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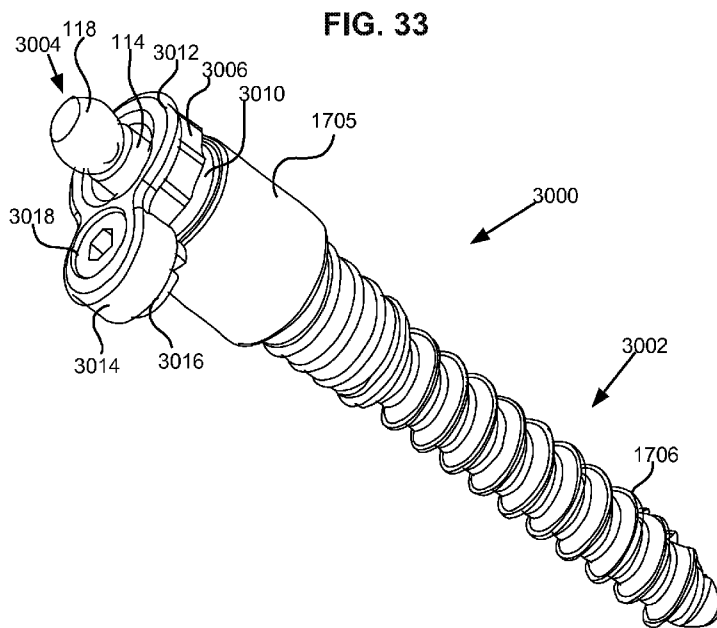
(71) Applicant (for all designated States except US):
SPARTEK MEDICAL, INC. [US/US]; 1100 Marina Village Parkway, Suite 103, Alameda, California 94501 (US).

(72) Inventors; and

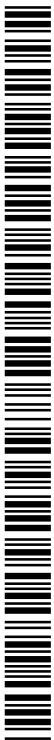
(75) Inventors/Applicants (for US only): **WINSLOW, Charles J.** [US/US]; 25 Hilton Court, Walnut Creek, California 94595 (US). **MITCHELL, Steven T.** [US/US]; 776 Duke Circle, Pleasant Hill, California 94523 (US). **FLYNN, John J.** [US/US]; 136 Panoramic Way, Walnut Creek, California 94595 (US). **ZUCHERMAN, James F.** [US/US]; 3035 Pierce Street, San Francisco, California 94123 (US). **HSU, Ken Y.** [US/US]; 52 Clarendon Av-

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(54) Title: A MODULAR IN-LINE DEFLECTION ROD AND BONE ANCHOR SYSTEM AND METHOD FOR DYNAMIC STABILIZATION OF THE SPINE



(57) Abstract: A dynamic spine stabilization component useful for stabilizing of the spine. The component is selectively attachable to a bone anchor for implantation in a bone of the spine. The component includes a deflectable post connectable to a bone anchor. Deflection of the deflectable post is controlled by a compliant member. The force/deflection properties of the deflectable post may be adapted to the functional requirements and anatomy of the patient. The dynamic spinal stabilization component, when secured to a bone anchor, provides load sharing while preserving range of motion and reducing stress exerted upon the bone anchor and spinal anatomy.



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enue, San Francisco, California 94114 (US). **KLYCE, Henry A.** [US/US]; 231 Sandringham Road, Piedmont, California 94611 (US). **KLYCE, H. Adam R.** [US/US]; 2943 Russell Street, Berkeley, California 94705 (US).

(74) **Agents:** MEYER, Sheldon, R. et al.; FLIESLER MEYER LLP, 650 California Street, Fourteenth Floor, San Francisco, California 94108 (US).

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**A MODULAR IN-LINE DEFLECTION ROD AND BONE ANCHOR
SYSTEM AND METHOD FOR DYNAMIC STABILIZATION OF THE SPINE**

5 **BACKGROUND OF INVENTION**

[0001] The most dynamic segment of orthopedic and neurosurgical medical practice over the past decade has been spinal devices designed to fuse the spine to treat a broad range of degenerative spinal disorders. Back pain is a significant clinical problem and the annual costs to treat it, both surgical and medical, is estimated to be over \$2 billion. Motion preserving
10 devices to treat back and extremity pain have, however, created a treatment alternative to or in combination with fusion for degenerative disk disease.

BRIEF DESCRIPTION OF THE DRAWINGS

[0002] FIG. 1A is a posterior view of an embodiment of a dynamic spine stabilization
15 system in accordance with the present invention.

[0003] FIG. 1B is a lateral view of the dynamic spine stabilization system of FIG. 1A.

[0004] FIG. 2 is a posterior view of the dynamic spine stabilization system of FIG. 1A implanted and extending between two vertebrae of a spine.

[0005] FIG. 3A is a posterior view of the dynamic spine stabilization system of FIG. 1A
20 implanted as shown in FIG. 2 and further comprising locking screws to resist rotation of the dynamic spine stabilization system.

[0006] FIG. 3B is a posterior view of another embodiment of the dynamic spine stabilization system of the invention.

[0007] FIG. 4 is a posterior view of another embodiment of the dynamic spine
25 stabilization system of the invention.

[0008] FIG. 5 is a posterior view of another embodiment of the dynamic spine stabilization system of the invention.

[0009] FIG. 6 is a posterior view of yet another embodiment of the dynamic spine stabilization system of the invention including horizontal rods to resist rotation.

30 [0010] FIG. 7A is a posterior view of an alternative embodiment of a dynamic spine stabilization system in accordance with the present invention.

[0011] FIG. 7B is a lateral view of the dynamic spine stabilization system of FIG. 7A.

[0012] FIG. 7C is a caudal view of the dynamic spine stabilization system of FIG. 7A.

[0013] FIG. 8 is a posterior view of the dynamic spine stabilization system of FIG. 7A
35 implanted and extending between two vertebrae of a spine.

[0014] FIG. 9 is a posterior view of the dynamic spine stabilization system of FIG. 7A implanted in an alternative arrangement to FIG. 8 and extending between the two vertebrae.

[0015] FIG. 10 is a posterior view of yet another embodiment of a dynamic spine stabilization system in accordance with the present invention implanted and extending

5 between two vertebrae of a spine.

[0016] FIG. 11A is a posterior view of an alternative embodiment of a dynamic spine stabilization system in accordance with the present invention.

[0017] FIG. 11B is a lateral view of the dynamic spine stabilization system of FIG. 11A.

[0018] FIG. 12 is a lateral view of the dynamic spine stabilization system of FIG. 11A

10 comprising an alternative seating arrangement for a horizontal rod.

[0019] FIG. 13 is a posterior view of the dynamic spine stabilization system of FIG. 11A implanted and extending between a vertebra of the spine and two adjacent vertebrae.

[0020] FIG. 14A is a posterior view of an alternative embodiment of a dynamic spine stabilization system in accordance with the present invention.

15 [0021] FIG. 14B is a lateral view of the dynamic spine stabilization system of FIG. 14A.

[0022] FIG. 15 is a posterior view of the dynamic spine stabilization system of FIG. 14A implanted and extending between two vertebrae of a spine.

[0023] FIG. 16 is a posterior view of yet another embodiment of a dynamic spine stabilization system in accordance with the present invention implanted and extending

20 between two vertebrae of a spine.

[0024] FIG. 17 is a lateral view of a further embodiment of a dynamic spine stabilization system in accordance with the present invention.

[0025] FIG. 18 is a lateral view of yet another embodiment of a dynamic spine stabilization system in accordance with the present invention.

25 [0026] FIG. 19 is a lateral view of a further embodiment of a dynamic spine stabilization system in accordance with the present invention.

[0027] FIG. 20A is an exploded perspective view of yet another embodiment of a dynamic spine system in accordance with the present invention.

[0028] FIG. 20B is a perspective view the dynamic spin stabilization system of FIG. 20A

30 with the deflection rod system and set screw seated within the anchoring device.

[0029] FIG. 21 is a posterior view of the dynamic spine stabilization system of FIG. 20A implanted and extending between a vertebra of the spine and two adjacent vertebrae.

[0030] FIG. 22 is a posterior view of an alternative embodiment of a dynamic spine stabilization system in accordance with the present invention.

[0031] FIG. 23 is a lateral view (in partial cross-section) of an alternative embodiment of a dynamic spine stabilization system in accordance with the present invention.

[0032] FIG. 24A is a lateral view (in partial cross-section) of an alternative embodiment of a dynamic spine stabilization system in accordance with the present invention.

5 [0033] FIG. 24B is a lateral view of the dynamic spine stabilization system of FIG. 24A.

[0034] FIG. 25 is a posterior view of the dynamic spine stabilization system of FIG. 24A implanted and extending between a vertebra of the spine and two adjacent vertebrae.

[0035] FIG. 26 is a lateral view of a further embodiment of a dynamic spine stabilization system in accordance with the present invention.

10 [0036] FIG. 27 is a lateral view of yet another embodiment of a dynamic spine stabilization system in accordance with the present invention

[0037] FIG. 28 is a posterior view of an alternative embodiment of a dynamic spine stabilization system in accordance with the present invention.

[0038] FIG. 29 is a posterior view of an alternative embodiment of a dynamic spine
15 stabilization system in accordance with the present invention.

[0039] FIG. 30 is a perspective view of an embodiment of a deflection rod system implant in accordance with the present invention.

[0040] FIG. 31 is a perspective view of an embodiment of the anchoring device of the deflection rod system implant of FIG. 30 in accordance with the present invention.

20 [0041] FIG. 32 is a perspective view of an embodiment of the deflection rod system of the deflection rod system implant of FIG. 30 in accordance with the present invention.

[0042] FIG. 33 is a perspective view of another embodiment of a deflection rod system implant in accordance with the present invention.

[0043] FIG. 34 is a perspective view of an embodiment of the anchoring device of the
25 deflection rod system implant of FIG. 33 in accordance with the present invention.

[0044] FIG. 35 is a perspective view of an embodiment of the deflection rod system of the deflection rod system implant of FIG. 33 in accordance with the present invention.

[0045] FIG. 36A is a bottom view of an embodiment of the deflection rod system implant of FIG. 33 in accordance with the present invention.

30 [0046] FIG. 36B is a bottom view of an embodiment of the deflection rod system implant of FIG. 33 in accordance with the present invention.

[0047] FIG. 37 is a perspective view of an embodiment of a deflection rod system implant of FIG. 33 in accordance with the present invention.

[0048] FIG. 38 is a perspective view of another embodiment of a deflection rod system implant in accordance with the present invention.

[0049] FIG. 39 is a perspective view of an embodiment of the anchoring device of the deflection rod system implant of FIG. 38 in accordance with the present invention.

5 [0050] FIG. 40 is a perspective view of an embodiment of the deflection rod system of the deflection rod system implant of FIG. 38 in accordance with the present invention.

[0051] FIG. 41 is a perspective view of the embodiment of a deflection rod system implant of FIG. 38 in accordance with the present invention.

10 **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS**

[0052] Embodiments of the present invention include a system or implant and method that can dynamically stabilize the spine while providing for the preservation of spinal motion. Alternative embodiments can be used for spine fusion.

[0053] Embodiments of the invention include a construct with an anchoring system, a
15 deflection rod system and a vertical rod system.

[0054] An advantage and aspect of some embodiments of anchoring systems in accordance with the present invention is that such embodiments include a head or saddle that allows for appropriate, efficient and convenient placement of the anchoring system relative to the spine in order to reduce the force that is placed on the anchoring system. Such
20 embodiments have enhanced degrees of freedom which contribute to the ease of implantation of the anchor system and are designed to isolate the head from the rest of the dynamic stabilization system and the forces that the rest of the dynamic stabilization system can place on the anchor system and the anchor system/bone interface. Thus, the anchor system can provide a secure purchase in the spine.

25 [0055] An aspect and advantage of the invention is the ability to maximize the range of motion of the spine after embodiments of the dynamic stabilization, motion preservation implant of the invention are implanted in a patient. While traditional solutions to back pain include fusion, discectomy, and artificial implants that replace spine structure, embodiments of the present invention preserve the bone and ligament structure of the spine and preserve a
30 wide range of motion of the spine, while stabilizing spines that were heretofore unstable due to degenerative and other spinal diseases.

[0056] Still another aspect of the invention is the preservation of the natural motion of the spine and the maintenance of the quality of motion as well as the wide range of motion so that the spine motion is as close to that of the natural spine as possible. The present embodiments

of the invention allow for the selection of a less stiff, yet dynamically stable implant for use in a non-fusion situation. A less stiff, yet dynamically stable implant relates directly to a positive patient outcome, including patient comfort and the quality of motion of the spine.

[0057] In another aspect of the invention, load sharing is provided by embodiments, and, in particular, the deflection rod or loading rod of the embodiments. For embodiments of this invention, the terms “deflection rod” and “loading rod” can be used interchangeably. Accordingly this aspect of the invention is directed to restoring the normal motion of the spine. The embodiment provides stiffness and support where needed to support the loads exerted on the spine during normal spine motion, which loads, the soft tissues of the spine are no longer able to accommodate since these spine tissues are either degenerated or damaged. Load sharing is enhanced by the ability to select the appropriate stiffness of the deflection rod or loading rod in order to match the load sharing characteristics desired. By selecting the appropriate stiffness of the deflection rod or loading rod to match the physiology of the patient and the loads that the patient places on the spine, a better outcome is realized for the patient. Prior to implantation of the embodiment, the stiffness of the implant of the system can be selected among a number of loading rods. In other words, the stiffness is variable depending on the deflection rod or loading rod selected. In another aspect, the load sharing is between the spine and the embodiment of the invention.

[0058] As the load is carried along the deflection rod or loading rod, the embodiments of the invention can be made smaller in order to fit in more spaces relative to the spine.

[0059] An aspect of the invention is to preserve and not restrict motion between the vertebra of the spine through the use of appropriately selected vertical rods (and optionally horizontal rods) of embodiments of the invention.

[0060] Another aspect of the invention is the ability to control stiffness for extension, flexion, lateral bending and axial rotation, and to control stiffness for each of these motions independently of the other motions.

[0061] An aspect of the invention is to use the stiffness and load bearing characteristics of super elastic materials.

[0062] Another aspect of the invention is to use super elastic materials to customize the implant to the motion preservation and the dynamic stabilization needs of a patient. An aspect of such embodiments of the invention is to provide for a force plateau where motion of the implantation system continues without placement of additional force of the bone anchor system, or, in other words, the bone/implantation system interface.

[0063] Accordingly, an aspect of the invention is to be able to selectively vary the stiffness and selectively vary the orientation and direction that the stiffness is felt by varying the structure of the implantation system of the invention.

5 [0064] Another aspect of some embodiments of the invention is to prevent and/or provide for any off-axis implantation by allowing the implantation system to have enhanced degrees of freedom of placement of the implant.

[0065] A further aspect of embodiments of the invention is to control stabilized motion from micro-motion to broad extension, flexion, axial rotation, and lateral bending motions of the spine.

10 [0066] Yet another aspect of the embodiments of the invention is to be able to revise a dynamic stabilization implant should a fusion implant be indicated. This procedure can be accomplished by, for example, the removal of the deflection rod system of the implantation system and replacement with, for example, a stiffer deflection rod system. Accordingly, an aspect of the invention is to provide for a convenient path for a revision of the original
15 implantation system, if needed.

[0067] A further aspect of the invention, due to the ease of implanting the anchoring system, is the ability to accommodate the bone structure of the spine, even if adjacent vertebra are misaligned with respect to each other.

20 [0068] A further aspect of the invention is that the implant is constructed around features of the spine such as the spinous processes and, thus, such features do not need to be removed and the implant does not get in the way of the normal motion of the spine features and the spine features do not get in the way of the operation of the implant.

[0069] Another aspect of embodiments of the invention is the ability to stabilize two, three and/or more levels of the spine by the selection of appropriate embodiments and
25 components of embodiments of the invention for implantation in a patient. Further embodiments of the invention allow for fused levels to be placed next to dynamically stabilized levels. Such embodiments of the invention enable vertebral levels adjacent to fusion levels to be shielded by providing a more anatomical change from a rigid fusion level to a dynamically stable, motion preserved, and more mobile level.

30 [0070] Accordingly, another aspect of the embodiments of the invention is to provide a modular system that can be customized to the needs of the patient. A deflection rod system can be selectively chosen for the particular patient as well the particular levels of the vertebrae of the spine that are treated. Further, the positioning of the embodiments of the invention can be selected to control stiffness and stability.

[0071] Another aspect of embodiments of the invention is that embodiments can be constructed to provide for higher stiffness and fusion at one level or to one portion of the spine while allowing for lower stiffness and dynamic stabilization at another adjacent level or to another portion of the spine.

5 [0072] Yet a further aspect of the invention is to provide for dynamic stabilization and motion preservation while preserving the bone and tissues of the spine in order to lessen trauma to the patient and to use the existing functional bone and tissue of the patient as optimally as possible in cooperation with embodiments of the invention.

10 [0073] Another object of the invention is to implant the embodiments of the invention in order to unload force from the spinal facets and other posterior spinal structures and also the intervertebral disc.

[0074] A further aspect of the invention is to implant the embodiment of the invention with a procedure that does not remove or alter bone or tear or sever tissue. In an aspect of the invention the muscle and other tissue can be urged out of the way during the inventive
15 implantation procedure.

[0075] Accordingly, an aspect of the invention is to provide for a novel implantation procedure that is minimally invasive.

Dynamic Stabilization Motion Preservation System for the Spine

20 [00119] Common reference numerals are used throughout the drawings and detailed description to indicate like elements; therefore, reference numerals used in a drawing may or may not be referenced in the detailed description specific to such drawing if the associated element is described elsewhere. Further, the terms “vertical” and “horizontal” are used throughout the detailed description to describe general orientation of structures relative to the
25 spine of a human patient that is standing.

[00120] FIG. 1A is a posterior view (in partial cross-section) and FIG. 1B is a lateral view of an embodiment of a deflection rod system implant 100 for use with dynamic stabilization, motion preservation systems (also referred to herein simply as “dynamic stabilization systems”) in accordance with the present invention. The deflection rod system implant 100
30 includes a deflection rod system or deflection rod system engine 110, an anchoring device 102 and a vertical rod 120. The deflection rod system 110 includes a deflection rod guide or shield 116 and a deflection rod 111 including an inner rod 112 within an outer shell 114. The deflection rod 111 can have a varying diameter along its length. A decreasing diameter allows the deflection rod 111 to be more flexible and bendable along the length deflection rod length

to more evenly distribute the load placed on the deflection rod system 100 by the spine. The outer shell 114 preferably is made of PEEK or other comparable polymer and has a diameter that continuously decreases along the length of the deflection rod 111. The inner rod 112 can be made of a super elastic material. Preferably, the super elastic material is made of Nitinol (NiTi). In addition to Nitinol or nickel-titanium (NiTi), other super elastic materials include copper-zinc-aluminum and copper-aluminum-nickel. However, for biocompatibility, nickel-titanium is the preferred material. The inner rod 112, like the overall deflection rod 111, can vary in diameter and shape, although in a preferred embodiment, the inner rod 112 is substantially cylindrical.

10 [00121] Alternatively, the diameter of the outer shell 114 can decrease in discrete steps along the length of the deflection rod 111, with the diameter of one step not being continuous with the diameter of the next adjacent step. Alternatively, for different force and load carrying criteria the diameters of the deflection rod can continuously increase in diameter or can have discreet step increases in diameter along the length of the deflection rod 111. Still further, the deflection rod 111 can have at least one step of decreasing diameter and at least one step of increasing diameter in any order along the length of the deflection rod 111, as desired for the force and load carrying characteristics of the deflection rod 111.

[00122] The deflection rod 111 is arranged within the deflection rod guide or shield 116 which covers and, in this embodiment, substantially surrounds the deflection rod 111. The deflection rod system 110 can be a preassembled unit provided to a surgeon for implantation by affixing the deflection rod system 110 to a bone (e.g., the pedicle of a vertebra) using an anchoring device 102 such as a bone screw. The deflection rod system 110 is connected with the anchoring device 102 by an arm 130, which arm 130 can be integrally formed with the deflection rod system 110, affixed to the deflection rod system 110 by one or more fasteners or fastening features (such as protruding structures that interlockingly engage each other when coupled), press fit to the deflection rod system 110, or otherwise fixedly secured to the deflection rod system 110.

25 [00123] As shown in FIG. 1B, the arm 130 includes an aperture 131 through which the anchoring device 102 is received and driven into the bone. The anchoring device 102 includes a head 104 that interferes with passage of the anchoring device 102 through the aperture 131. Threads 106 of the anchoring device 102 grip the bone to hold the arm 130 between the bone and the head 104, thereby affixing the arm 130 and by extension the deflection rod system 110 to the bone. Preferably, the anchoring device 102 is made of titanium; however, other biocompatible materials such as stainless steel and/or PEEK can be used. As will be

appreciated upon reflecting on the different embodiments, the structures described herein can vary in size and shape based on factors such as material of construction, anatomical structure of the implantation site, implantation technique and targeted system performance (e.g., stiffness).

5 [00124] FIG. 2 is a posterior view of the dynamic spine stabilization system of FIG. 1A implanted and extending between two vertebrae 2, 4 of a spine. Referring to FIG. 2, the vertical rod 120 is connected to the deflection rod 111 and can urge the deflection rod 111 in response to relative movement of two vertebrae between which the vertical rod 120 extends. In the embodiment shown, a distal end of the deflection rod 111 can be fixedly mated with a
10 spherical (or semi-spherical) ball or joint 118 that can pivot within a cradle at a proximal end of the vertical rod 120. The vertical rod 120 can pivot in a posterior-to-anterior or anterior-to-posterior direction about the joint 118, and optionally can pivot slightly in a lateral direction. The pivoting motion can allow adjustment of the vertical rod 120 relative to the deflection rod system 110 to ease manipulation of the dynamic stabilization system during implantation and
15 optionally to reduce torque forces applied to the deflection rod 111. A distal end of the vertical rod 120 can be fixedly connected with an upper (or lower) vertebra of the two vertebrae by an additional anchoring device 152, such as a bone screw. The anchoring device 152 can include an arm 170 extending a clamp 162 that receives and secures the vertical rod 120. The arm 170 extends laterally from the anchoring device 152 so that the anchoring
20 device 152 can be positioned and secured to the upper pedicle 8 (a good source of bone for anchoring) while the clamp 162 can be aligned with the vertical rod 120 to receive the vertical rod 120, which extends generally (though not necessarily) parallel to the spine. The dynamic stabilization system 100 includes two substantially similar, mirrored structures connected at opposite pedicles 8, 10 of the vertebrae 2, 4. However, in alternative embodiments, the
25 dynamic stabilization system can include dissimilar structures, for example to accommodate anatomical asymmetry.

[00125] FIG. 3A is a posterior view of the dynamic spine stabilization system of FIG. 1A implanted as shown in FIG. 2 and further comprising locking screws 334, 364 to resist rotation of the dynamic spine stabilization system. FIG. 3A illustrates an alternative
30 embodiment wherein one or both of the deflection rod system arms 330 and clamp arm 370 can include a secondary aperture for receiving a locking screw 334, 364 that can resist rotation of the corresponding arm. FIG. 3B illustrates another alternative embodiment wherein the deflection rod system arm 330 includes a secondary aperture for receiving the locking screw 334, and wherein the clamp and clamp arm of FIG. 3A are supplanted by an anchoring

device 352 that receives the vertical rod 120 over a bone screw thread. The anchoring device 352 may be for example a bone screw/pedicle screw with a receiver for receiving the vertical rod 120 and a fastener for securing the vertical rod 120. For example, the anchoring device 352 may be a conventional polyaxial pedicle screw. The anchoring device 352 can resemble the anchoring device 752 shown in FIGS. 7A, 7B, and described below in the description of FIGS. 7A, 7B. Such anchoring devices can resemble anchoring devices described in U.S. Patent Application 12/130,395, entitled "A Deflection Rod System For A Dynamic Stabilization And Motion Preservation Spinal Implantation System And Method." This alternative embodiment may reduce torque applied to the anchoring device 352 by the vertical rod 120 and simplify the anchoring device 352 to ease implantation of the anchoring device 352.

[00126] The stiffness of the deflection rod system 100 (See, e.g. FIGS. 1A, 1B, 2, 3A and 3B) can preferably be adjusted by the selection of the placement of the deflection rod system as well as the horizontal and vertical rods. More lateral placement of the vertical rods provides for more stiffness in lateral bending and an easier implant approach by, for example, a Wiltse approach as described in "The Paraspinal Sacraspinalis-Splitting Approach to the Lumbar Spine," by Leon L. Wiltse et al., *The Journal of Bone & Joint Surgery*, Vol. 50-A, No. 5, July 1968.

[00127] The stiffness of the deflection rod system 100 (See, e.g. FIGS. 1A, 1B, 2, 3A and 3B) can also be adjusted by the selection of the materials and diameters of the deflection rod system as well as the horizontal and vertical rods. Larger diameter rods would increase the resistance of the deflection rod system 100 to flexion, extension rotation, and bending of the spine, while smaller diameter rods would decrease the resistance of the deflection rod system 100 to flexion, extension, rotation and bending of the spine. Further, continually or discretely changing the diameter of the deflection rods 111 along the length of the deflection rods 111 changes the stiffness characteristics. Thus, with the deflection rods 111 tapered toward the vertical rod 120, the deflection rod system 100 can have more flexibility in flexion and extension of the spine. Further, using a super elastic material for the vertical rod 120 in addition to the deflection rod 111 adds to the flexibility of the deflection rod system 100. Further, the vertical rods 120, in addition to the deflection rods 111, can be made of titanium or stainless steel or PEEK should a stiffer deflection rod system 100 be required. Thus, it can be appreciated that the deflection rod system 100 can selectively accommodate the desired stiffness for the patient depending on the materials used, and the diameter of the components, and the placement of the elements of the deflection rod system 100.

[00128] Should an implanted deflection rod system 100 need to be revised, the revision can be accomplished by removing and replacing the vertical rod 120 and/or deflection rod system 110 to obtain the desired stiffness. By way of example only, should a stiffer revised deflection rod system 100 be desired, more akin to a fusion, or, in fact, a fusion, then the deflection rod system 110 having the deflection rods 111 can be removed and replaced by a deflection rod system 110 having the stiffer deflection rods 111 (made of titanium, or stainless steel, or non-super elastic rods) to increase the stiffness of the deflection rod system 100. This can be accomplished in some embodiments described herein by leaving the anchoring device 102 in place and removing the existing deflection rod systems 110 and replacing the deflection rod systems with deflection rod systems having stiffer deflection rods 111 and outer shells and associated vertical rods 120.

[00129] In alternative embodiments of methods of stabilizing vertebral motion segments in accordance with the present invention, the dynamic stabilization system 100 can be implanted in an arrangement vertically flipped from the arrangement of FIG. 2.

[00130] FIG. 4 is a posterior view of another embodiment of the dynamic spine stabilization system of the invention. As shown in FIG. 4, the deflection rod system 110 is fixedly connected with the upper vertebra 2 by the anchoring system 102. The vertical rod 120 is connected to the deflection rod 111 and extends caudally to the lower vertebra 4. The vertical rod 120 urges the deflection rod 111 in response to relative movement of the two vertebrae 2, 4 between which the vertical rod 120 extends.

[00131] FIG. 5 is a posterior view of another embodiment of the dynamic spine stabilization system of the invention. As with the previously described arrangement and as shown in FIG. 5, one or both of the deflection rod system arms 330 and clamp arms 370 can include a secondary aperture for receiving a locking screw 334, 364 that can resist rotation of the corresponding arm.

[00132] FIG. 6 is a posterior view of yet another embodiment of the dynamic spine stabilization system of the invention including horizontal rods to resist rotation. Referring to FIG. 6, in this embodiment, one or both of the deflection rod system arms 630 and clamp arms 670 can be adapted to connect with horizontal rods 680, 682 that extend between pedicles 8, 10 of a vertebra. The anchoring devices 602, 652 can include a U-shaped channel for receiving the horizontal rod 680, 682, the horizontal rod being held in the channel by a locking set screw 644, 654. The horizontal rods 680, 682 are positioned between adjacent spinous processes 2, 4 associated with the vertebrae and can pierce or displace the interspinous ligament without severing or removing tissue. The horizontal rods 680, 682 can resist rotation

and can be used in place of locking screws. In a preferred embodiment, the horizontal rod 680, 682 can be made of titanium, stainless steel or PEEK or another biocompatible material, and the first and second deflection rods 111 or loading rods can be made of a super elastic material. Preferably, the super elastic material is made of Nitinol (NiTi). In addition to Nitinol
5 or nickel-titanium (NiTi), other super elastic materials include copper-zinc-aluminum and copper-aluminum-nickel. However, for biocompatibility, the nickel-titanium is the preferred material.

[00133] The particular dynamic stabilization assemblies shown in FIGS. 2-6 are provided by way of example only. It is an aspect of preferred embodiments of the present invention that
10 a range of components be provided and that the components may be assembled in different combinations and organizations to create different assemblies suitable for the functional needs and anatomy of different patients. Also, deflection rods having different force deflection characteristics may be incorporated at different spinal levels in accordance with the anatomical and functional requirements. Dynamic stabilization may be provided at one or
15 more motion segments and in some cases dynamic stabilization may be provided at one or more motion segments in conjunction with fusion at an adjacent motion segment. Particular dynamic stabilization assemblies may incorporate combinations of the bone anchors, vertical rods, deflection rods, offset and coaxial connectors described herein, in the related applications, and standard spinal stabilization and/or fusion components, for example screws,
20 rods and polyaxial screws. In particular the following related patent applications disclose components and assemblies useful in combination with the components and assemblies disclosed in the present patent application:

[00134] U.S. Provisional Application No. 61/100,593 filed September 26, 2008, entitled
25 “A Spine Implant With A Deflection Rod System Selectively Alignable And Selectively Lockable To A Bone Anchor And Method” (Attorney Docket No. SPART-01042US0); and

[00135] U.S. Provisional Application No. 61/100,625 filed September 26, 2008, entitled
“Versatile Components And Methods For Dynamic Stabilization” (Attorney Docket No. SPART-01043US0); and

[00136] U.S. Provisional Application No. 61/119,651 filed December 3, 2008, entitled
30 “Load-sharing Component Having A Deflectable Post And Methods For Dynamic Spinal Stabilization” (Attorney Docket No. SPART-01044US0); and

[00137] U.S. Provisional Application No. 61/122,658 filed December 15, 2008, entitled
“Load-sharing Component Having A Deflectable Post And Methods For Dynamic Spinal Stabilization” (Attorney Docket No. SPART-01044US2); and

- [00138] U.S. Provisional Application No. 61/144,426 filed January 13, 2009, entitled “Load-sharing Component Having A Deflectable Post And Methods For Dynamic Spinal Stabilization” (Attorney Docket No. SPART-01044US3); and
- [00139] U.S. Provisional Application No. 61/225,478 filed July 14, 2009, entitled “Load-sharing Component Having A Deflectable Post And Methods For Dynamic Spinal Stabilization” (Attorney Docket No. SPART-01044US4); and
- [00140] U.S. Provisional Application No. 61/167,789 filed April 8, 2009, entitled “Load-sharing Component Having A Deflectable Post And Spring And Methods For Dynamic Spinal Stabilization” (Attorney Docket No. SPART-01049US0); and
- [00141] U.S. Provisional Application No. 61/217,556 filed June 1, 2009, entitled “Load-sharing Component Having A Deflectable Post And Axially-Compressible Spring And Methods For Dynamic Spinal Stabilization” (Attorney Docket No. SPART-01053US0); and
- [00142] U.S. Patent Application No. 12/566,478, filed September 24, 2009, entitled “A Modular In-Line Deflection Rod And Bone Anchor System And Method For Dynamic Stabilization Of The Spine” (Attorney Docket No. SPART-01042US1); and
- [00143] U.S. Patent Application No. 12/566,485, filed September 24, 2009, entitled “Versatile Polyaxial Connector Assembly And Method For Dynamic Stabilization Of The Spine” (Attorney Docket No. SPART-01043US1); and
- [00144] U.S. Patent Application No. 12/566,487, filed September 24, 2009, entitled “Versatile Offset Polyaxial Connector And Method For Dynamic Stabilization Of The Spine” (Attorney Docket No. SPART-01043US2); and
- [00145] U.S. Patent Application No. 12/566,491, filed September 24, 2009, entitled “Load-Sharing Bone Anchor Having A Deflectable Post and Method For Dynamic Stabilization Of The Spine” (Attorney Docket No. SPART-01044US1); and
- [00146] U.S. Patent Application No. 12/566,494, filed September 24, 2009, entitled “Load-Sharing Component Having A Deflectable Post And Method For Dynamic Stabilization Of The Spine” (Attorney Docket No. SPART-01044US5); and
- [00147] U.S. Patent Application No. 12/566,498, filed September 24, 2009, entitled “Load-Sharing Bone Anchor Having A Durable Compliant Member And Method For Dynamic Stabilization Of The Spine” (Attorney Docket No. SPART-01044US6); and
- [00148] U.S. Patent Application No. 12/566,504, filed September 24, 2009, entitled “Load-Sharing Bone Anchor Having A Deflectable Post With A Compliant Ring And Method For Stabilization Of The Spine” (Attorney Docket No. SPART-01044US7); and

- [00149] U.S. Patent Application No. 12/566,507, filed September 24, 2009, entitled “Load-Sharing Bone Anchor Having A Deflectable Post With A Compliant Ring And Method For Stabilization Of The Spine” (Attorney Docket No. SPART-01044US8); and
- [00150] U.S. Patent Application No. 12/566,511, filed September 24, 2009, entitled “Load-Sharing Bone Anchor Having A Deflectable Post And Method For Stabilization Of The Spine” (Attorney Docket No. SPART-01044US9); and
- [00151] U.S. Patent Application No. 12/566,516, filed September 24, 2009, entitled “Load-Sharing Bone Anchor Having A Deflectable Post And Method For Stabilization Of The Spine” (Attorney Docket No. SPART-01044USA); and
- [00152] U.S. Patent Application No. 12/566,519, filed September 24, 2009, entitled “Dynamic Spinal Rod And Method For Dynamic Stabilization Of The Spine” (Attorney Docket No. SPART-01044USC); and
- [00153] U.S. Patent Application No. 12/566,522, filed September 24, 2009, entitled “Dynamic Spinal Rod Assembly And Method For Dynamic Stabilization Of The Spine” (Attorney Docket No. SPART-01044USD); and
- [00154] U.S. Patent Application No. 12/566,529, filed September 24, 2009, entitled “Configurable Dynamic Spinal Rod And Method For Dynamic Stabilization Of The Spine” (Attorney Docket No. SPART-01044USE); and
- [00155] U.S. Patent Application No. 12/566,531, filed September 24, 2009, entitled “A Spinal Prosthesis Having A Three Bar Linkage For Motion Preservation And Dynamic Stabilization Of The Spine” (Attorney Docket No. SPART-01044USF); and
- [00156] U.S. Patent Application No. 12/566,534, filed September 24, 2009, entitled “Surgical Tool And Method For Implantation of A Dynamic Bone Anchor” (Attorney Docket No. SPART-01045US1); and
- [00157] U.S. Patent Application No. 12/566,547, filed September 24, 2009, entitled “Surgical Tool And Method For Connecting A Dynamic Bone Anchor and Dynamic Vertical Rod” (Attorney Docket No. SPART-01045US2); and
- [00158] U.S. Patent Application No. 12/566,551, filed September 24, 2009, entitled “Load-Sharing Bone Anchor Having A Deflectable Post And Centering Spring And Method For Dynamic Stabilization Of The Spine” (Attorney Docket No. SPART-01049US1); and
- [00159] U.S. Patent Application No. 12/566,553, filed September 24, 2009, entitled “Load-Sharing Component Having A Deflectable Post And Centering Spring And Method For Dynamic Stabilization Of The Spine” (Attorney Docket No. SPART-01049US2); and

[00160] U.S. Patent Application No. 12/566,559, filed September 24, 2009, entitled "Load-Sharing Bone Anchor Having A Deflectable Post And Axial Spring And Method For Dynamic Stabilization Of The Spine" (Attorney Docket No. SPART-01053US1); and

[00161] U.S. Patent Application No. 12/130,395, filed May 30, 2008, entitled "A Deflection Rod System For A Dynamic Stabilization And Motion Preservation Spinal Implantation System And Method" (Attorney Docket No.: SPART-01037US1); and

[00162] U.S. Patent Application No. 12/130,095, filed May 30, 2008, entitled "A Spine Implant With A Deflection Rod System Including A Deflection Limiting Shield Associated With A Bone Screw And Method" (Attorney Docket No.: SPART-01039US2).

[00163] FIGS. 7A-9 illustrate a still further embodiment of a deflection rod system 700 in accordance with the present invention. FIG. 7A is a posterior view of an alternative embodiment of a dynamic spine stabilization system in accordance with the present invention. FIG. 7B is a lateral view of the dynamic spine stabilization system of FIG. 7A. Referring to FIGS. 7A and 7B, the deflection rod system 710 can be connected with an anchoring device 702 after the anchoring device 702 is secured to a pedicle. Such embodiments can reduce visual obstruction of the pedicle during seating of the anchoring device 702 by reducing the size of the structure seated.

[00164] An anchoring block 732 receives the anchoring device 702 through an aperture 731 and is secured to the pedicle as threads 106 of the anchoring device 702 grip the bone and the head 704 is seated within the anchoring block 732. The anchoring block 732 includes an internal screw thread 734 through at least a portion of the anchoring block 732 for receiving a screw 742 to secure a deflection rod system arm 730 of the deflection rod system 710. As in previous embodiments, the deflection rod system 710 includes a deflection rod shield or guide 716 and a deflection rod 711 including an inner rod (not visible) within an outer shell 714.

[00165] FIG. 7C is a caudal view of the dynamic spine stabilization system of FIGS. 7A and 7b. As shown in FIG. 7C, deflection rod system 710 is connected with an arm 730 having a curved base that meets a curved surface of the anchoring block 732. The arm 730 can pivot slightly relative to the anchoring device 702, allowing the surgeon to adjust an angle of protrusion of the deflection rod system 710 relative to the spine. The arm 730 is fastened to the anchoring block 732 by the screw 742 which is connected through a spacer 744 having a surface in sliding contact with a curved surface of the arm 730 to distribute force generally evenly along the arm 730 when arranged at a desired orientation. In this arrangement, preferably, the joint 718 is adjacent with and located over the anchor 702 in order to minimize

or eliminate the transfer of torque forces from the rod 720 to the anchor 702. Other complementary mating surfaces may be used to obtain the desired relative motion.

[00166] A vertical rod 720 is connected to the deflection rod 711 and can urge the deflection rod 711 in response to relative movement of two vertebrae between which the vertical rod 720 extends. A distal end of the deflection rod 711 can be fixedly mated with a spherical (or semi-spherical) ball or joint 718 that can pivot within a cradle at a proximal end of the vertical rod 720. The vertical rod 720 can pivot in a posterior-to-anterior or anterior-to-posterior direction about the joint 718, and optionally can pivot in a lateral direction. The pivoting motion can allow adjustment of the vertical rod 720 relative to the deflection rod system 710 to ease manipulation of the dynamic stabilization system during implantation and optionally to reduce torque forces applied to the deflection rod 711. A distal end of the vertical rod 720 can be fixedly connected with an upper or lower vertebra of the two vertebrae by an additional anchoring device 752. The anchoring device can resemble anchoring devices as described in U.S. Provisional Application No. 61/031,598. As shown, the anchoring device 752 includes a saddle 758 that can receive the vertical rod 720. A locking set screw 754 can be urged along threads of the saddle 758 so that the locking set screw 754 secures the vertical rod 720 against the U-shaped channel of the saddle 758. A bone screw thread 756 can optionally be mated with a body of the anchoring device 752 by a fastener 772 that permits at least cranial-to-caudal pivoting. The saddle 758 can include a hex-shaped outer surface to assist in seating the bone screw 756 within the upper pedicle 8.

[00167] As shown in FIGS. 8 and 9, the deflection rod system 700 of FIGS. 7A-7C can be arranged with the deflection rod system 710 anchored to an upper of two vertebrae, or alternatively, the lower of two vertebrae. FIG. 8 is a posterior view of the dynamic spine stabilization system of FIGS. 7A-7C implanted and extending between two vertebrae of a spine. As shown in FIG. 8, the deflection rod system 700 of FIGS. 7A-7C is arranged with the deflection rods 710 anchored to the upper vertebra 2 of two vertebrae 2, 4. FIG. 9 is a posterior view of the dynamic spine stabilization system of FIG. 7A implanted in an alternative arrangement to FIG. 8 and extending between the two vertebrae. As shown in FIG. 9, the deflection rod system 700 of FIGS. 7A-7C is arranged with the deflection rods 710 anchored to the lower vertebra 4 of two vertebrae 2, 4.

[00168] FIG. 10 is a posterior view of a still further embodiment of a deflection rod system implant 1000 in accordance with the present invention comprising a deflection rod system 610 that is engaged during spine extension, but not engaged during spine flexion. The deflection rod system 610 and associated structures resemble the deflection rod system and associated

structures of FIG. 6, and can be connected with a horizontal rod 680 extending between pedicles of a vertebra. A vertical rod 1020 is connected at a proximal end to a deflection rod 111 of the deflection rod system 610. The distal end of the vertical rod 1020 is unattached and slides within a boot 1090. The boot 1090 blocks movement of the vertical rod 1020 when the distal end of the vertical rod 1020 abuts the base of the boot 1090, and further extension movement will cause the vertical rod 1020 to deflect the deflection rod 111. The boot 1090 is preferably sized to accommodate movement of vertical rod 1020 within the boot 1090 that spans a length of natural movement of the spine during extension, to avoid separation of the vertical rod 1020 from the boot 1090. Alternatively, the distal end of the vertical rod can include a ball or other slidable structure that is held within a cavity of the boot, enabling the boot to resist both extension and flexion, and to permit a range of free motion determined by the surgeon. As shown, in FIG. 10, the boot 1090 is connected with an anchoring device 1052 by an arm 1070. A locking screw 1062 resists rotation of the boot 1090 about the anchoring device 1052 in response to a force applied by the vertical rod 1020.

[00169] FIG. 11A is a posterior view (in partial cross-section) and FIG. 11B is a lateral view (in partial cross-section) of a still further embodiment of a deflection rod system implant 1100 for use with dynamic stabilization systems accordance with the present invention. The deflection rod system implant 1100 is adapted to support multiple motion segments and includes a first deflection rod system 1110a connected with a vertical rod 1120a extending cranially, a second deflection rod system 1110b connected with a vertical rod 1120b extending caudally, and an anchoring device 1102. The first and second deflection rod systems 1110a, 1110b can have similar or different bending or load carrying or stiffness characteristics, as prescribed by the surgeon or a physician. A common arm 1130 connects the first and second deflection rod systems 1110a, 1110b with the anchoring device 1102. As shown in FIG. 11B, the arm 1130 includes an aperture 1131 through which the anchoring device 1102 is received and driven into the bone. The anchoring device 1102 includes a head 1104 that interferes with passage of the anchoring device 1102 through the aperture 1131. Threads 1106 of the anchoring device 1102 grip the bone to hold the arm 1130 between the bone and the head 1104, thereby affixing the arm 1130 and by extension the deflection rod systems 1110a, 1110b. The arm 1130 can be adapted to connect with a horizontal rod 1180 that extend between pedicles 10 of a vertebra. The horizontal rod 1180 can, for example be received in U-shaped slots of the arm 1130 and urged against the head 1104 of the anchoring device 1102 by a locking set screw 1144 having external threads that mate with internal threads of the walls of the arm channel.

[00170] FIG. 12 is a lateral view of the dynamic spine stabilization system of FIG. 11A comprising an alternative seating arrangement for a horizontal rod. The deflection rod system implant 1200 resembles the deflection rod system implant 1100 of FIG. 11B. However, the deflection rod system implant 1200 has a compressor element or cradle 1236 positioned
5 within the channel and between the horizontal rod 1180 and anchoring device 1202. As shown, the head 1204 of the anchoring device 1202 has a spherical or semi-spherical shape, although alternatively the head can have some other shape that complements the compressor element or cradle 1236 while permitted at least limited movement between the two structures to allow flexibility in relative arrangement during implantation. For example, the head can
10 have a rounded indentation mateable with a spherical surface.

[00171] The compressor element or cradle 1236 has a generally cylindrical body so that the compressor element 1236 can fit within a bore of the arm 1230. A posterior surface of the compressor element 1236 is concave and generally complementing the horizontal rod 1180 which rests thereon. The anterior surface of the compressor 1236 is in sliding contact with the
15 head 1204 to allow the anchoring device 1202 to be positioned as desired and/or appropriate. The locking set screw 1144 urges the horizontal rod 1180 against the compressor element 1236, which in turn is urged against the head 1204 of the anchoring device 1202. Alternatively, the compressor element 1236 and head 1204 can have some other complementary shape that allows some or no sliding contact between the structures.

[00172] FIG. 13 is a posterior view of the deflection rod system implant 1100 of FIG. 11A comprising the first deflection rod system 1110a and second deflection rod system 1110b secured to a vertebra 4 by an anchoring device 1102. Vertebra 4 is located between two adjacent vertebrae 2, 5. Deflection rod system implant 1100 thus spans two motion segments targeted for stabilization. A first vertical rod 1120a is connected to a deflection rod 111a of
25 the first deflection rod system 1110a and extends cranially to the upper vertebra 2 of the upper targeted motion segment. vertical rod 1120a is secured to the upper vertebra 2 by a clamp 162 connected by an arm 170 to an anchoring device 152. A second vertical rod 1120b is connected to a deflection rod 111b of the second deflection rod system 1110b and extends caudally to the lower vertebra 5 of the lower targeted motion segment. Vertical rod 1120b is
30 secured to the lower vertebra 5 by a clamp 162 connected by an arm 170 to an anchoring device 152. The vertical rods 1120a, 1120b urge respective deflection rods 111a, 111b in response to relative movement of the two vertebrae 2, 5 between which the vertical rods 1120a, 1120b extend. Preferably, vertical rod 1120a is aligned with vertical rod 1120b in order to reduce or eliminate torque forces. An arm 1130 common to the deflection rod

systems 1110a, 1110b is connected with a horizontal rod 1180 that extends between pedicles of the middle vertebra 4 to a complementary pair of deflection rod systems. The horizontal rod 1180 is positioned between adjacent spinous processes associated with the vertebrae 2, 4 and can pierce or displace the interspinous ligament without severing or removing tissue. The horizontal rod 1180 can resist rotation of the deflection rod systems 1110a, 1110b and can be used in place of locking screws.

[00173] FIGS. 14A and 14B illustrate yet another embodiment of a deflection rod system implant 1400 in accordance with the present invention. FIG. 14A is a posterior view of an alternative embodiment of a dynamic spine stabilization system in accordance with the present invention. FIG. 14B is a lateral view of the dynamic spine stabilization system of FIG. 14A. Deflection rod system implant 1400 includes a deflection rod system 1410 connectable with an anchoring device 1402, preferably after the anchoring device 1402 is secured to a pedicle. An arm 1430 of the deflection rod system 1410 includes a collar 1464 that can be received over a head 1404 of the anchoring device 1402 to capture a horizontal bar 1480. The arm 1430 can be secured to the head 1404 by a collar screw 1450. The horizontal bar 1480 can be held in place by one or both of the arm 1430 which is urged against the horizontal bar 1480 by the collar screw 1450, and a locking set screw 1458. Optionally, the head 1404 of the anchoring device can be connected with a yoke 1407 by a pin 1403 to allow the head 1404 to be pivoted during implantation. Such an arrangement can allow a thread 106 of the anchoring device 1402 to be seated within the pedicle at an angle relative to a plane of the collar.

[00174] FIG. 15 shows a posterior view of the dynamic spine stabilization system of FIGS. 14A and 14B implanted and extending between two vertebrae 2, 4 of a spine. Referring to FIG. 15, the deflection rod system implant 1400 of FIGS. 14A and 14B is shown implanted between two vertebrae 2, 4 to stabilize the motion segment associated with the vertebrae. The deflection rod system 1410 is anchored to the upper vertebra of the motion segment and a vertical rod 1420 is connected between a deflection rod 1411 of the deflection rod system 1410 and a clamp 162 connected with the lower vertebra by an anchoring device 152.

[00175] FIG. 16 is a posterior view of yet another embodiment of a dynamic spine stabilization system in accordance with the present invention implanted and extending between two vertebrae 2, 4 of a spine. As shown in FIG. 16, deflection rod system implant 1600 includes a deflection rod system 1610 connected with an arm 1630 that resembles the arm 1430 of FIG. 14A, 14B and 15. However, the deflection rod system 1610 is connected with the arm 1630 so that the deflection rod 111 extends toward the spinous process of vertebra 2 rather than away from the spinous process (i.e., the deflection rod system 1610 is

“inboard). The clamp 162 is connected with the anchoring device 152 by a clamp arm 1670 that likewise extends toward a spinous process of vertebra 4.

[00176] The embodiments described above include deflection rods extending generally in a transverse direction to the orientation of the bone anchor screw. In still other embodiments, deflection rod systems can be oriented generally in a co-axial or collinear or parallel orientation to a bone anchor screw. Referring to FIGS. 17-22, the deflection rod system can extend substantially co-axial or parallel to the threaded shaft of an anchoring device. As will be appreciated upon reflecting on the teaching provided herein, such embodiments can simplify implantation, reduce trauma to structures surrounding an implantation site, and reduce system components.

[00177] FIG. 17 illustrates an embodiment of a deflection rod system implant 1700 comprising an anchoring device 1702 with a cavity 1709 for receiving a deflection rod system 1710. In some embodiments, the cavity can have a size and shape that can accommodate deflection rod systems having a range of different performance characteristics (e.g., stiffness, range of motion). A physician or surgeon can implant an anchoring device 1702 selected independently from the deflection rod system 1710 and based on the anatomy into which it is implanted. For example, the anchoring device 1702 can be selected based on the location of the vertebrae (e.g., L5-S1 vs. C7-T1) or the age and sex of the patient. The deflection rod system 1710 can then be selected based on the desired performance characteristics. The deflection rod system 1710 can be seated within the cavity using myriad different techniques. For example, the deflection rod guide or shield 1716 can be press fit into the walls of the cavity 1709, or the deflection rod guide 1716 can be cemented or otherwise adhesively fixed to the walls of the cavity 1709. Alternatively, the deflection rod guide or shield 1716 can be captured in the cavity 1709 by a locking set screw or ratchet feature. Further, the deflection rod guide 1716 (and deflection rod system 1710) can have a length longer than that of the cavity 1709 so that a portion of the deflection rod guide 1716 extends outside of the cavity 1702 and posterior to the anchoring device 1702. One of ordinary skill in the art, upon reflecting on the teachings provided herein, will appreciate the myriad ways in which the deflection rod system 1710 can be fixedly associated with an anchoring device 1702.

[00178] It has been observed that acceptable anchoring can be achieved in a bone such as a pedicle using a thread 1706 pattern that include deep threads nearer the distal end of the shaft and comparatively shallow threads nearer the shank. The comparatively shallow threads near the shank leave additional cross-section of material within the shank to accommodate the deflection rod system 1710. As shown in FIG. 17, anchor 1702 is provided with deep threads

1706x (i.e., having a maximum difference between inner diameter, D_{11} , and outer diameter, D_O , of a shaft of the anchoring device) nearer the distal end of the shaft. Anchor 1702 is provided with comparatively shallow threads 1706y nearer the shank 1705. The comparatively shallow threads 1706y can enable a larger inner diameter, D_{12} , of the shank 1705 of anchoring device 1702 which can accommodate the deflection rod system 1710. Thus, in some embodiments, the anchor 1703 may be threaded over a length of the shank which includes cavity 1709. Thus, upon implantation, in a vertebra, the portion of the shank of anchor 1702 which includes cavity 1709 may be implanted at or below the surface of the bone. Consequently, portions of coaxially mounted deflection rod system 1710 may be at or below the surface of the vertebra upon installation in cavity 1709.

[00179] The deflection rod system 1700 of FIG. 17 generally includes less, or simpler footprint than the previously described embodiments, potentially reducing the amount of displacement of tissue and/or bone, reducing trauma to tissue and/or bone during surgery. Further, the smaller footprint can reduce the amount of tissue that needs to be exposed during implantation. Still further, arranging the deflection rod system 1710 co-axial with a shaft of the anchoring device 1702 can substantially transfer a moment force applied by the deflection rod system 1710 from a moment force tending to pivot or rotate the anchoring device 1702 about the axis of the shaft, to a moment force tending to act perpendicular to the axis of the shaft. The deflection rod system implant 1700 can effectively resist repositioning of the deflection rod system 1710 and/or anchoring device 1702 without the use of locking screws or horizontal bars to resist rotation. Eliminating locking screws and/or horizontal bars can reduce exposure of tissue and/or bone to foreign bodies and reduce the complexity of the implant and method of implantation.

[00180] FIG. 18 illustrates an alternative embodiment of a deflection rod system implant 1800 comprising an anchoring device 1802 with a cavity 1809 for receiving a deflection rod 111. The embodiment resembles the deflection rod system 1700 of FIG. 17; however, the deflection rod guide or shield 1816 is integrally formed in a shank 1805 of the anchoring device 1802. The deflection rod guide or shield 1816 can be sized and shaped to provide, in combination with the choice of inner rod 112 and outer shell 114, a desired performance characteristic. Integrally forming the deflection rod guide 1816 in a shank 1805 of the anchoring device 1802 can potentially reduce a thickness otherwise required to accommodate separate components. The deflection rod 111 can be mated with the deflection rod guide 1816 applying similar techniques to mate deflection rods within previously described deflection rod guide or shield. The deflection rod 111 is installed in the anchor 1802 such that deflection rod

111 is coaxial with the anchor 1802. Note again that anchoring device 1802 has threads 1806 which extend over cavity 1809 in anchor 1802.

[00181] FIG. 19 illustrates a still further embodiment of a deflection rod system implant 1900 comprising an anchoring device 1902 with a cavity 1909 including inner threads for receiving a deflection rod system screw 1913, with complementary external threads extending from a deflection rod system 1910. The deflection rod system screw 1913 provides easy mating of the deflection rod system 1910 with the anchoring device 1902. Once again deflection rod system 1910 is installed coaxial with anchor 1902. The deflection rod system 1910 can further include a spherical (or semi-spherical) ball or joint 1918 that allows pivoting of a vertical rod 1920 connected with the deflection rod system 1910 so that the vertical rod 1920 can be oriented in a needed direction as the deflection rod system 1910 is rotated and the deflection rod system screw 1913 is seated within the cavity 1909. The vertical rod 1920 can then be pivoted into place extending between pedicles. The embodiment of FIG. 19 can simplify and shorten surgery by providing an easy technique for implanting the deflection rod system 1910.

[00182] FIGS. 20A and 20B illustrate yet another embodiment of a deflection rod system implant 2000 in accordance with the present invention comprising an anchoring device 2002 with a housing 2009 for receiving a deflection rod system 2010. The embodiment resembles the deflection rod system implant 1700 of FIG. 17; however, housing 2009 is connected with the anchoring device 2002 at the shank 2005, but is not formed in the shank 2005. Depending on the outer diameter of the housing 2009 and the inner diameter of the cavity that receives the deflection rod system 2010, the housing 2009 permits use of one or both of (1) a threaded shaft 2006 having a smaller diameter (for example for use in smaller bones, such as in the cervical region) and (2) a deflection rod system 2010 comprising a deflection rod guide shield 2016 with a larger diameter (e.g., for use with thicker (and stiffer) deflection rods). As shown, the housing 2009 further includes a threaded screw hole 2057 extending along an axis at an acute angle to the axis of the threaded shaft. The threaded screw hole 2057 receives a locking set screw 2058 that when seated (FIG. 20B) protrudes into the housing 2009 or against the deflection rod system 2010, where the deflection rod system 2010 is seated within the housing 2009. The locking set screw 2058 holds the deflection rod system 2010 in place within the housing 2009. In this embodiment, a deflection rod system 2010 can be selected to have an appropriate stiffness for the patient. Further, if several deflection rod system implants 2000 are used in a patient, each deflection rod system 2010, if desired, can have a different stiffness.

[00183] FIG. 21 is a posterior view of the deflection rod system implant 2000 of FIGS. 20A and 20B implanted between pedicles 8, 10 of adjacent vertebrae of a targeted motion segment. As shown, the end of a vertical rod 2020 connected with the deflection rod system implant 2000 is connected at the other end with a deflection rod system 2010, in contrast to
5 previous figures. Alternatively, one end of the vertical rod 2020 can be connected with an anchoring device such as described above, for example in FIG. 9. As will be appreciated, the deflection rod system implant 2000 has a small footprint from a posterior perspective.

[00184] FIG. 22 is a posterior view of still another embodiment of a deflection rod system implant 2200 in accordance with the present invention adapted to support multiple motion
10 segments. An anchoring device 2202 resembles the anchoring devices of FIGS. 17-20B and includes an outer wall 2203 having a hex portion for gripping using a torque wrench or other tool during implantation of the anchoring device 2202 in a bone. An anchoring device 2202 is secured to each of the two pedicles 8, 10 of a vertebra common to the two motion segments to be supported. A vertical rod 2220 connected with a deflection rod system 2210 mated with the
15 anchoring device 2202, extends between the common vertebra and an upper vertebra of the upper motion segment, and is connected to a pedicle 8 of the upper vertebra by an upper anchoring device 752. As above, the vertical rod 2220 is connected to the deflection rod and can deflect the deflection rod in response to relative movement of the common vertebra and upper vertebra between which the upper vertical rod 2220 extends. Another vertical rod 2222
20 includes a yolk 2223 resembling a box-end wrench with a shape generally complementing the hex pattern of the outer wall of the bone anchor. The yolk 2223 is received over the outer wall 2203 of the anchoring device 2202, and can resist rotation the vertical rod 2222 relative to the anchoring device 2202. The vertical rod 2222 extends to the lower vertebra of the lower motion segment, and is connected to a pedicle 12 of the motion segment by a lower anchoring
25 device 752. The vertical rod 2222 can resist movement between the common vertebra and the lower vertebra and thus supplement or substitute for other fusion devices, for example.

[00185] FIG. 23 is a lateral view (in partial cross-section) of an alternative embodiment of a deflection rod system implant 2300 for use with dynamic stabilization systems in
30 accordance with the present invention and adapted to dynamically support multiple motion segments of the spine. The deflection rod system implant 2300 resembles the deflection rod system implant 1100 of FIG. 11A, but includes deflection rod systems generally oriented in an anterior-to-posterior direction. The deflection rod system implant 2300 is adapted to support multiple motion segments and includes a first deflection rod system 2310a connected with a vertical rod 120a extending cranially, a second deflection rod system 2310b connected

with a vertical rod 120b extending caudally, and an anchoring device 2302. The first and second deflection rod systems 2310a, 2310b can have similar or different bending characteristics, as prescribed by the surgeon or a physician. A common arm 2330 connects the first and second deflection rod systems 2310a, 2310b with the anchoring device 2302. The orientation of the deflection rod systems 2310a, 2310b can reduce the moment force that tends to cause rotation of the arm 2330; however, in other embodiments it may be desirable to include a head capable of receiving a horizontal rod to further resist moment force. In this embodiment, the deflection rod systems 2310a, 2310b are substantially parallel.

[00186] FIG. 24A is a lateral view (in partial cross-section) and FIG. 24B is a cranial view (in partial cross-section) of still another embodiment of a deflection rod system implant 2400 for use with dynamic stabilization systems accordance with the present invention and adapted to dynamically support multiple motion segments. The deflection rod system implant 2400 resembles the deflection rod system implant 2300 of FIG. 23. An arm 2430 is mated with the anchoring device 2402 after the anchoring device 2402 has been implanted within a bone. The arm 2430 receives a locking screw 2440 having threads that complement threads of a screw hole within the head 2404 of the anchoring device 2402. The locking screw 2440 fixedly connects the arm 2430 to the anchoring device 2402 when the locking screw 2440 is seated within the head 2404. The embodiment also includes a deflection rod guide or shield 2416 integrally formed with the arm 2430. In this embodiment, the deflection rod systems 2410 are substantially parallel. As seen in FIGS. 24A, 24B the arm 2430 can connect to the head 2404 in a number of orientations. This can be accomplished with an arm 2430 with a convex surface that mates with a concave surface of the head 2404 as shown, by way of example only, in FIG. 7C.

[00187] FIG. 25 is a posterior view of the deflection rod system implant 2300 of FIG. 23 comprising the first deflection rod system 2310a and second deflection rod system 2310b secured to a vertebra common to two adjacent motion segments or vertebrae targeted for stabilization by an anchoring device. A first vertical rod 2320a is connected to a deflection rod 2311a of the first deflection rod system 2310a and extends cranially to the upper vertebra of the upper targeted motion segment, and is secured to the upper vertebra by an upper anchoring device 752. A second vertical rod 2320b is connected to a deflection rod 2311b of the second deflection rod system 2310b and extends caudally to the lower vertebra of the lower targeted motion segment, and is secured to the lower vertebra by a lower anchoring device 752. The vertical rods 2320a, 2320b deflect respective deflection rods 2311a, 2311b in

response to relative movement of the two vertebrae between which the vertical rods 2320a, 2320b extend.

[00188] FIG. 26 illustrates an embodiment of a deflection rod system implant 2600 comprising an anchoring device 2602 with a cavity 2609 (in FIG. 27) for receiving a deflection rod system 2610. As mentioned above, it has been observed that acceptable anchoring can be achieved in a bone such as a pedicle using a thread 2606 pattern that include deep threads 2606y and shallow threads 2606x. The anchoring device 2602 can have a length such that when implanted a portion of the anchoring device 2602 further from the deflection rod system 2610 is seated within cancellous bone while a portion of the anchoring device 2602 nearer the deflection rod system 2610 is seated within cortical bone. Screw threads 2606x having a high pitch (i.e., having a comparatively large gap between threads) and deep threads are usable with satisfactory results in cancellous bone, which bone is an osseous tissue with a low density strength but high surface area. Screw threads 2606y having a low pitch and shallow threads are usable with satisfactory results in cortical bone, which bone is an osseous tissue with a high density strength. The diameter of the anchoring device shaft can be expanded along a portion 2620 of the shaft that is seated within the cortical bone and/or a portion of the shaft that accommodates the deflection rod system 2610. Expanding the diameter of the shaft can allow the threads to cut new thread patterns within the cortical bone, and can accommodate a deflection rod system 2610 (or range of deflection rod systems) having a larger diameter. Further, the diameter of the shaft can be larger where the cortical threads are, as the vertebral bone is thicker in this area. For the same reason, the corresponding diameter of the bone as shown in FIG. 27 can be larger.

[00189] FIG. 27 illustrates a still further embodiment of a deflection rod system implant 2700 comprising an anchoring device 2702 including an external thread pattern resembling the external thread pattern of FIG. 26, and further including a cavity 2709 with inner threads for receiving an deflection rod system screw 1913, with complementary external threads extending from an deflection rod system 1910. The deflection rod system screw 1913 provides easy mating of the deflection rod system 1910 with the anchoring device 2702. The deflection rod system 1910 can further include a spherical (or semi-spherical) ball or joint 118 that allows pivoting of a vertical rod 120 connected with the deflection rod system 1910 so that the vertical rod 120 can be oriented in a needed direction as the deflection rod system 1910 is rotated and the deflection rod system screw 1913 is seated within the cavity 2709. The vertical rod 120 can then be pivoted into place extending between pedicles.

[00190] Referring again to FIG. 22, multiple motion segments can be stabilized by stringing together vertical rods and deflection rod systems individually selected for the corresponding motion segment. As shown in FIG. 22, the yoke 2223 of a vertical rod 2222 is fitted over the outer wall 2203 of a deflection rod system 2210. An opposite end of the vertical rod 2222 is connected to an anchoring device 2202. However, in still other
5 vertical rod 2222 is connected to an anchoring device 2202. However, in still other embodiment (as shown in FIG. 28), the vertical rod 2822 can be connected with a second deflection rod system 2810b anchored by an anchoring device 2808b to a pedicle 12 of a lower vertebra of the motion segment. The deflection rod system 2810b allows controlled relative movement of the two vertebrae. Systems and methods in accordance with the present
10 invention can include a series of implants connected with, and selected for the corresponding motion segment. The implants can include vertical rods rigidly connected between vertebrae as shown in FIG. 22 (for example to support fusion), or alternatively the vertical rods can be dynamically connected between vertebrae by a deflection rod system as shown in FIG. 28. Any combination of implants can be used having a stiffness selected for the respective motion
15 segment. For example, FIG. 29 illustrates dynamic stabilization of three motion segments with two yoked vertical rods 2922a, 2922b fitted over dynamic stabilization systems 2810a, 2810b anchored at an upper vertebra of the targeted segment.

[00191] While the vertical rods 2822, 2922 of FIGS. 28 and 29 are shown to be connected with dynamic stabilization systems implanted in respective pedicles, embodiments of systems
20 and methods can include vertical rods that are connected with dynamic stabilization systems after implantation of dynamic stabilization systems. The vertical rods 2822, 2922 can be attachable with a dynamic stabilization system at or near the connection with the spherical ball joint. Such an arrangement can allow a yoke of a vertical rod to be placed over and around the outer wall of a dynamic stabilization system (or simply past the spherical ball joint
25 in a staging position for further adjustment) without interference from the vertical rod of that dynamic stabilization system.

[00192] It is proposed that a preferred embodiment may have the following preferred dimensions, although dimension can vary substantially based on a number of performance factors.

- Inner rod having a diameter of about .080 inches.
- Outer shell having a major diameter of about 0.165 inches and the tapered portion tapers at about 2.5 degrees per side.
- Shield and deflection guide having a housing diameter of about 0.265 inches.

- The deflection rod is secured to the deflection guide along a length of about 0.200 inches from the end of the deflection rod system.

- The deflection rod system has a working length from the end of the system to the center of the ball joint of about 1.040 less the press fit length of about 0.200 which is length of
5 about 0.840.

- The overall length of the deflection rod system is about 1.100 inches.

- The spherical ball in the ball and socket joint that secures the vertical rod to the deflection rod system has a diameter of about 0.188 inches.

- The vertical rod has a diameter of about 0.150 inches.

10

Additional Deflection Rod System Implant Embodiments

[00193] FIGS. 30-32 illustrate an alternative embodiment of a deflection rod system implant 2900 including an anchoring device 2902 with a cavity 1709 for receiving a deflection rod system 2904 that is substantially similar to the deflection rod system implant
15 1700 in FIG. 17. In this embodiment of the deflection rod system implant 2900, the anchoring device 2902 includes an external housing 2906 having a threaded screw hole 2908 for receiving a locking device 2916 (e.g., a locking screw). In this embodiment, the external housing 2906 is integrally attached to the anchoring device 2902 proximal to the top 2910 of the shank 1705 of the anchoring device 2902.

20 [00194] As shown in FIG. 32, the deflection rod system 2904 of this embodiment is substantially similar to the deflection rod system 1710 illustrated in FIG. 17. In this embodiment of the deflection rod system 2904, the deflection rod guide or shield 1716 includes an upper rim 2912 having an external band forming an eyelet 2914 laterally attached to the upper rim 2912.

25 [00195] In the deployed configuration of the deflection rod system implant 2900, the deflection rod guide or shield 1716 can be inserted into the cavity 1709 of the anchoring device 2902 until the upper rim 2912 contacts the top 2910 of the shank 1705 of the anchoring device 2902. Once the deflection rod system 2904 has been inserted, the eyelet 2914 can be aligned with the threaded screw hole 2908 of the external housing 2906 of the anchoring
30 device 2902 as shown in FIG. 30. In this configuration, a locking device can be inserted into the eyelet 2914 of the deflection rod guide or shield 1716 as well as the threaded screw hole 2908 of the external housing 2906 of the anchoring device 2902 in order to secure the deflection rod system 2904 to the anchoring device 2902 and/or prevent the deflection rod system 2904 from moving relative to the anchoring device 2902 during use.

[00196] FIGS. 33-37 illustrate another embodiment of a deflection rod system implant 3000 including an anchoring device 3002 with a cavity 1709 for receiving a deflection rod system 3004 that is substantially similar to the deflection rod system implant 1700 in FIG. 17. In this embodiment of the deflection rod system implant 3000, the anchoring device 3002
5 includes a plurality of concave grooves 3006 about the outer surface of the shank 1705 of the anchoring device 2902, the concave grooves 3006 being located proximal to the top 3008 of the shank 1705 of the anchoring device 2902. The concave grooves 3006 are oriented in a collinear orientation relative to the longitudinal axis of the anchoring device 3002 as shown in FIGS. 33-34. In this embodiment, the concave grooves 3006 are located on the shank 1705 of
10 the anchoring device 2902 between the top 3008 of the shank 1705 and a channel 3010 located on the shank 1705 of the anchoring device 2902, the channel 3010 being oriented perpendicular to the concave grooves 3006 and circumferentially about the shank 1705 as shown in FIG. 34.

[00197] As shown in FIG. 35, the deflection rod system 3004 of this embodiment is
15 substantially similar to the deflection rod system 1710 illustrated in FIG. 17. In this embodiment of the deflection rod system 3004, however, the deflection rod guide or shield 1716 also includes an upper rim 3012 having an external housing 3014, the external housing 3014 including an aperture 3018 for receiving a locking device 3016 (e.g., a screw or a cam). In this embodiment, the locking device 3016 is a cam that is placed within the aperture 3018
20 of the external housing 3014 to help secure the deflection rod system 3004 to the anchoring device 3002 as will be described in greater detail below.

[00198] In the deployed configuration of the deflection rod system implant 3000, the deflection rod guide or shield 1716 of the deflection rod system 3004 is inserted into the cavity 1709 of the anchoring device 3002 until the upper rim 3012 contacts the top 3008 of
25 the shank 1705 of the anchoring device 3002 and the external housing 3014, if so configured, can be positioned within one of the concave grooves 3006 surrounding the shank 1705. Alternatively the external housing 3014 can be positioned on the anchoring device 3002 without engaging the concave grooves 3006 until the locking device 3016 is turned so as to be locked in channel 3010 under the concave grooves 3006. Thus once the deflection rod system
30 3004 has been positioned at the desired location within the anchoring device 3002, the locking device 3016 can be repositioned within the aperture 3018 of the housing 3014 (also as shown in FIGS. 33).

[00199] FIGS. 36A-37 further illustrate how the locking device 3016 is used to help secure the deflection rod system 3004 to the anchoring device 3002 in this embodiment. FIGS. 36A-

36B represent bottom views of the deflection rod system implant 3000, while FIG. 37 represents a bottom perspective view of the deflection rod system implant 3000. As is depicted in FIG. 36A, the locking device 3016, which is a cam in this embodiment, includes a bottom lock tab 3020 having a convex front face 3022 that can initially be oriented away from the anchoring device 3002 as the deflection rod system 3004 is seated in the anchoring device 3002. The locking device 3016 can be rotated in direction 3024 (or the opposite direction) until the convex front face 3022 of the bottom lock tab 3020 is positioned adjacent to the shank 1705 of the anchoring device 2902 as depicted in FIG. 36B and in the channel 3010, so as to be locked into position as shown in FIGS. 36B-37. As shown in FIG. 37, the bottom lock tab 3020 of the locking device 3016 is configured to fit within the channel 3010 on the shank 1705 of the anchoring device 3002 in the deflection rod system implant's 3000 deployed configuration. This configuration allows the anchoring device 3002 to be secured to the anchoring device 3002.

[00200] FIGS. 38-41 illustrate another embodiment of a deflection rod system implant 3100 including an anchoring device 3102 with a cavity 1709 for receiving a deflection rod system 3104 that is substantially similar to the deflection rod system implant 1700 in FIG. 17. In this embodiment of the deflection rod system implant 3100, the anchoring device 3102 includes a channel 3106 located proximal to the top 3108 of the shank 1705 of the anchoring device 3102, the channel 3106 being oriented circumferentially about the shank 1705 as shown in FIG. 39.

[00201] As shown in FIG. 40, the deflection rod system 3104 of this embodiment is substantially similar to the deflection rod system 1710 illustrated in FIG. 17. In this embodiment of the deflection rod system 3004, however, the deflection rod guide or shield 1716 also includes an upper rim 3110 having an external housing 3112, the external housing 3112 including an aperture 3114 for receiving a locking device 3116 (e.g., a locking screw—FIG. 41). In this embodiment, the aperture 3114 is angled relative to the anchoring device 3102 to allow the locking device 3116 to engage the shank 1705 of the anchoring device 3102 as will be explained in greater detail below.

[00202] In the deployed configuration of the deflection rod system implant 3100, the deflection rod guide or shield 1716 of the deflection rod system 3104 is inserted into the cavity 1709 of the anchoring device 3102 until the upper rim 3110 contacts the top 3108 of the anchoring device 3102. In this embodiment, once the deflection rod system 3104 has been positioned at the desired location, the locking device 3116 is screwed through the aperture 3114 of the external housing 3112, the aperture 3114 including a threaded interior surface,

until the bottom 3118 of the locking device 3116 is engaged to the shank 1705 of the anchoring device 3102 within the channel 3106 as shown in FIG. 41. In this configuration, the deflection rod system 3104 is secured to the anchoring device 3102 as the locking device 3116 also prevents the deflection rod system 3104 from moving relative to the anchoring device 3102. A cam device, such as locking tabs 3020 (FIG. 37) can also be used in this embodiment to lock the deflection rod system 3009 to the anchoring device 3002.

Materials of Embodiments of the Invention

[00203] In addition to Nitinol or nickel-titanium (NiTi) other super elastic materials including copper-zinc-aluminum and copper-aluminum-nickel may be used in embodiments of the deflection rods disclosed herein. However for biocompatibility the nickel-titanium is the preferred material.

[00204] As desired, the implant can, in part, be made of titanium, titanium alloy or stainless steel. Other suitable material includes by way of example only polyetheretherketone (PEEK), polyetherketoneketone (PEKK), polyetherketone (PEK), polyetherketoneetherketoneketone (PEKEKK), and polyetheretherketoneketone (PEEKK). Still, more specifically, the material can be PEEK 450G, which is an unfilled PEEK approved for medical implantation available from Victrex of Lancashire, Great Britain. (Victrex is located at www.matweb.com or see Boedeker www.boedeker.com). Other sources of this material include Gharda located in Panoli, India (www.ghardapolymers.com).

[00205] As will be appreciated by those of skill in the art, other suitable similarly biocompatible thermoplastic or thermoplastic polycondensate materials that resist fatigue, have good memory, are flexible, and/or deflectable have very low moisture absorption, and good wear and/or abrasion resistance, can be used without departing from the scope of the invention.

[00206] Reference to appropriate polymers that can be used in the spacer can be made to the following documents. These documents include: PCT Publication WO 02/02158 A1, dated January 10, 2002, entitled "Bio-Compatible Polymeric Materials;" PCT Publication WO 02/00275 A1, dated January 3, 2002, entitled "Bio-Compatible Polymeric Materials;" and PCT Publication WO 02/00270 A1, dated January 3, 2002, entitled "Bio-Compatible Polymeric Materials."

[00207] The foregoing description of preferred embodiments of the present invention has been provided for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Many embodiments were

chosen and described in order to best explain the principles of the invention and its practical application, thereby enabling others skilled in the art to understand the invention for various embodiments and with various modifications that are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the claims and their
5 equivalents.

CLAIMS

What is claimed is:

1. A spine stabilization component comprising:
 - a deflectable post which includes a shaft associated with a compliant member and
 - 5 further associated with a tubular shield;
 - the shaft having a mount at a proximal end;
 - a tubular shield surrounding the compliant member;
 - the mount extending beyond the tubular shield;
 - the compliant member positioned around the shaft between the shaft and the shield
 - 10 such that the mount may deflect relative to the shield; and
 - a fastening mechanism adapted to secure the shield to a bone screw so that the deflectable post is one of substantially parallel and substantially coaxial with the bone screw and the mount is exposed and adapted for connection of a spinal rod.
- 15 2. The spine stabilization component of claim 1, wherein:
 - said tubular shield is adapted to be secured to a bone screw at a plurality of relative rotational positions; and
 - said fastening mechanism is adapted to secure the shield to the bone screw in any one of the a plurality of relative rotational positions.
- 20 3. The spine stabilization component of claim 2, wherein the tubular shield is adapted to fit, at least in part, within a bore in a proximal end of a bone screw with the bore being coaxial with the bone screw.
- 25 4. The spine stabilization component of claim 3, wherein the tubular shield is adapted to fit, substantially entirely within a bore in a proximal end of a bone screw with the bore being coaxial with the bone screw.
- 30 5. The dynamic spine stabilization component of claim 4, wherein the shaft is made of a superelastic metal.
6. The spine stabilization component of claim 5, wherein the compliant member comprises a compliant polymer sleeve.

7. The spine stabilization component of claim 6, in combination with a bone screw having a bore in a proximal end thereof, said bore being configured such that the tubular shield may fit substantially entirely therein.

5

8. The spine stabilization component of claim 6, in combination with a bone screw having a bore in a proximal end thereof, said bore being configured such that the tubular shield may fit substantially entirely therein; and

10 the bone screw having a recess engageable by the fastening mechanism to secure the shield to the bone screw.

9. The spine stabilization component of claim 6, in combination with a bone screw having a bore in a proximal end thereof, said bore being configured such that the tubular shield can fit substantially entirely therein;

15 the bone screw having a recess; and

the fastening mechanism comprises a threaded member which can be turned to engage said recess to secure the shield to the bone screw.

10. The spine stabilization component of claim 6, wherein said fastening mechanism is
20 releasable to permit removal of the spine stabilization component from the bore of a bone anchor.

11. A bone stabilization component comprising:

a deflection rod mounted in a shield;

25 the deflection rod having a mount at a proximal end;

the mount extending beyond the shield;

the deflection rod being configured to allow compliant deflection of the mount relative to the shield; and

30 a connector attached to the shield and adapted to secure the shield to a bone anchor so that the deflection rod is substantially in-line with the bone anchor and the mount is exposed and adapted for connection of a bone-stabilizing rod.

12. The bone stabilization component of claim 11, wherein:

said shield is adapted to be secured to a bone anchor at a plurality of relative rotational positions; and

said connector is adapted to secure the shield to the bone anchor in any one of the a plurality of relative rotational positions.

5

13. The bone stabilization component of claim 11, wherein the shield is adapted to fit, at least in part, within a bore in a proximal end of a bone anchor, the bore being in-line with the bone anchor.

10 14. The dynamic bone stabilization component of claim 11, wherein:
the deflection rod comprises a flexible shaft located within a bore of the shield; and
the bore of the shield and the shaft are substantially coaxial with the shield.

15 15. The dynamic bone stabilization component of claim 11, wherein:
the deflection rod comprises a flexible shaft located within a bore of the shield;
the bore of the shield and the shaft are substantially coaxial with the shield; and
a compliant sleeve is positioned within the bore of the shield between the flexible
shaft and the shield.

20 16. The bone stabilization component of claim 11, in combination with a bone anchor
having a bore in a proximal end thereof, said bore being configured such that the shield can fit
substantially entirely therein; and

the bone anchor having a recess engageable by the connector to secure the shield to
the bone anchor.

25

17. The bone stabilization component of claim 11, in combination with a bone anchor
having a bore in a proximal end thereof, said bore being configured such that the shield can fit
substantially entirely therein; and

30 the bone anchor having a recess engageable by the connector to secure the shield to
the bone anchor; and

the connector comprises a threaded member that is turnable to engage said recess to
secure the shield to the bone anchor.

18. The bone stabilization component of claim 11, wherein said connector is releasable to permit removal of the bone stabilization component from the bone anchor.

19. A bone stabilization component bone anchor in combination with a bone stabilization
5 component wherein:

the bone stabilization component comprises a deflectable shaft mounted in a shield,

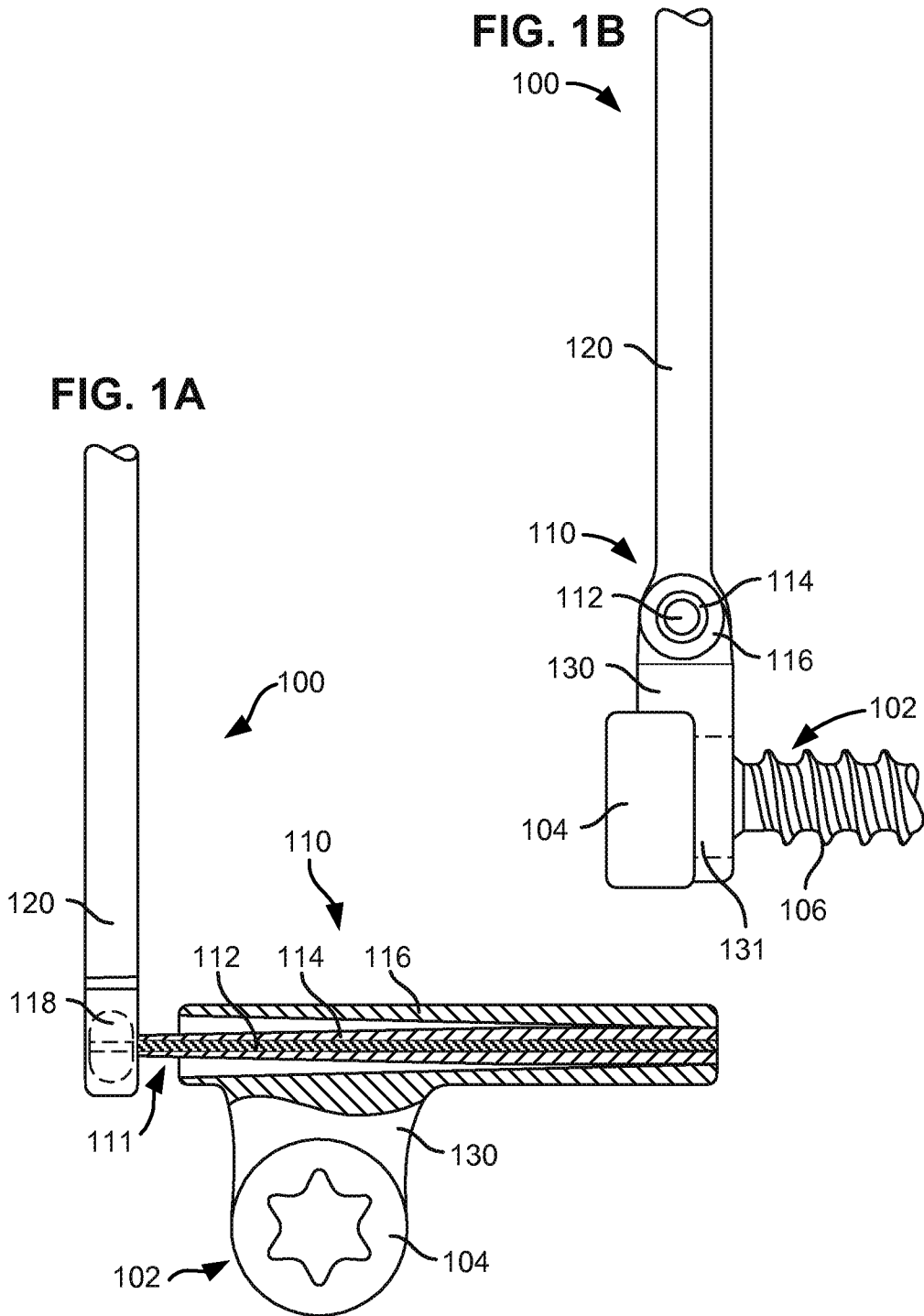
the deflectable shaft having a mount at a proximal end thereof;

the mount extending beyond the shield;

10 the bone stabilization component being configured to allow deflection of the mount
relative to the shield; and

the shield comprising a connector to secure the shield to the bone anchor so that the
deflectable shaft is substantially in-line with the bone anchor and the mount is exposed for
connection of a bone-stabilizing rod.

15 20. The bone stabilization component of claim 19, wherein said connector can secure the
shield to the bone anchor at a plurality of relative rotational positions.



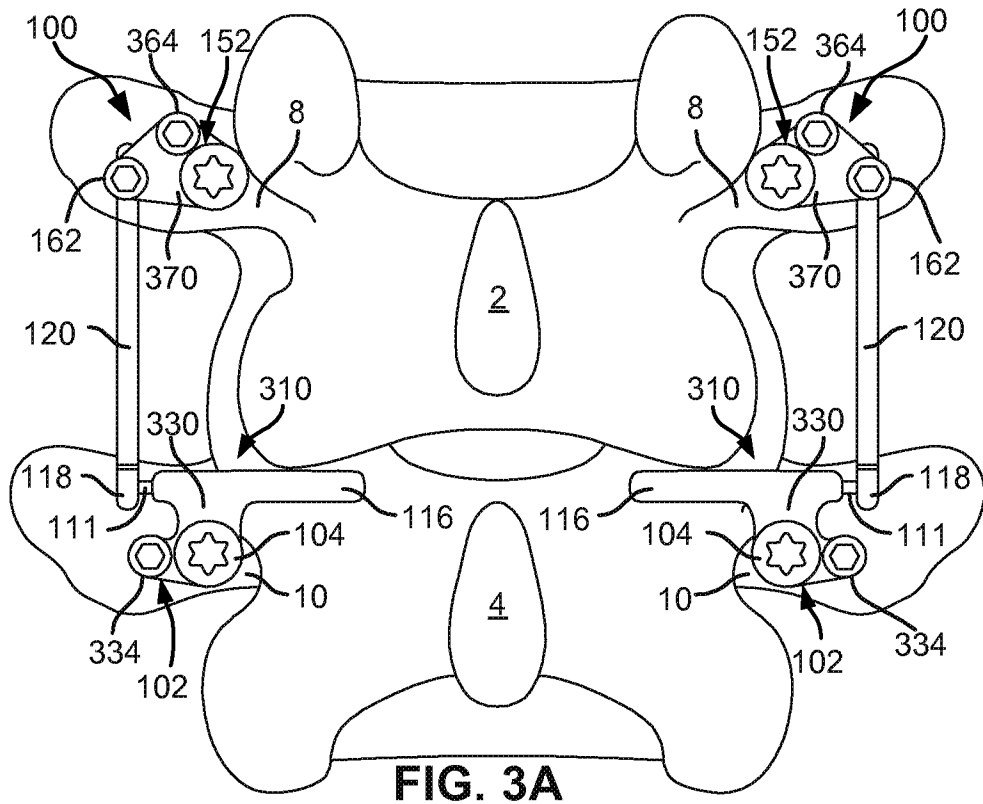
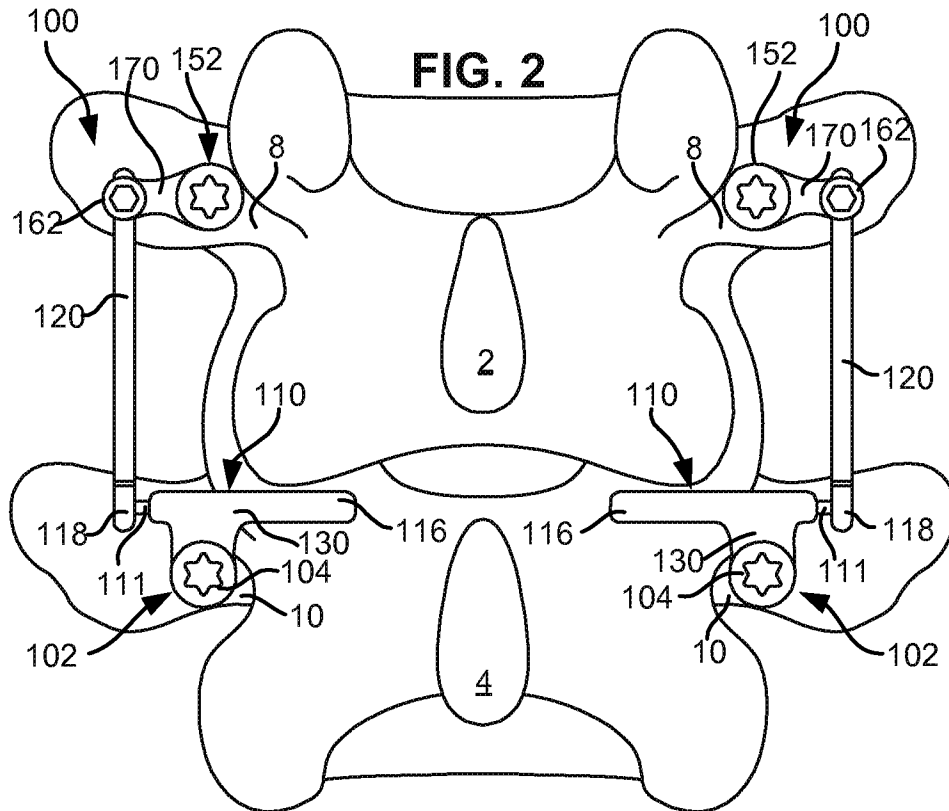


FIG. 3B

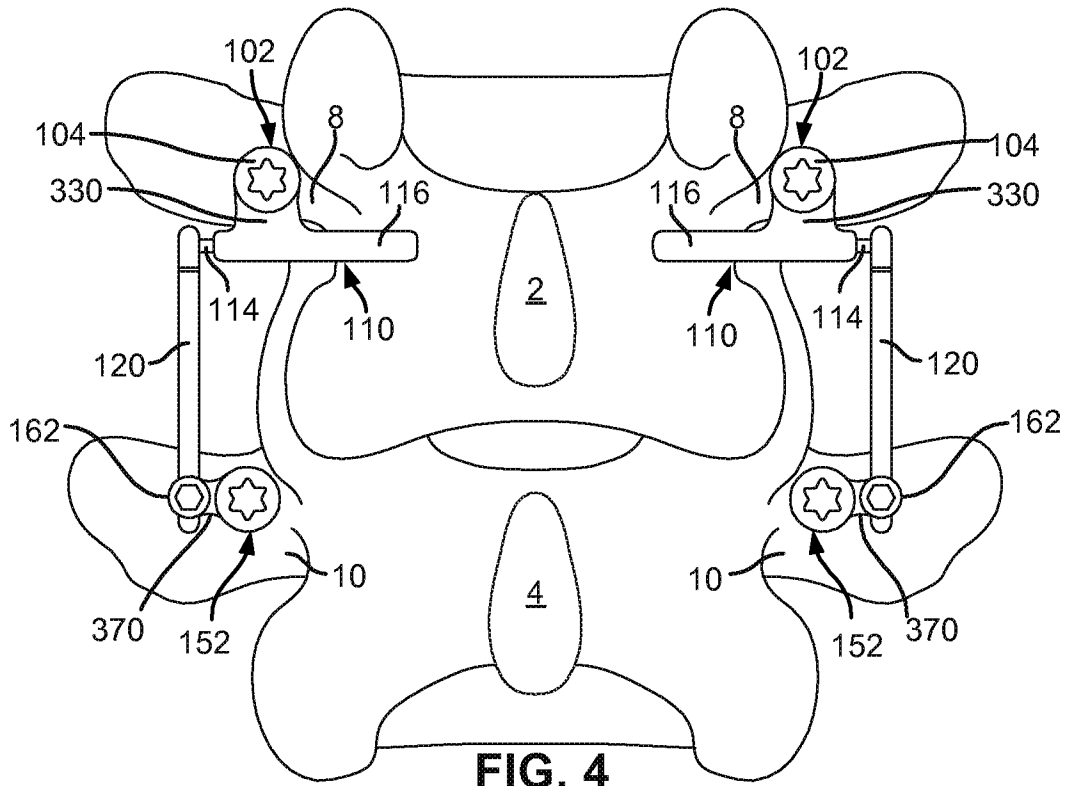
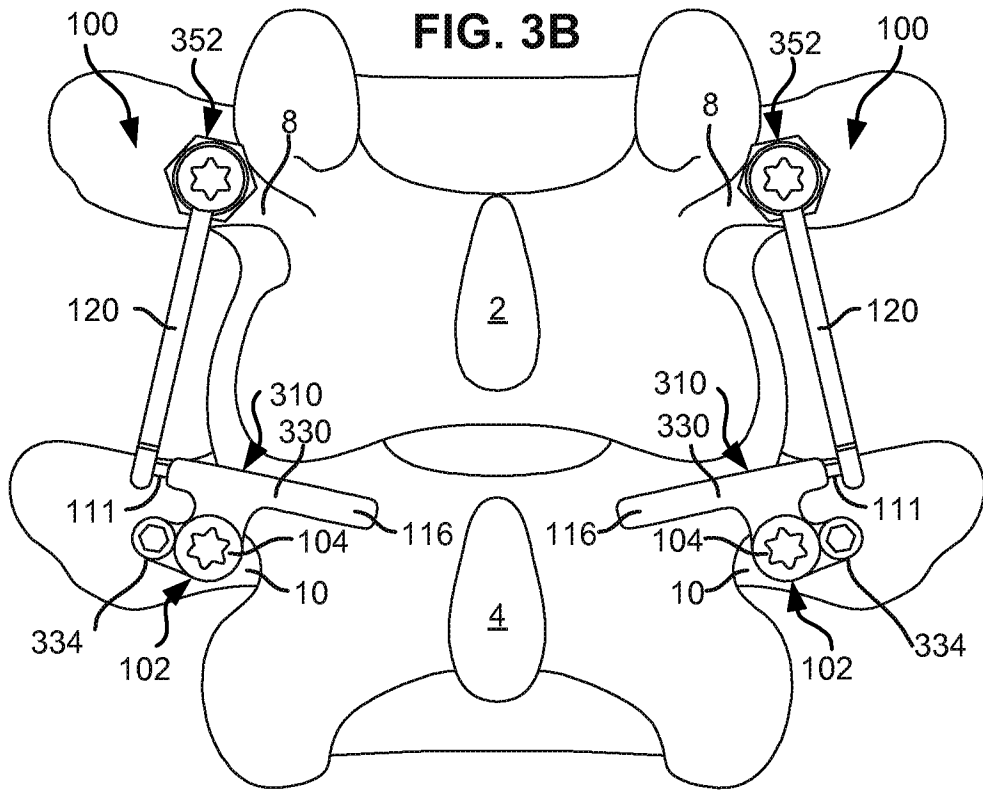


FIG. 4

FIG. 5

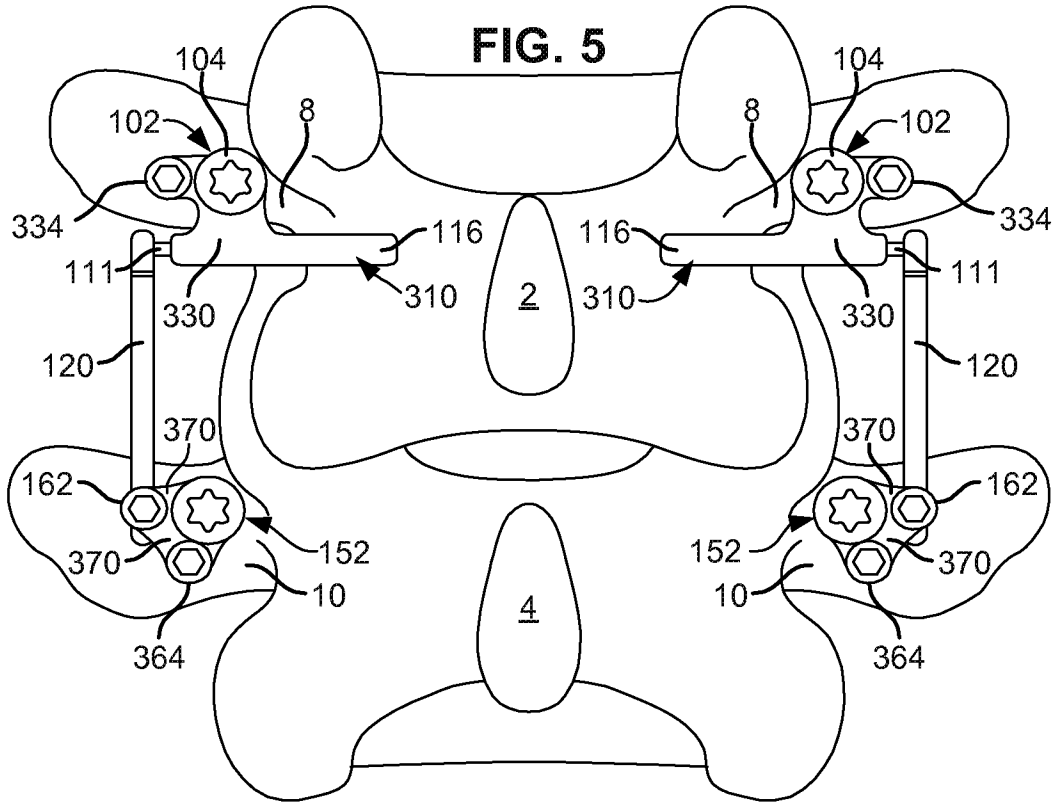


FIG. 6

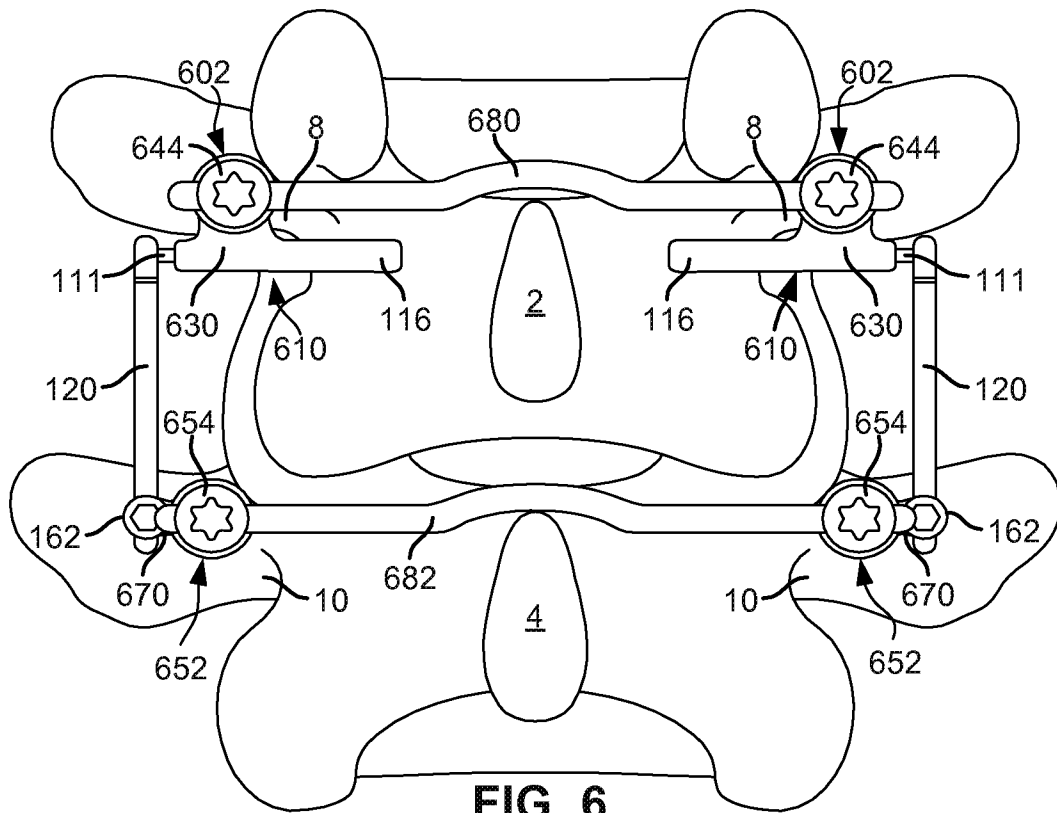


FIG. 7A

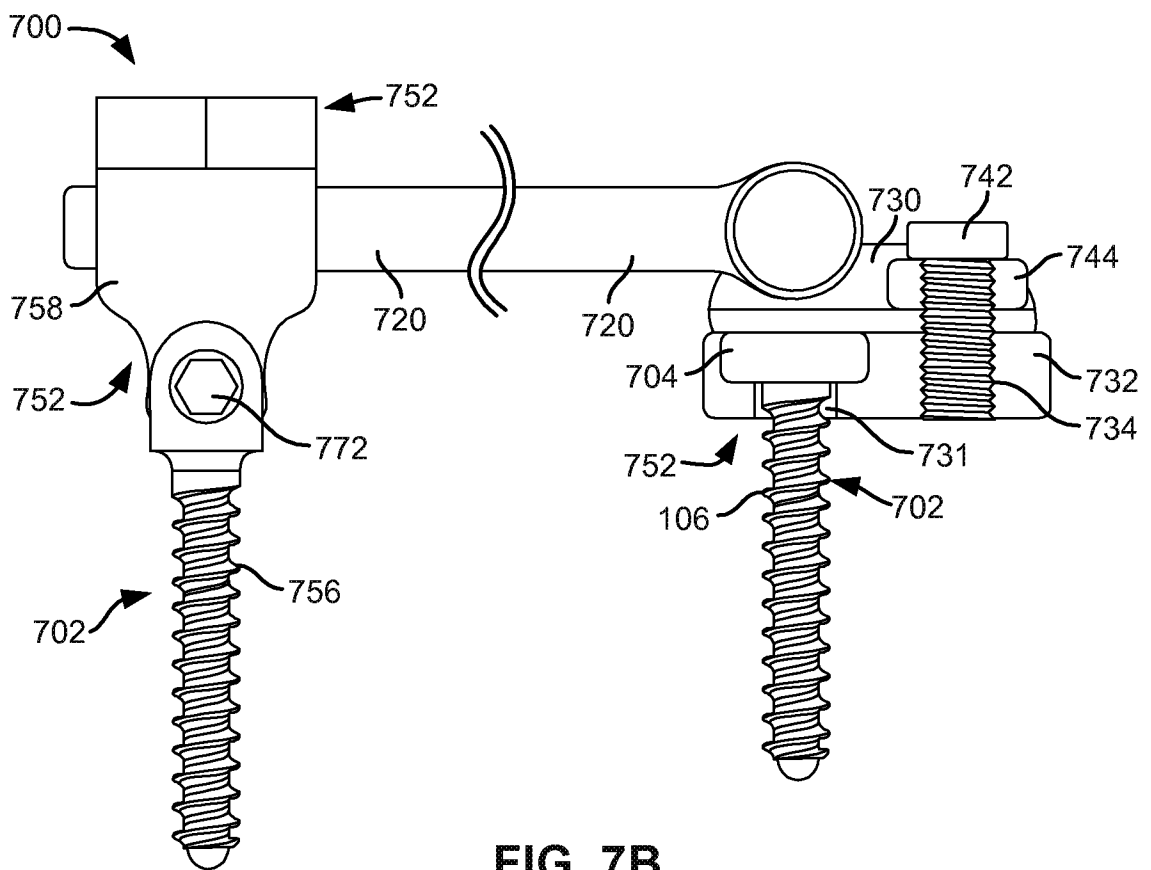
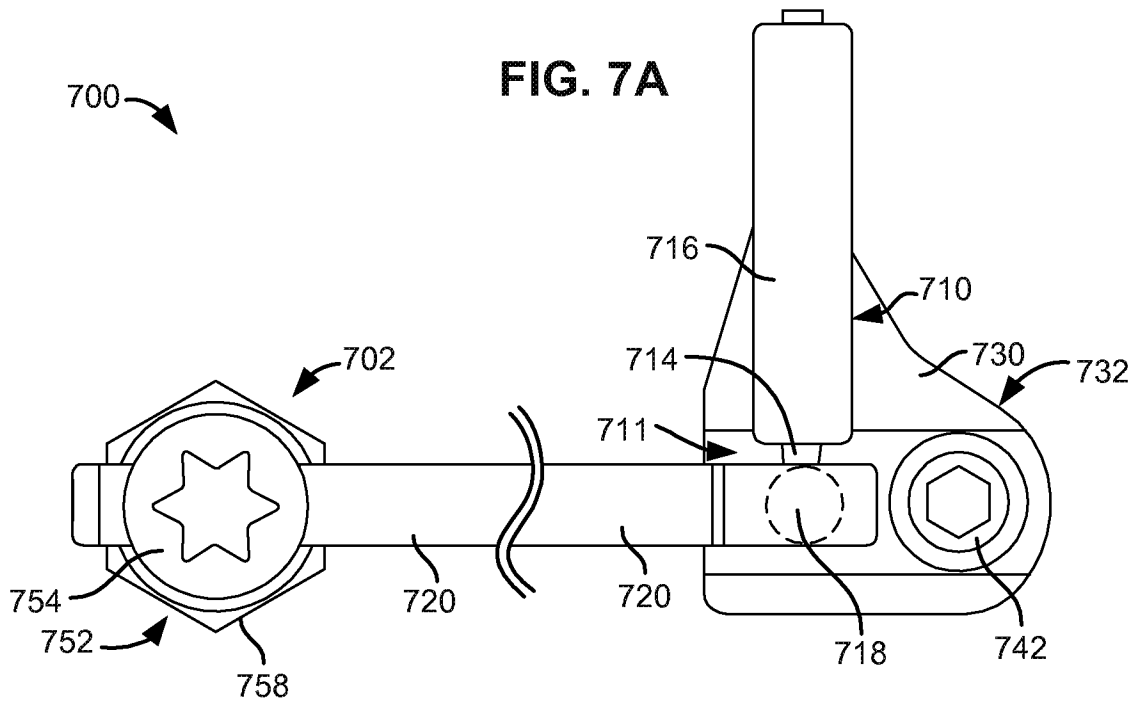


FIG. 7B

FIG. 7C

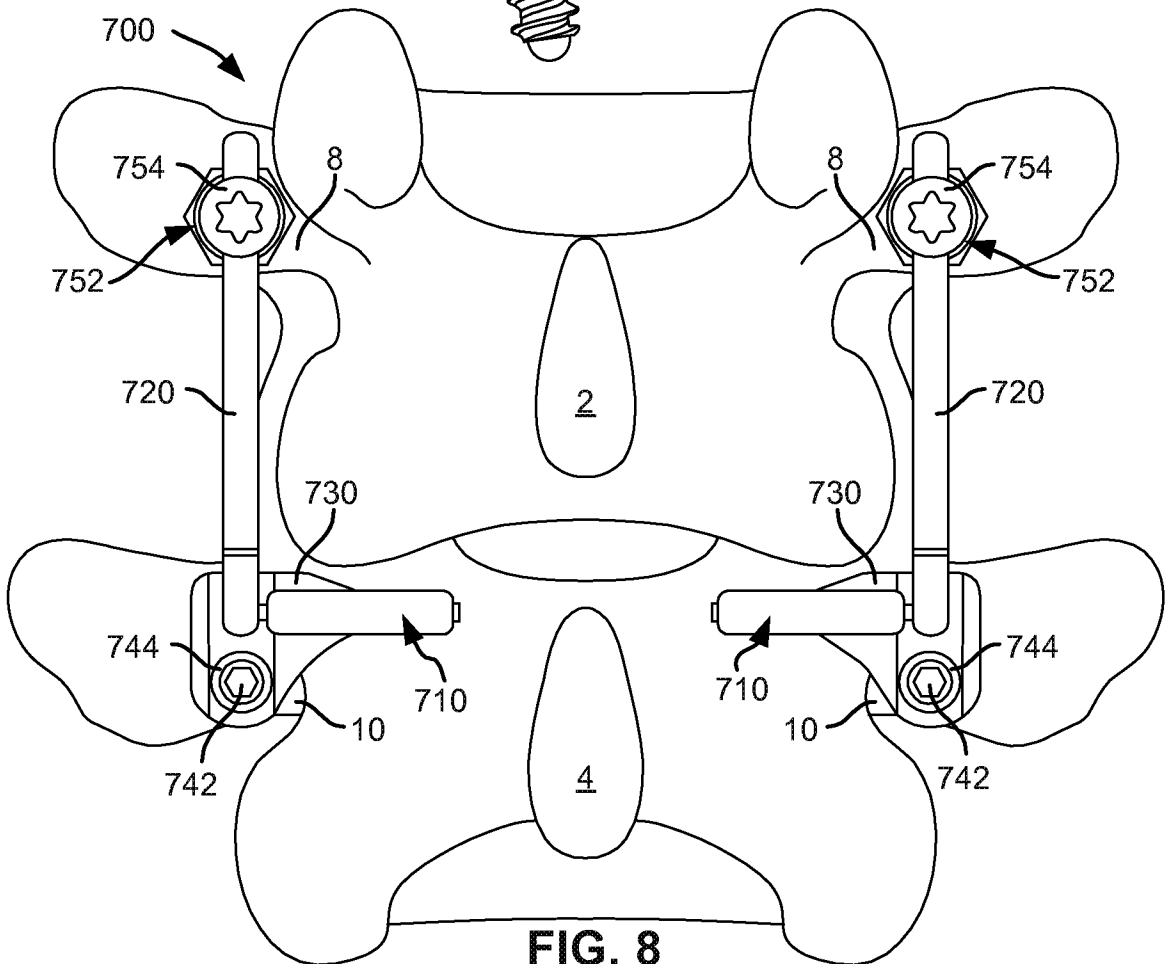
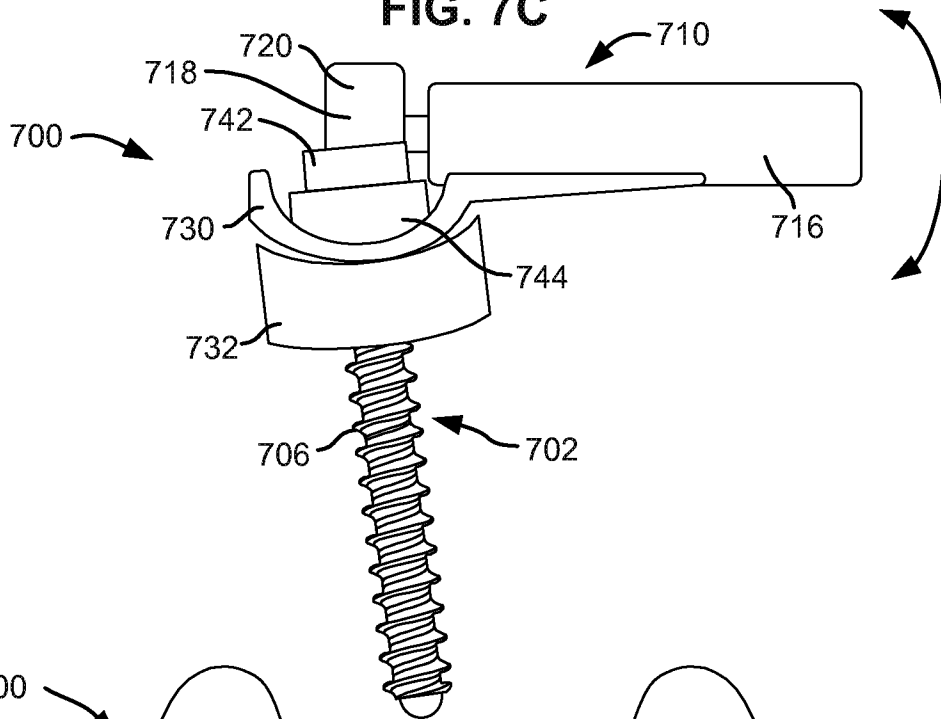


FIG. 8

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FIG. 9

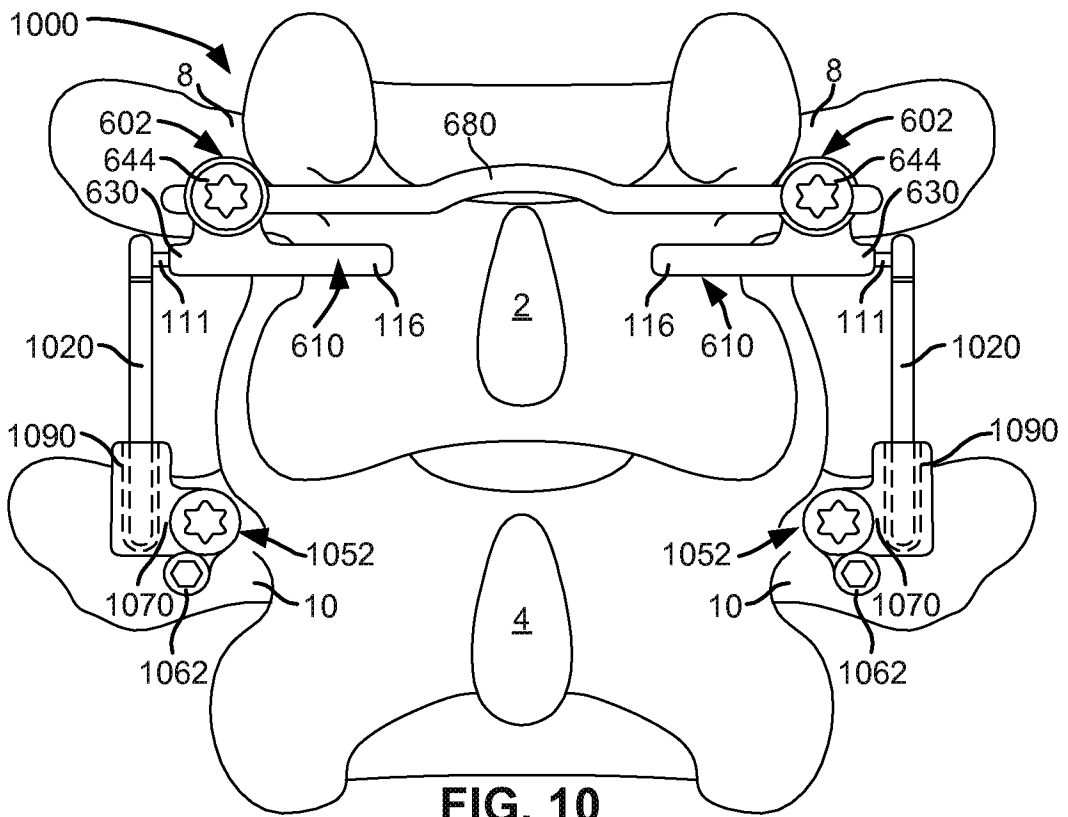
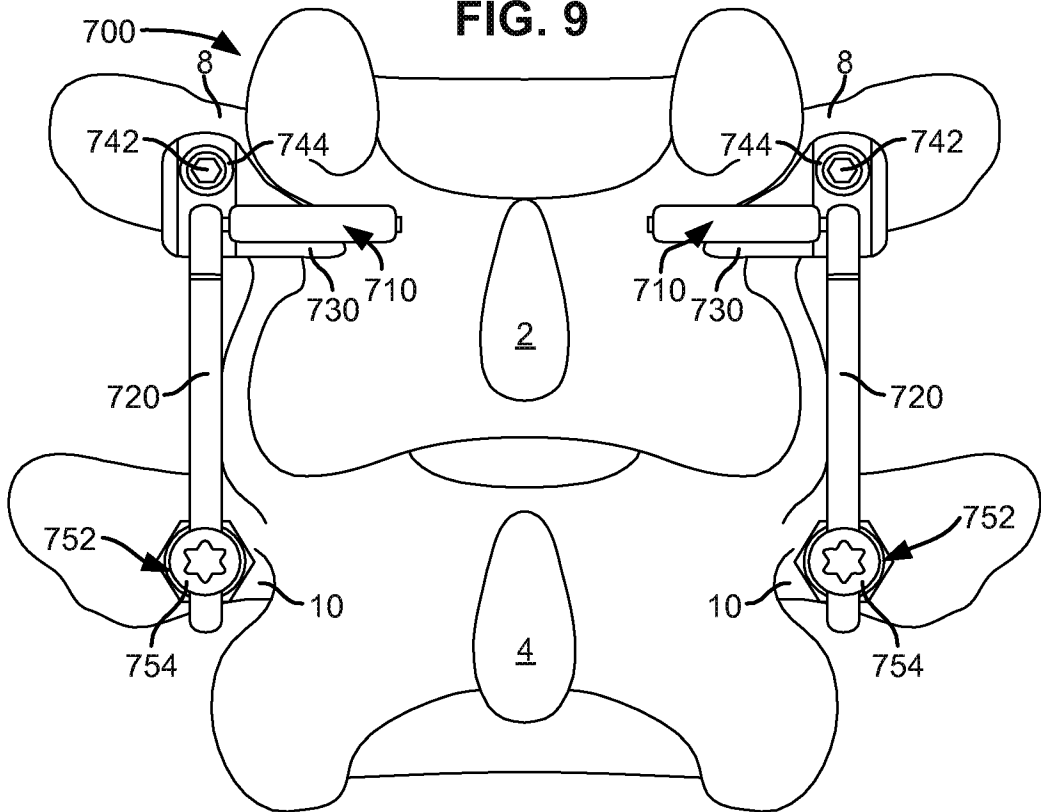


FIG. 10

FIG. 11A

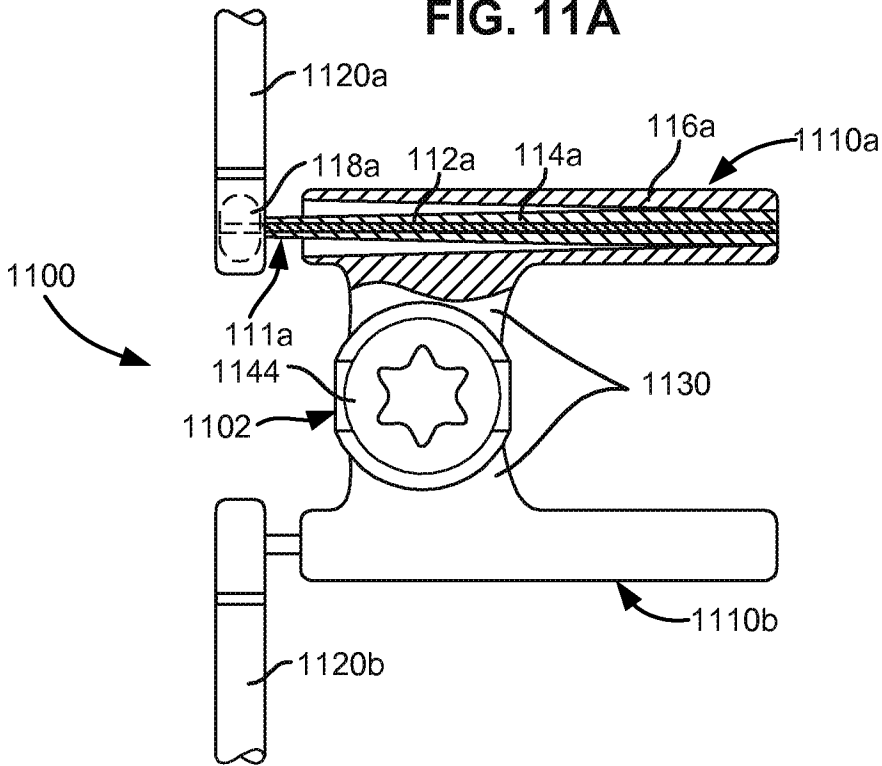


FIG. 11B

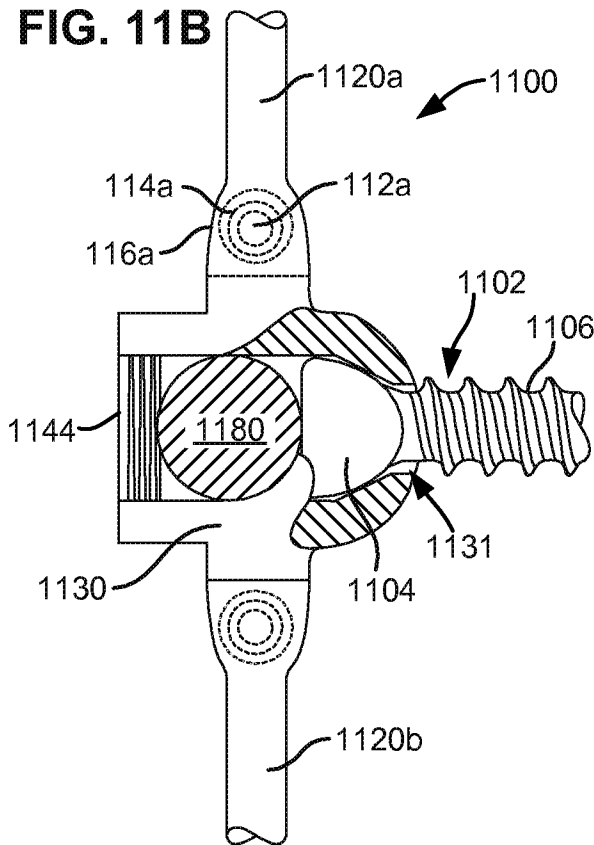
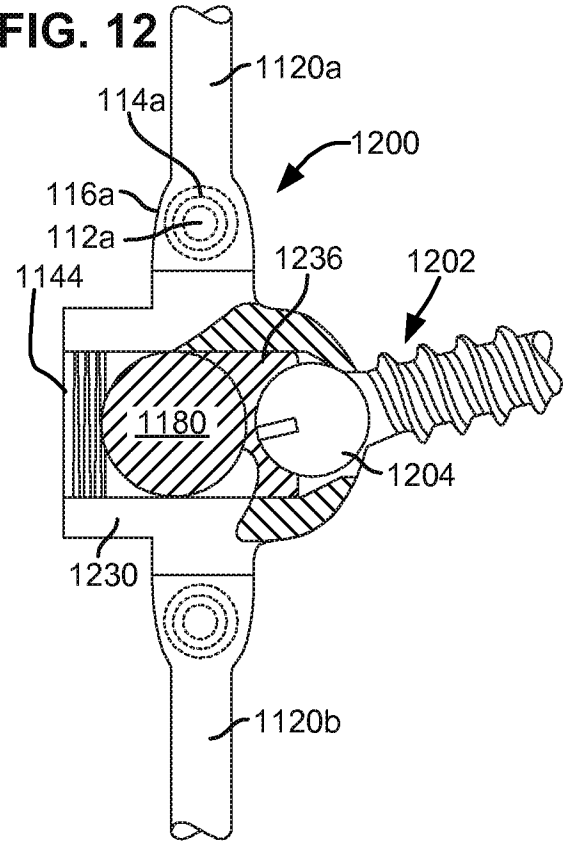


FIG. 12



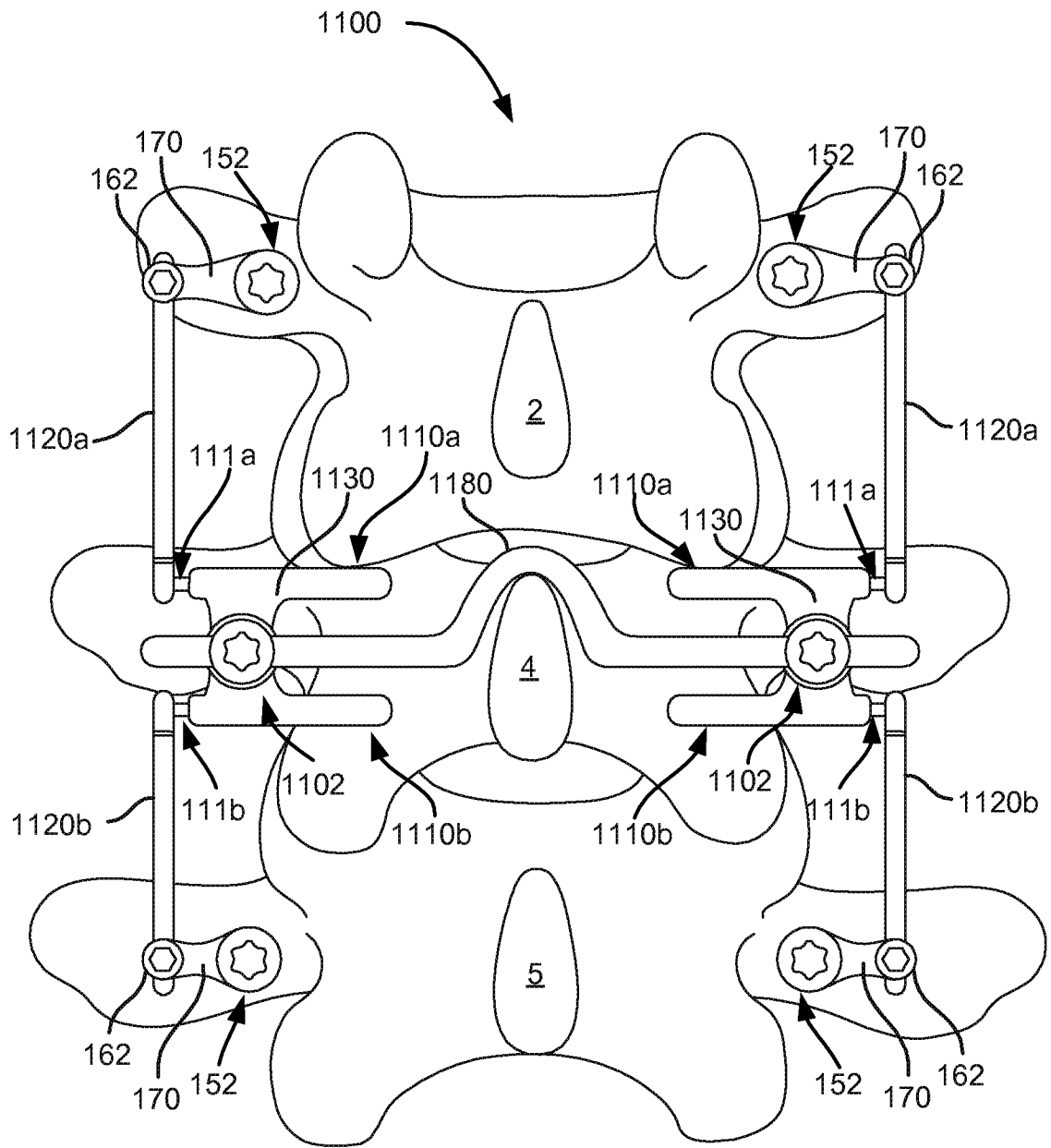


FIG. 13

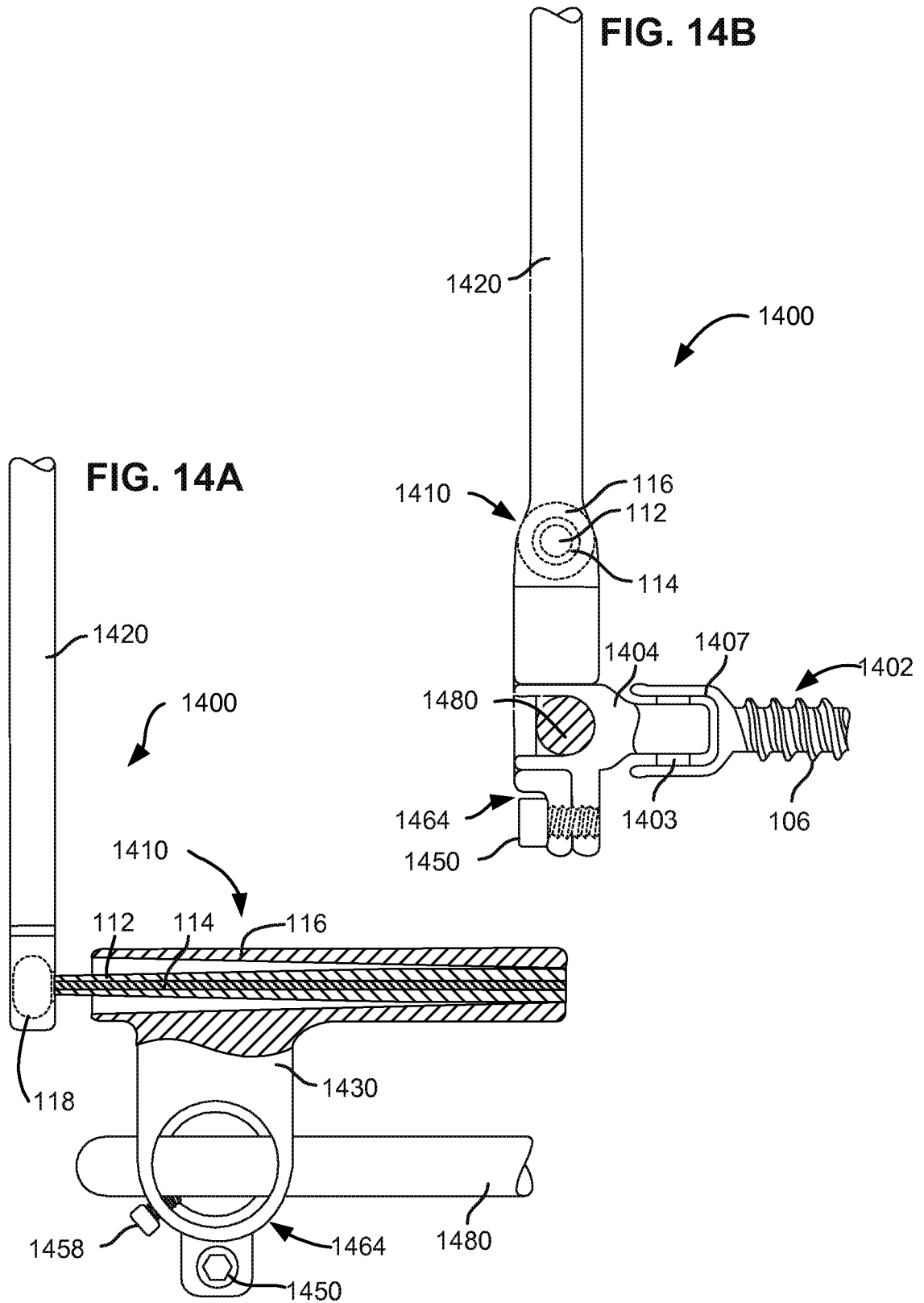


FIG. 15

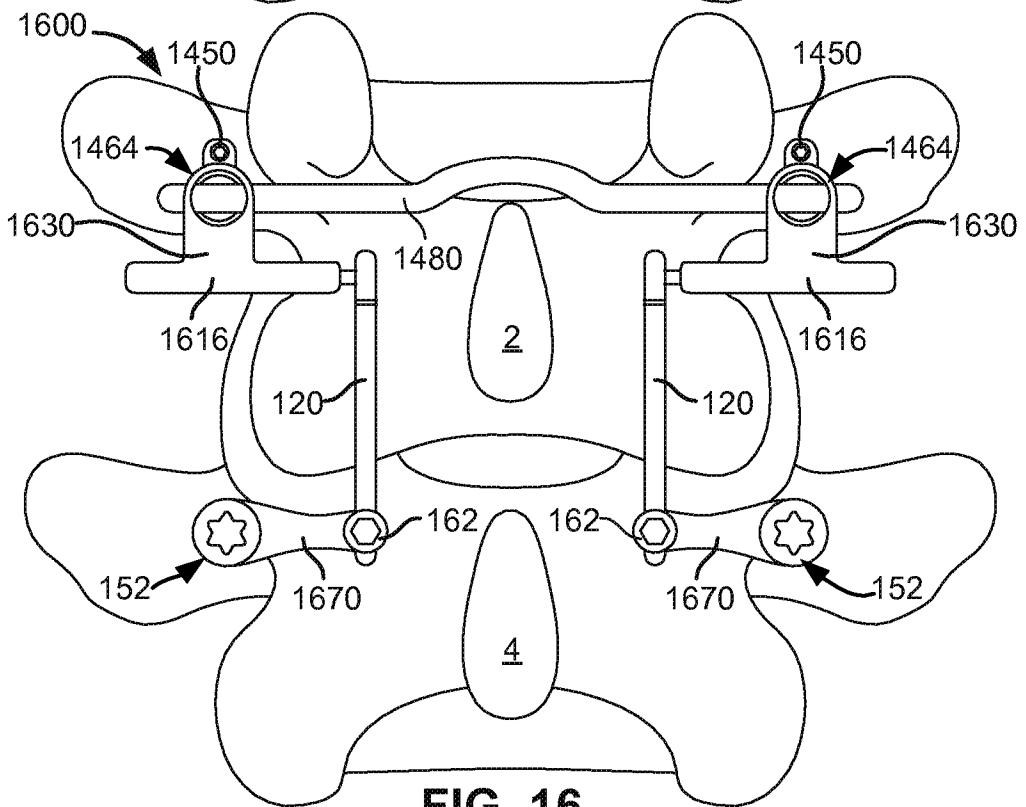
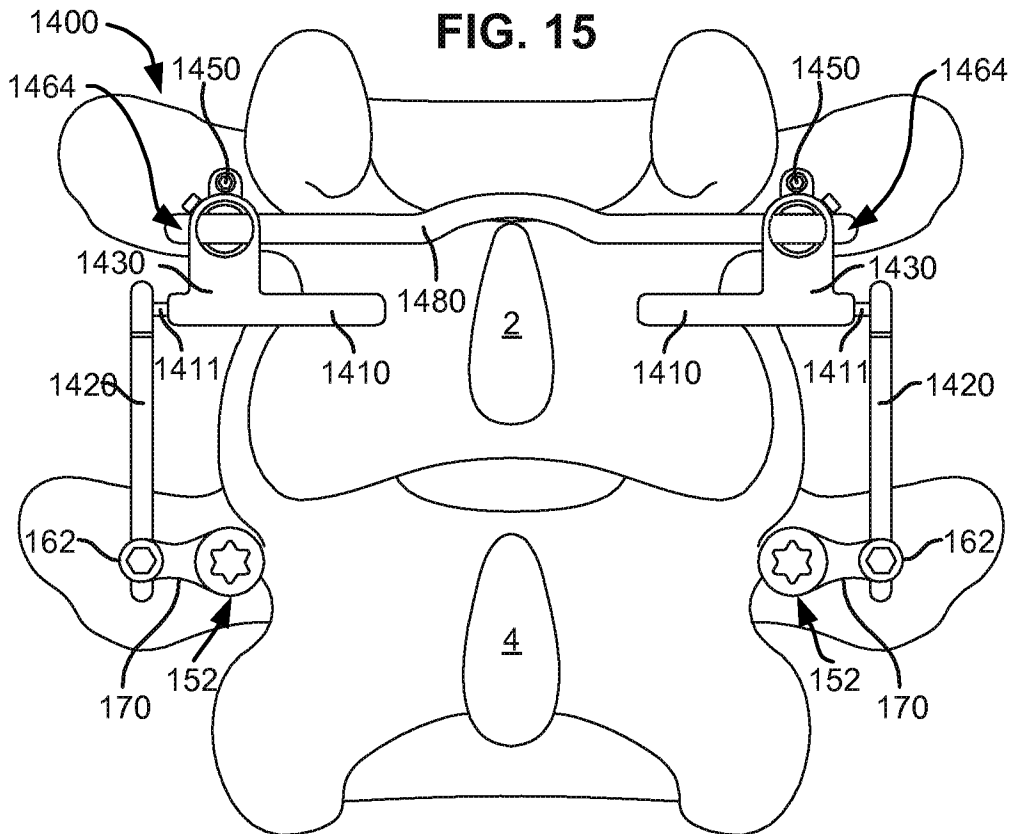


FIG. 16

FIG. 17

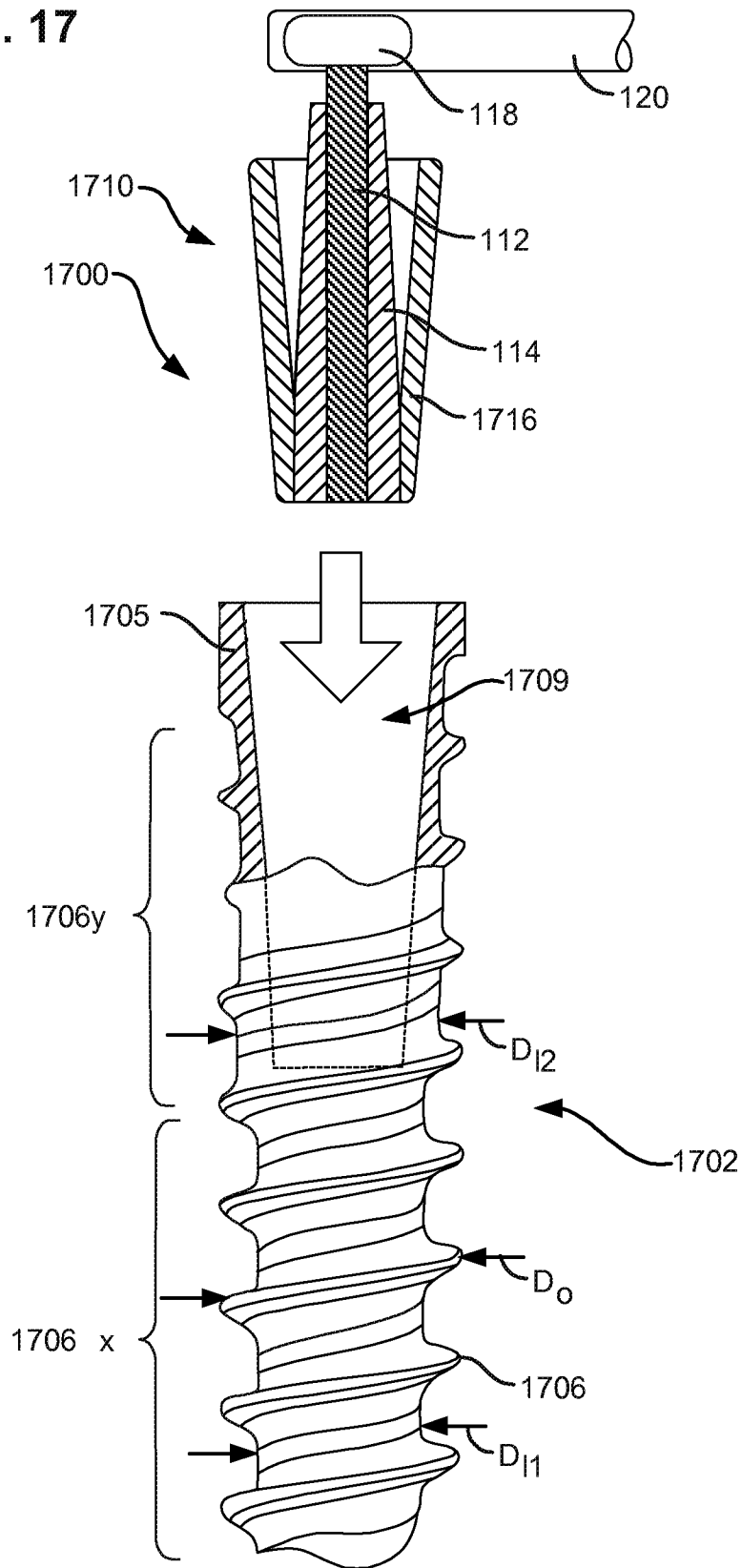


FIG. 18

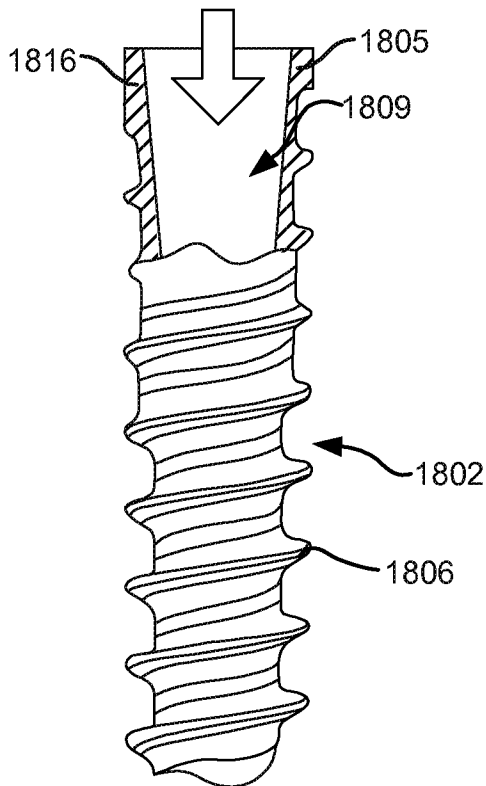
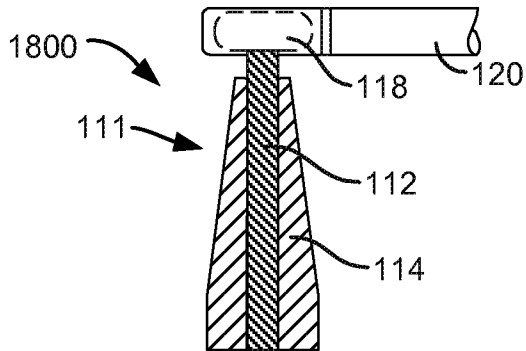
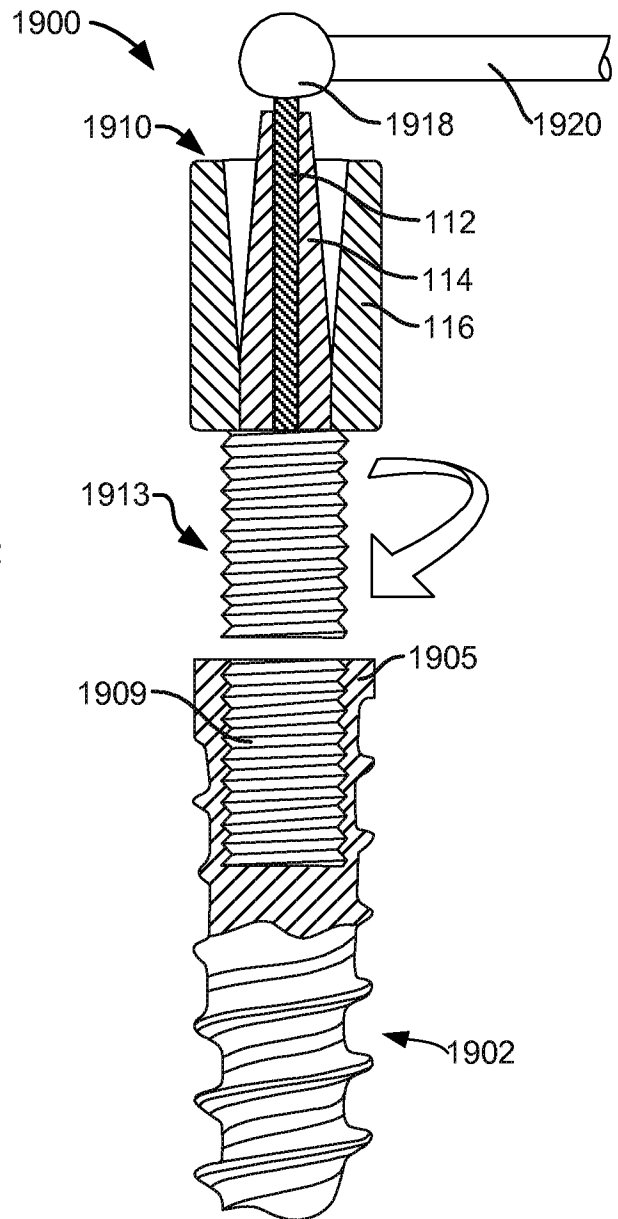


FIG. 19



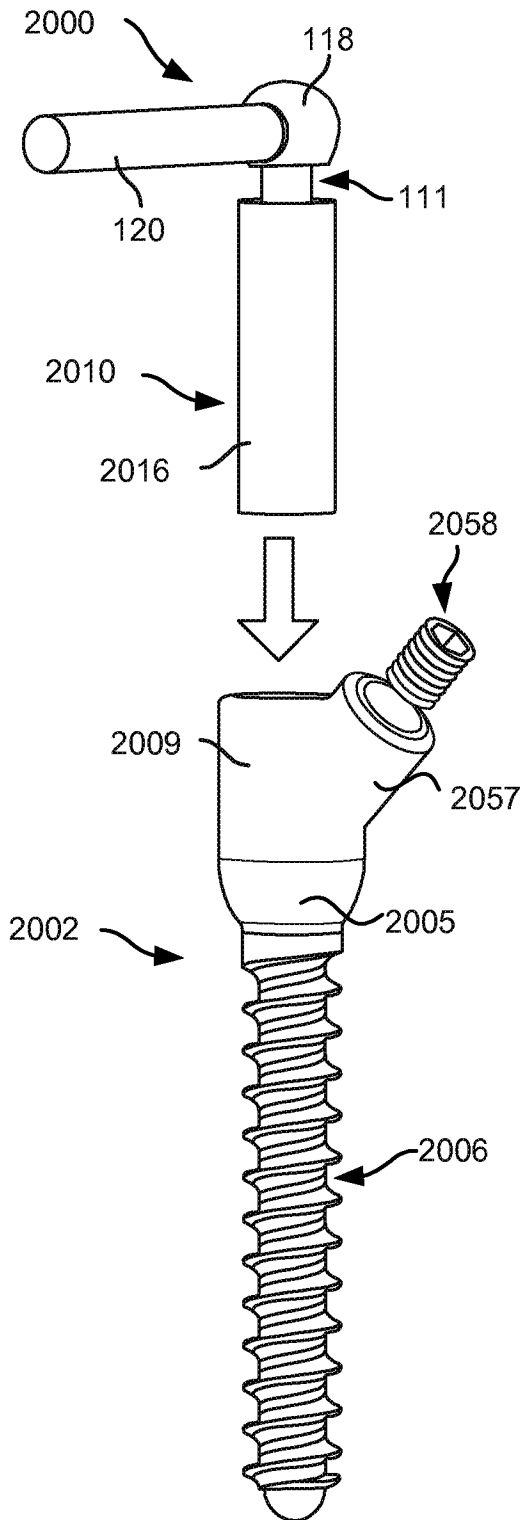


FIG. 20A

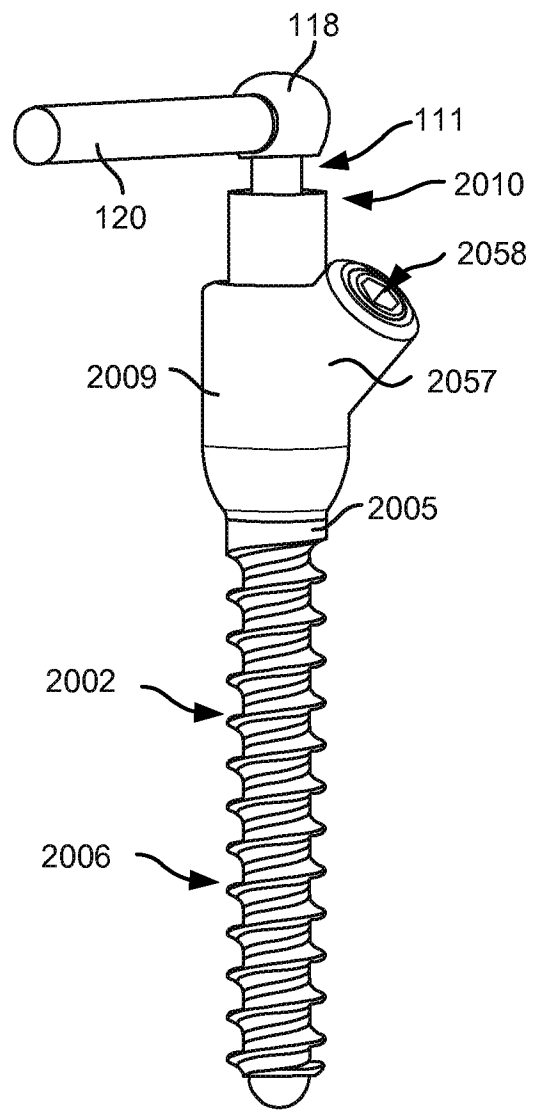


FIG. 20B

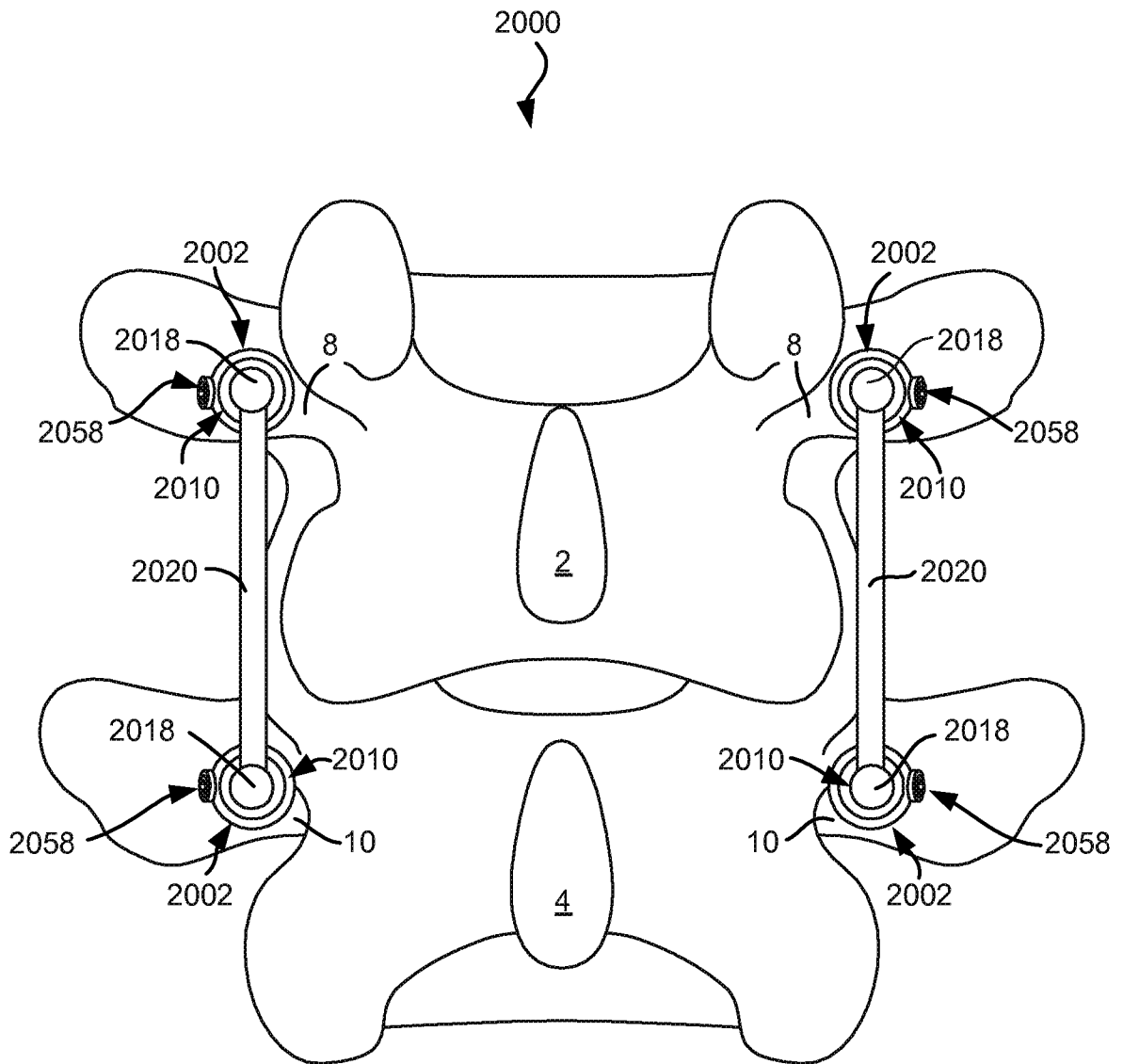


FIG. 21

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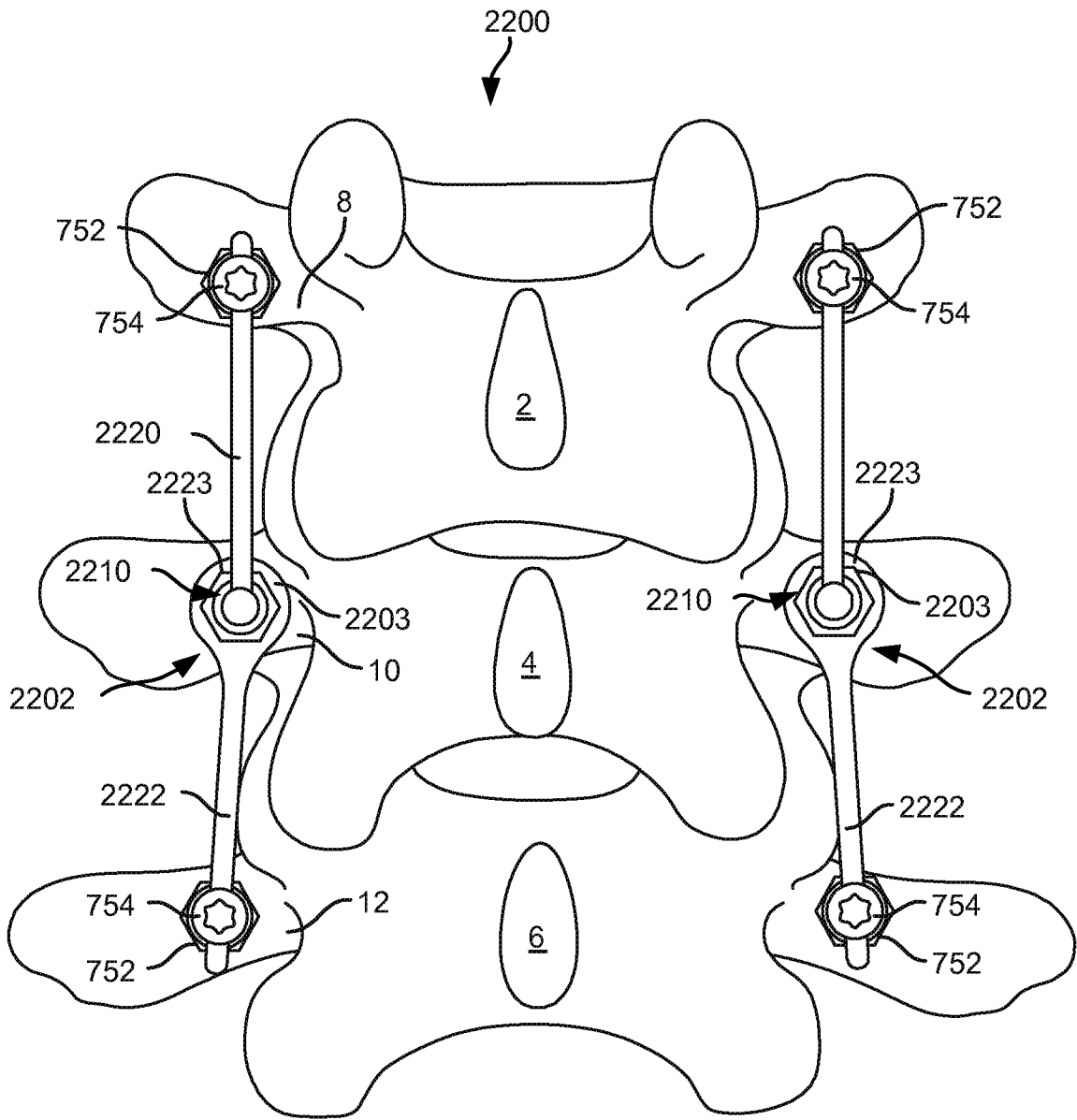


FIG. 22

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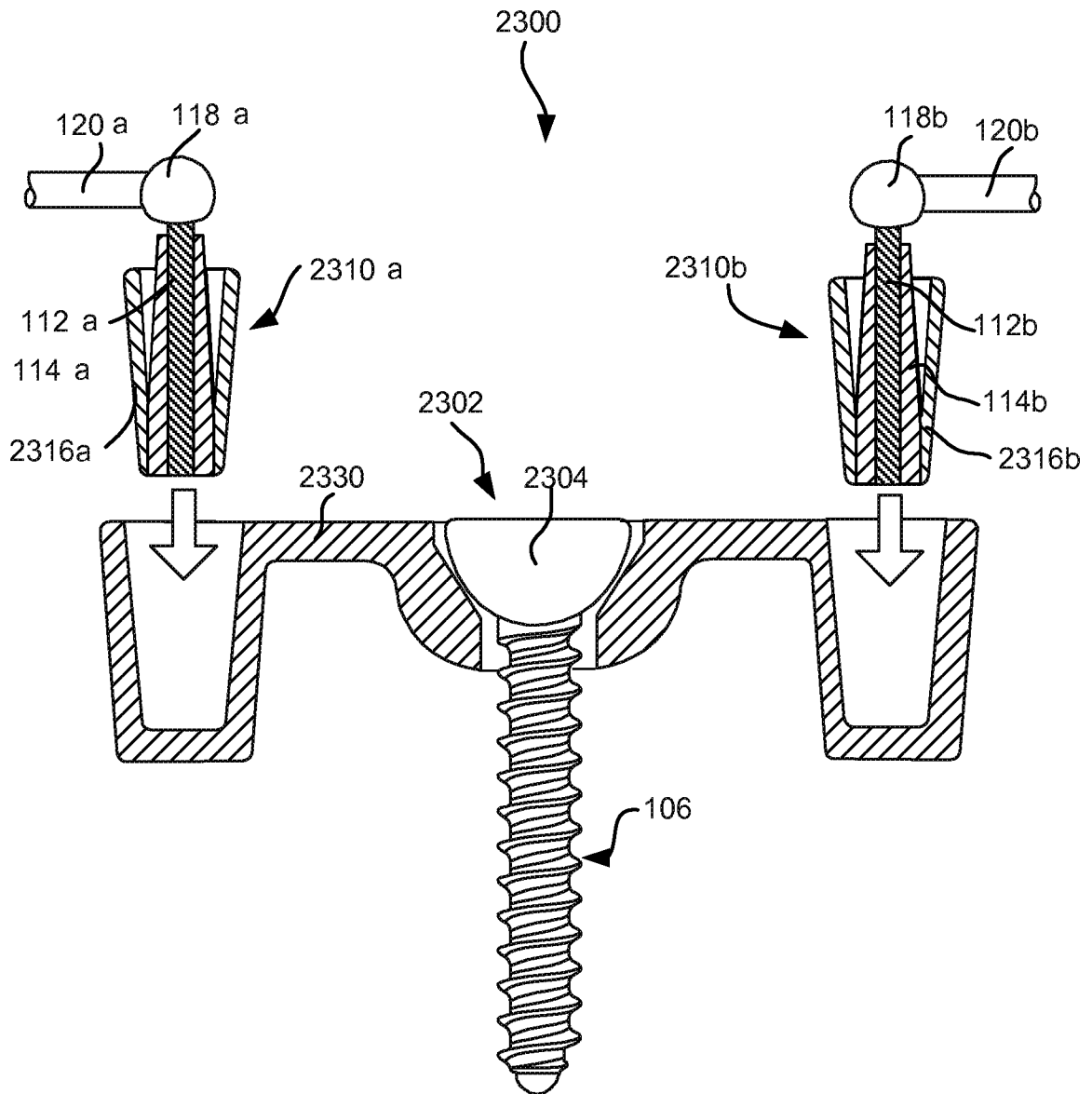


FIG. 23

FIG. 24A

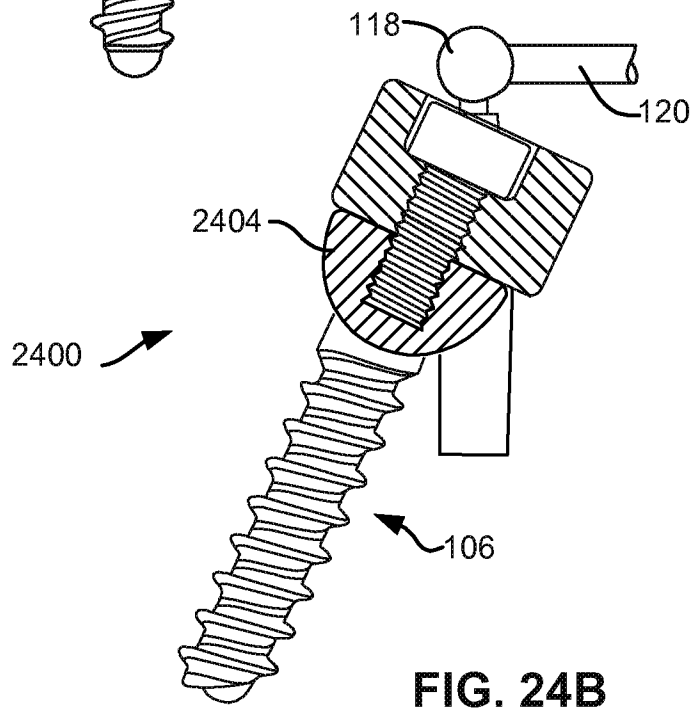
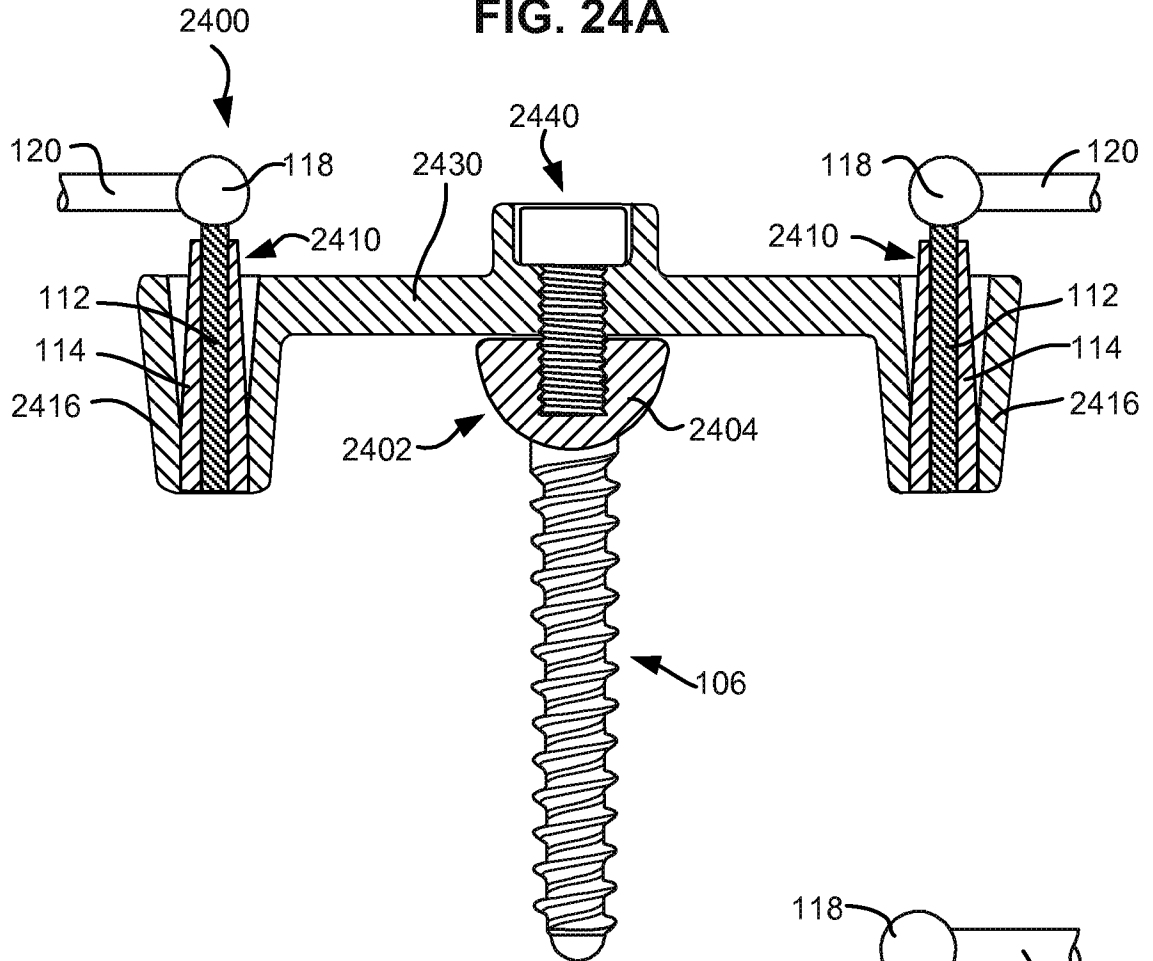


FIG. 24B

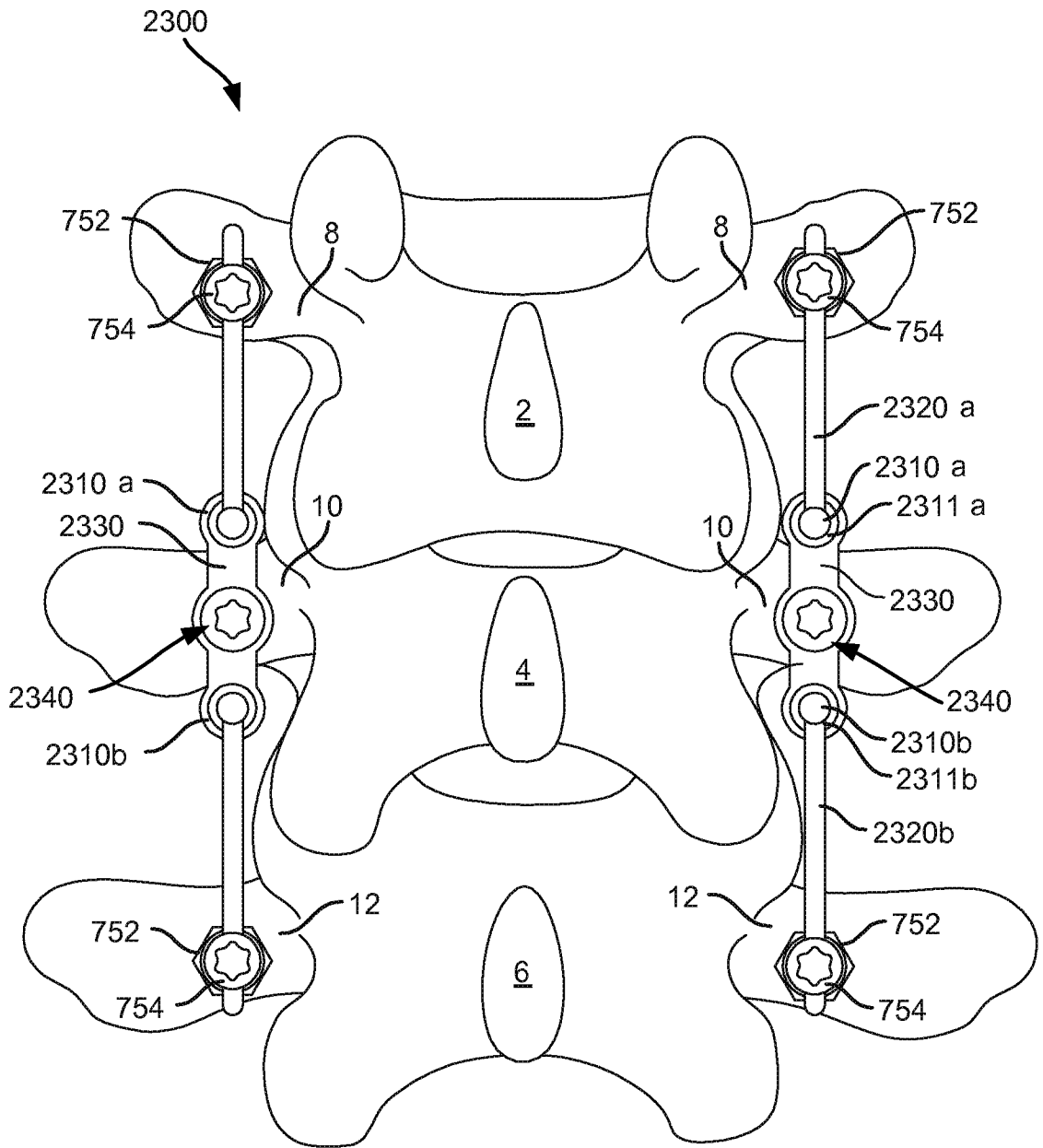


FIG. 25

FIG. 26

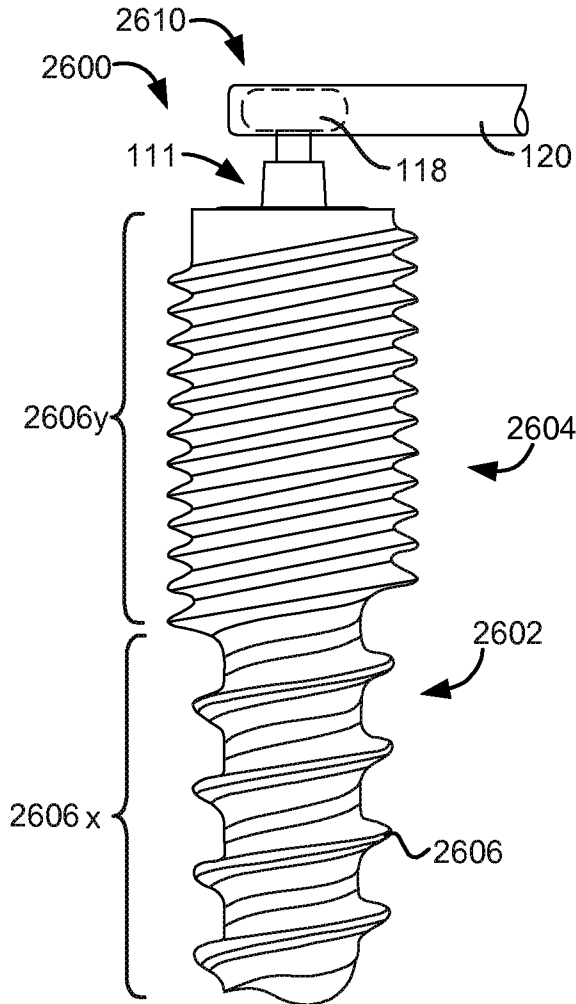
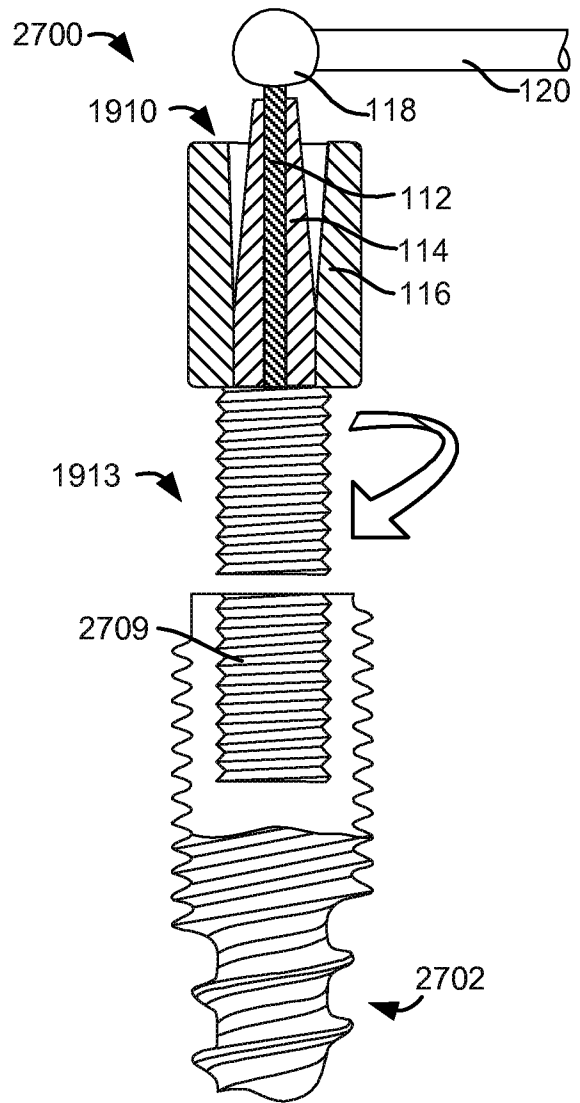


FIG. 27



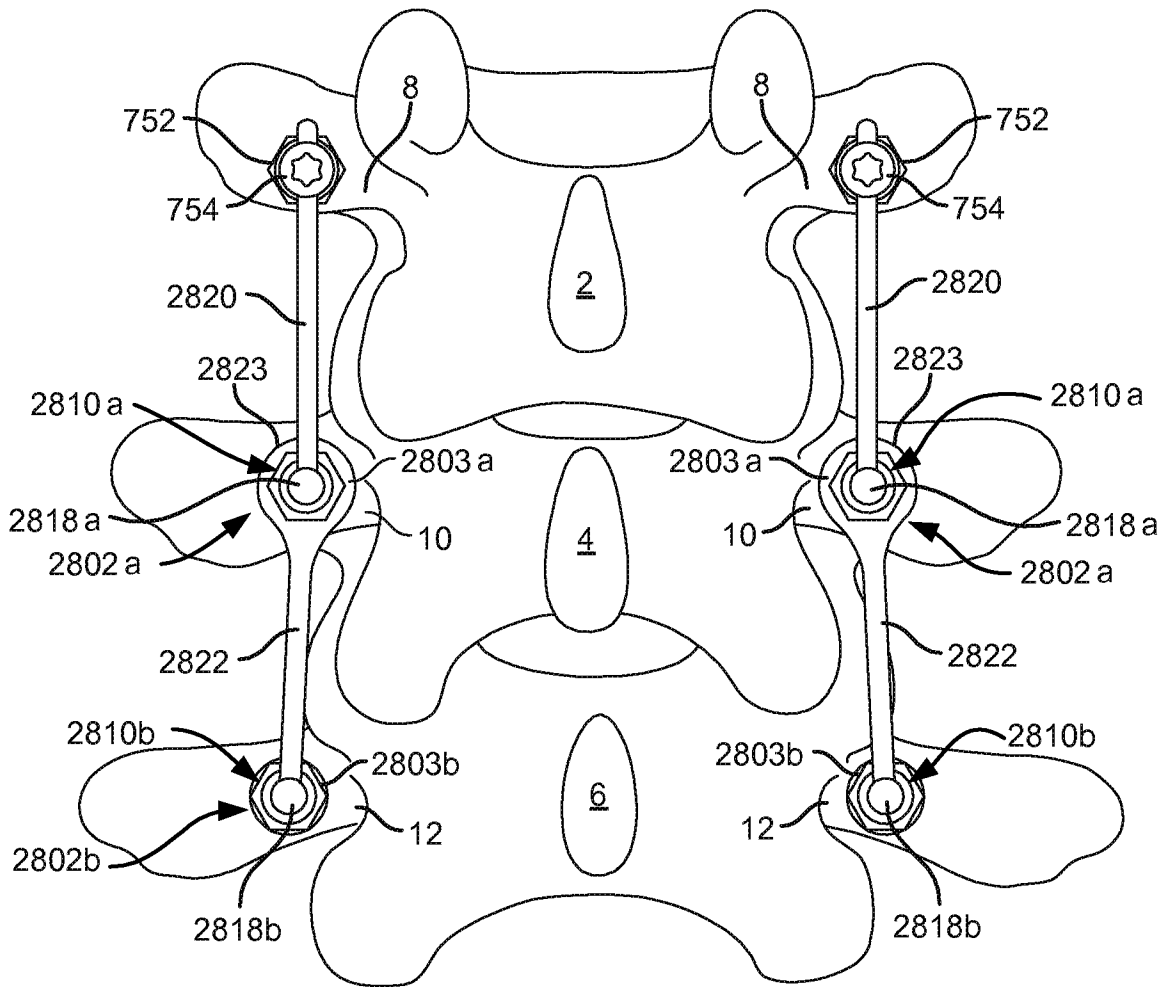


FIG. 28

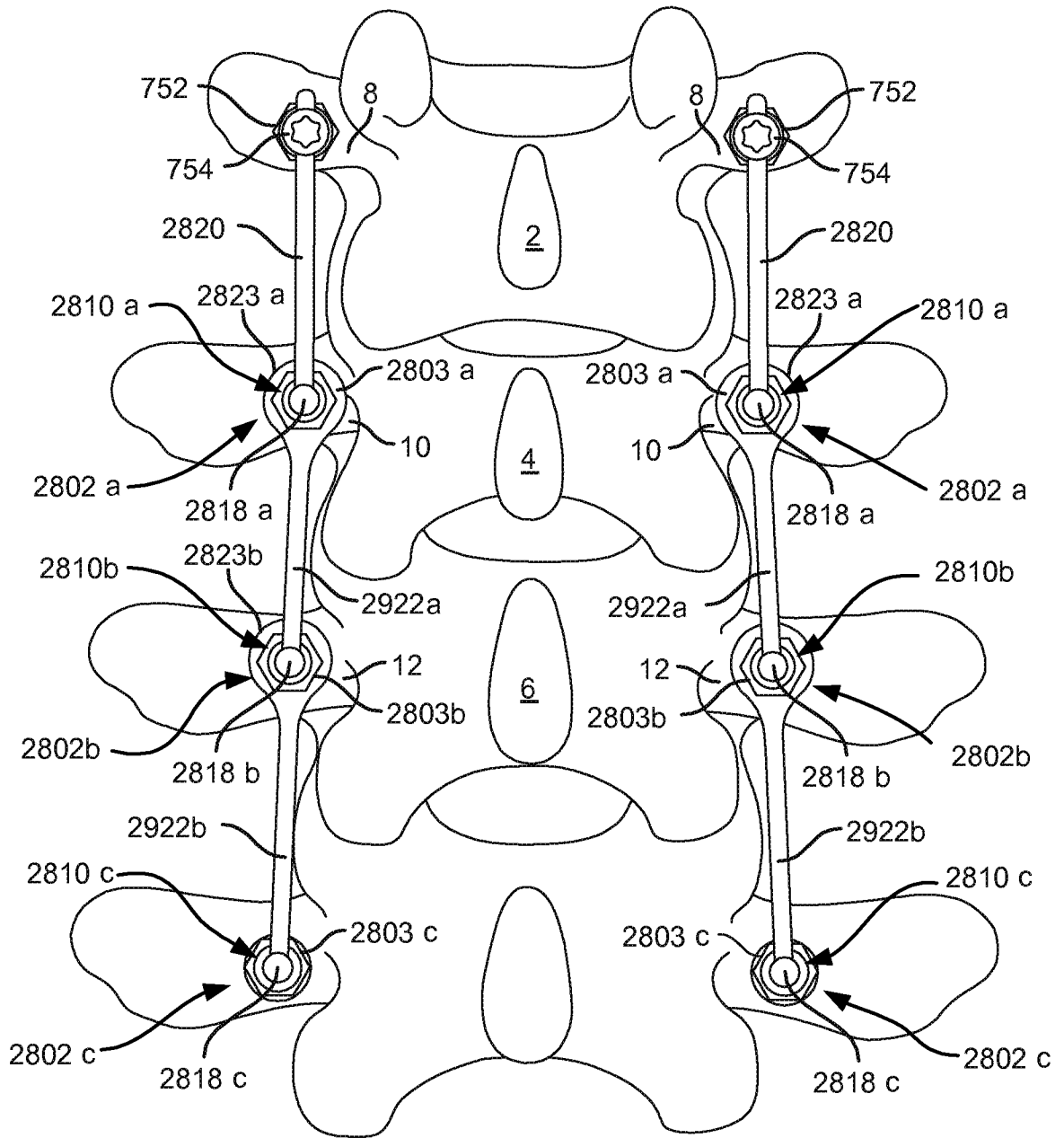
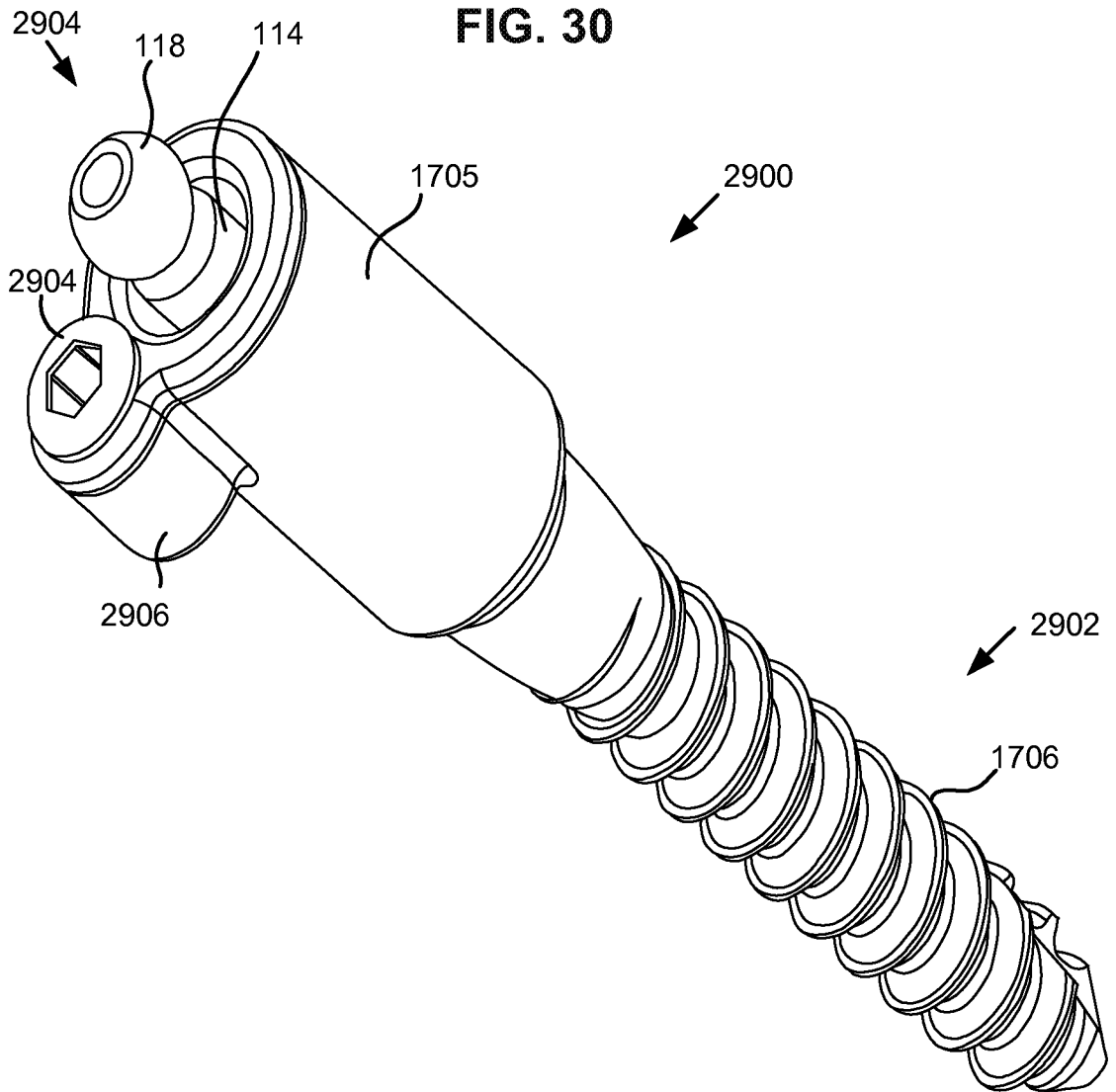


FIG. 29

FIG. 30



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FIG. 31

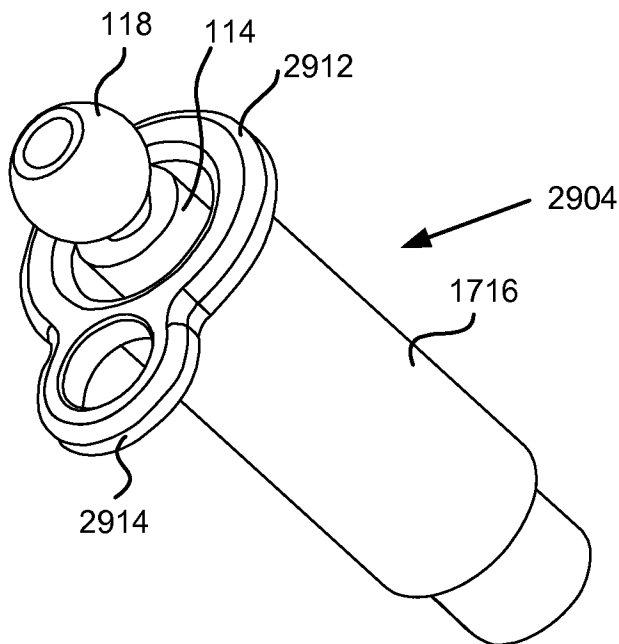
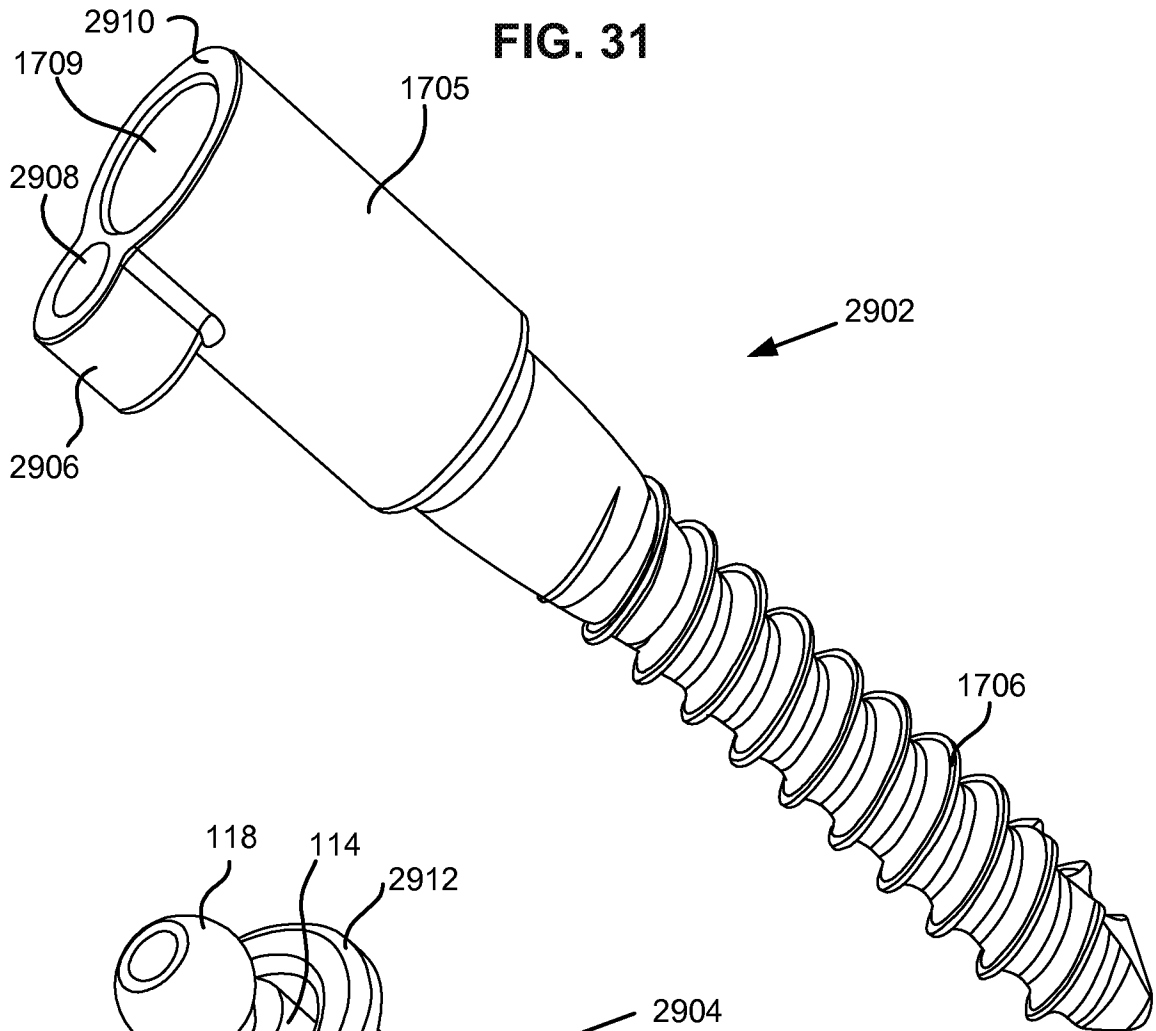


FIG. 32

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FIG. 33

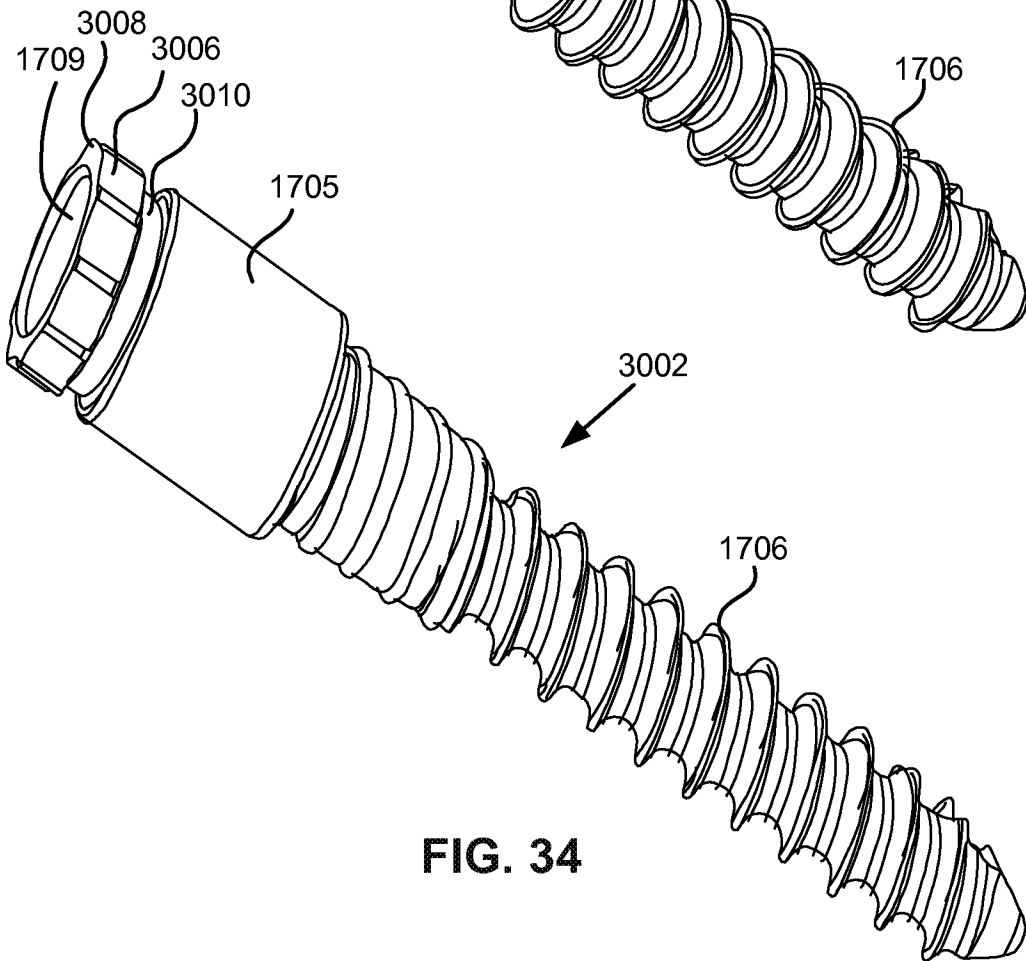
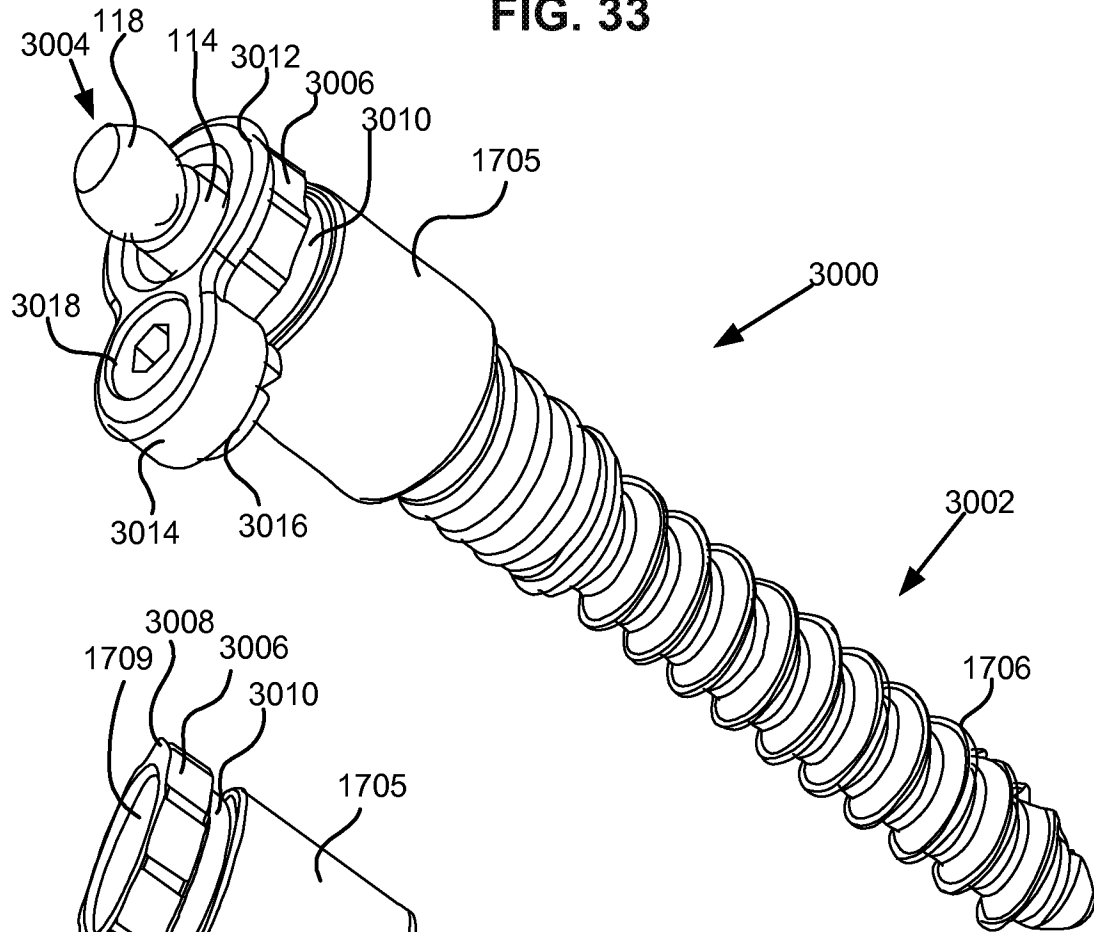
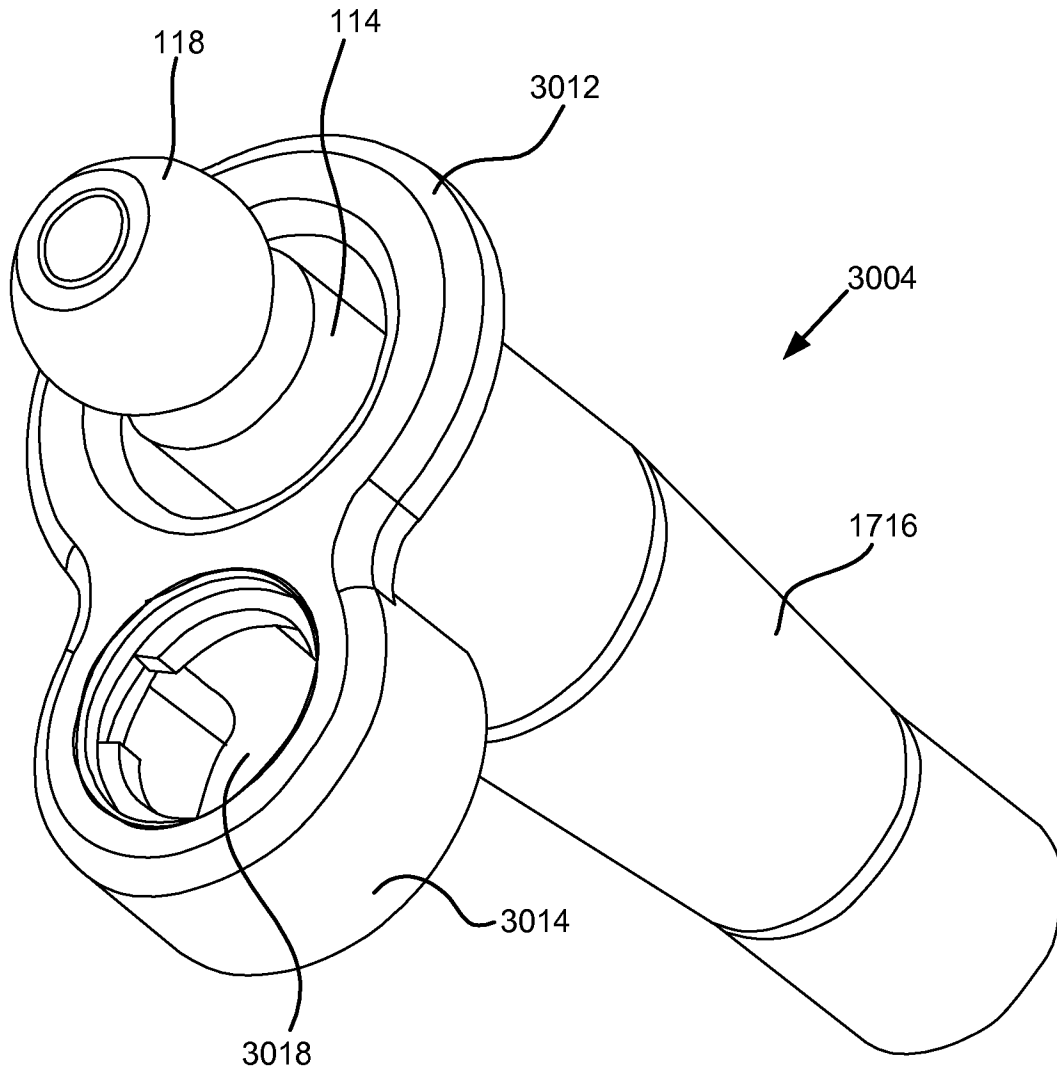


FIG. 34

FIG. 35



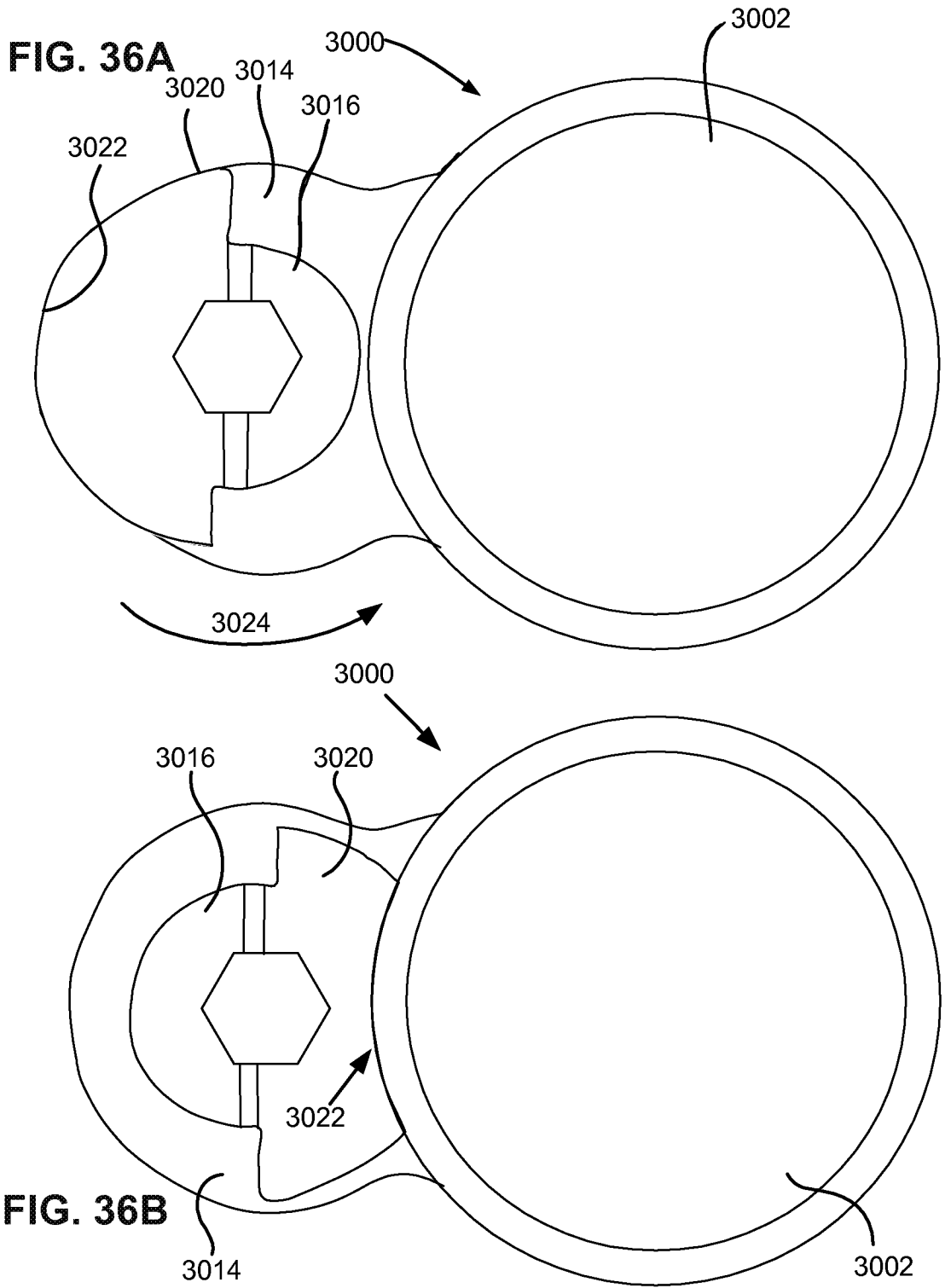
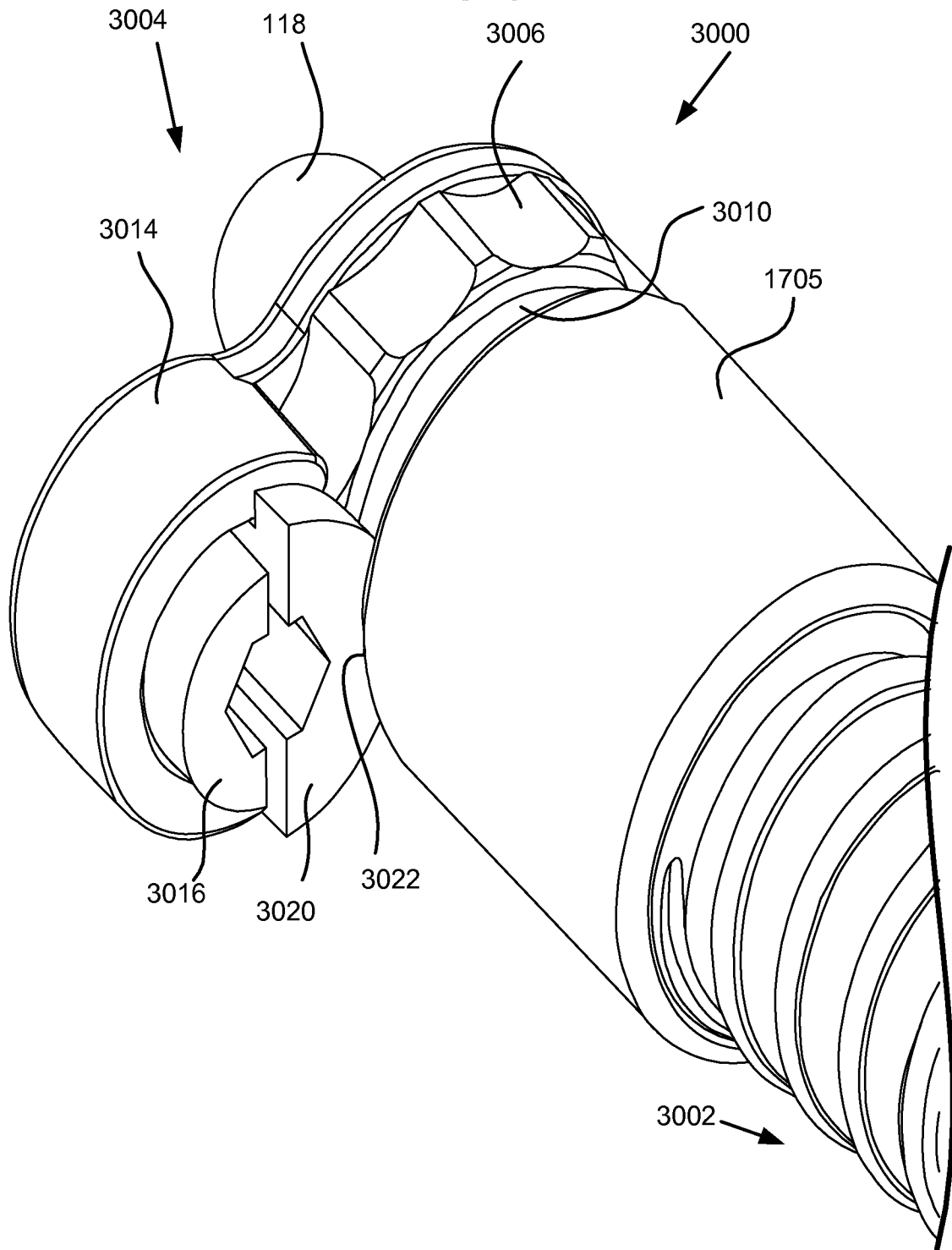
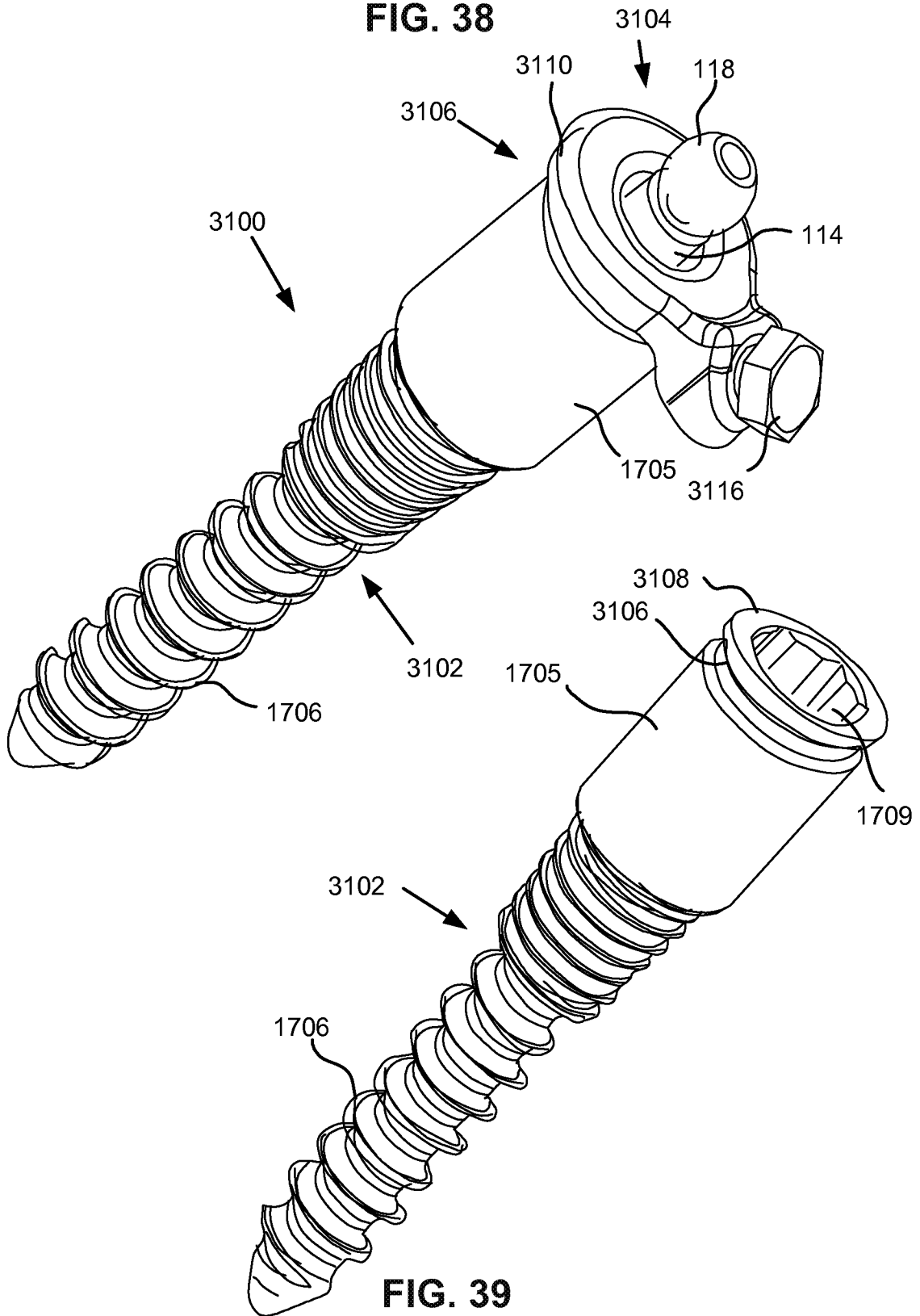


FIG. 37



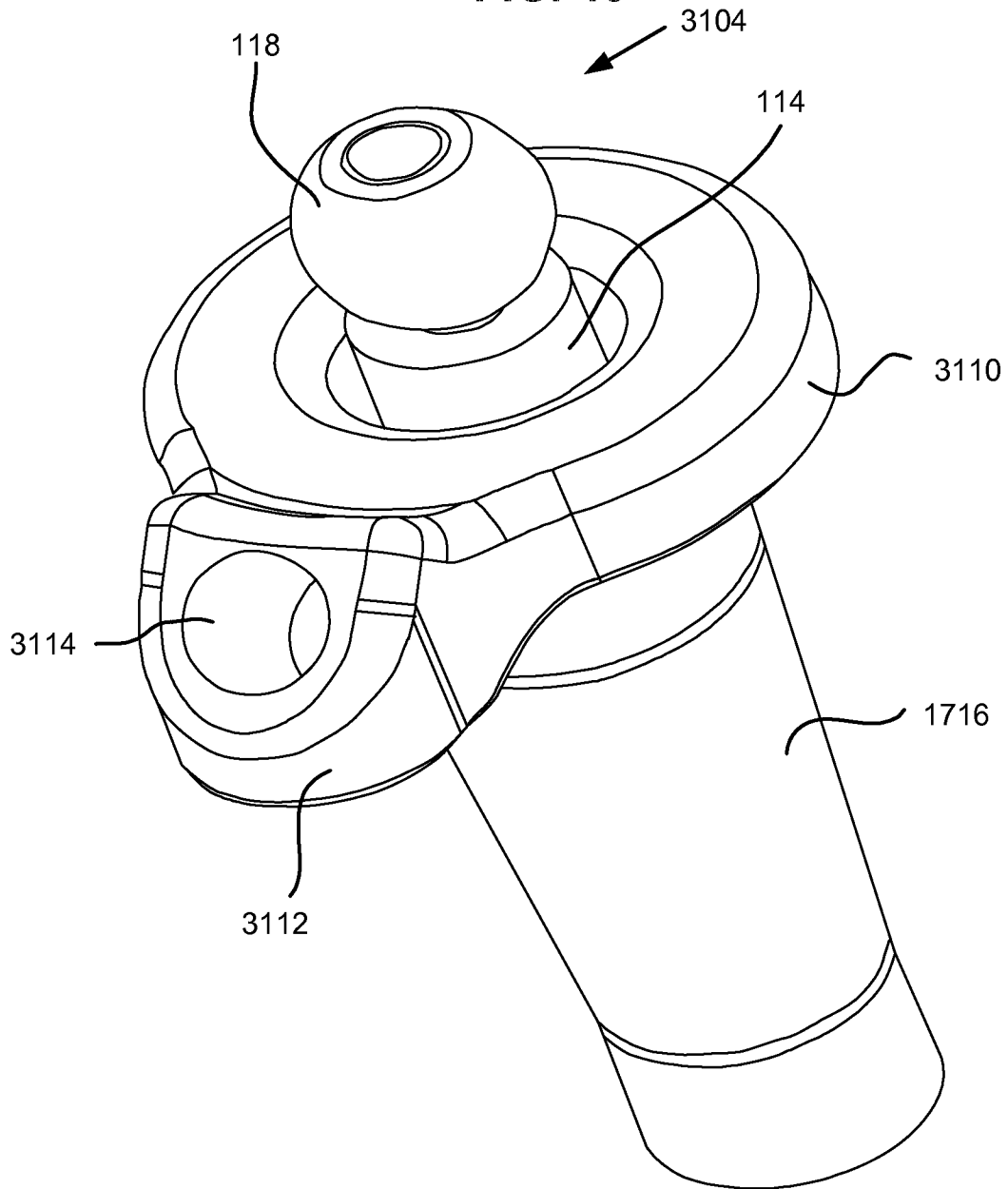
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FIG. 38



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FIG. 40



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FIG. 41

