 1512 as indicated by proximal portion 1501' and axis 1520'. Proximal portion 1501 includes a handle 1502. Handle 1502 is coupled to an outer shaft 1504 extending distally from handle 1502. An inner shaft 1506 is slidably received in outer shaft 1504. Inner shaft 1506 is spring biased distally with respect to handle 1502 to engage a distal portion 1512 of inserter instrument 1500. An actuator 1508 is positioned around outer shaft 1504 and engaged to inner shaft 1506 with pin 1516 extending through a slot 1514 in outer shaft 1504. For proximal portion 1501', inner shaft 1506 and spring 1508 are removed to show slot 1514' through which pin 1516 extends. Actuator 1508 is moved proximally from a first engaged position to a disengaged position to push inner shaft 1506 against spring 1508, disengaging inner shaft 1506 from distal portion 1512 and allowing proximal portion 1501 to be pivoted to the position indicated by proximal portion 1501'.

Distal portion 1512 includes a shaft engaging portion 1522 extending along an axis 1524. Distal portion 1512 further includes a distal implant engaging portion 1526 and a lateral offset portion 1528 extending between shaft engaging portion 1522 and implant engaging portion 1526. Distal portion 1512 also includes a notched portion 1530 for engagement with a pusher instrument, such as pusher instrument 1580 shown in Fig. 65a.

Pusher instrument 1580 includes a handle 1582, a shaft 1584 extending proximally from handle 1582, and an inserter instrument engaging portion 1586 at a distal end of shaft

1584. In the illustrated embodiment, inserter instrument engaging portion 1586 is a forked prong sized to be positioned around notched portion 1530 and to push against shaft engaging portion 1522.

As shown in Fig. 66, shaft engaging portion 1522 includes a first receptacle 1522a and
5 a second receptacle 1522b. Shaft engaging portion 1522 further includes a through-hole 1522e to receive a pin to pivotally couple outer shaft 1504 thereto. Extending from first receptacle 1522a on one side of hole 1522e is a first surface 1522c, and extending from second receptacle 1522b on the other side of hole 1522e is a second surface 1522d.

Receptacles 1522a and 1522b are configured to receive first and second extensions 1506a and
10 1506b, respectively, extending distally from inner shaft 1506. In the illustrated embodiment, receptacles 1522a, 1522b are tapered to facilitate sliding of extensions 1506a, 1506b therein between their engaged and disengaged positions.

When proximal portion 1501 is in its first position, second extension 1506b extends
15 along second surface 1522d, and spring 1508 biases first extension 1506a into first receptacle 1522a. First receptacle 1522a engages first extension 1506a such that proximal portion 1501 cannot pivot relative to distal portion 1512. When actuator 1508 is pulled proximally, first extension 1506a is withdrawn proximally from first receptacle 1522a sufficiently so that proximal portion 1501 can be pivoted relative to distal portion 1512 to the position indicated
20 by proximal portion 1501', wherein second extension 1506b is aligned with second receptacle 1522b. Actuator 1508 is released to spring bias second extension 1506b into second receptacle 1522b, and first extension 1506a extends along first surface 1522c. Second receptacle 1522b engages second extension 1506b to prevent movement of proximal portion 1501' relative to distal portion 1512 and lock proximal portion 1501' in the second position. Other embodiments contemplate that more than two positions are provided for proximal
25 portion 1501.

In Fig. 65 inserter instrument 1500 is positioned adjacent vertebra V1 for insertion of
an implant, such as implant 1400, into disc space D. When proximal portion 1501 is in its first position, as indicated by axis 1520 in Fig. 66, axis 1524 of shaft engaging portion 1522 extends toward vertebra V1 relative axis 1520. In the illustrated embodiment, axis 1524
30 forms angle B1 with axis 1520, and proximal portion 1501 is pivotal about an angle B2 between its first position indicated by axis 1520 and its second position indicated by axis

1520'. Lateral offset 1528 includes an axis 1529 that forms angle B3 with axis 1524, and implant engaging portion 1526 has a distal portion with axis 1527 forming angle B4 with lateral offset axis 1529. Implant 1400 has an axis C1 extending longitudinally therethrough that forms an angle B5 with distal implant engaging portion axis 1527. When implant 1400 is inserted in disc space D, axis C1 can be oriented substantially orthogonally to the sagittal plane of the spinal column.

In one specific embodiment, proximal portion 1501 moves between an angle B2 of 70 degrees between its first position along axis 1520 and its second position along axis 1520'. In this specific embodiment, shaft engaging portion 1522 extends from proximal portion 1501 at an angle B1 of or about 135 degrees. Lateral offset 1528 extends along axis 1529 forming an angle of or about 55 degrees. The distal portion of implant engaging portion 1526 extends along axis 1527 forming angle B4 of or about 65 degrees with lateral offset portion 1528. Axis C1 of implant 1400 forms an angle B5 of or about 65 degrees with axis 1527 of the distal portion of implant engaging portion 1526. Other embodiments of the insertion instrument contemplate other values for angles B1, B2, B3, B4 and B5.

Implant engaging portion 1526 includes a first member 1532 and a second member 1534 movably engaged to first member 1532. Second member 1534 has a first position along first member 1532, shown in Fig. 68, wherein a spinal implant such as implant 1400 is insertable between first and second members 1532, 1534. Second member 1534 is movable along first member 1532 to a second position wherein first member 1532 and second member 1534 engage implant 1400 therebetween.

First member 1532 includes a first arcuate finger 1532a at a distal end thereof and second member 1534 includes a second arcuate finger 1534a at a distal end thereof. With second member 1534 in its second position, first finger 1532a and second finger 1534a form an implant receptacle 1536 sized and shaped to receive a trailing end wall of an implant therein. In the illustrated embodiment, implant receptacle 1536 is sized and shaped to conform to the trailing end wall 1408 of implant 1400. Other embodiments contemplate that implant receptacle 1536 is sized and shaped to conform to the trailing ends of other sized and shaped implants.

Implant receptacle 1536 is defined by a first concave surface 1538 extending along the inner side of first finger 1532a of first member 1532 and a second concave surface 1540

extending along the inner side of second finger 1534a of second member 1534. First concave surface 1538 and second concave surface 1540 are oriented toward one another. First finger 1532a includes a projection 1541 extending from first concave surface 1538 toward second concave surface 1540. Projection 1541 is positionable in a hole or receptacle in implant 1400, such as hole 1432b. In the illustrated embodiment, first concave surface 1538 extends along the anterior wall of implant 1400, and second concave surface 1540 extends along a portion of the posterior wall of implant 1400. The curvature of first concave surface 1538 can be greater than that of second concave surface 1540 to accommodate the differences in curvature of the respective wall portions of the implant against which concave surfaces 1538, 1540 are positioned.

First finger 1532a can be configured to reside at least partially in recessed area 1442 extending along trailing end portion 1408 to minimize the protrusion of first finger 1532a into the adjacent anatomy and disc space during and after insertion of implant 1400. The height of finger 1532a can be less than the height of implant 1400 and correspond to the height of recessed area 1442 so as to not contact the vertebral endplates during insertion and to facilitate detachment of engaging portion 1526 from implant 1400. Second finger 1534a can have a height that is less than the height of implant 1400 so as to not contact the vertebral endplates during insertion and facilitate detachment of engaging portion 1526 from implant 1400.

A driving member 1542 is provided to move second member 1534 between its first and second positions. In the illustrated embodiment, driving member 1542 is in the form of an externally threaded cylindrical body rotatably captured in first member 1532. Driving member 1542 is threadingly engaged to an internally threaded passage 1544 extending along second member 1534. Driving member 1542 is accessible through opening 1546 for engagement with a driving tool (not shown.) In use, first finger 1532a is positioned in recess 1442 with projection 1541 in hole 1432b. The driving tool can be used to apply a force to rotate driving member 1542 in a first direction to move second member 1534 via threaded passage 1544. Second finger 1534a is moved toward implant 1400 until second finger 1534a is firmly positioned in the groove formed at inserter, instrument engaging receptacle 1448 of implant 1400, thereby gripping implant 1400 in receptacle 1536 between fingers 1532a, 1532b.

There are further provided alignment instruments that extend from proximal portion 1501 to point toward an anatomical feature of the patient to provide an indication that the implant is properly positioned in disc space D. A first alignment instrument 1560 is removably engageable to the proximal end of handle 1502. First alignment instrument 1560 includes a cup portion 1562 positionable over handle 1502, and includes an extension member 1566 extending laterally to an alignment member 1564. Extension member 1566 has a length between cup portion 1562 and alignment member 1564 sized for use with proximal portion 1501 in its first position. Alignment member 1564 extends toward the patient and is alignable with an anatomical portion of the patient to provide an indication that the implant is properly positioned in disc space D. In the illustrated embodiment, alignment member 1564 also extends toward a reference point on implant 1400, such as the center of implant 1400 along its posterior and anterior walls. Thus, the anatomical feature to be aligned is positioned between the center of implant 1400 and the reference point on implant 1400. In the illustrated embodiment, alignment member 1564 aligns with or points to spinous process SP of vertebra V1 and also the center of implant 1400. Alignment with other anatomical features of the patient is also contemplated.

A second alignment instrument 1570 is removably engageable to proximal portion 1501 in its second position. Second alignment instrument 1570 includes a cup portion 1572 positionable over handle 1502', and includes an extension member 1576 extending laterally to an alignment member 1574. Extension member 1576 has a length between cup portion 1572 and alignment member 1574 sized for use with proximal portion 1501' in its second position. Alignment member 1574 extends toward the patient and is alignable with an anatomical portion of the patient, such as spinous process SP, and also a reference point on implant 1400, to provide an indication that the implant is properly positioned in disc space D.

One surgical procedure contemplated with inserter instrument 1500 includes engaging an implant, such as implant 1400, to engaging portion 1526. The disc space is accessed and prepared for postero-lateral insertion of the implant. Proximal portion 1501 is engaged in its first position along axis 1520 relative to distal portion 1512. Inserter instrument 1500 is positioned with respect to the entry to disc space D such that leading end portion 1406 of implant 1400 is adjacent the disc space opening, and inserter instrument 1500 extends across the spinous process such as shown and discussed above with respect to instrument 1100.

Implant 1400 is inserted into disc space D by alternately and/or simultaneously pivoting inserter instrument 1500 about the spinous process SP, as indicated by arrow R and pushing implant 1400 into disc space D, as indicated by arrow P. When implant 1400 is properly positioned in disc space D, alignment instrument 1560 can be engaged, if not already so, to inserter instrument 1500. Orientation of alignment member 1564 toward spinous process SP provides an indication of proper implant positioning in disc space D. Insertion of implant 1400 and its positioning in disc space D can also be confirmed radiographically or fluoroscopically. A pusher instrument, such as pusher instrument 1580, can be engaged with notched portion 1530 to assist in application of the pushing force to push implant 1400 across disc space D to the desired position.

It is further contemplated that proximal portion 1501 can be pivoted to the position indicated by proximal portion 1501' and axis 1520'. Movement of proximal portion 1501 from the first position to the second position can be completed when implant 1400 is partially inserted, or prior to insertion of implant 1400. It is further contemplated that proximal portion 1501 can be moved back and forth between the first and second positions during implant insertion. The second position of proximal portion 1501' of inserter instrument 1500 facilitates application of a pushing force, with or without pushing instrument 1580, to push implant 1400 across disc space D to the desired position with inserter instrument 1500. When proximal portion 1501' in its second position, alignment member 1574 of alignment instrument 1570 is oriented toward spinous process SP to provide an indication of proper implant positioning in disc space D.

Referring now to Figs. 70 and 71, there is shown the proximal portion of another embodiment inserter instrument 1600 and alignment instrument 1670. Except as otherwise discussed, inserter instrument 1600 can be substantially identical to inserter instrument 1500 discussed above. Inserter instrument 1600 includes a proximal portion 1601 movably engaged to a distal portion. Proximal portion 1601 includes a handle 1602 having a bore 1609 extending therein from the proximal end face of handle 1602. Handle 1602 further includes a well 1603 formed therein in which a ball mechanism resides. The ball mechanism includes a spring 1605 and a ball 1607 movably captured in well 1603.

Alignment instrument 1670 includes an alignment member 1674 and an extension member 1676 such as discussed above with respect to alignment instruments 1560, 1570.

The engagement end of alignment instrument 1670 includes a rod portion 1672 positionable in bore 1603. Rod portion 1672 includes a detent 1673 formed therein into which ball 1607 is removably engaged to secure alignment instrument 1670 to inserter instrument 1600. It is contemplated that detent 1673 is positioned on rod portion 1672 such that alignment instrument 1670 is properly aligned with the implant engaged to the implant engaging portion of insertion instrument 1600 when ball 1607 is received in detent 1673.

Fig. 72 is an enlarged section view shown an alternate connection arrangement between the proximal portion and the distal portion of the inserter instrument of Fig. 65. In Fig. 72 only a portion of proximal portion 1601 and distal portion 1612 are shown. Proximal portion 1601 includes an outer shaft 1604 and an inner shaft 1606 movably received therein. Outer shaft 1604 is pivotally engaged to distal portion 1612 via a pin through pin hole 1622d of implant engaging portion 1612. An actuator (not shown) is coupled to inner shaft 1606 to move it in outer shaft 1604 between an engaged position and a disengaged position with distal portion 1612. Inner shaft 1606 is spring-biased distally and includes a distal extension 1606a for positioning in respective one of a first receptacle 1622a when proximal portion 1601 in its first position and a second receptacle 1622b when proximal portion 1601 is in its second position. A pusher instrument notch 1630 and a lateral extension 1628 of distal portion 1612 are also shown, it being understood these features and the remaining portion of distal portion 1612 can be similar to or identical to that provided with distal portion 1512 of inserter instrument 1500.

In the illustrated embodiment, extension 1606a is rectangular and is received in close fitting engagement in respective ones of the receptacles 1622a, 1622b to secure proximal portion 1601 in respective ones of the first and second positions. Outer shaft 1604 includes a distal end surface 1604a that is curved along an arc defined by the pivot path of proximal portion 1601. Distal end surface 1604a moves along a correspondingly curved proximal end surface 1622c of distal portion 1612. Distal end surface 1604a rides against proximal end surface 1622c to provide a firm coupling arrangement between proximal portion 1601 and distal portion 1612 during movement of proximal portion 1601 and when proximal portion 1601 is in one of the first and second positions.

The implants described herein can be made from any biocompatible material, including synthetic or natural autograft, allograft or xenograft tissues, and can be resorbable or non-

resorbable nature. Examples of tissue materials include hard tissues, connective tissues, demineralized bone matrix and combinations thereof. Further examples of resorbable materials are polylactide, polyglycolide, tyrosine-derived polycarbonate, polyanhydride, polyorthoester, polyphosphazene, calcium phosphate, hydroxyapatite, bioactive glass, and combinations thereof. Further examples of non-resorbable materials are non-reinforced polymers, carbon-reinforced polymer composites, PEEK and PEEK composites; shape-memory alloys; titanium and titanium alloys; cobalt chrome alloys; stainless steel; ceramics; and combinations thereof. Instruments described herein can be made from any suitable surgical grade material, including stainless steel, aluminum, plastics, and combinations of materials.

Any suitable osteogenetic material or composition is contemplated for placement within the chambers defined by the implants described herein. Such osteogenic material includes, for example, autograft, allograft, xenograft, demineralized bone, synthetic and natural bone graft substitutes, such as bioceramics and polymers, and osteoinductive factors. Where bony material is placed within the chambers of the implant, the material can be pre-packed into the hollow chambers before the device is implanted, or can be pushed through the wall openings after the device is in position in the spinal column. A separate carrier to hold the materials within the chambers of the device can also be used. These carriers can include collagen-based carriers, bioceramic materials, such as BIOGLASS®, hydroxyapatite and calcium phosphate compositions. The carrier material can be provided in the form of a sponge, a block, folded sheet, putty, paste, graft material or other suitable form. Moreover, the osteogenetic compositions contained within the implant can comprise an effective amount of a bone morphogenetic protein, transforming growth factor β 1, insulin-like growth factor 1, platelet-derived growth factor, fibroblast growth factor, LIM mineralization protein (LMP), and combinations thereof or other therapeutic or infection resistant agent, held within a suitable carrier material.

The above-described instruments and methods have been disclosed with reference to use in substantially open surgical procedures. However, it is contemplated that the implants, instruments and methods may be utilized through guide sleeves or tubes to provided greater protection to adjacent tissues, to reduce the size of access incisions, to provide direct visualization of the surgical site, and/or to provide greater control of the method. The

implants, instruments and methods may further be used in combination with disc space preparation and implant insertion through microscopic or endoscopic instruments that provide direct visualization of the surgical site, such as disclosed in U.S. Patent Application Serial No. 09/692,932 entitled METHODS AND INSTRUMENTS FOR ENDOSCOPIC
5 INTERBODY SURGICAL TECHNIQUES, filed October 20, 2000, which is incorporated herein by reference in its entirety.

The instruments and methods have been disclosed with reference to a particular application for disc space preparation and implant insertion from a transforaminal approach to the spine. However, there are aspects of the inventions described herein that may be
10 utilized or modified for use for a variety of surgical applications including, but not limited to, spinal surgery from a unilateral posterior approach, a lateral approach, an oblique approach, and through laparoscopic or endoscopic instruments from any of a variety of angles or approaches to the spine.

While the invention has been illustrated and described in detail in the drawings and the
15 foregoing description, the same is considered to be illustrative and not restrictive in character. It is understood that only the preferred embodiments have been shown and described and that all changes and modifications that come within the spirit of the invention are desired to be protected.

What is claimed is:

1. An instrument for inserting a spinal implant, comprising:
a proximal portion including a handle and a shaft extending distally from said handle;
and

5 an implant engaging portion at a distal end of said shaft, said implant engaging portion having a first member and a second member, said second member movable along said first member from a first position wherein said spinal implant is insertable between said first and second members to a second position wherein said first member and said second member engage the implant therebetween.

10 2. The instrument of claim 1, wherein in said second position said first and second members define an implant receptacle therebetween.

15 3. The instrument of claim 2, wherein said implant receptacle is defined by a first concave surface extending along an inner side of said first member and a second concave surface extending along an inner side of said second member, said first and second concave surfaces being oriented toward one another.

20 4. The instrument of claim 3, wherein said first member includes a projection extending from said first concave surface toward said second concave surface.

5. The instrument of claim 3, wherein said first concave surface has a first curvature and said second concave surface has a second concave curvature.

25 6. The instrument of claim 5, wherein said first concave curvature is different than said second concave curvature.

30 7. The instrument of claim 1, wherein said proximal portion is pivotal relative to said implant engaging portion.

8. The instrument of claim 1, wherein said first member and said second member are movably engaged along a distal shaft of said implant engaging portion.

5 9. The instrument of claim 7, wherein said first member includes a first finger extending distally from said distal shaft of said implant engaging portion and said second member includes a second finger extending distally from said distal shaft of said implant engaging portion, said first and second fingers defining an implant receptacle therebetween when said second member is in said second position.

10 10. The instrument of claim 1, wherein said shaft of said proximal portion includes an inner shaft movably positioned therein.

15 11. The instrument of claim 10, further comprising an actuator slidably positioned about said shaft and engaged to said inner shaft, said actuator being movable from a first position wherein said inner shaft engages said implant engaging portion to a second position wherein said inner shaft is disengaged from said implant engaging portion.

20 12. The instrument of claim 11, wherein with said actuator in said second position said proximal portion is pivotal relative to said implant engaging portion.

25 13. The instrument of claim 12, wherein:
with said actuator in said second position said proximal portion is pivotal between a first position and a second position; and
with said actuator in said first position said inner shaft engages said implant engaging portion to fix said proximal portion in one of said first position and said second position.

30 14. The instrument of claim 1, wherein said implant engaging portion includes a lateral offset portion extending in a first direction from a central axis of said proximal portion.

15. The instrument of claim 1, wherein:

said shaft includes an inner shaft movably positioned therein, said inner shaft including a first extension, a second extension and a slot between said first extension and said second extension; and

5 said implant engaging portion includes a shaft engaging portion at a proximal end thereof, said shaft engaging portion including a first receptacle engaging said first extension with said proximal portion in a first position relative to said implant engaging portion, said shaft engaging portion including a second receptacle engaging said second extension with said proximal portion pivoted to a second position relative to said implant engaging portion.

10 16. The instrument of claim 15, wherein said inner shaft is spring biased to engage said first extension and said second extension in one of said first receptacle and said second receptacle when said proximal portion is in a corresponding one of said first position and said second position.

15 17. The instrument of claim 16, further comprising an actuator slidably position about said shaft and coupled to said inner shaft to move said inner shaft proximally to disengage said first extension and said second extension with respect ones of said first receptacle and said second receptacle.

20 18. The instrument of claim 1, further comprising an alignment instrument engageable to a proximal end of said proximal portion, said alignment instrument having an alignment member alignable with a portion of a patient's anatomy when the spinal implant is inserted to a desired position in the patient.

25 19. The instrument of claim 1, further comprising a driving member rotatably captured in said first member and engaged to said second member, said driving member rotatable to move said second member between said first position and said second position.

30 20. An instrument for inserting a spinal implant in a disc space, comprising:
a proximal portion including a handle and a shaft extending distally from said handle;
and

an implant engaging portion at a distal end of said shaft, said implant engaging portion engageable to the spinal implant, said proximal portion engageable to said implant engaging portion in a first position for inserting the spinal implant in the disc space, said proximal portion movable relative to said implant engaging portion and engageable to said implant engaging portion in a second position for inserting the spinal implant in the disc space.

21. The instrument of claim 20, wherein said implant engaging portion includes a first member and a second member, said second member movable along said first member from a first position wherein said spinal implant is insertable between said first and second members to a second position wherein said first member and said second member engage the implant therebetween.

22. The instrument of claim 21, wherein in said second position said first and second members define an implant receptacle therebetween.

23. The instrument of claim 22, wherein said implant receptacle is defined by a first concave surface extending along an inner side of said first member and a second concave surface extending along an inner side of said second member, said first and second concave surfaces being oriented toward one another.

24. The instrument of claim 23, wherein said first member includes a projection extending from said first concave surface toward said second concave surface.

25. The instrument of claim 21, wherein said first member and said second member are movably engaged along a distal shaft of said implant engaging portion.

26. The instrument of claim 25, wherein said first member includes a first finger extending distally from said distal shaft and said second member includes a second finger extending distally from said distal shaft, said first and second fingers defining an implant receptacle therebetween when said second member is in said second position.

27. The instrument of claim 20, wherein said shaft of said proximal portion includes an inner shaft movably positioned therein.

5 28. The instrument of claim 27, further comprising an actuator slidably positioned about said shaft and engaged to said inner shaft, said actuator being movable from an engaged position wherein said inner shaft engages said implant engaging portion to a disengaged position wherein said inner shaft is disengaged from said implant engaging portion.

10 29. The instrument of claim 28, wherein:
said shaft of said proximal portion is pivotally coupled to said implant engaging portion;
said inner shaft engages said implant engaging portion with said proximal portion in said first position;

15 said inner shaft is disengaged from said implant engaging portion with said actuator in said disengaged position and said proximal portion is pivotal to said second position; and
said actuator is movable to said engaged position to engage said inner shaft to said implant engaging portion with said proximal portion in said second position to fix said proximal portion in said second position.

20 30. The instrument of claim 20, wherein:
said shaft includes an inner shaft movably positioned therein, said inner shaft including a first extension, a second extension and a slot between said first extension and said second extension; and

25 said implant engaging portion including a shaft engaging portion, said shaft engaging portion including a first receptacle engaging said first extension with said proximal portion in said first position, said shaft engaging portion including a second receptacle engaging said second extension with said proximal portion in said second position.

31. The instrument of claim 30, wherein said inner shaft is spring biased to engage said first extension and said second extension with respective ones of said first receptacle and said second receptacle.

5 32. The instrument of claim 31, further comprising an actuator slidably position about said shaft and coupled to said inner shaft to move said inner shaft proximally to disengage said first extension and said second extension with respective ones of said first receptacle and said second receptacle.

10 33. The instrument of claim 20, further comprising an alignment instrument engageable to a proximal end of said proximal portion, said alignment instrument having an alignment member alignable with a portion of a patient's anatomy when the spinal implant is inserted to a desired position in the disc space.

15 34. An instrument for inserting a spinal implant in a disc space, comprising:
a proximal portion including a handle and shaft extending distally from said handle;
and
an implant engaging portion at a distal end of said shaft, said implant engaging portion engageable to the spinal implant; and

20 an alignment instrument engageable to a proximal end of said proximal portion, said alignment instrument having an alignment member alignable with a portion of a patient's anatomy when the spinal implant is inserted to a desired position in the disc space.

25 35. The instrument of claim 34, wherein said alignment instrument includes an engagement end including a cup portion positionable over a proximal end of said handle.

36. The instrument of claim 34, wherein said alignment instrument includes an engagement end including a shaft engageable with a ball detent mechanism in said handle.

30 37. The instrument of claim 36, wherein said alignment member includes an extension member extending from said engagement end to said alignment member.

38. The instrument of claim 34, wherein said proximal portion has a first position and a second position relative to said implant engaging portion.

5 39. The instrument of claim 38, wherein said alignment instrument includes a second alignment instrument, each of said alignment instruments adapted for use with a corresponding one of said first position and said second position of said proximal portion.

10 40. The instrument of claim 34, wherein the portion of the patient anatomy is alignable between a predetermined location on the spinal implant and said alignment member.

41. A spinal implant insertable in a spinal disc space, the implant comprising a body including:

15 a middle portion having opposite first and second ends;
a leading end portion extending from said first end of said middle portion;
a trailing end portion extending from said second end of said middle portion;
an upper surface and an opposite lower surface along said middle portion and said leading end portion and said trailing end portion; and
20 an inserter instrument engaging receptacle at a junction of said middle portion and said trailing end portion.

25 42. The implant of claim 41, wherein said receptacle is a groove formed in a posterior wall of said body, said groove extending between said upper surface and said lower surface.

43. The implant of claim 41, further comprising an inserter instrument engaging receptacle at a junction of said middle portion and said leading end portion.

44. The implant of claim 41, wherein said body includes an anterior wall and a posterior wall each extending along a respective side of said middle portion, said leading end portion and said trailing end portion.

5 45. The implant of claim 44, wherein said anterior wall has a generally convex profile and said posterior wall has a generally concave profile.

46. The implant of claim 44, wherein said anterior wall includes a recessed area extending along said trailing end portion.

10 47. The implant of claim 46, wherein said anterior wall includes a second recessed area extending along said leading end portion.

15 48. The implant of claim 44, wherein said posterior wall has a height that is less than a height of said anterior end wall.

49. The implant of claim 41, wherein said leading end portion and said trailing end portion each define a chamber extending between said upper surface and said lower surface.

20 50. The implant of claim 49, wherein said middle portion defines a chamber extending between said upper surface and said lower surface.

51. The implant of claim 50, further comprising:
a first strut between said chamber of said leading end portion and said chamber of said
25 middle portion; and
a second strut between said chamber of said trailing end portion and said chamber of said middle portion.

30 52. The implant of claim 51, wherein said inserter instrument engaging receptacle is formed at the junction of said second strut and a posterior wall of said body.

53. The implant of claim 41, wherein said body is comprised of non-resorbable material selected from the group consisting of: non-reinforced polymers, carbon-reinforced polymer composites, PEEK, PEEK composites, shape-memory alloys, titanium, titanium alloys, cobalt chrome alloys, stainless steel, ceramics and combinations thereof.

5

54. The implant of claim 41, wherein said body is comprised of PEEK material.

55. The implant of claim 54, further comprising at least one radiographic marker in said body.

10

56. The implant of claim 41, wherein said body includes at least one chamber.

57. The implant of claim 41, further comprising bone growth material in said at least one chamber.

15

58. The implant of claim 57, wherein said bone growth material includes one or more selected from group consisting of: bone morphogenetic protein, transforming growth factor, insulin-like growth factor, platelet-derived growth factor, fibroblast growth factor, and LIM mineralization protein (LMP).

20

59. A spinal implant insertable in a spinal disc space, the implant comprising a body having:

a leading end wall;

a trailing end wall;

25

a posterior wall extending between said leading end wall and said trailing end wall; and

an anterior wall extending between said leading end wall and said trailing end wall,

wherein said anterior wall includes a middle portion, a trailing end portion, and a leading end portion, said middle portion being offset anteriorly from said leading end portion and said trailing end portion.

30

60. The implant of claim 59, further comprising:

an upper bearing surface extending between said leading end wall, said anterior wall, said posterior wall and said trailing end wall; and

an opposite lower bearing surface extending between said leading end wall, said anterior wall, said posterior wall and said trailing end wall.

5

61. The implant of claim 59, wherein:

said posterior wall includes a middle portion, a leading end portion, and a trailing end portion; and

said posterior wall includes an inserter instrument engaging receptacle at a junction of said middle portion and said trailing end portion thereof.

10

62. The implant of claim 61, wherein said receptacle is a groove extending said upper surface and said lower surface.

15

63. The implant of claim 61, wherein said posterior wall includes an inserter instrument engaging receptacle at a junction of said middle portion and said leading end portion thereof.

20

64. The implant of claim 59, wherein said anterior wall has a generally convex profile and said posterior wall has a generally concave profile.

25

65. The implant of claim 59, wherein said anterior wall includes a first recessed area extending along said leading end portion thereof and a second recessed area extending along said trailing end portion thereof.

66. The implant of claim 59, wherein said posterior wall has a height that is less than a height of said anterior end wall.

30

67. The implant of claim 59, further comprising a first chamber between a leading end portion of said posterior wall and said leading end portion of said anterior wall and a

second chamber between a trailing end portion of said posterior wall and said trailing end portion of said anterior wall.

5 68. The implant of claim 67, further comprising a third chamber between a middle portion of said posterior wall and said middle portion of said anterior wall.

69. The implant of claim 68, further comprising:
a first strut extending from said anterior wall to said posterior wall between said first chamber and said third chamber; and

10 a second strut extending from said anterior wall to said posterior wall between said second chamber and said third chamber.

70. The implant of claim 69, further comprising an inserter instrument engaging receptacle in said posterior wall at the junction of said second strut and said posterior wall.

15 71. The implant of claim 70, further comprising a second inserter instrument engaging receptacle in said posterior wall formed at the junction of said first strut and said posterior wall.

20 72. A spinal implant insertable in a spinal disc space, the implant comprising a body including:

a leading end wall;

a trailing end wall;

a posterior wall extending between said leading end wall and said trailing end wall;

25 an anterior wall extending between said leading end wall and said trailing end wall;

a first strut adjacent said leading end wall extending from said anterior wall to said posterior wall;

a second strut adjacent said trailing end wall extending from said anterior wall to said posterior wall;

30 a chamber formed by said first strut, said second strut, said anterior wall and said posterior wall; and

an inserter instrument engaging receptacle at the junction of said second strut and said posterior wall.

73. The implant of claim 72, further comprising:

5 a second chamber formed by said first strut, said leading end wall, said anterior wall and said posterior wall; and

a third chamber formed by said second strut, said trailing end wall, said anterior wall and said posterior wall forming a second chamber.

10 74. The implant of claim 72, wherein said anterior wall includes a middle portion, a trailing end portion, and a leading end portion, said middle portion being offset anteriorly from said leading end portion and said trailing end portion.

15 75. The implant of claim 72, further comprising an inserter instrument engaging receptacle at the junction of said first strut and said posterior wall.

76. A kit, comprising:

an implant insertable in a spinal disc space, said implant having a leading end portion, a trailing end portion, and a middle portion therebetween;

20 an inserter instrument comprising:

a proximal portion including a handle and a shaft extending distally from said handle, said proximal portion extending along a central axis;

25 an implant engaging portion at a distal end of said shaft, said implant engaging portion configured to engage said trailing end portion of said implant such that said leading end portion of said implant extends way from the central axis of said proximal portion.

30 77. The kit of claim 76, wherein said implant engaging portion is laterally offset from the central axis of said shaft.

78. The kit of claim 76, wherein said proximal portion is pivotally engaged to said implant engaging portion and movable between a first implant insertion position and a second implant insertion position relative to said implant engaging portion.

5 79. The kit of claim 76, further comprising a pusher instrument engageable with said inserter instrument to provide a pushing force to said implant through said inserter instrument.

10 80. The kit of claim 76, further comprising an alignment instrument engageable to said inserter instrument, said alignment instrument having an alignment member alignable with a portion of a patient's anatomy when said spinal implant is inserted to a desired position in the spinal disc space.

15 81. The kit of claim 80, wherein the portion of the patient anatomy is alignable between a predetermined location on the spinal implant and said alignment member.

82. A method for inserting an implant in a spinal disc space of a patient, comprising:
accessing the spinal disc space;
20 preparing the spinal disc space for insertion of the implant;
engaging the implant to an inserter instrument in a first position relative to a proximal portion of the inserter instrument, the proximal portion being movable relative to the implant to a second position;
selecting one of the first position and the second position; and
25 inserting the implant in the spinal disc space with the proximal portion of the inserter instrument in the selected position.

83. The method of claim 82, further comprising:
moving the proximal portion of the inserter instrument to the other of the first position
30 and the second position during insertion of the implant.

84. The method of claim 82, wherein selecting one of the first position and the second position includes pivoting the proximal portion of the inserter instrument relative to a distal implant engaging portion of the inserter instrument.

5 85. The method of claim 82, further comprising applying a pushing force to the inserter instrument during insertion of the implant in the spinal disc space.

86. The method of claim 82, further comprising:
engaging an alignment instrument with the inserter instrument; and
10 inserting the implant in the spinal disc space so that the alignment instrument aligns with an anatomical feature of the patient.

87. A surgical instrument for performing a surgical procedure in a spinal disc space, comprising:

15 a shaft extending generally along a longitudinal axis, said shaft having a proximal portion along said longitudinal axis and a distal portion offset laterally in a first direction from said longitudinal axis; and

a rasp head at a distal end of said shaft extending in said first direction laterally further from said longitudinal axis than said distal portion.

20 88. The instrument of claim 87, wherein said rasp head has a first rasping surface positionable against the endplate of an upper vertebral body and an opposite second rasping surface positionable against the endplate of a lower vertebral body.

25 89. The instrument of claim 87, wherein said shaft includes a connecting portion extending along a second axis, said second axis forming a first angle with said longitudinal axis, and said distal portion extending from said connecting portion to said distal end along a third axis, said third axis forming a second angle with said second axis.

30 90. The instrument of claim 89, wherein said first angle is different than said second angle.

91. The instrument of claim 89, wherein said longitudinal axis and said third axis intersect distally of said rasp head at an angle of about 5 degrees.

5 92. The instrument of claim 87, wherein in said rasp head has an anterior wall, an opposite posterior wall, a trailing end wall extending between said anterior wall and said posterior wall, and a leading end wall extending between said anterior wall and said posterior wall opposite said trailing end wall.

10 93. The instrument of claim 92, wherein said leading end wall is tapered.

94. The instrument of claim 92, wherein said anterior wall, said posterior wall, said leading end wall and said trailing end wall are smooth.

15 95. The instrument of claim 92, wherein said anterior wall is convex and said posterior wall is concave.

96. The instrument of claim 95, wherein said anterior wall is longer than said posterior wall.

20 97. The instrument of claim 87, wherein said distal portion is laterally offset by a distance of 10 millimeters.

25 98. A surgical instrument for performing a surgical procedure in a spinal disc space, comprising:

a shaft having a length extending substantially along a longitudinal axis, wherein said shaft includes a proximal portion extending along said longitudinal axis, a connecting portion extending from a distal end of said proximal portion along a second axis, said second axis forming a first angle with said longitudinal axis, and a distal portion extending distally from a distal end of said connecting portion along a third axis, said third axis forming a second angle

30

with said second axis such that said distal portion is non-parallel to said proximal portion;
and

a rasp head extending from a distal end of said distal portion of said shaft.

5 99. The instrument of claim 98, wherein:
 said distal portion of said shaft is offset laterally in a first direction from said proximal
portion of said shaft; and
 said rasp head extends further laterally than said distal portion in said first direction.

10 100. The instrument of claim 99, wherein said distal portion is laterally offset by a
distance of 10 millimeters.

 101. The instrument of claim 98, wherein said shaft has a handle along said proximal
portion.

15 102. The instrument of claim 98, wherein said shaft has a circular cross-section.

 103. The instrument of claim 98, wherein said rasp head has a shape that generally
corresponds to the shape of an implant to be inserted into the intradiscal space.

20 104. The instrument of claim 98, wherein said rasp head has a first rasping surface
positionable against the endplate of an upper vertebral body and an opposite second rasping
surface positionable against the endplate of a lower vertebral body.

25 105. The instrument of claim 98, wherein said first angle is different than said second
angle.

 106. The instrument of claim 98, wherein a distal extension of said longitudinal axis
and a distal extension of said third axis intersect to form an angle of about 5 degrees.

30

107. The instrument of claim 98, wherein said rasp head has an anterior wall, an opposite posterior wall, a trailing end wall extending between said anterior wall and said posterior wall, and a leading end wall extending between said anterior wall and said posterior wall opposite said trailing end wall.

5

108. The instrument of claim 107, wherein said leading end wall is tapered.

109. The instrument of claim 107, wherein said anterior wall is convex and said posterior wall is concave.

10

110. The instrument of claim 109, wherein said anterior wall is longer than said posterior wall.

111. A surgical instrument for performing a surgical procedure in a spinal disc space, comprising:

15

a shaft extending generally along a longitudinal axis, said shaft having a proximal portion along said longitudinal axis and a distal portion offset laterally in a first direction from said longitudinal axis; and

a rasp head extending from a distal end of said shaft laterally in said first direction further from said longitudinal axis than said distal end, wherein said distal portion is laterally offset by a distance of 10 millimeters.

20

112. A surgical instrument for performing a surgical procedure in a spinal disc space, comprising:

25

a shaft having a length extending substantially along a longitudinal axis, wherein said shaft includes:

a proximal portion extending along said longitudinal axis;

a connecting portion extending from a distal end of said proximal portion along a second axis, said second axis forming a first angle with said longitudinal axis;

30

a distal portion extending distally from a distal end of said connecting portion along a third axis, said third axis forming a second angle with said second axis, wherein

a distal extension of said longitudinal axis and a distal extension of said third axis intersect at an angle of about 5 degrees; and
a rasp head extending from a distal end of said distal portion of said shaft.

5 113. A method for inserting an implant in a spinal disc space, comprising:
providing a posterior lateral opening into the disc space;
selecting an implant for insertion into the disc space;
securing a trailing end of an implant to an implant inserter;
positioning a leading end of the implant at the opening;
10 engaging a pusher to the implant inserter;
applying an impaction force to the implant with the pusher to push the implant through
the opening and into the disc space; and
applying a pivoting force to the implant with the implant inserter to move the leading
end of the implant towards a distal portion of the disc space.

15 114. The method of claim 113, further comprising alternating between applying an
impaction force and applying a pivoting force.

20 115. The method of claim 113, further comprising removing disc material from the
disc space prior to positioning the leading end wall of the implant at the opening.

116. The method of claim 115, further comprising forming a square entrance port at
the opening prior to positioning the leading end of the implant at the opening.

25 117. The method of claim 113, further comprising:
positioning the implant at a distal portion of the disc space; and
inserting a second implant into the disc space through the opening after positioning the
implant at the distal portion of the disc space.

30 118. The method of claim 113, further comprising:
inserting an implant template into the disc space prior to selecting the implant.

119. The method of claim 113, further comprising inserting an implant insertion guide into the disc space prior to positioning the leading end of the implant at the opening.

5 120. A method of preparing a spinal disc space for insertion of an implant, comprising:
providing a posterior lateral opening into the disc space;
providing a rasp including a shaft extending generally along a longitudinal axis, said shaft having a proximal portion along said longitudinal axis and a distal portion offset
10 laterally to a first side of said longitudinal axis, said rasp further including a rasp head extending from a distal end of said shaft towards said first side; and
orienting said shaft so that the spinous process is positioned toward a second side of said longitudinal axis, said second side opposite said first side.

15 121. The method of claim 120, further comprising:
positioning a leading end wall of said rasp head at the opening and the proximal portion of the shaft adjacent the spinous process; and
applying a pivoting force to the rasp to move the leading end wall of the rasp towards a distal portion of the disc space and the proximal portion of the shaft away from the spinous
20 process.

122. The method of claim 121, further comprising rasping the vertebral endplates.

25 123. The method of claim 122, wherein rasping the vertebral endplates includes rasping each endplate separately.

124. The method of claim 122, further comprising inserting an implant into the rasped disc space.

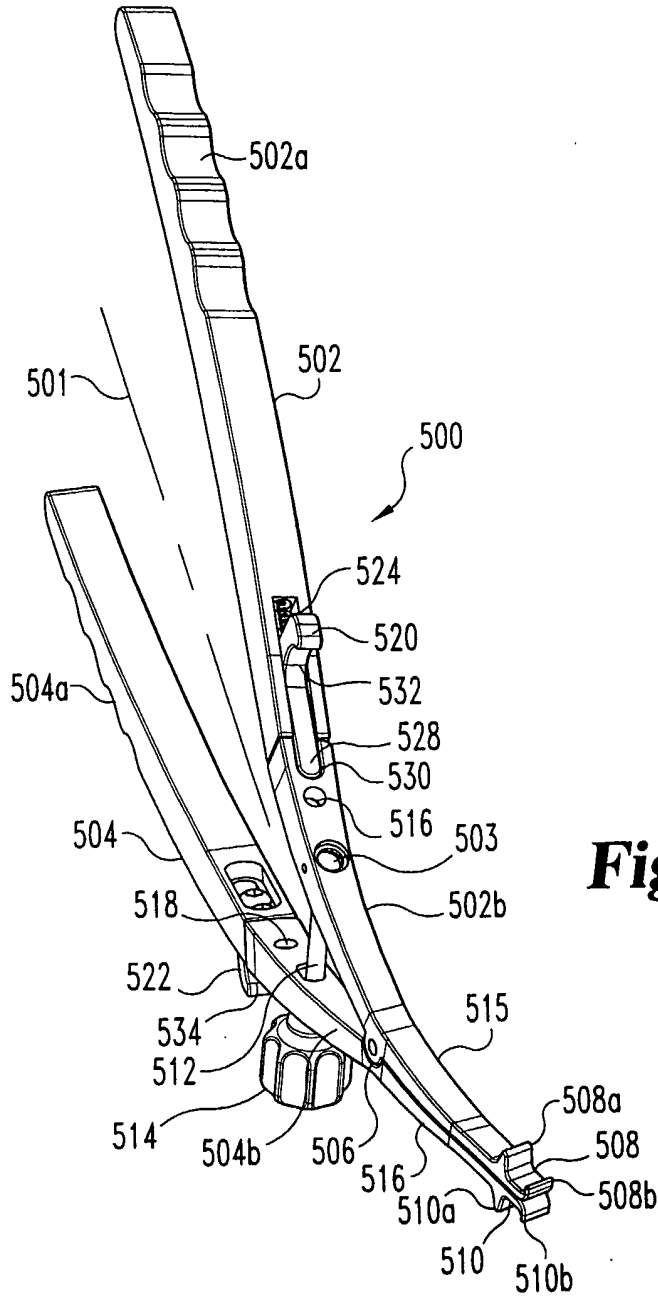


Fig. 1

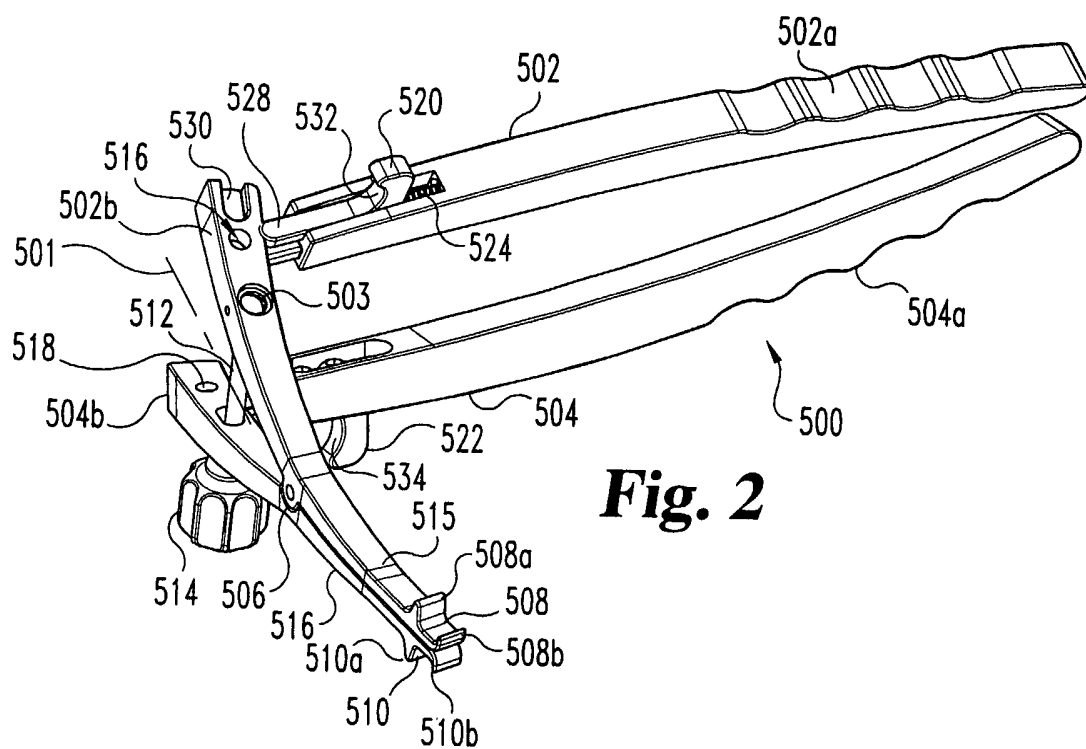


Fig. 2

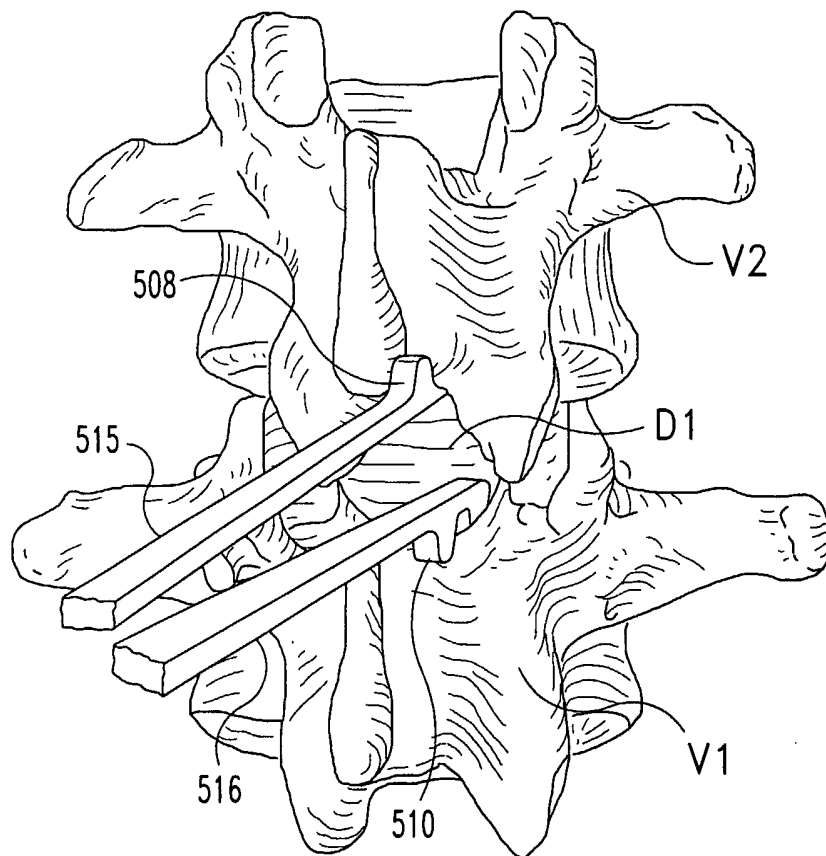


Fig. 3

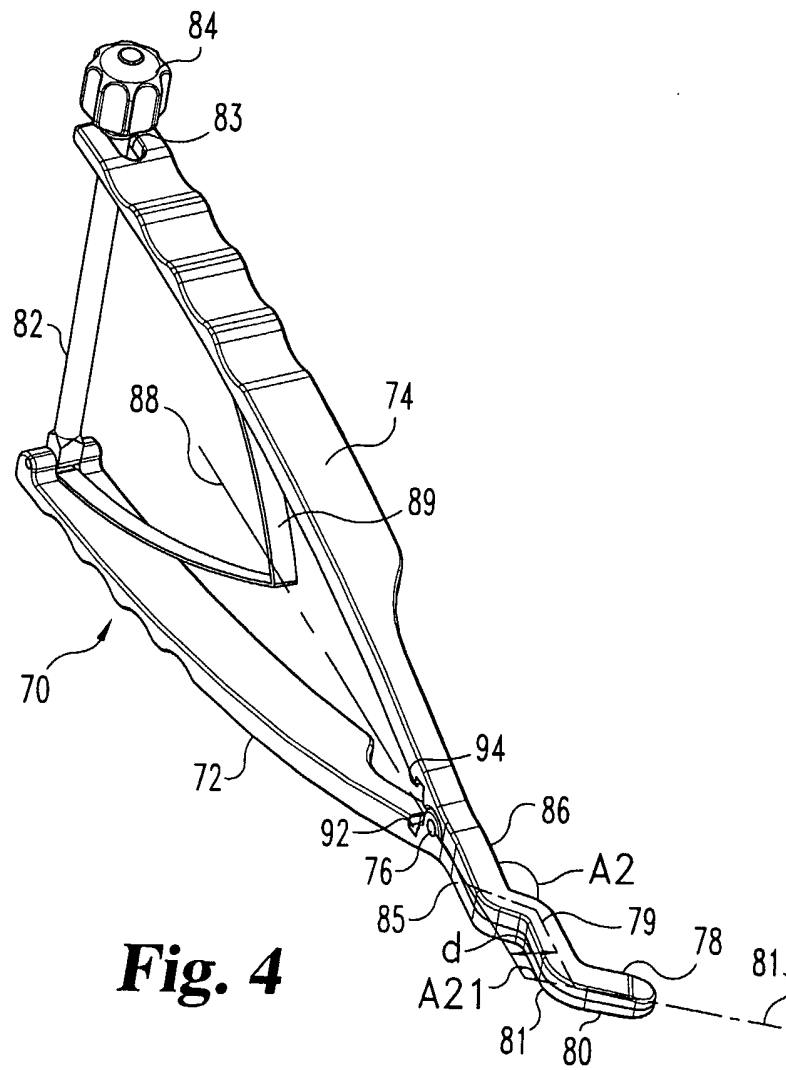


Fig. 4

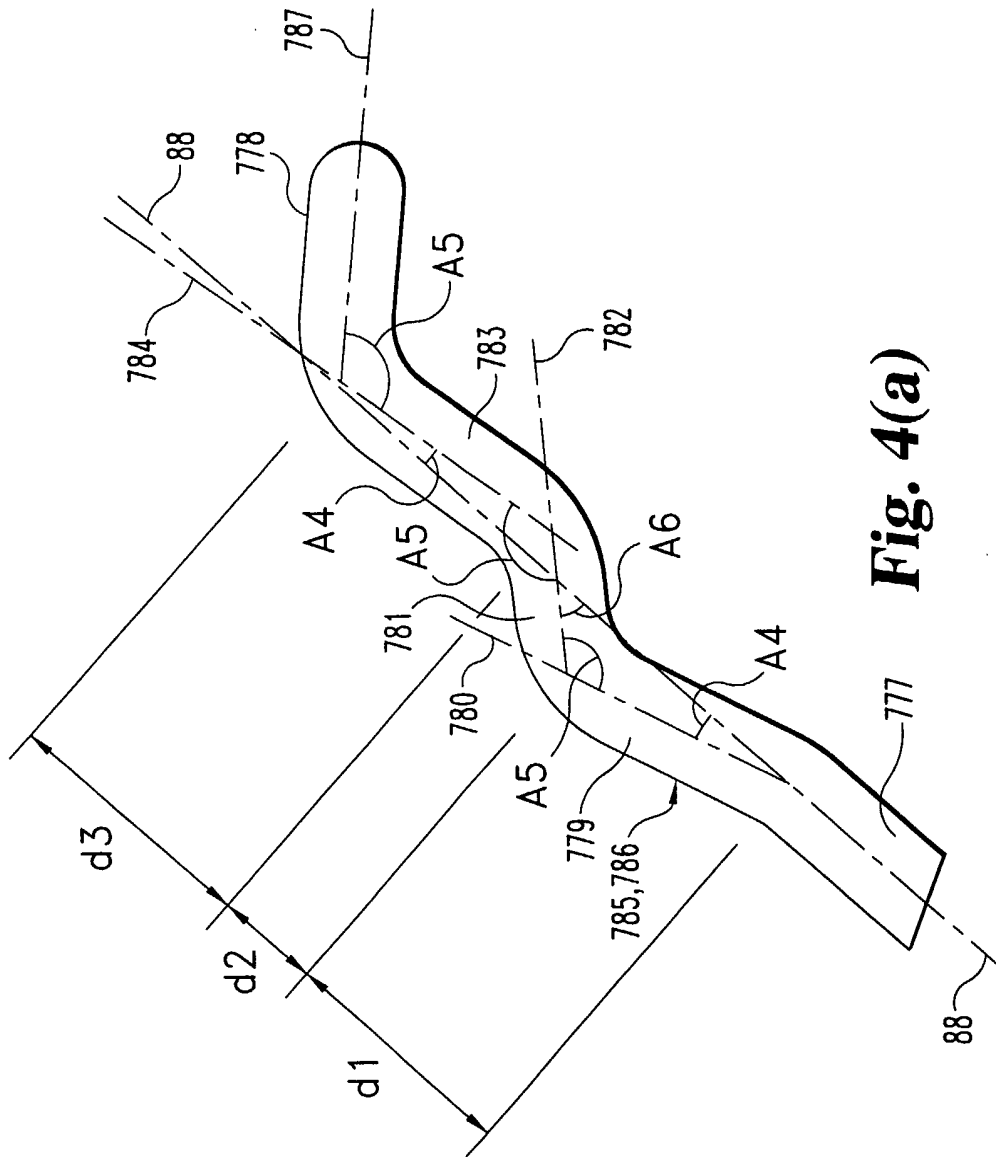
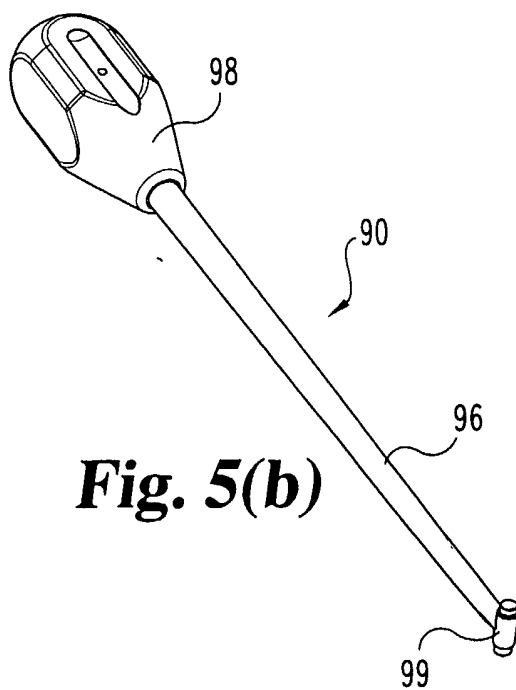
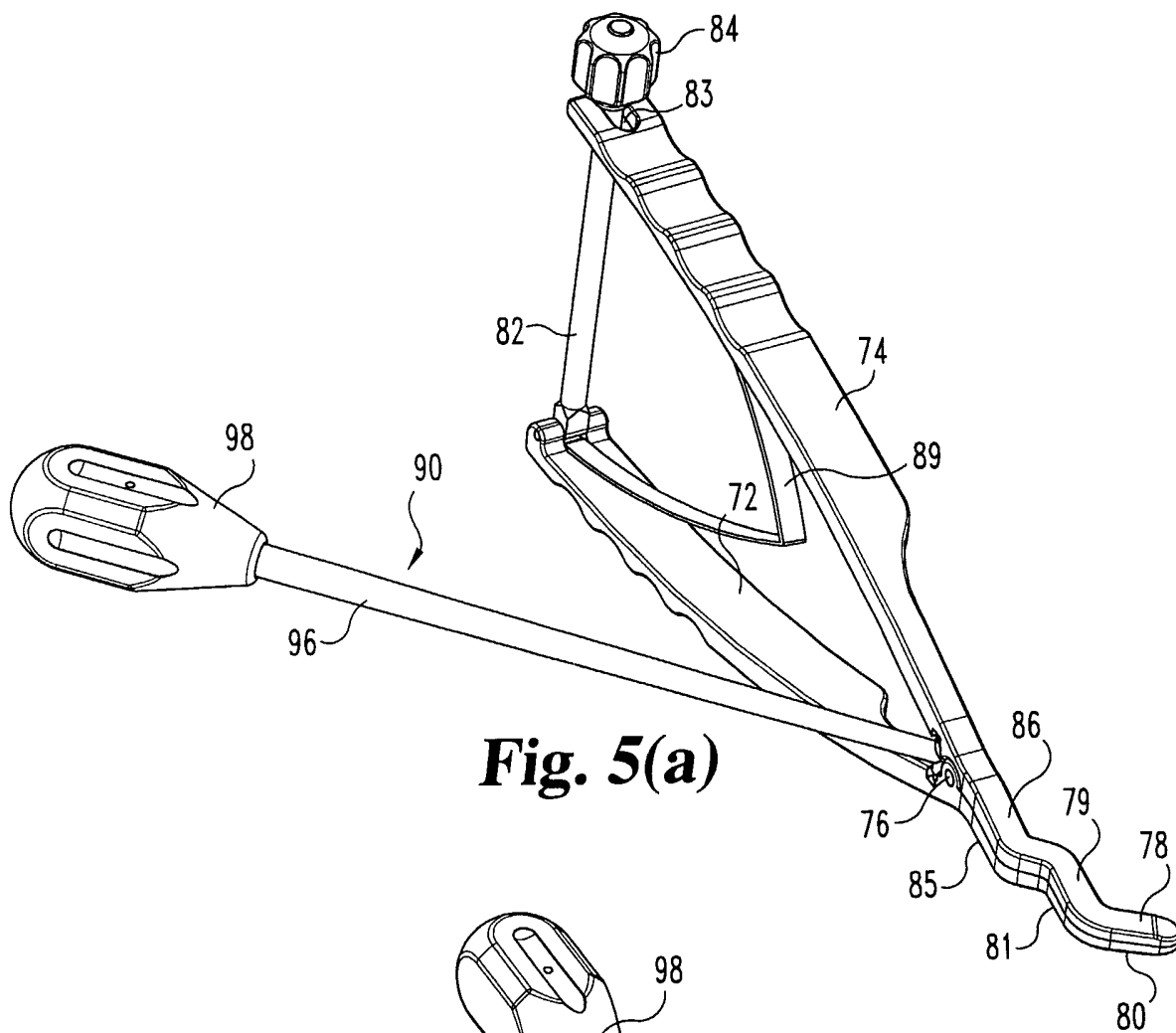


Fig. 4(a)

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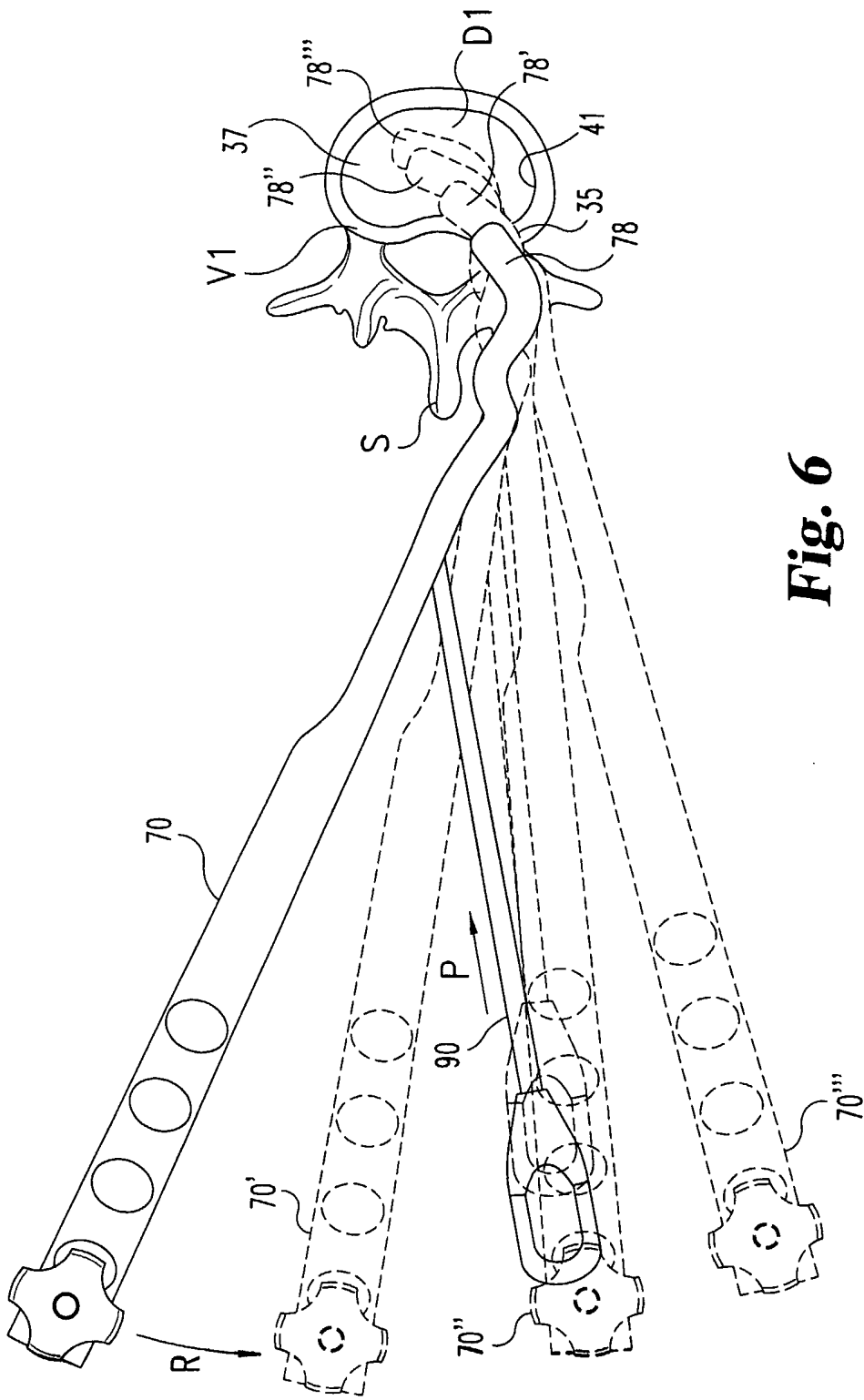


Fig. 6

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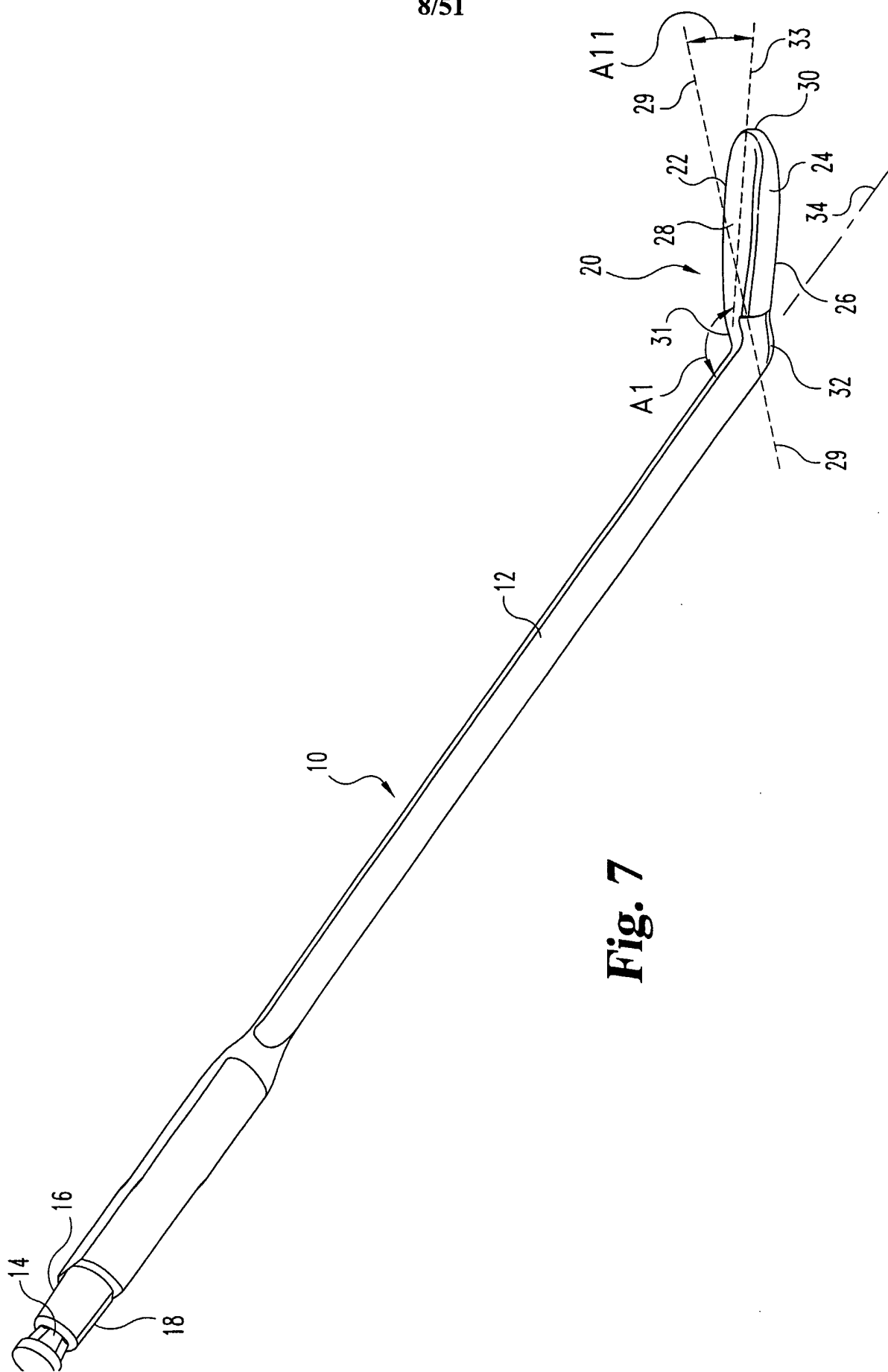


Fig. 7

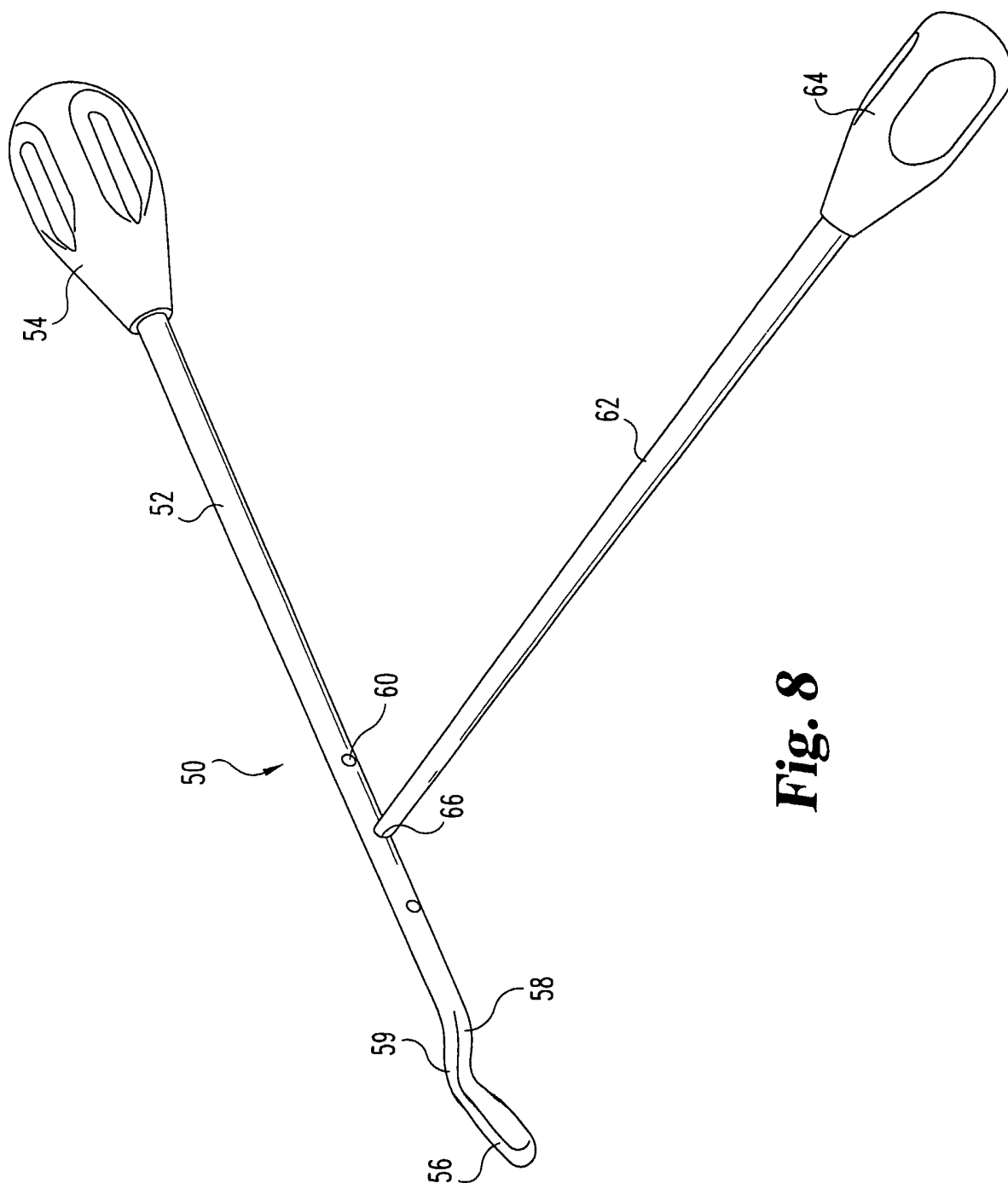


Fig. 8

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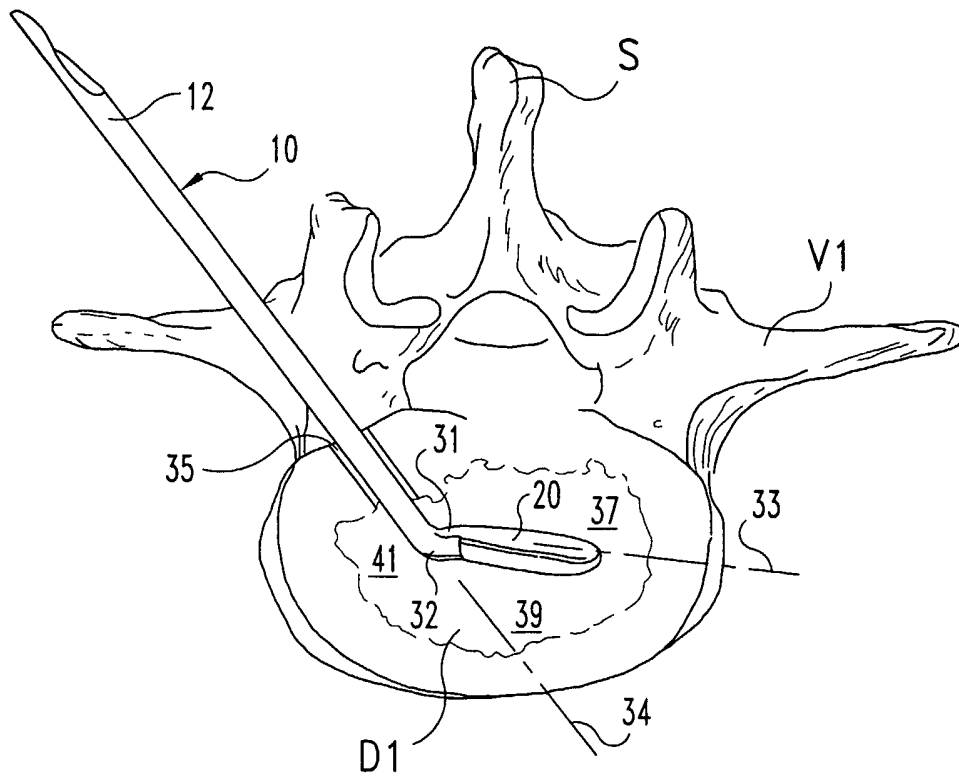


Fig. 9

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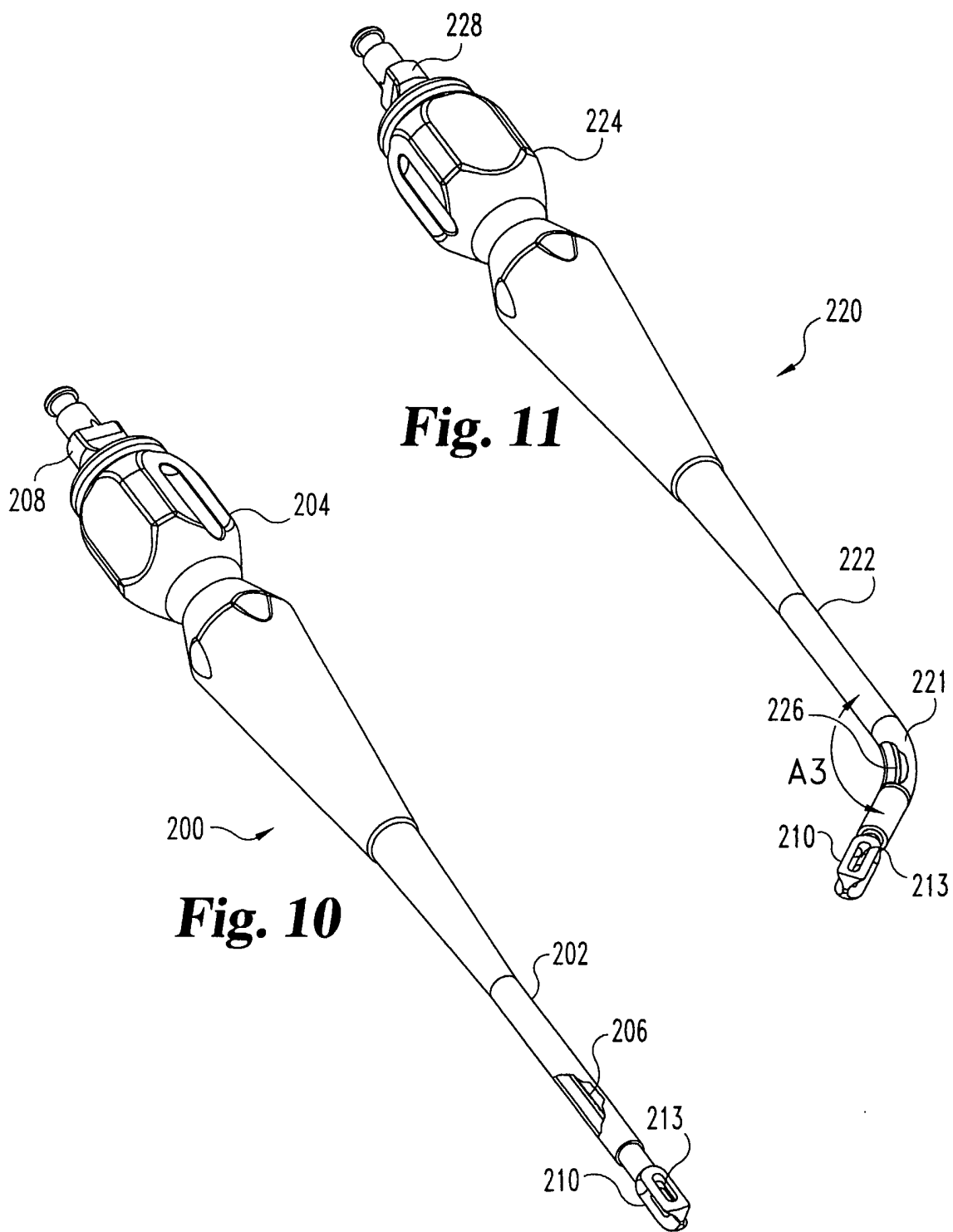


Fig. 11

Fig. 10

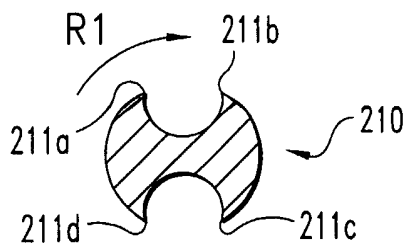


Fig. 12

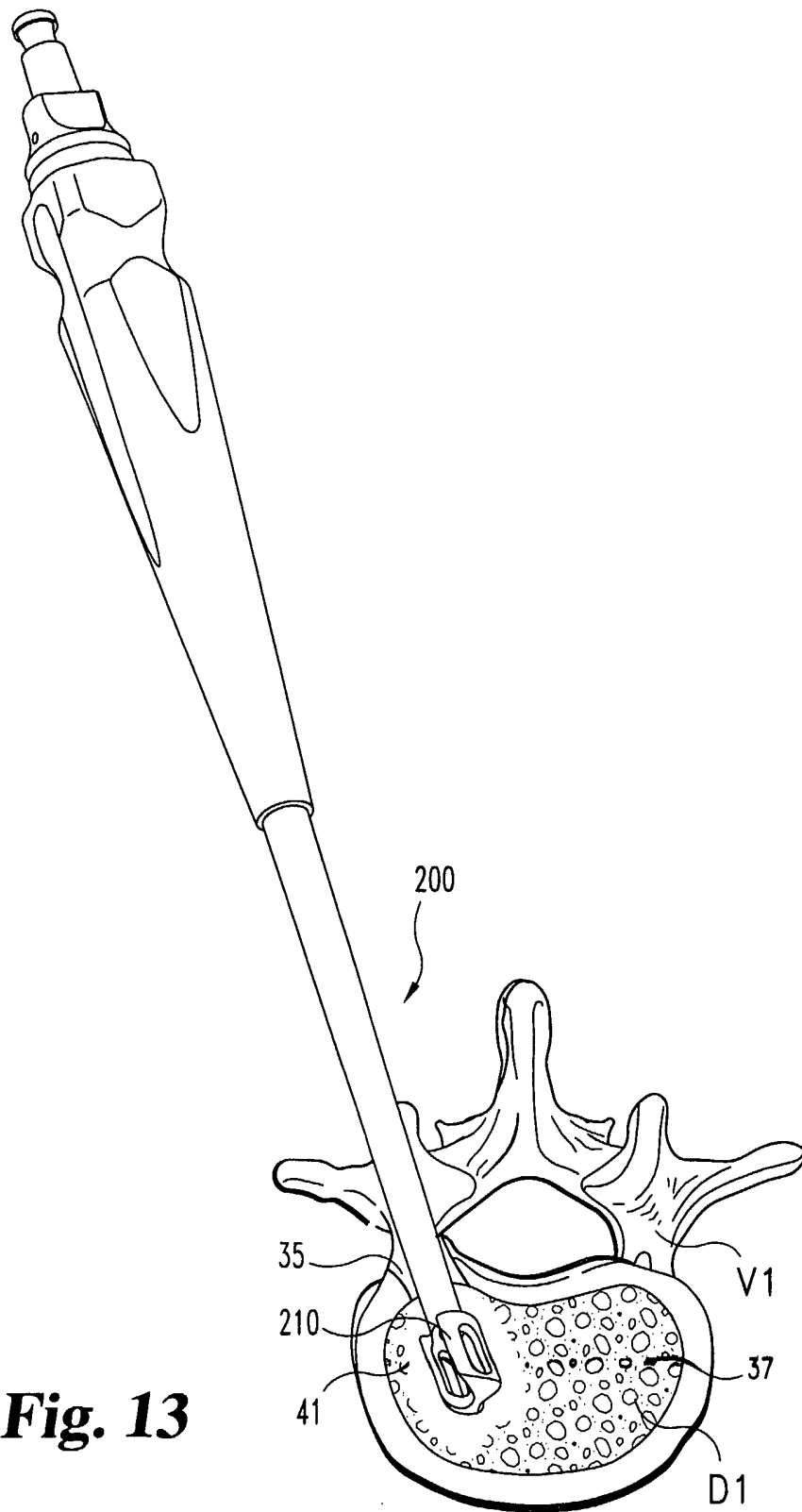


Fig. 13

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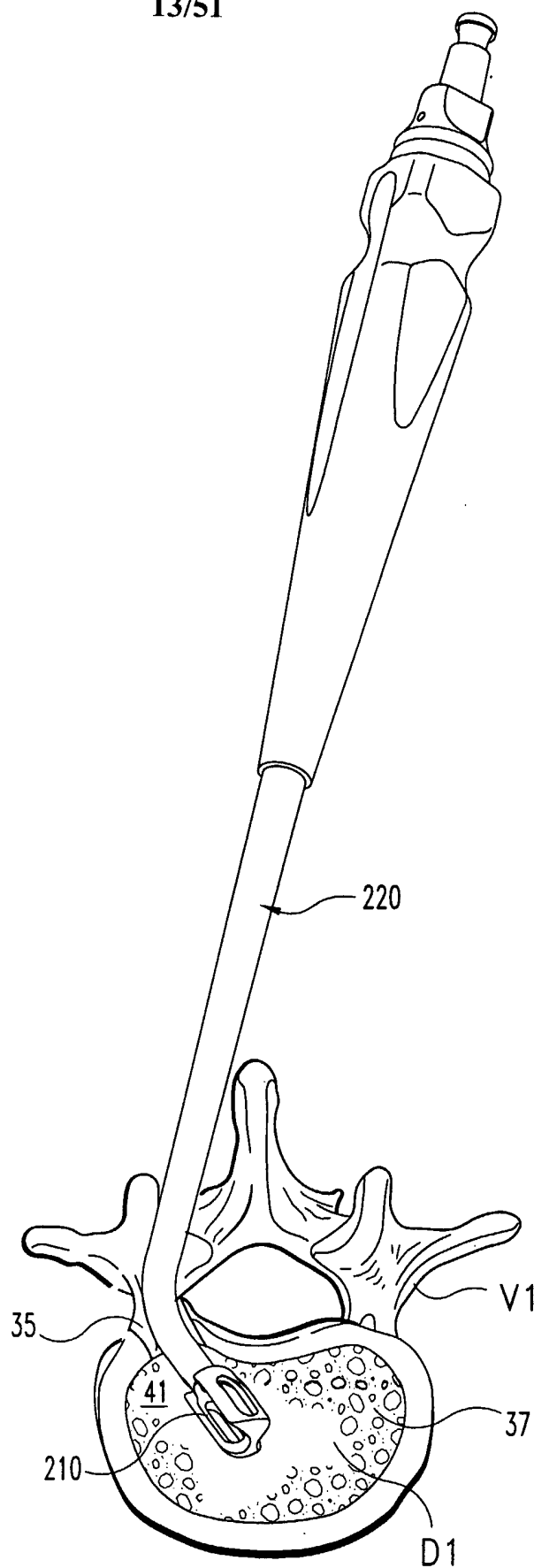


Fig. 14

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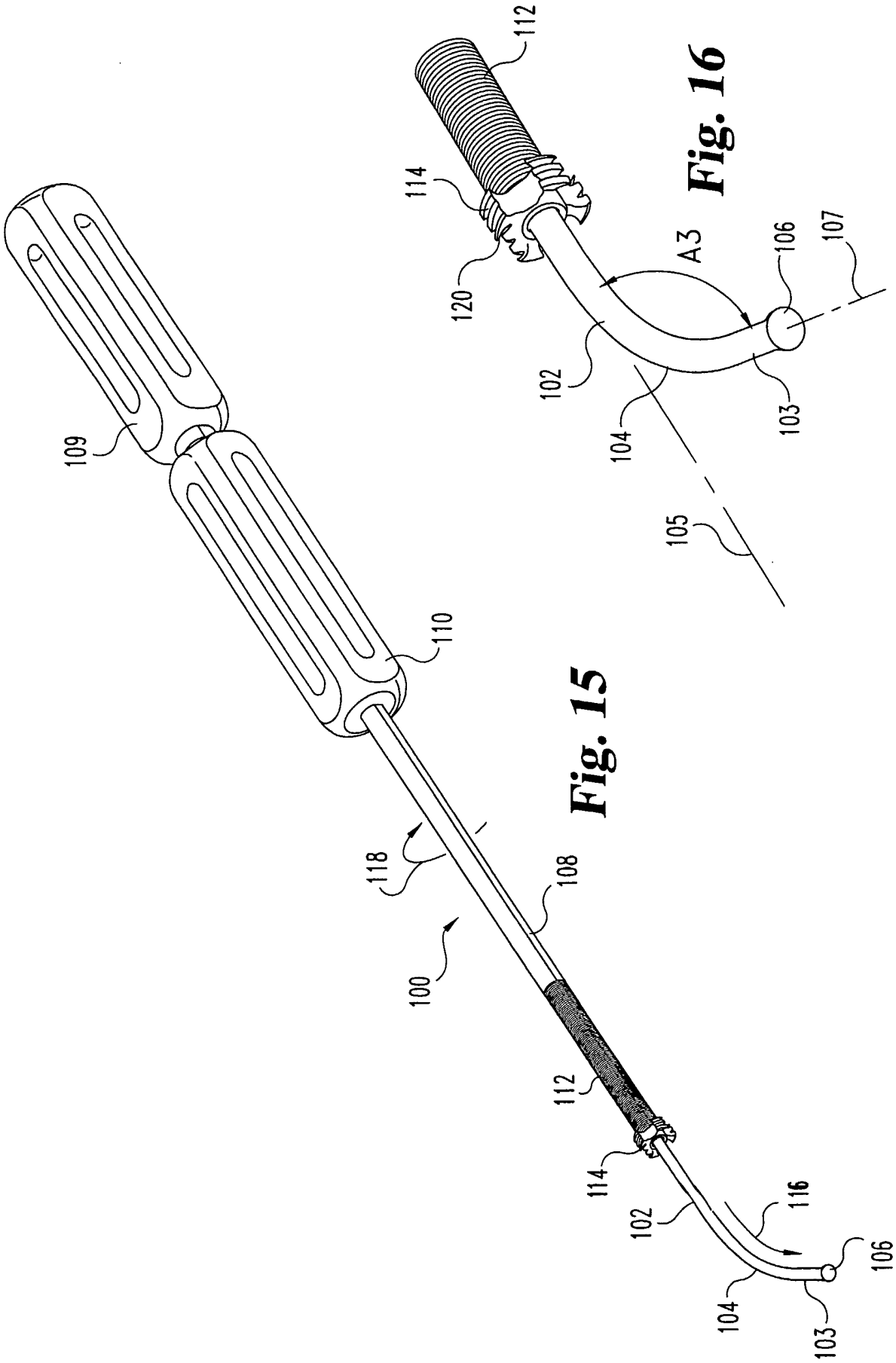


Fig. 15

Fig. 16

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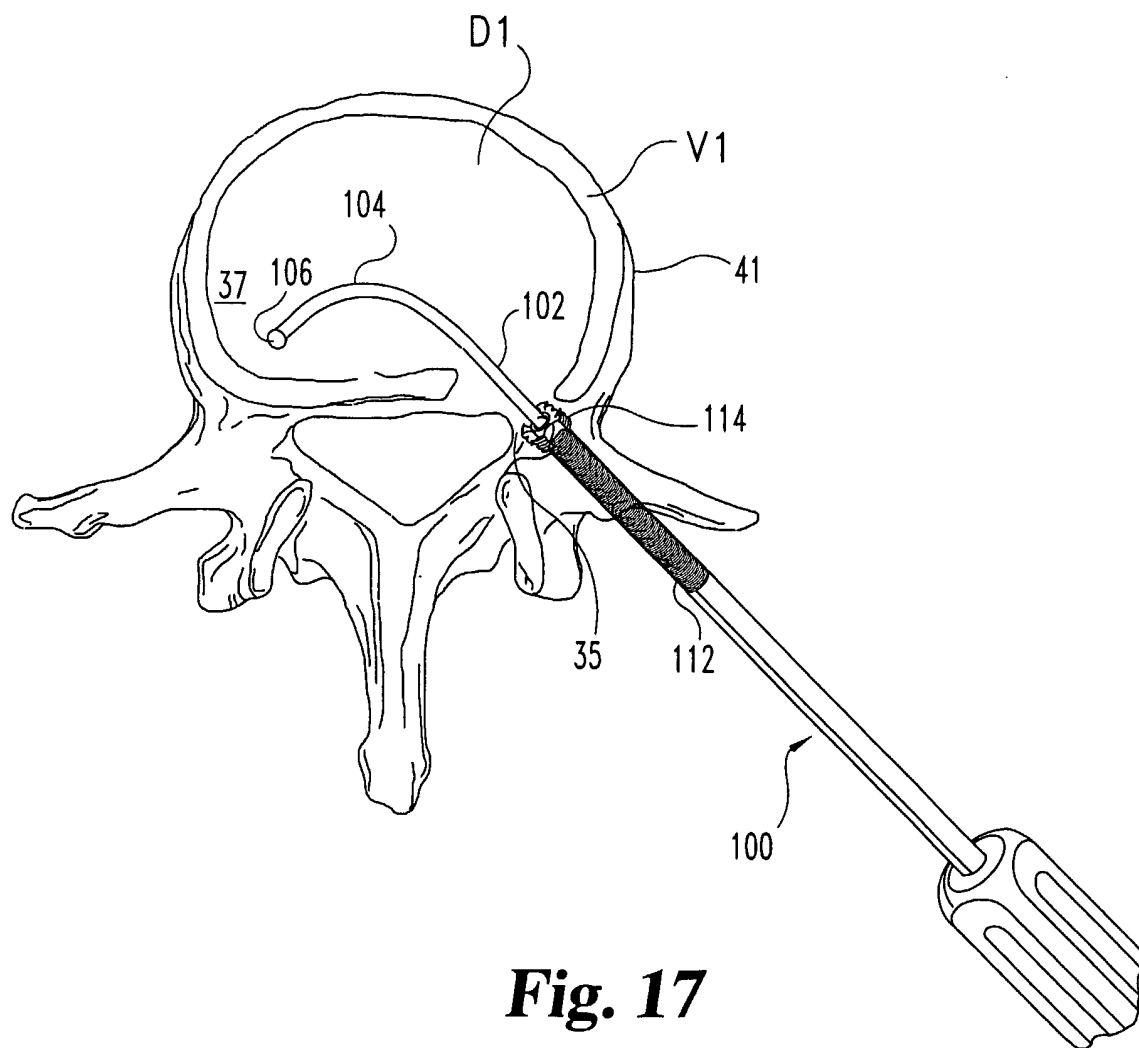
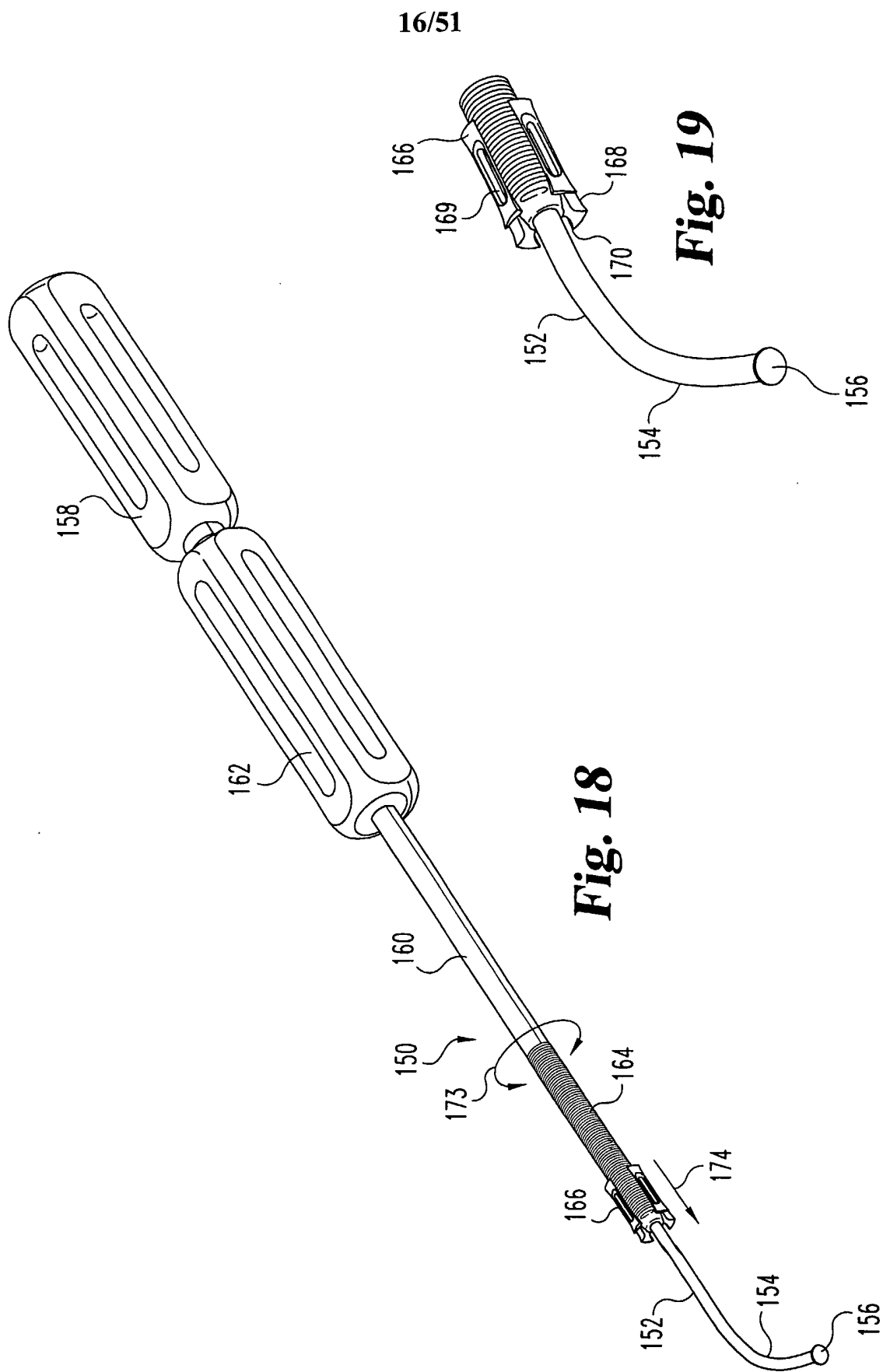


Fig. 17



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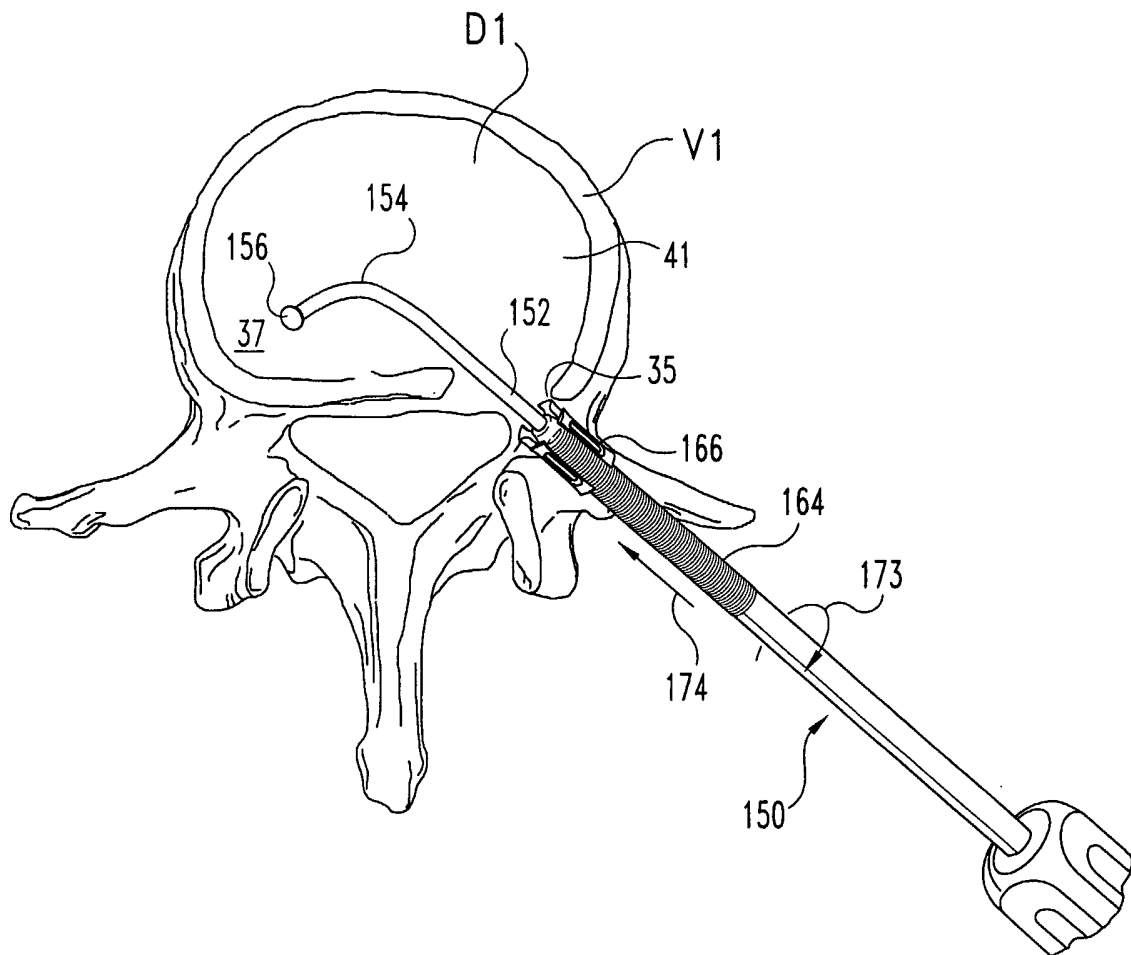


Fig. 20

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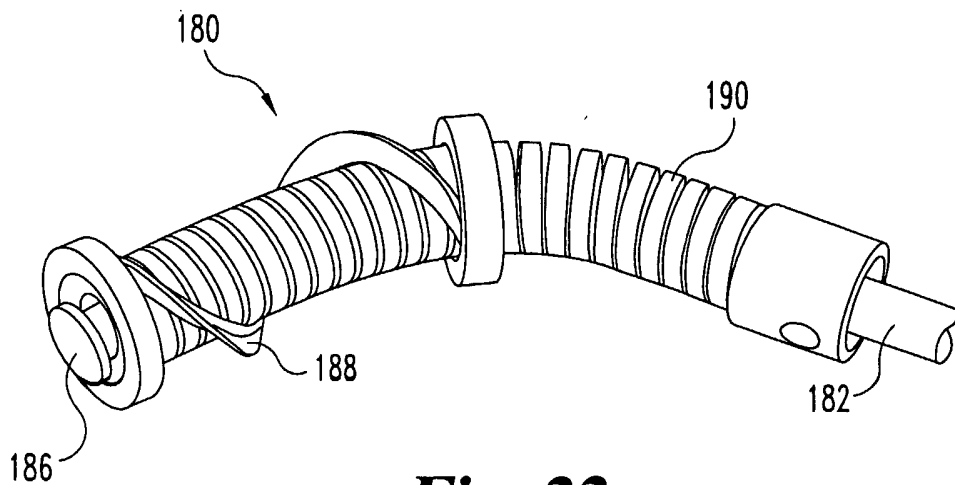
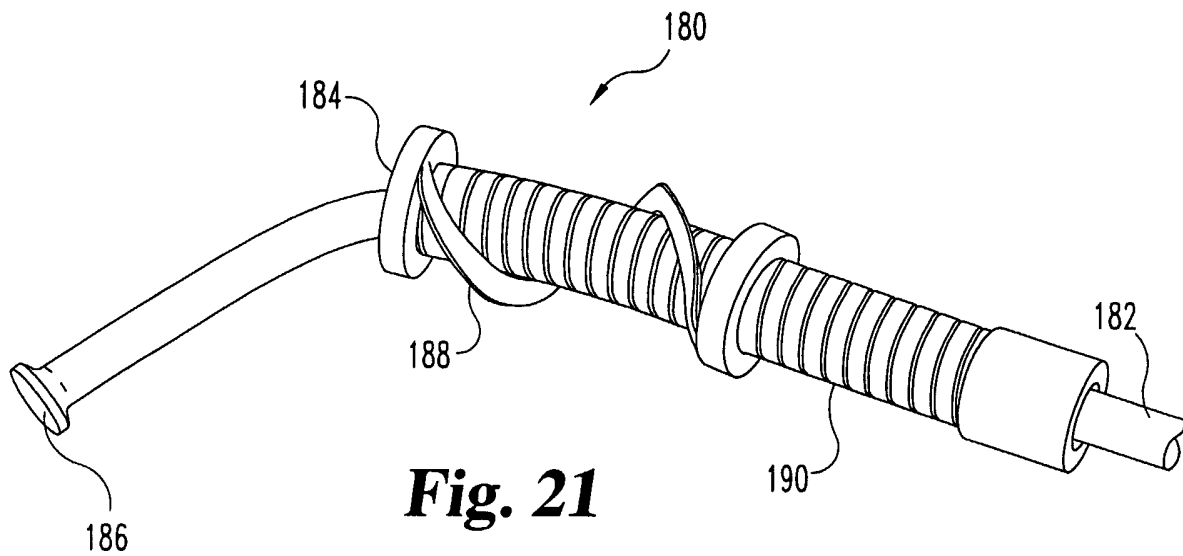


Fig. 22

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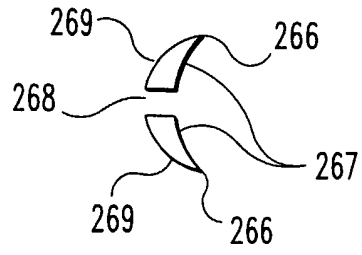
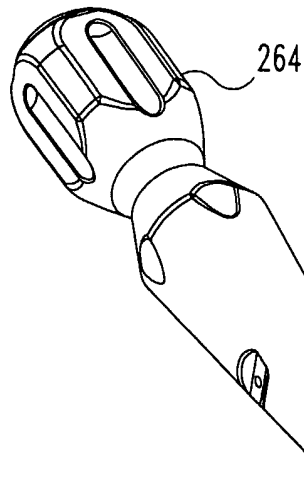


Fig. 23(a)

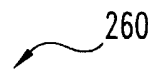


Fig. 23

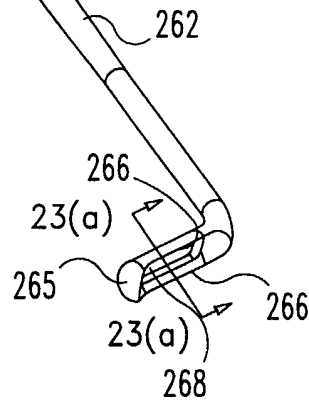
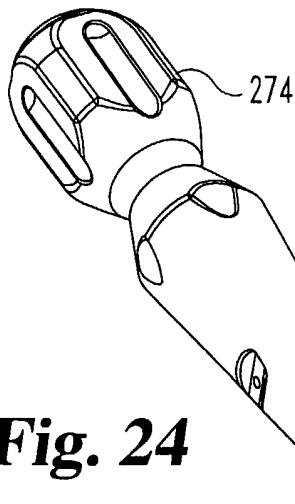


Fig. 24

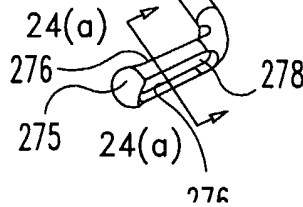
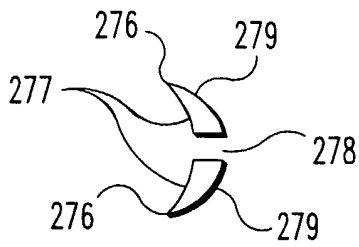


Fig. 24(a)



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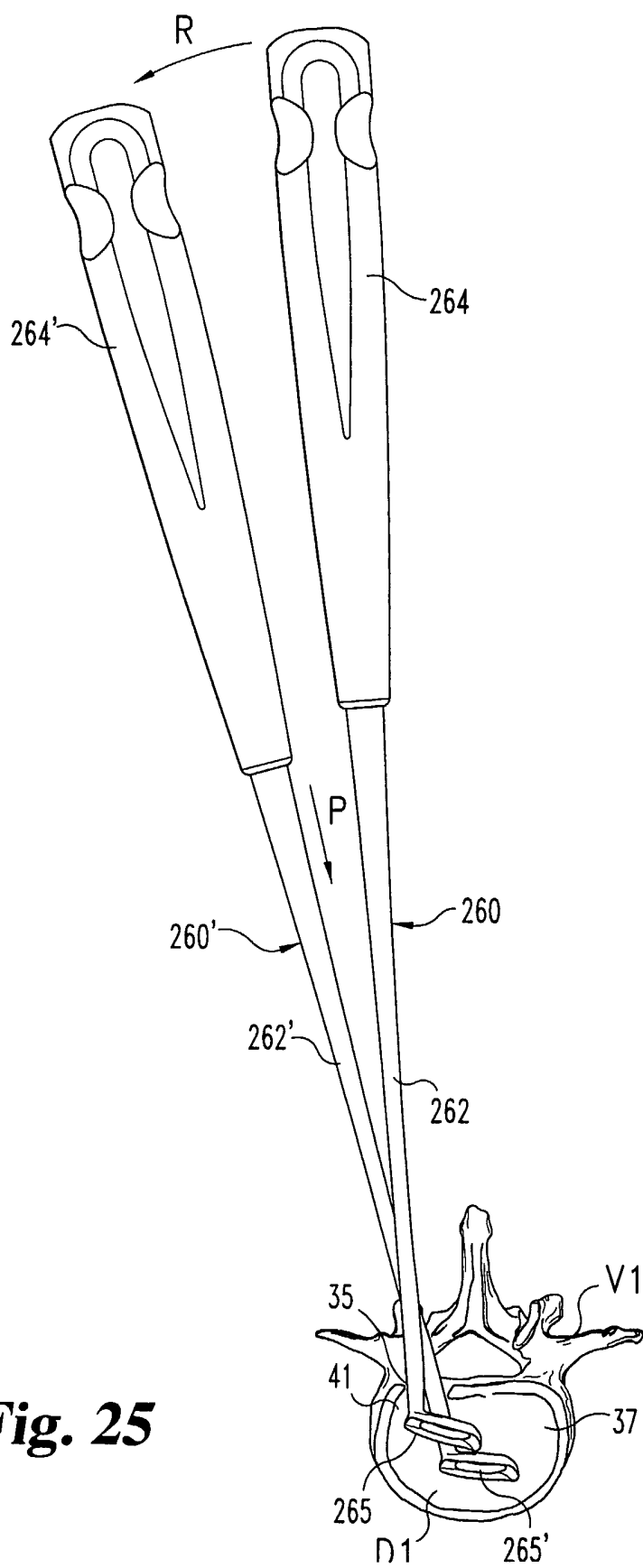


Fig. 25

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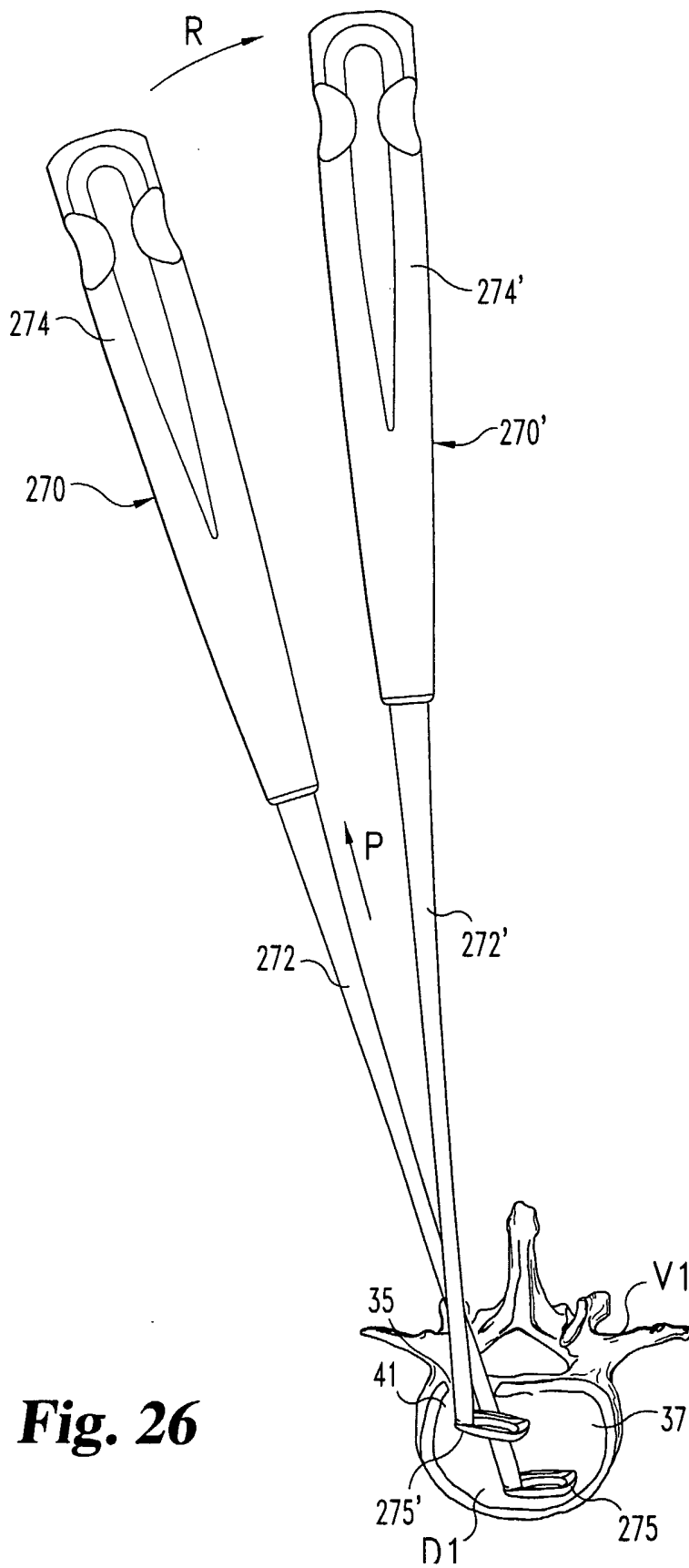


Fig. 26

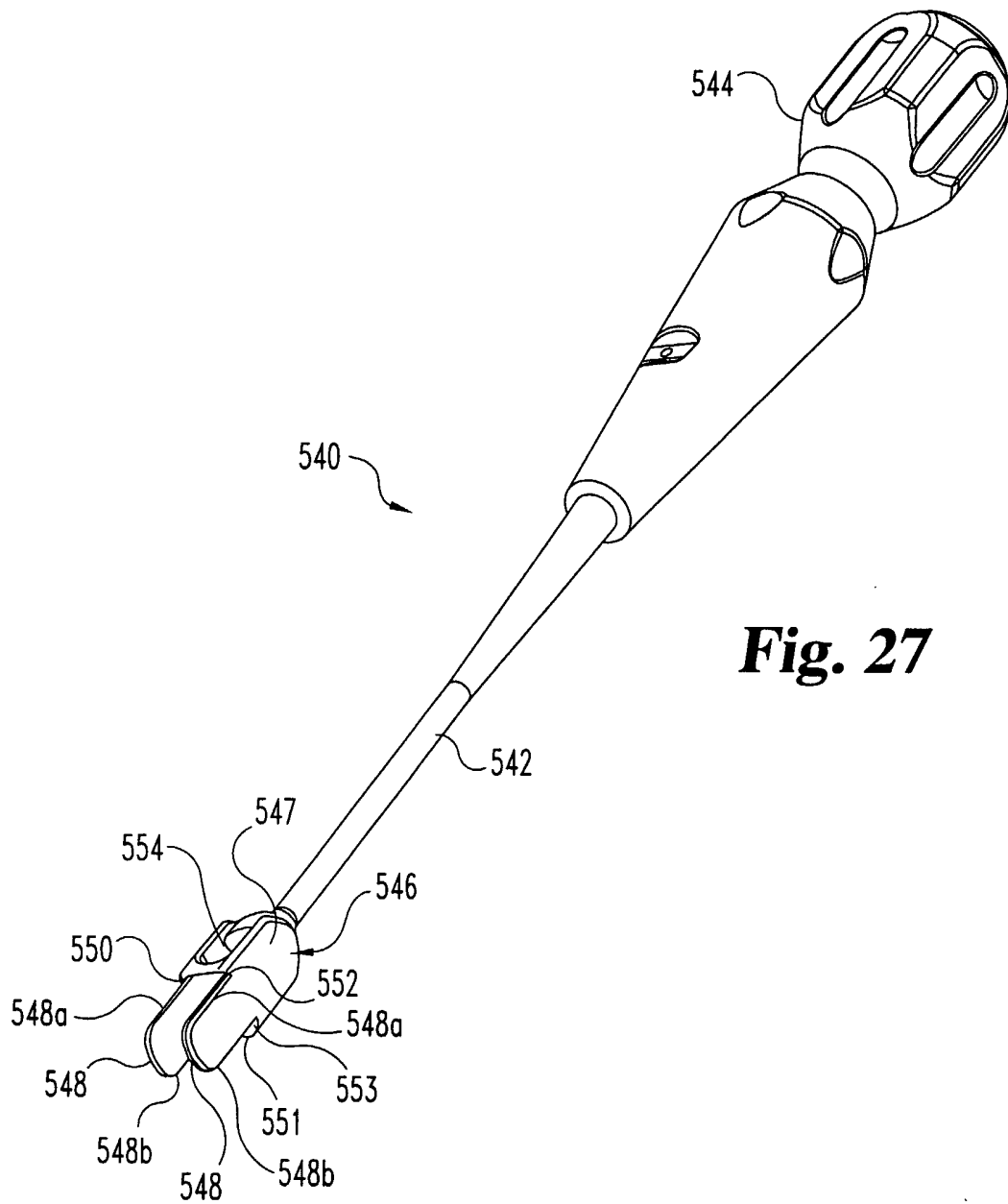


Fig. 27

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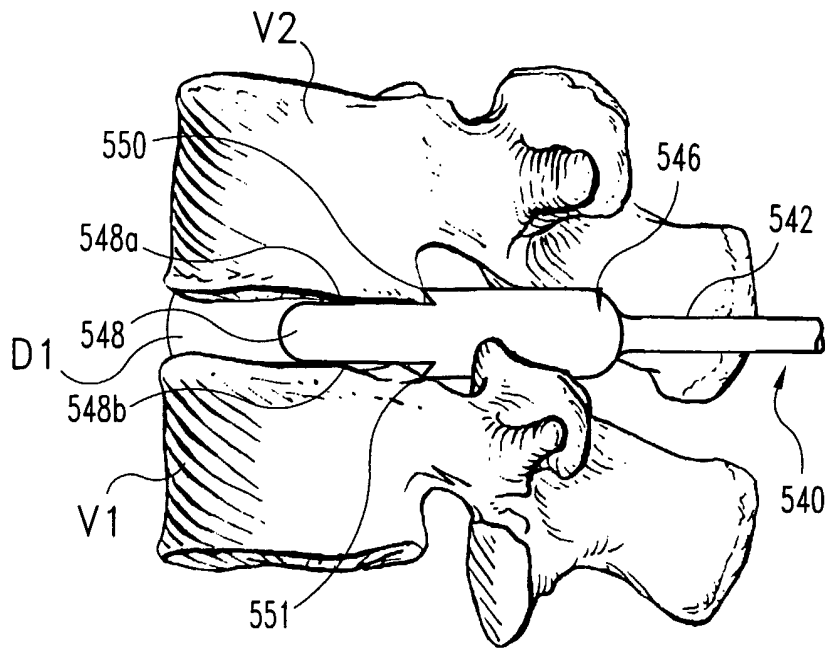


Fig. 28

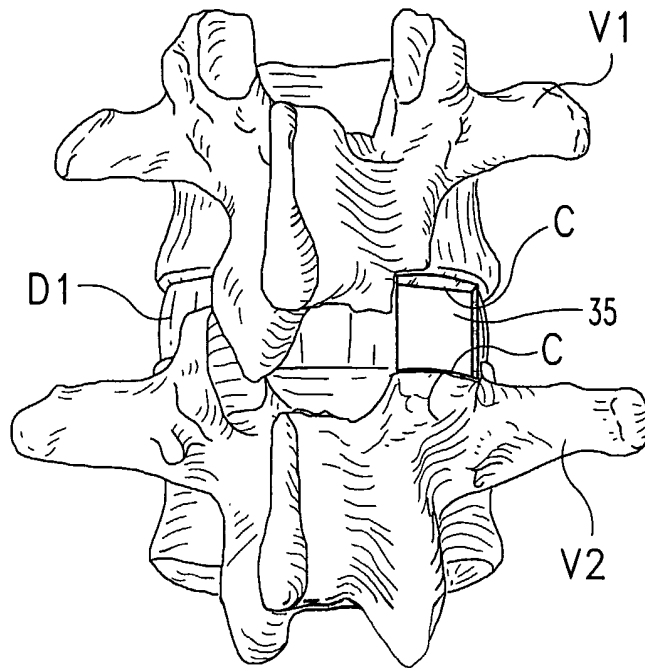


Fig. 29

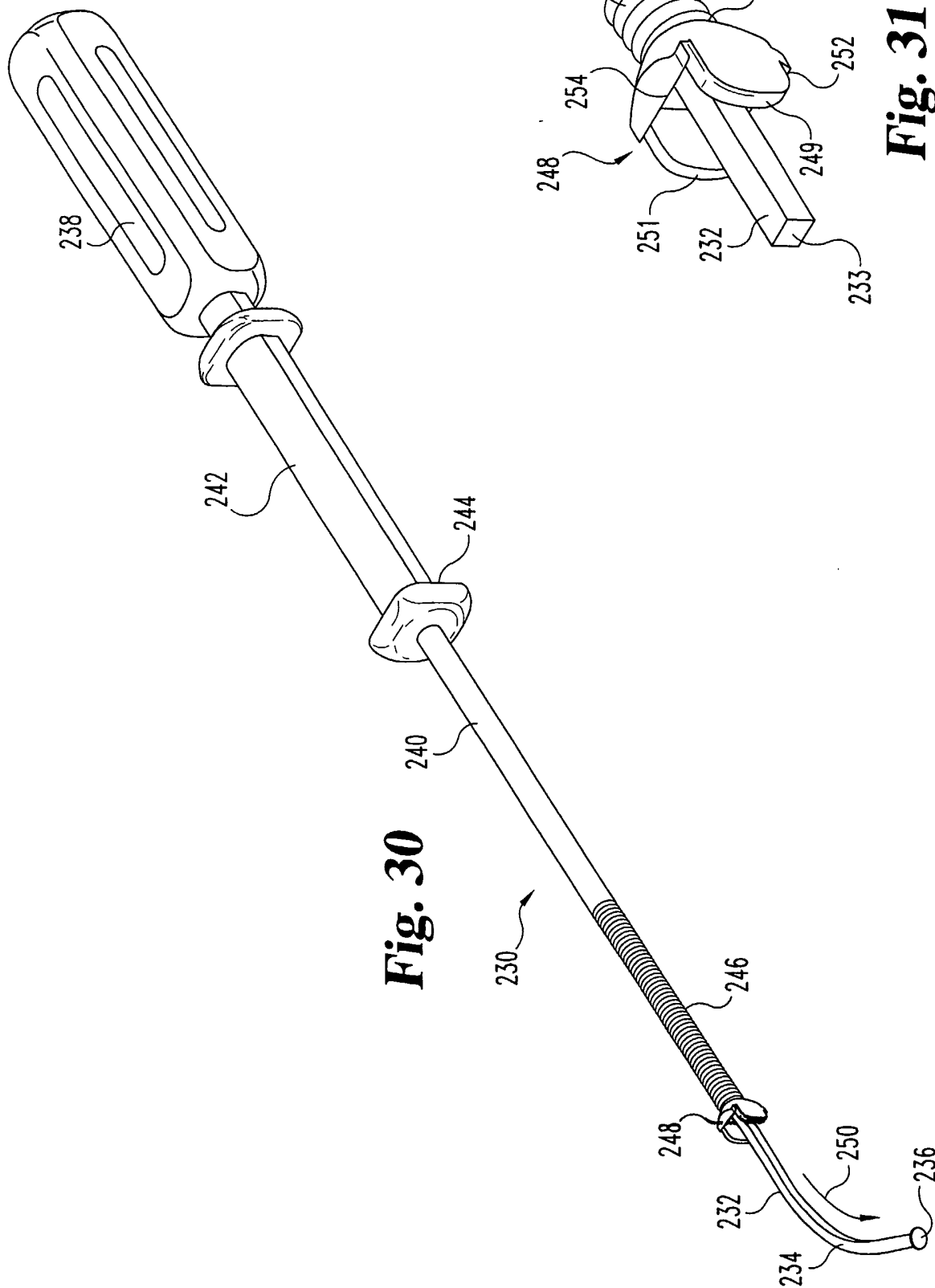


Fig. 30

Fig. 31

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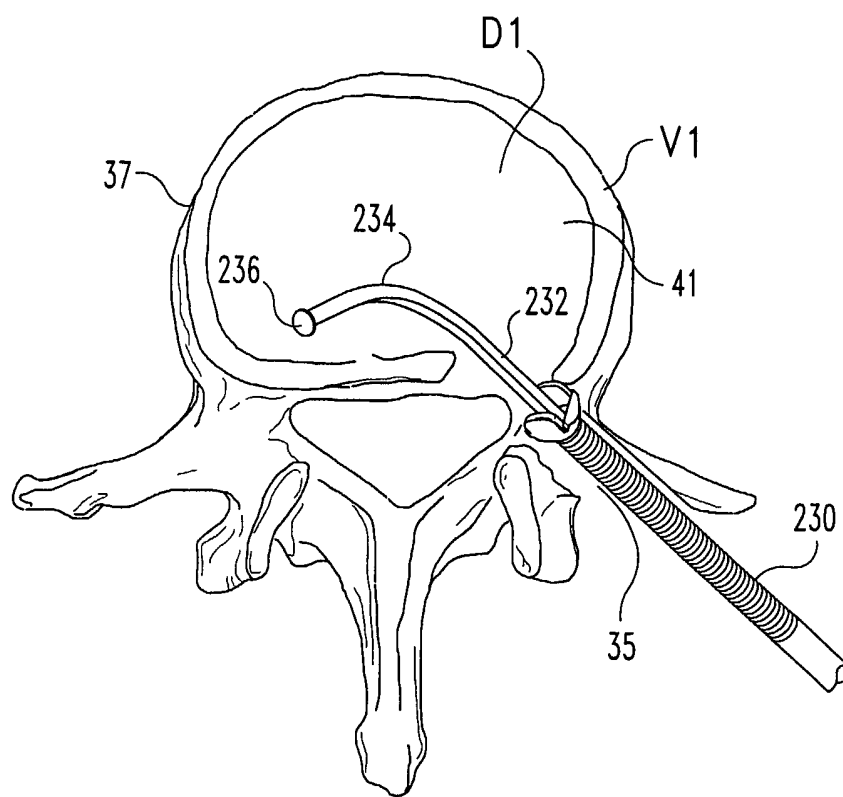
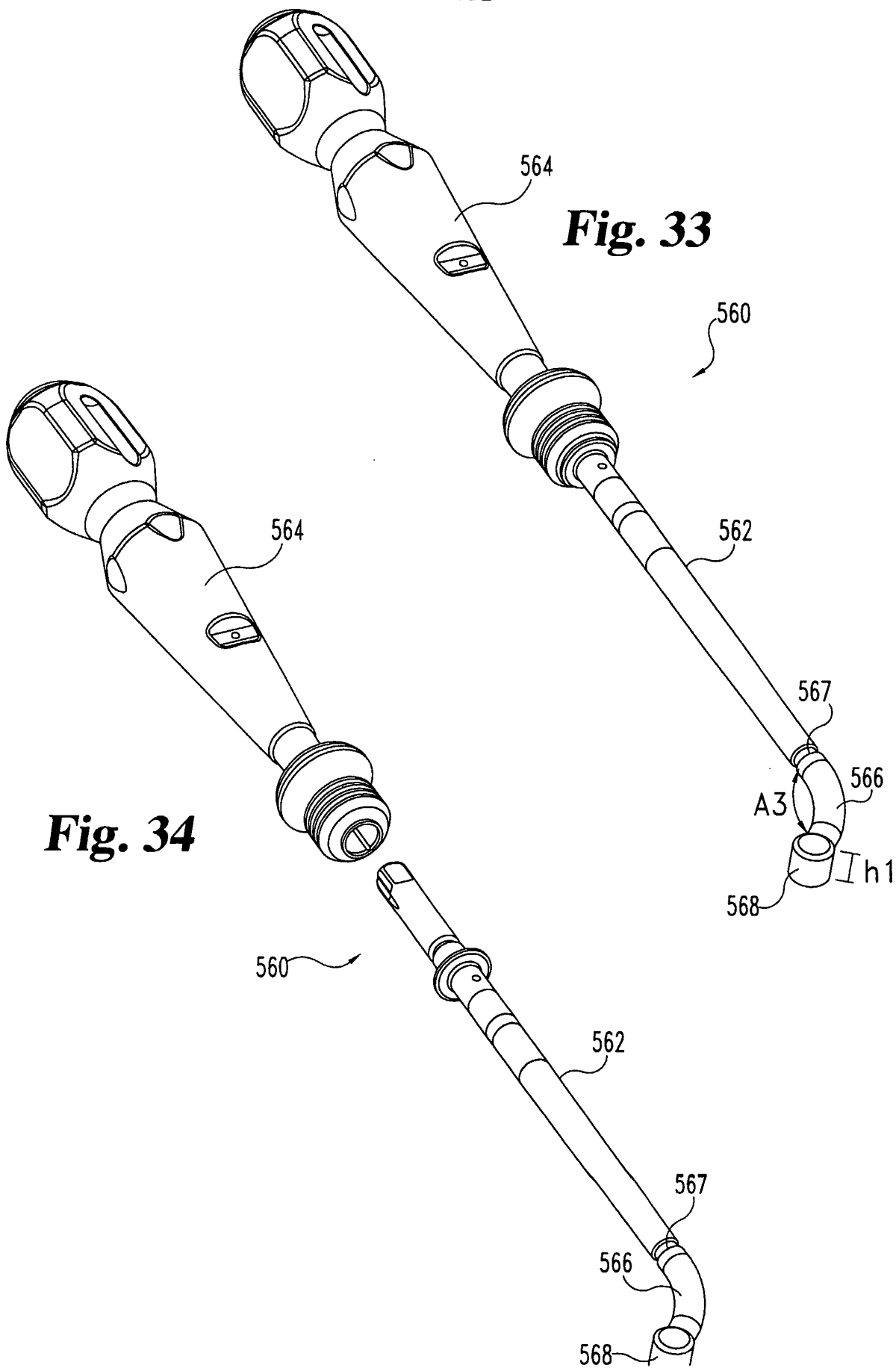


Fig. 32

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Fig. 33



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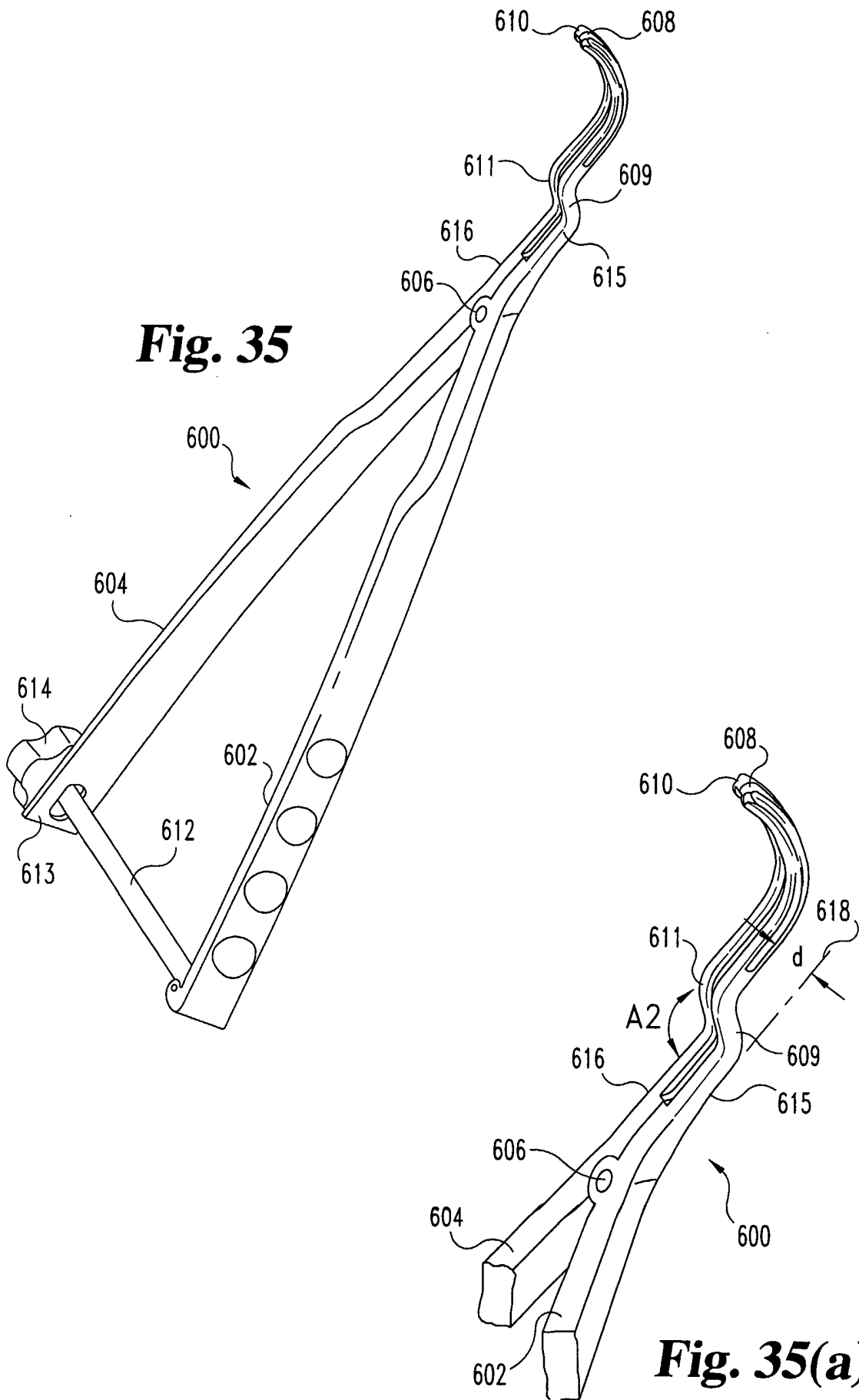


Fig. 35

Fig. 35(a)

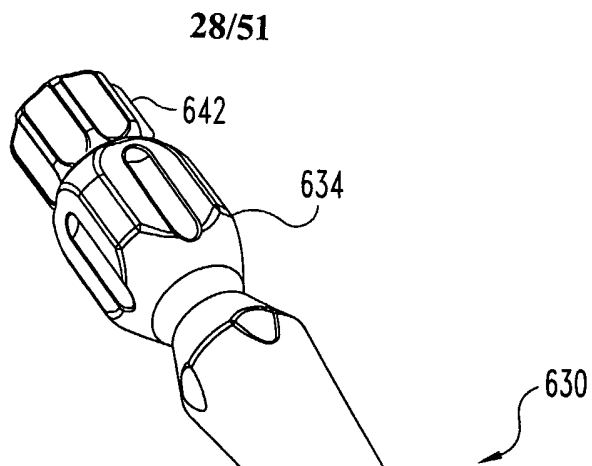


Fig. 36

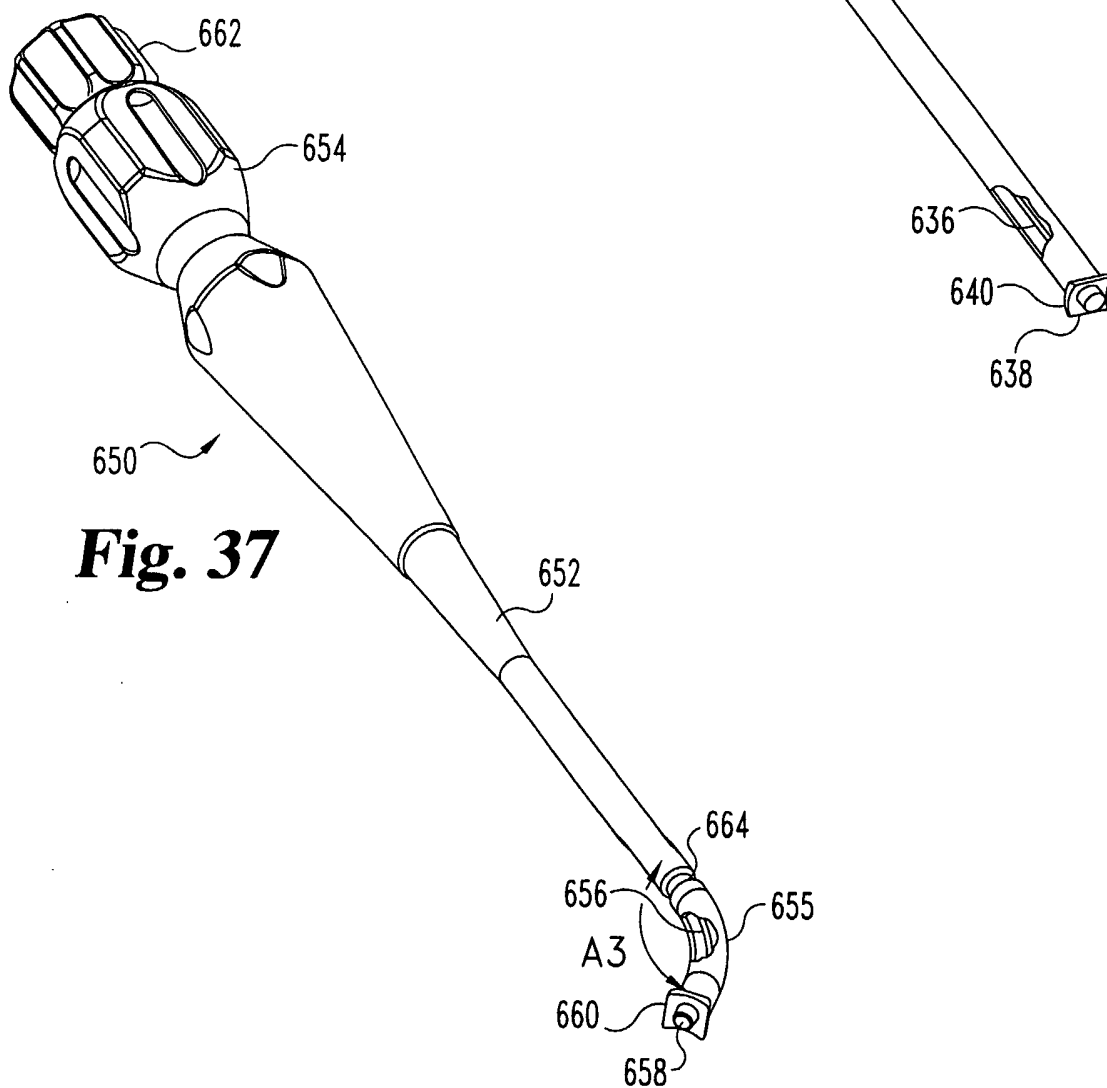
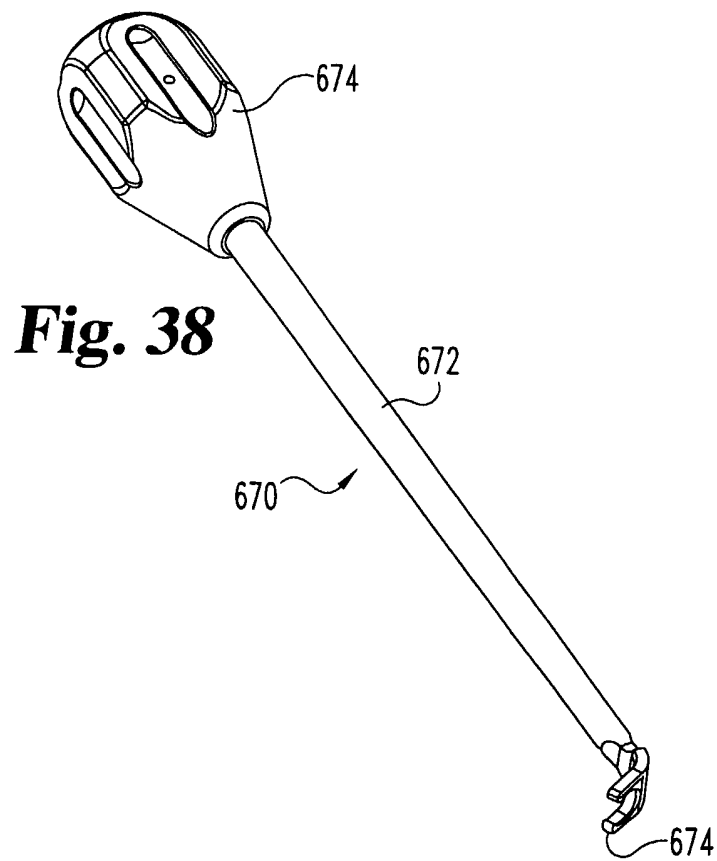


Fig. 37



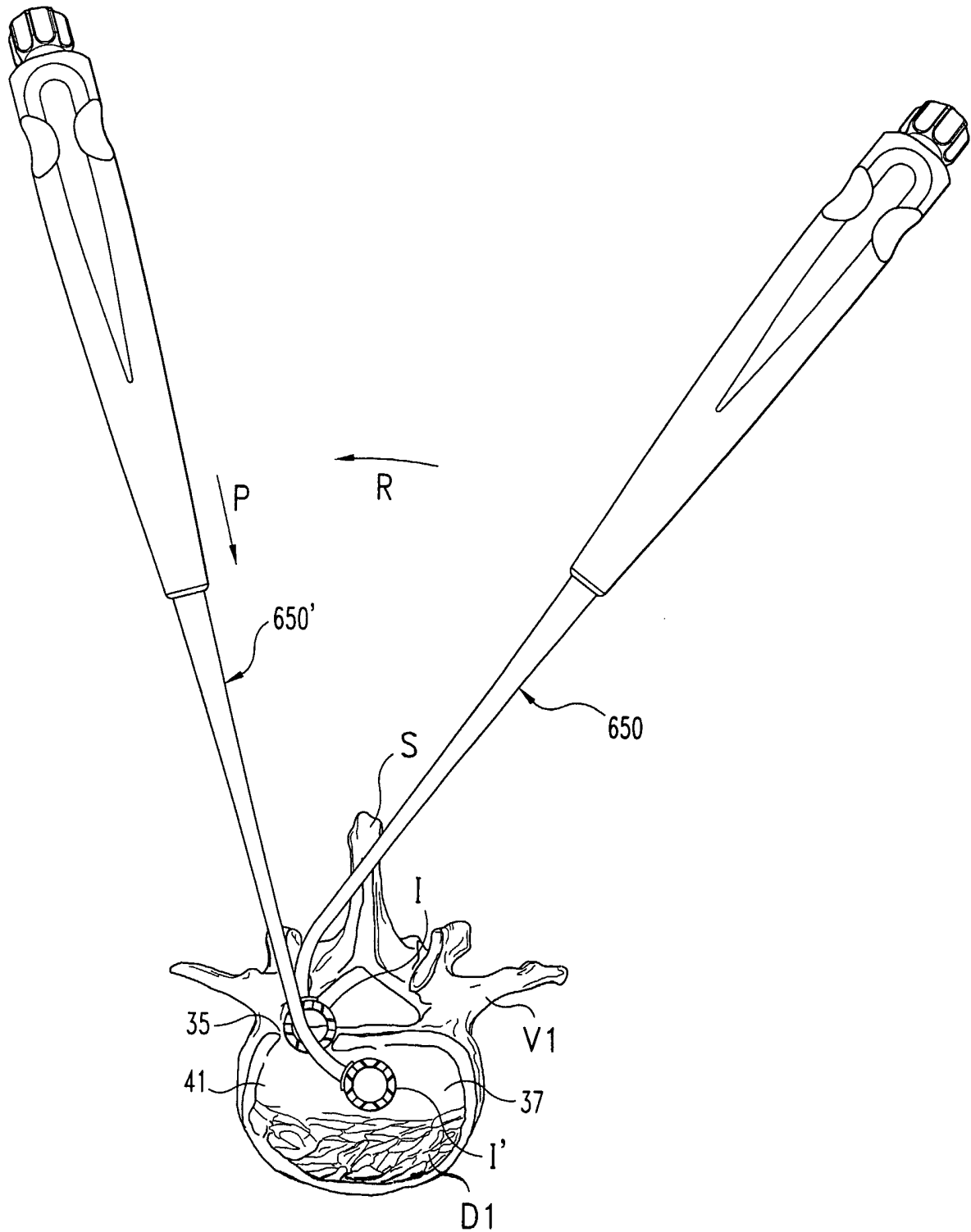
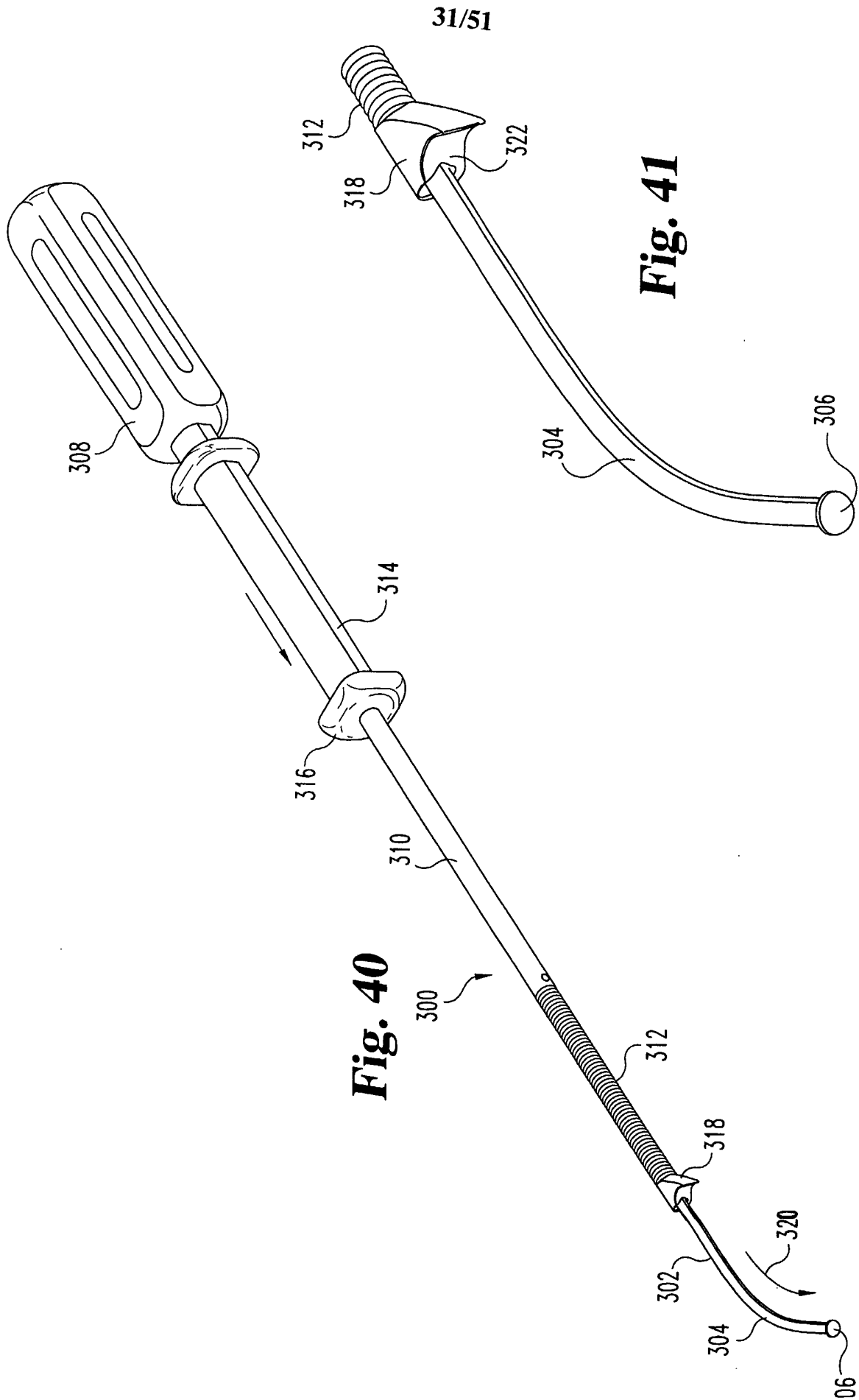


Fig. 39



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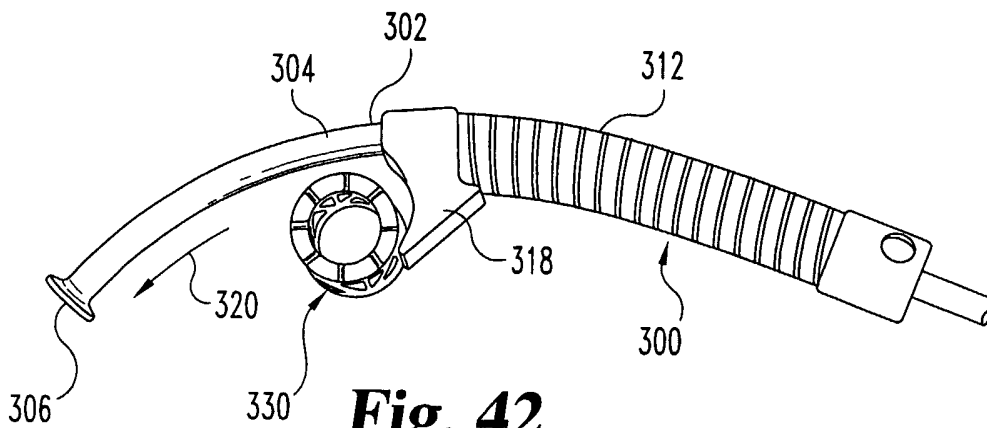


Fig. 42

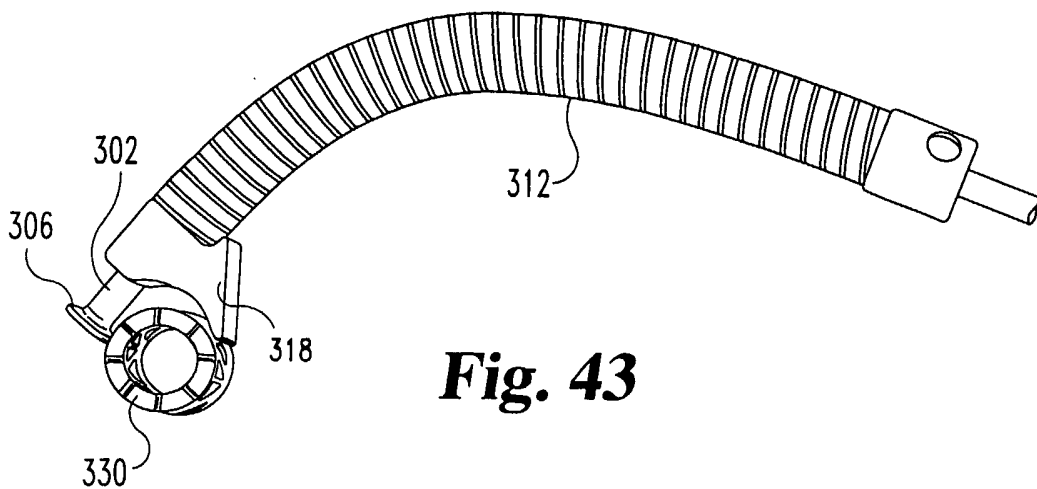


Fig. 43

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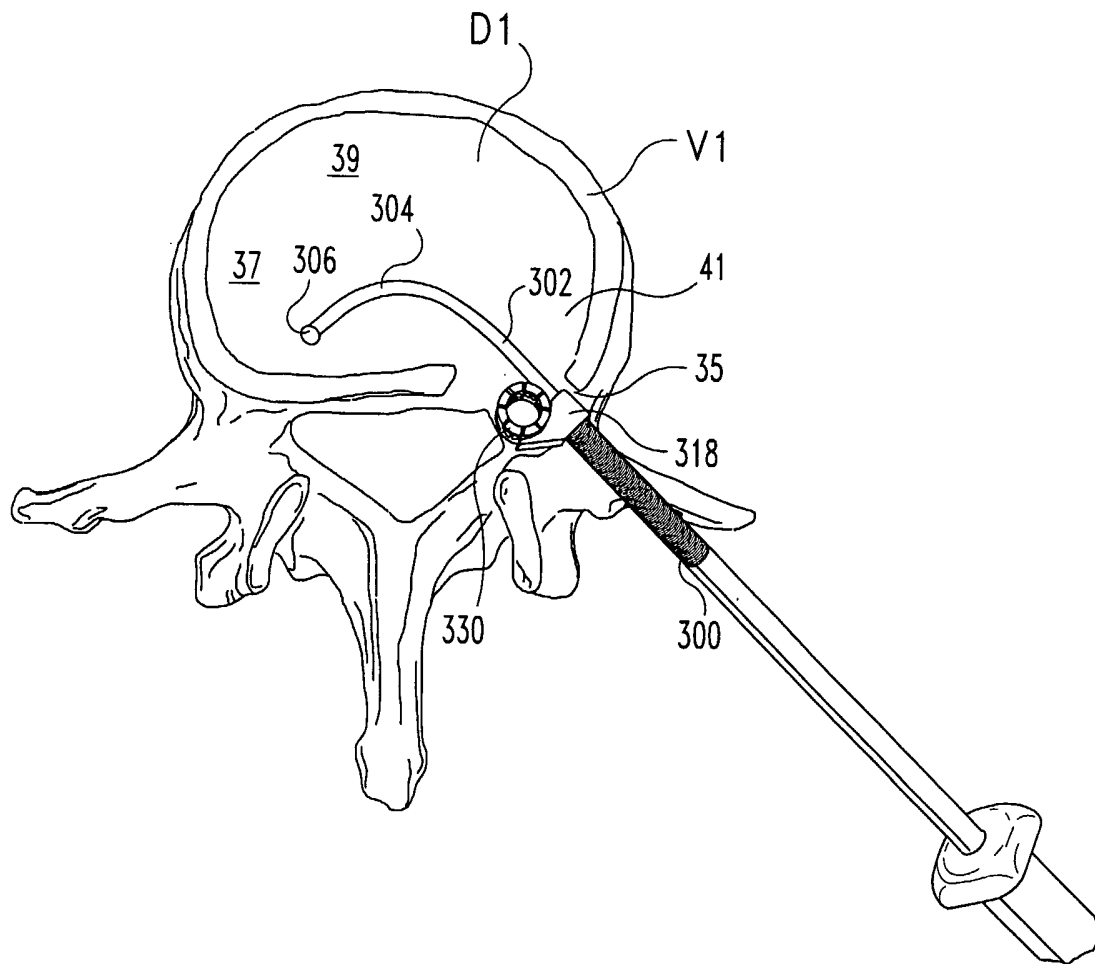


Fig. 44

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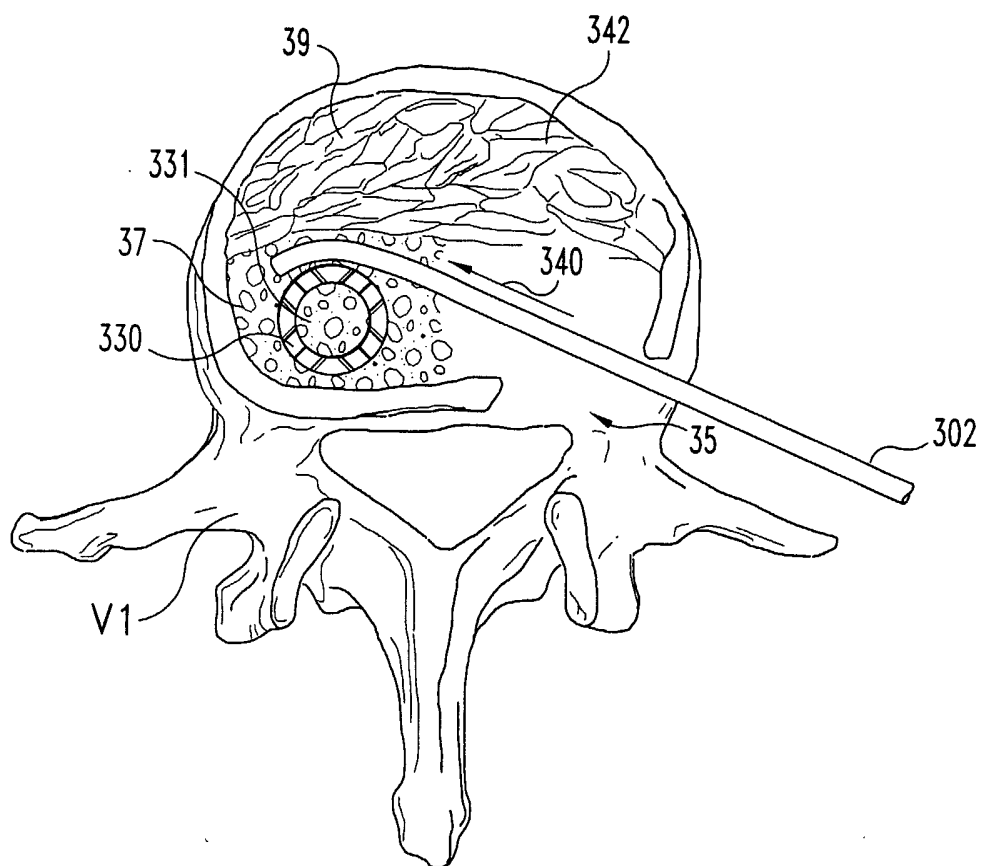


Fig. 45

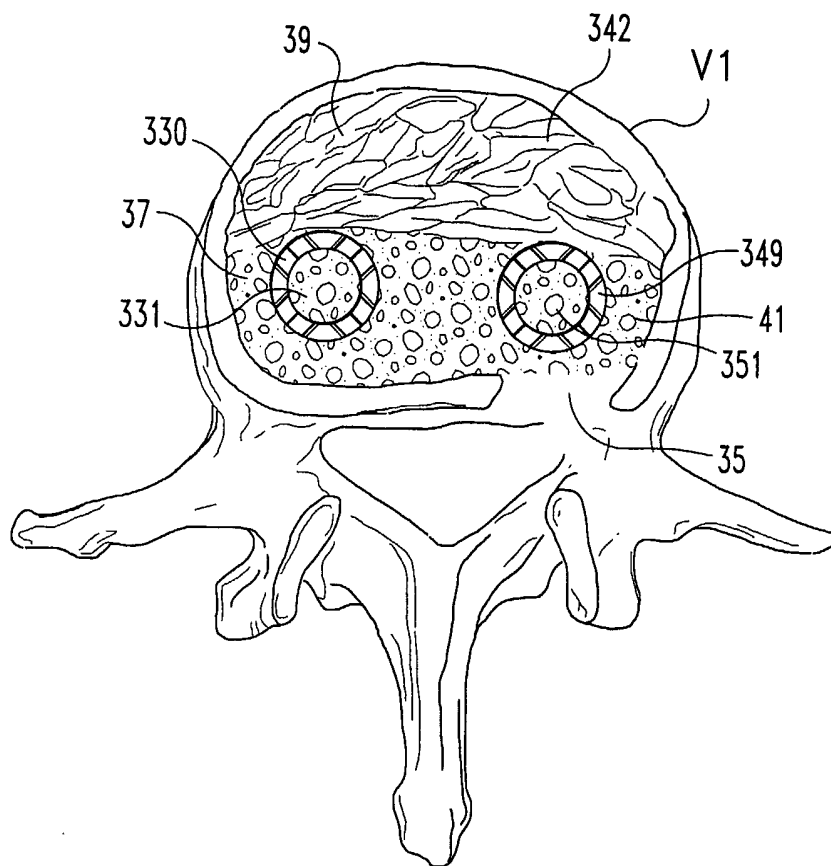


Fig. 46

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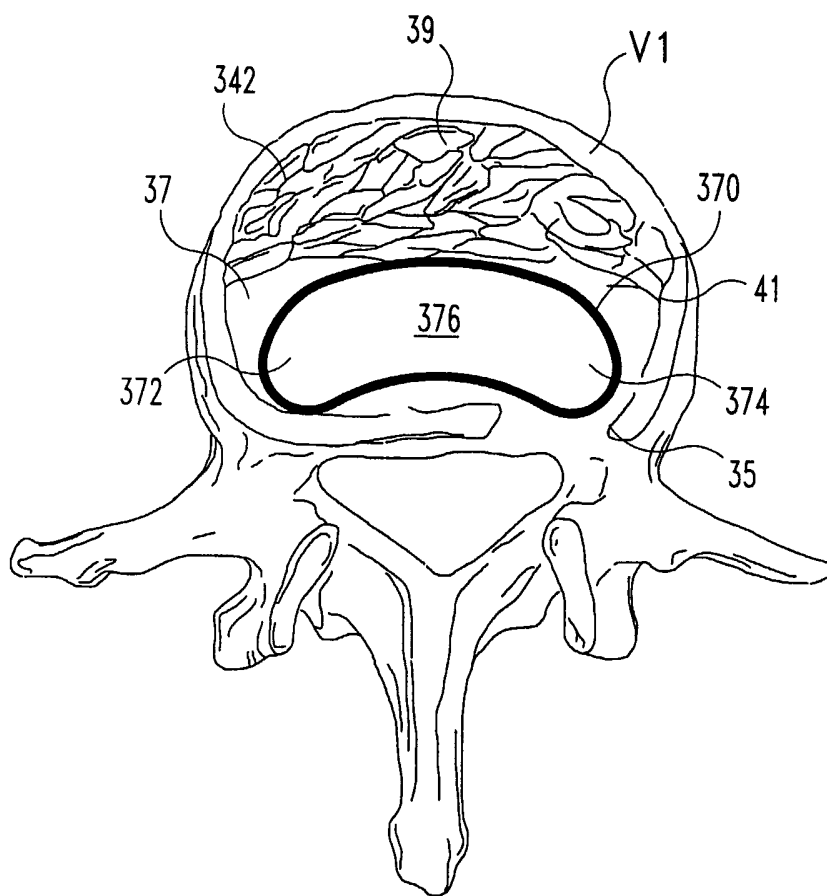


Fig. 47

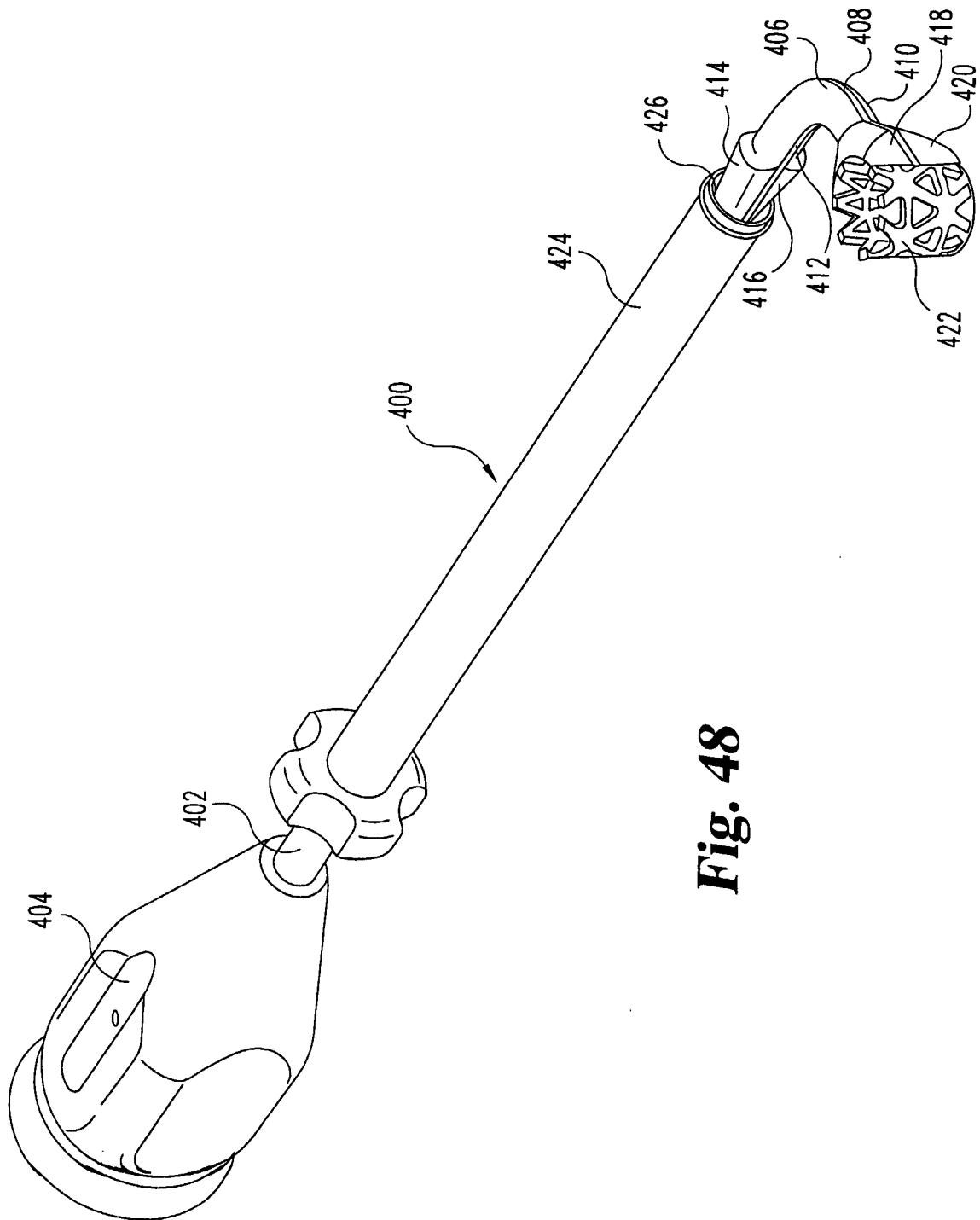


Fig. 48

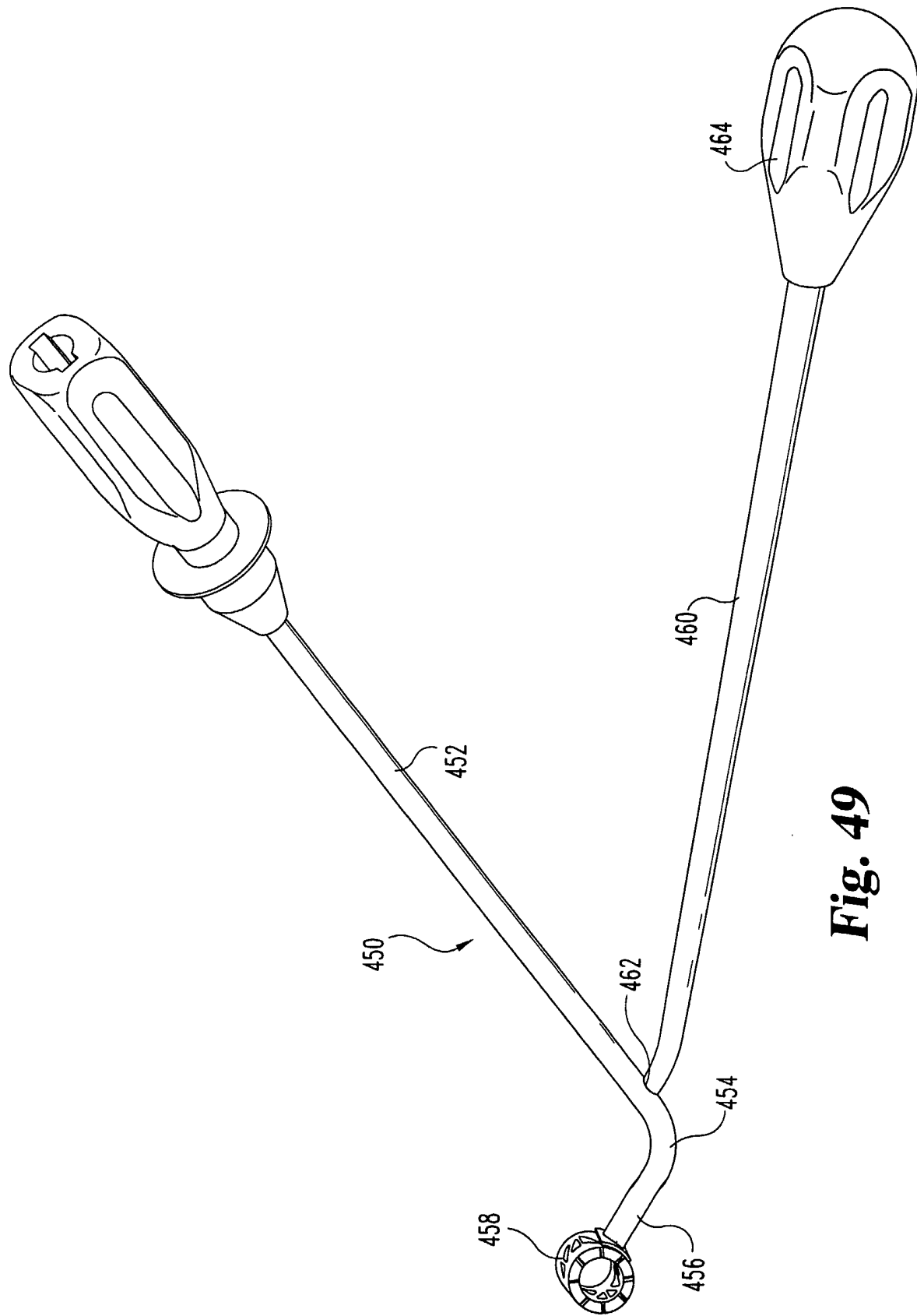


Fig. 49

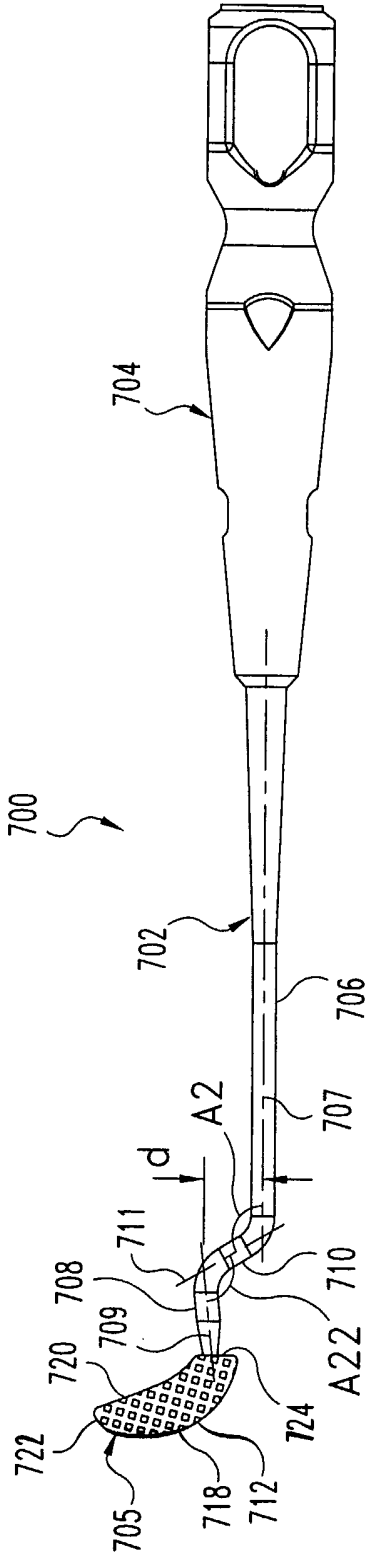


Fig. 50

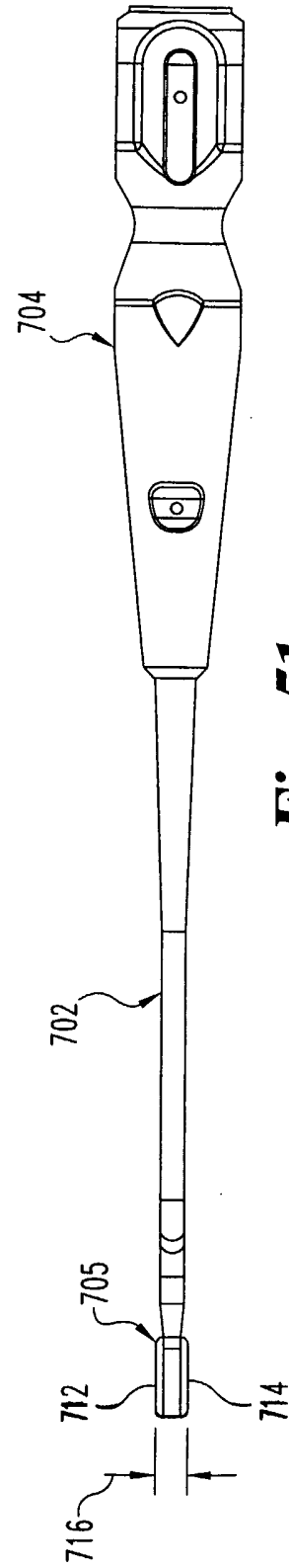


Fig. 51

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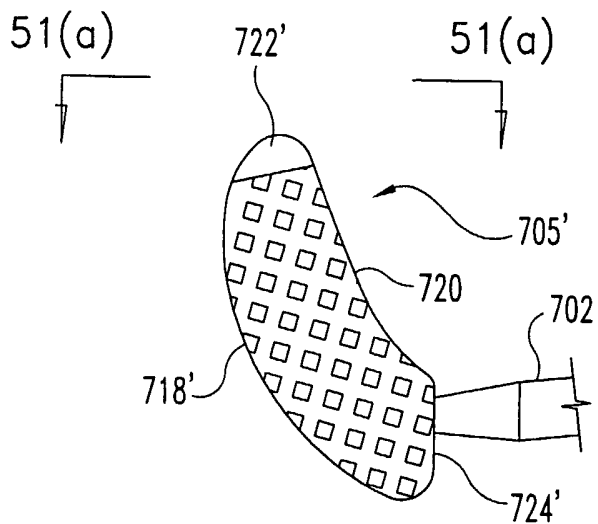


Fig. 50(a)

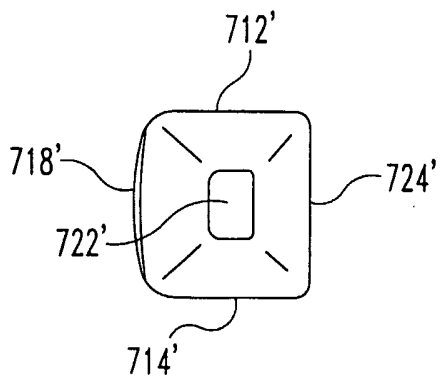


Fig. 51(a)

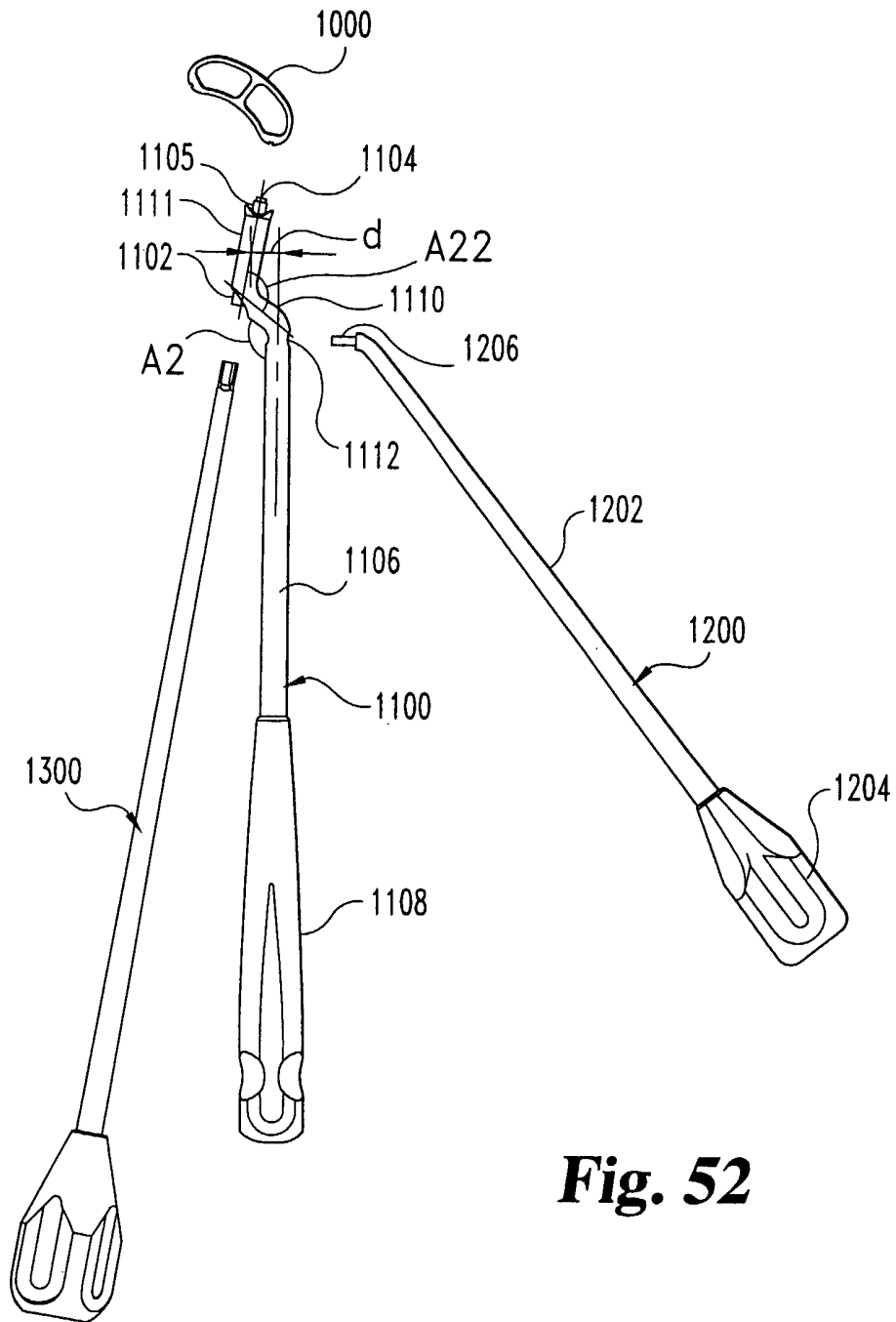


Fig. 52

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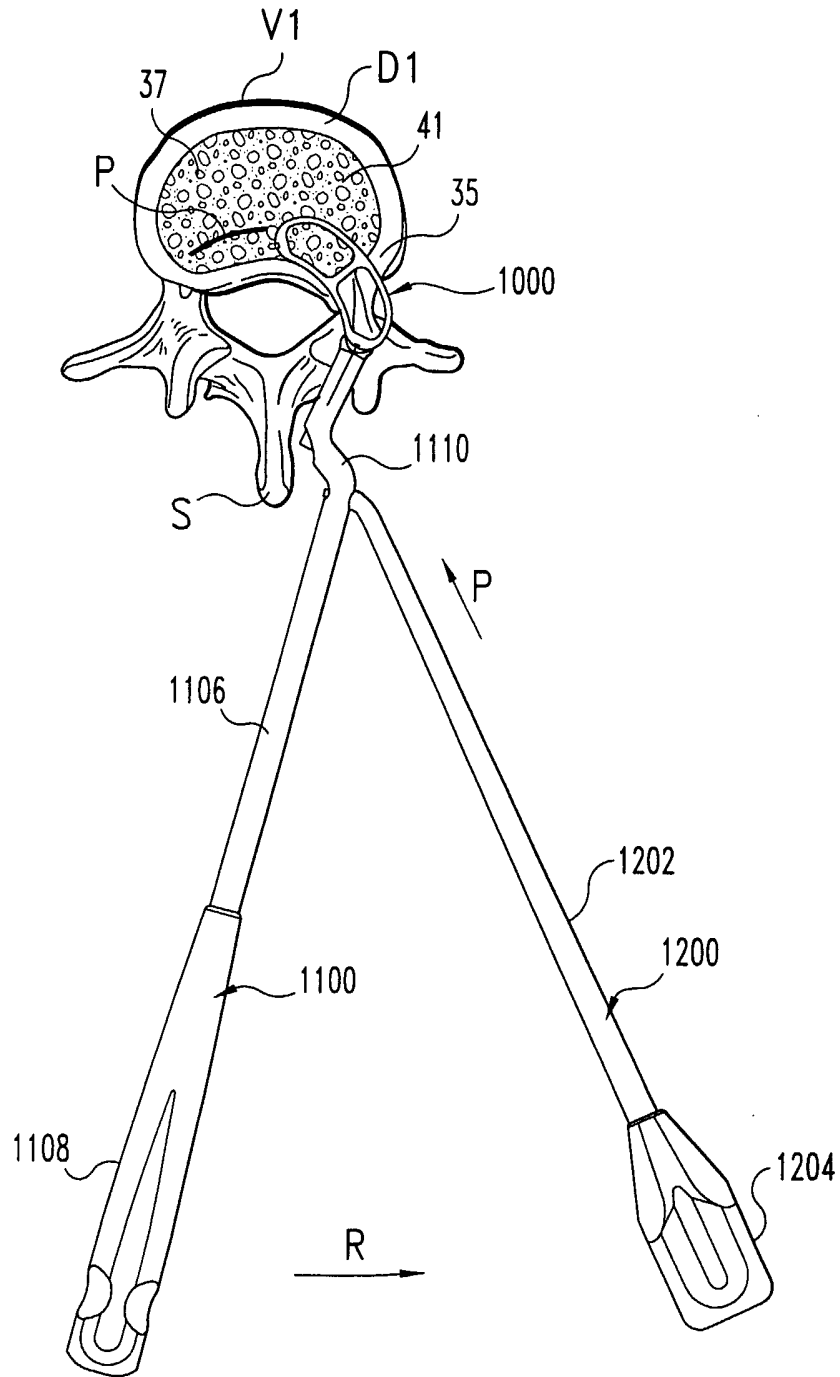


Fig. 53

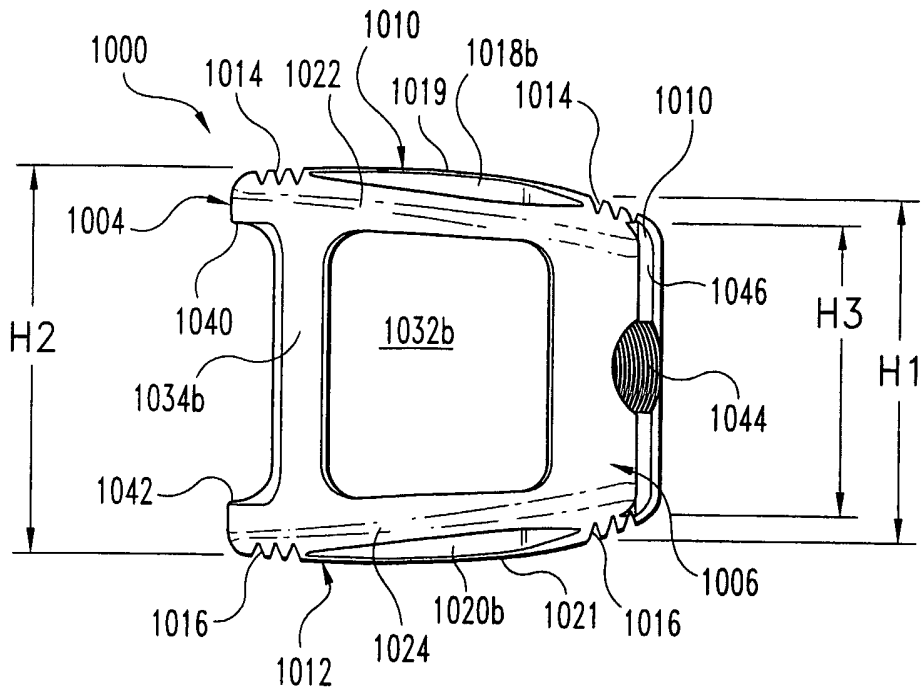


Fig. 54

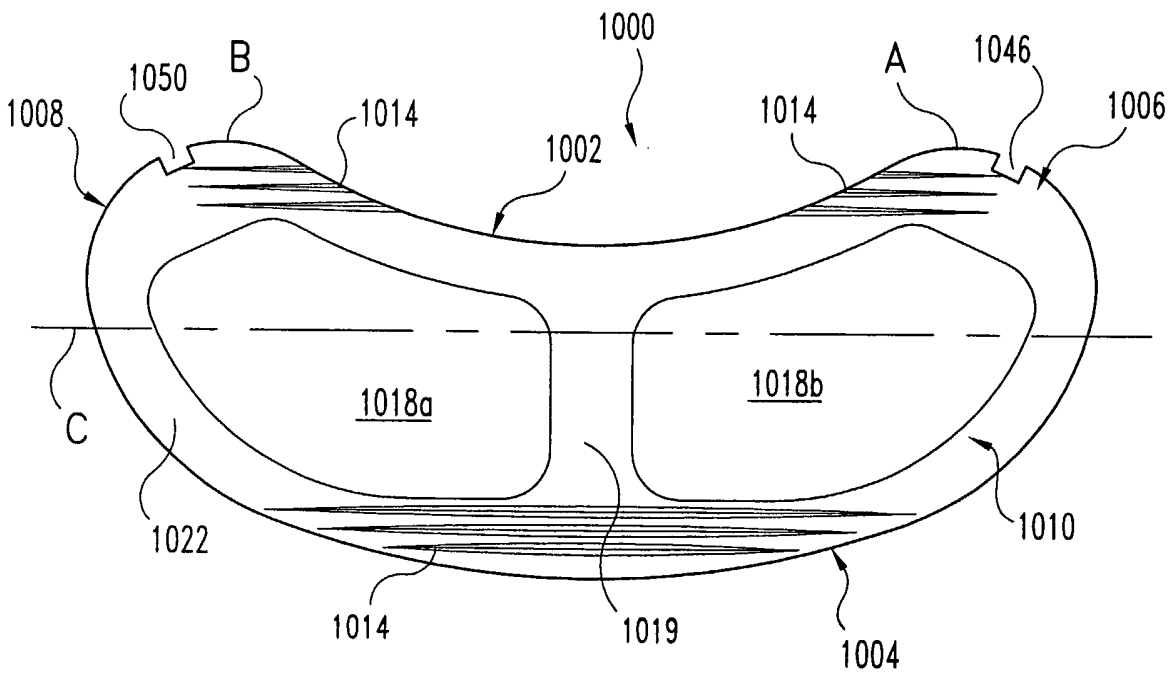


Fig. 55

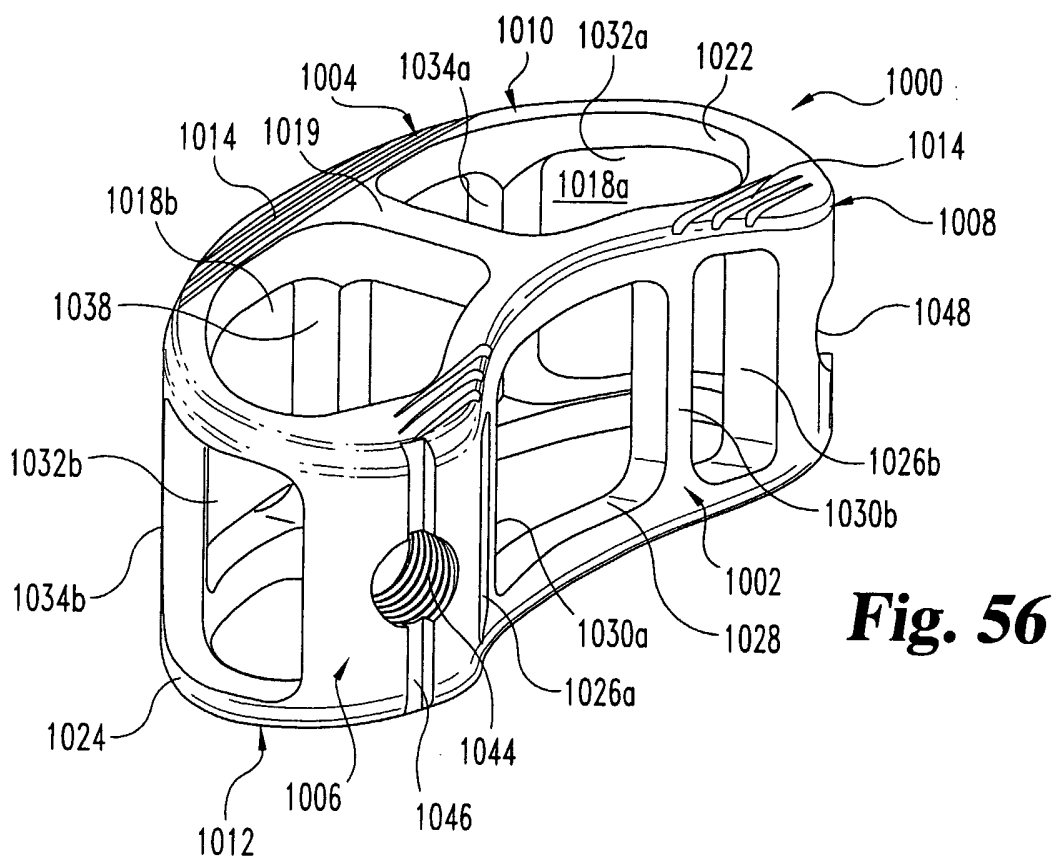


Fig. 56

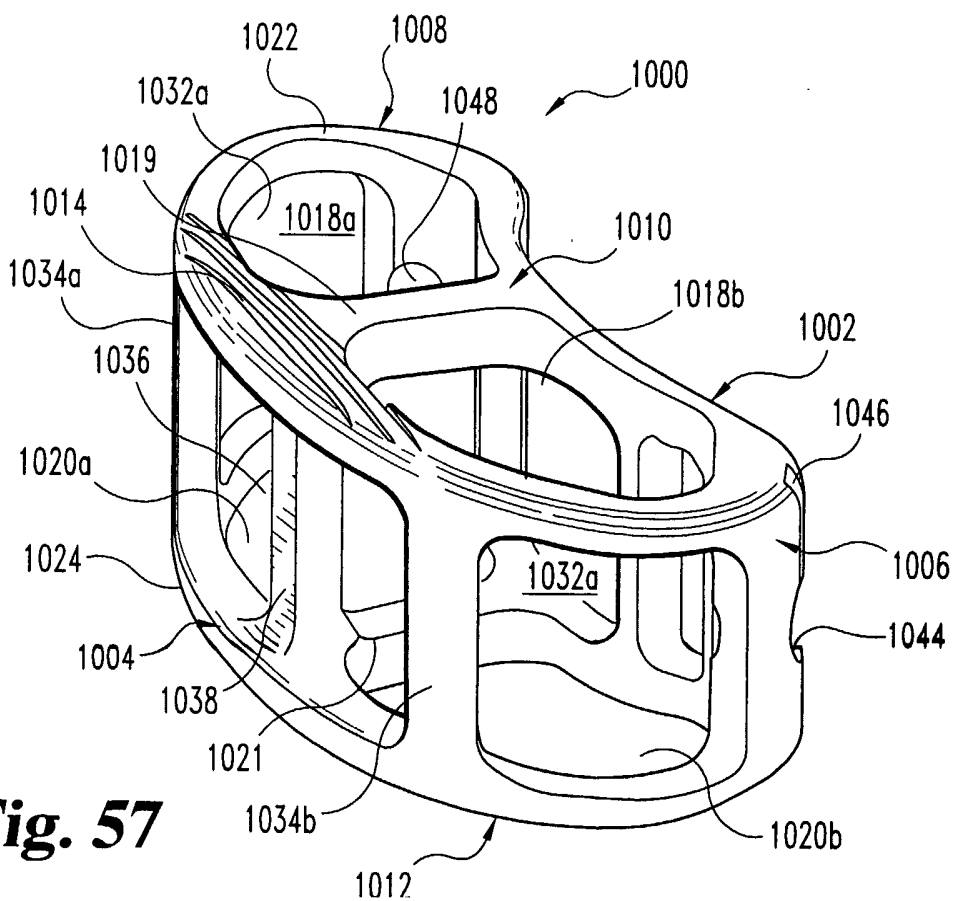


Fig. 57

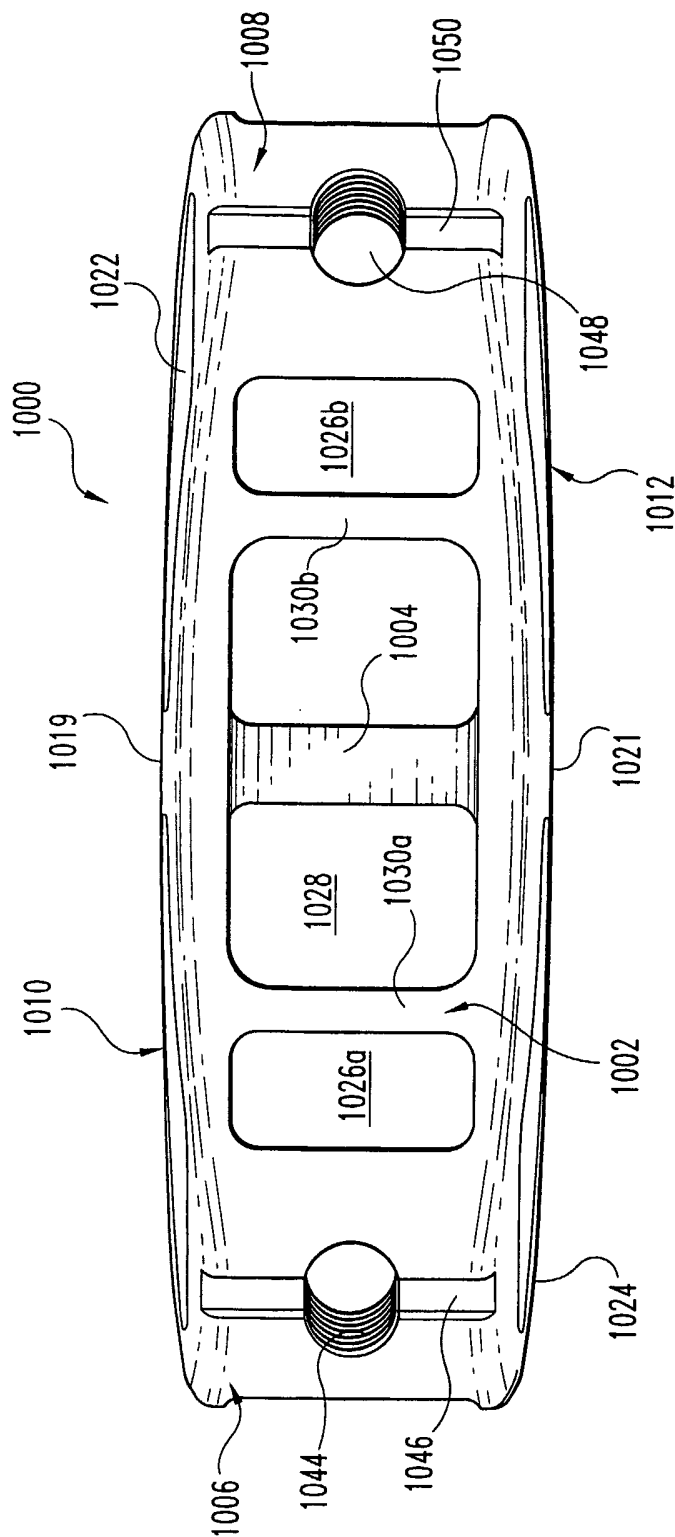


Fig. 58

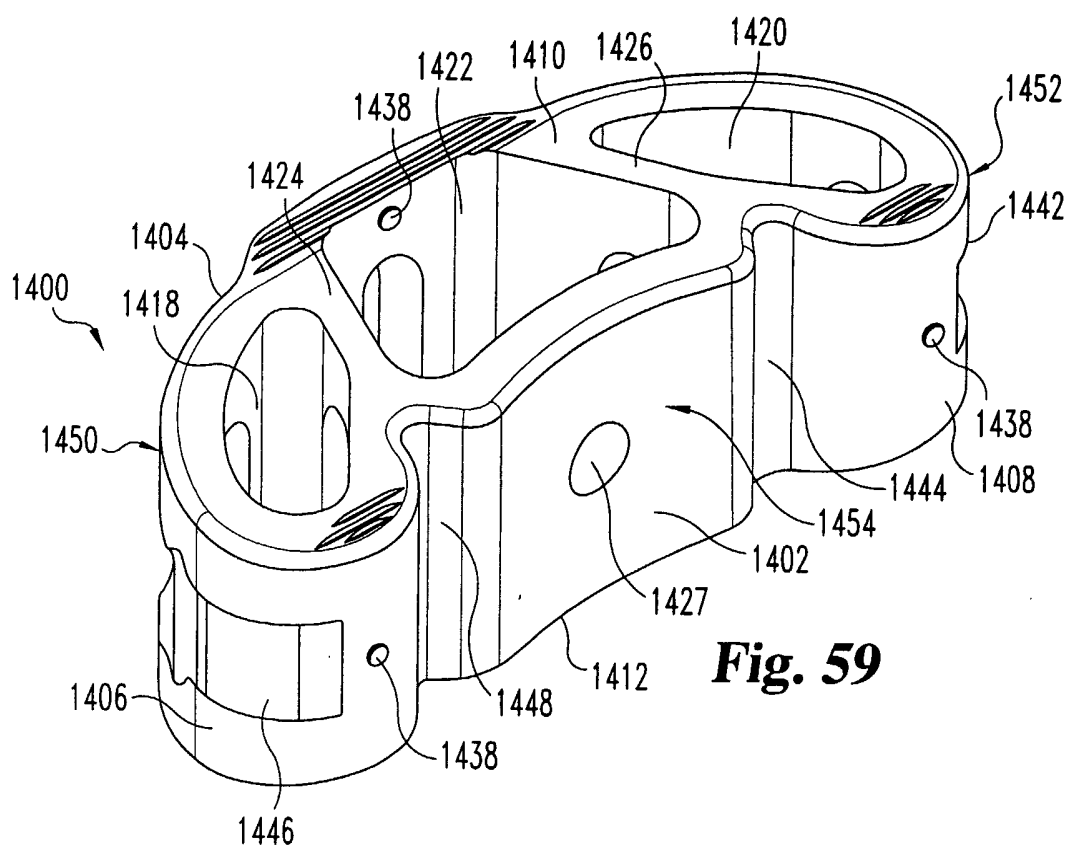


Fig. 59

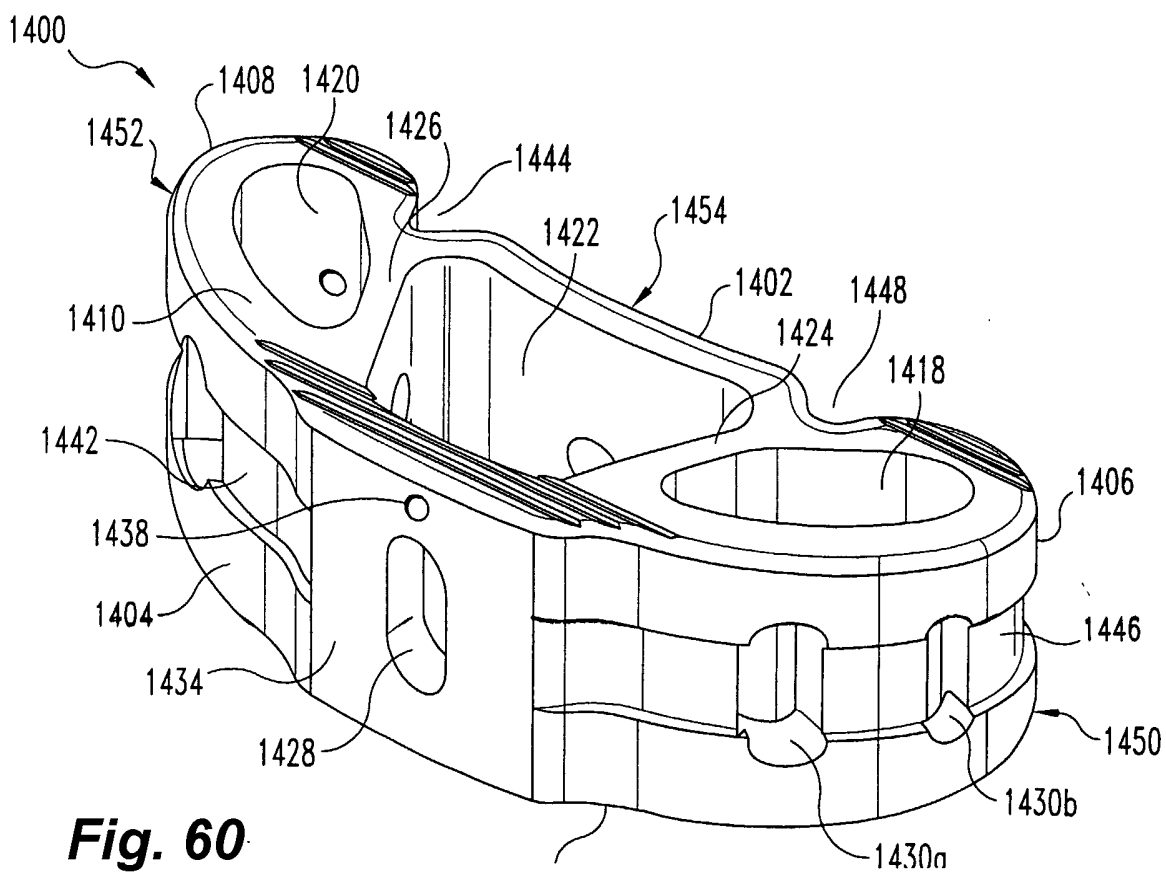


Fig. 60

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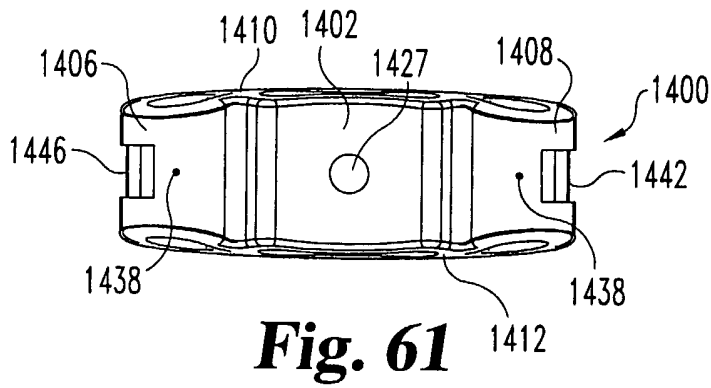


Fig. 61

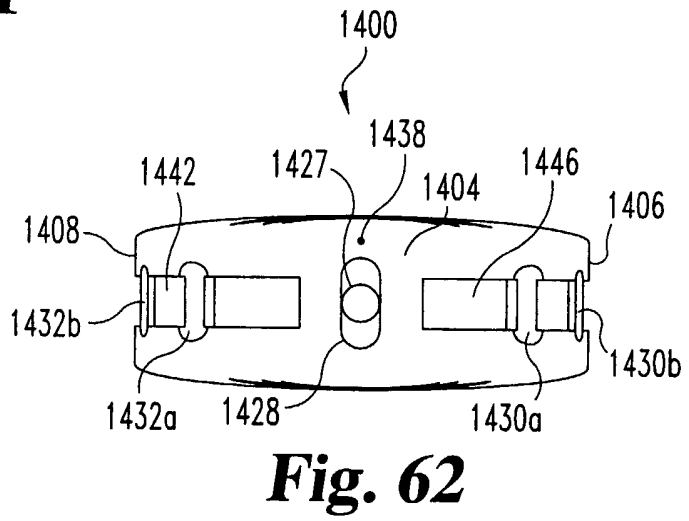


Fig. 62

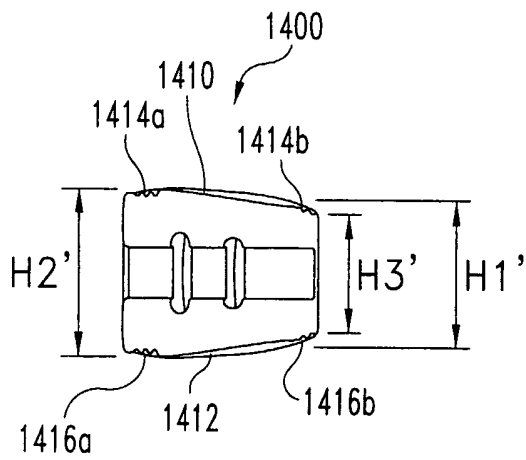


Fig. 64

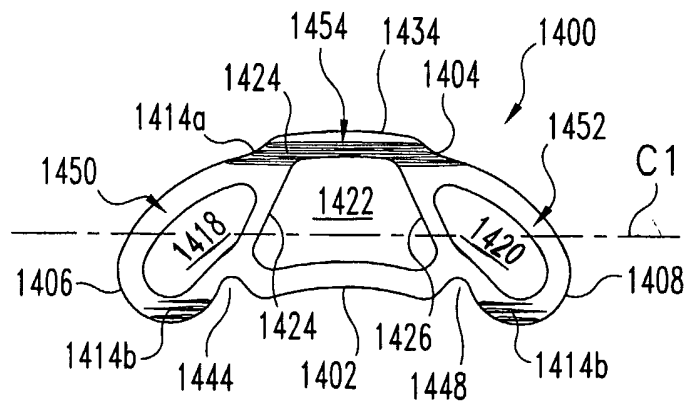


Fig. 63

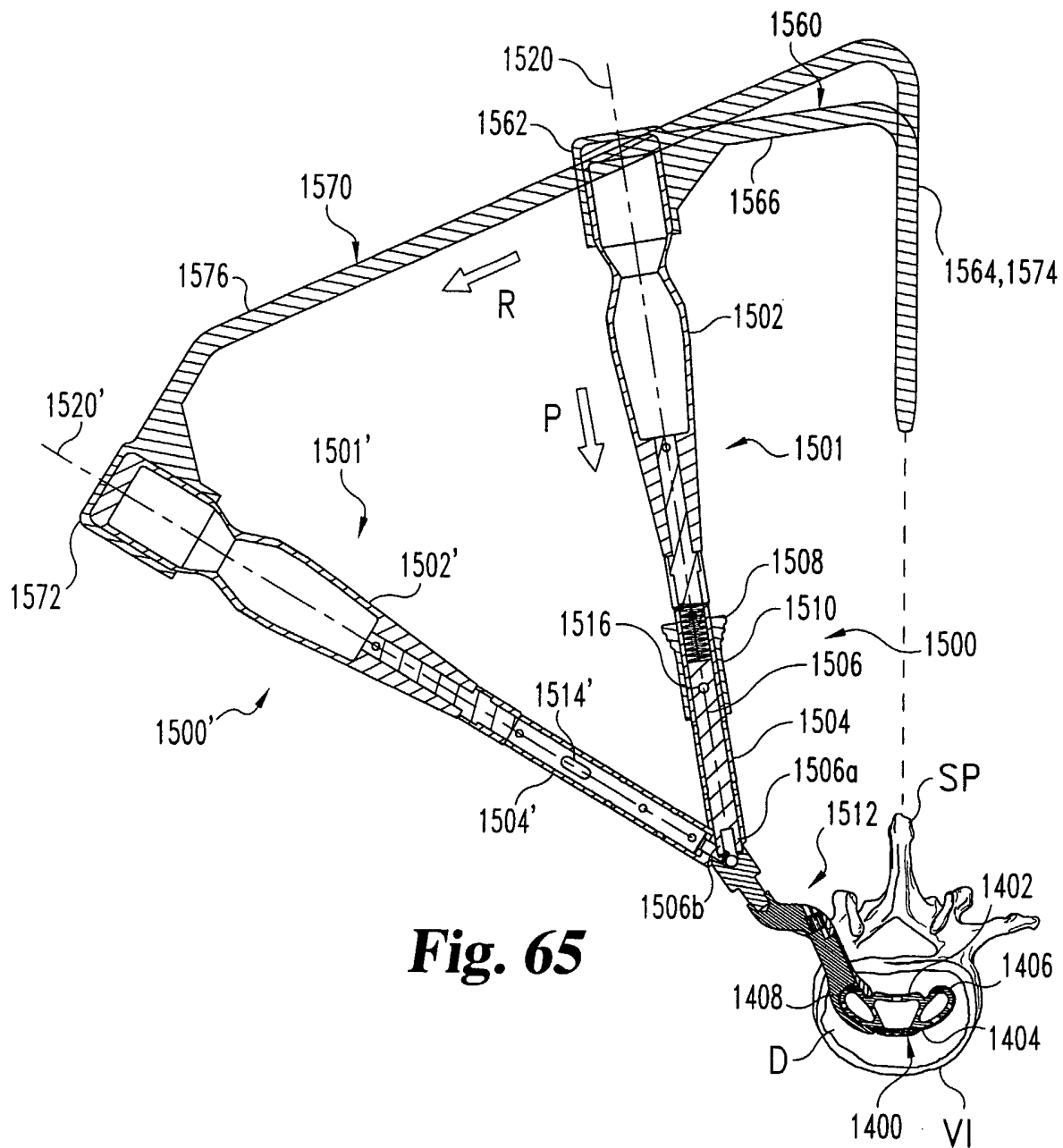


Fig. 65

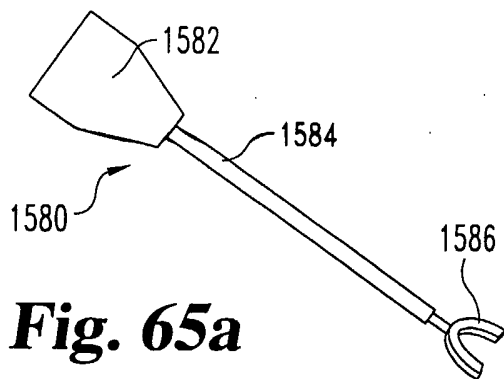


Fig. 65a

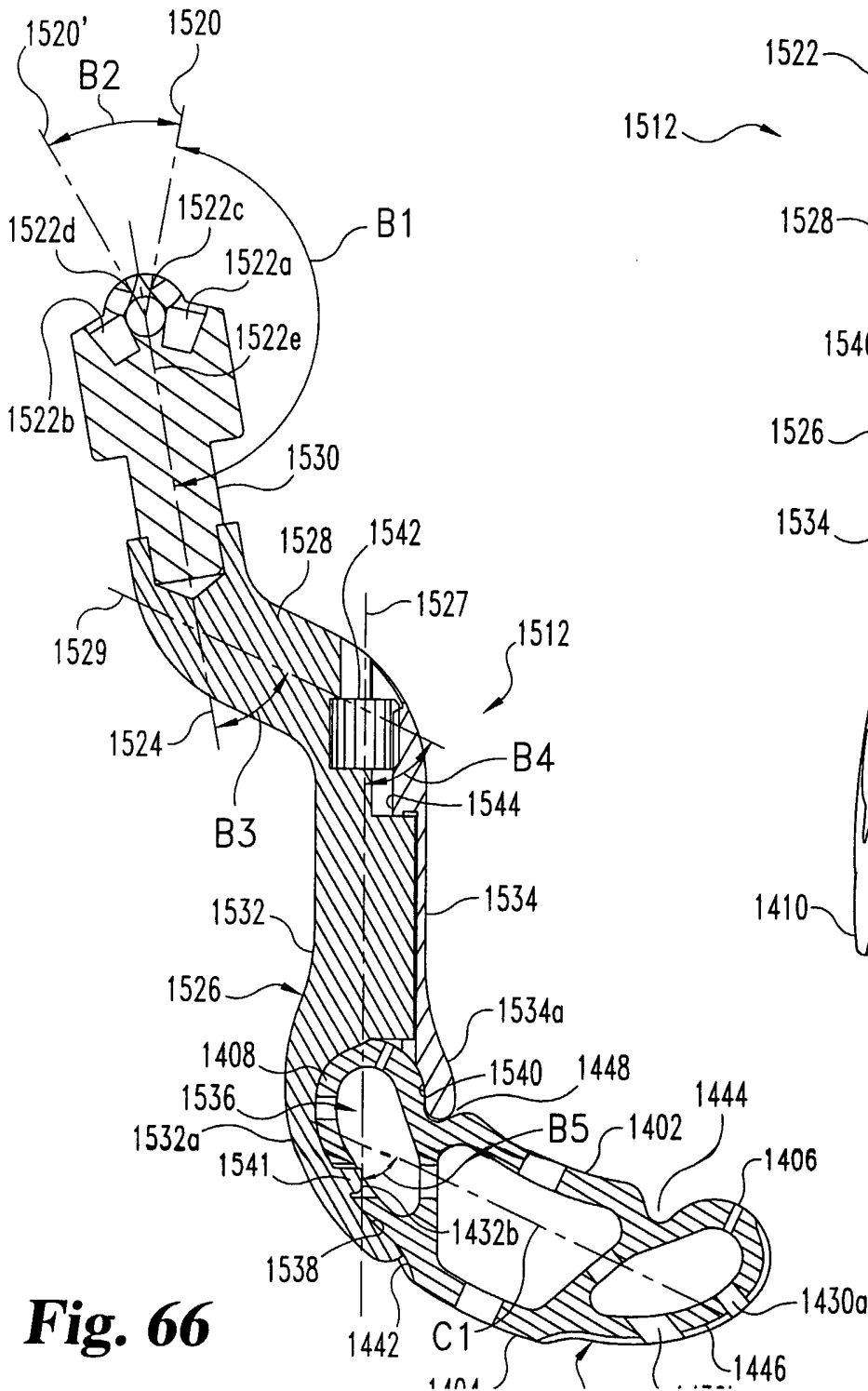


Fig. 66

Fig. 67

