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(54) **BONE SCREW APPARATUS, SYSTEM AND METHOD**

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CPC ***A61B 17/70*** (2013.01)

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See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,209,753	A		5/1993	Biedermann et al.	
5,291,075	A		3/1994	Hollstein et al.	
5,312,404	A	*	5/1994	Asher et al.	606/264
5,352,224	A	*	10/1994	Westermann	606/286
5,360,431	A	*	11/1994	Puno et al.	606/308
5,454,813	A		10/1995	Lawes	
5,466,237	A		11/1995	Byrd, III et al.	
5,474,555	A		12/1995	Puno et al.	
5,496,321	A		3/1996	Puno et al.	
5,499,983	A		3/1996	Hughes	
5,584,834	A		12/1996	Errico et al.	
5,669,911	A		9/1997	Errico et al.	
5,683,390	A		11/1997	Metz-Stavenhagen et al.	
5,690,630	A	*	11/1997	Errico et al.	606/264

(Continued)

FOREIGN PATENT DOCUMENTS

CA	2289629	A1	11/1998
DE	19509332	C1	8/1996

(Continued)

OTHER PUBLICATIONS

DePuy Spine, Mountaineer OCT Spinal System, Surgical Technique. © 2005 DePuy Spine, Inc.

(Continued)

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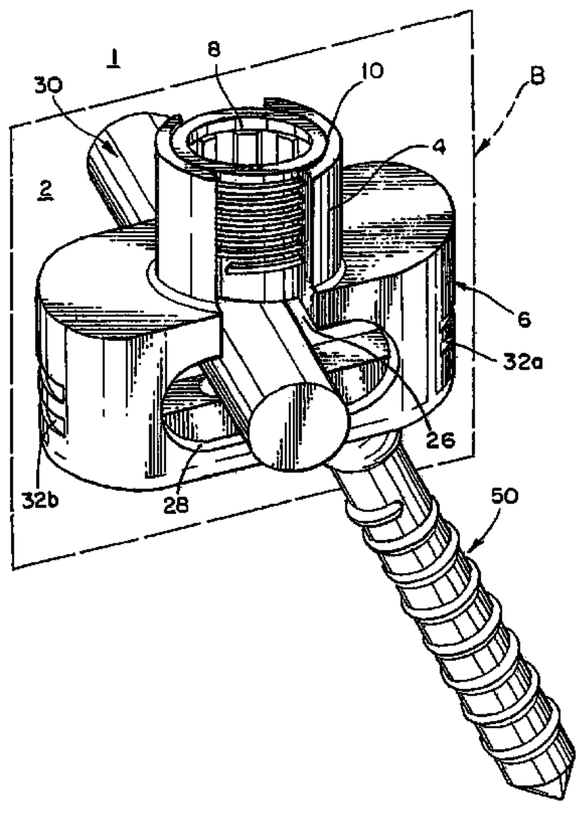
(57) **ABSTRACT**

A bone screw apparatus, system, and method for assisting in the placement and alignment of a bone screw and for aligning bone are described. The present invention allows a surgeon to position a bone screw in a desired position and adjust a coupling element in a variety of positions and angles with respect to the bone screw.

80 Claims, 4 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

5,713,900	A	2/1998	Benzel et al.	
5,743,907	A *	4/1998	Asher et al.	606/264
5,876,402	A	3/1999	Errico et al.	
5,879,350	A	3/1999	Sherman et al.	
5,908,422	A	6/1999	Bresina	
5,938,663	A *	8/1999	Petreto	606/278
6,010,503	A	1/2000	Richelsoph et al.	
6,053,917	A	4/2000	Sherman et al.	
6,060,111	A	5/2000	Buecher et al.	
6,063,090	A	5/2000	Schlapfer	
6,074,391	A	6/2000	Metz-Stavenhagen et al.	
6,090,111	A	7/2000	Nichols	
6,110,172	A	8/2000	Jackson	
6,248,105	B1	6/2001	Schlapfer et al.	
6,251,112	B1	6/2001	Jackson	
6,254,602	B1	7/2001	Justis	
6,273,888	B1	8/2001	Justis	
6,280,442	B1	8/2001	Barker et al.	
6,296,642	B1	10/2001	Morrison et al.	
6,335,040	B1	1/2002	Hoier et al.	
RE37,665	E	4/2002	Ralph et al.	
6,406,477	B1	6/2002	Fujiwara	
6,440,132	B1	8/2002	Jackson	
6,443,953	B1	9/2002	Perra et al.	
6,443,954	B1	9/2002	Bramlet et al.	
6,471,705	B1	10/2002	Biedermann et al.	
6,478,798	B1	11/2002	Howland	
6,520,963	B1	2/2003	McKinley	
6,565,565	B1	5/2003	Yuan et al.	
6,565,566	B1	5/2003	Wagner et al.	
6,652,526	B1	11/2003	Arafiles	
6,660,004	B2	12/2003	Barker et al.	
6,660,005	B2	12/2003	Toyama et al.	
6,682,529	B2 *	1/2004	Stahurski	606/301
6,685,705	B1	2/2004	Taylor	
6,689,133	B2	2/2004	Morrison et al.	
6,709,434	B1 *	3/2004	Gournay et al.	606/266
6,716,214	B1	4/2004	Jackson	
6,736,820	B2	5/2004	Biedermann et al.	
6,755,829	B1	6/2004	Bono et al.	
6,780,186	B2	8/2004	Errico et al.	
6,860,884	B2	3/2005	Shirado et al.	
6,974,460	B2	12/2005	Carbone et al.	
RE39,089	E	5/2006	Ralph et al.	
7,081,116	B1	7/2006	Carly	
7,081,117	B2	7/2006	Bono et al.	
7,087,057	B2	8/2006	Konieczynski et al.	
7,235,075	B1 *	6/2007	Metz-Stavenhagen	606/86 A
7,306,602	B2	12/2007	Bono et al.	
7,322,981	B2	1/2008	Jackson	
7,338,491	B2 *	3/2008	Baker et al.	606/308
7,445,627	B2	11/2008	Hawkes et al.	
7,559,943	B2	7/2009	Mujwid	
7,572,279	B2	8/2009	Jackson	
7,578,833	B2 *	8/2009	Bray	606/246
7,591,839	B2	9/2009	Biedermann et al.	
7,635,380	B2	12/2009	Zucherman et al.	
7,691,131	B2	4/2010	Graf	
7,699,876	B2	4/2010	Barry et al.	
7,704,270	B2	4/2010	De Coninck	
7,731,734	B2	6/2010	Clement et al.	
7,749,258	B2	7/2010	Biedermann et al.	
7,776,067	B2	8/2010	Jackson	
7,780,706	B2	8/2010	Marino et al.	
7,811,310	B2	10/2010	Baker et al.	
7,850,718	B2	12/2010	Bette et al.	
7,850,719	B2	12/2010	Gournay et al.	
7,857,834	B2	12/2010	Boschert	
7,922,748	B2	4/2011	Hoffman	
7,955,358	B2	6/2011	Albert	
7,967,849	B2	6/2011	Carson et al.	
7,967,850	B2	6/2011	Jackson	
8,012,183	B2	9/2011	Alain	
8,092,494	B2	1/2012	Butler et al.	
8,100,945	B2	1/2012	Dewey et al.	
8,298,275	B2	10/2012	Rezach	
8,337,530	B2	12/2012	Hestad et al.	
2001/0001119	A1	5/2001	Lombardo	
2001/0047173	A1	11/2001	Schlapfer et al.	
2002/0120272	A1	8/2002	Yuan et al.	
2002/0183747	A1 *	12/2002	Jao et al.	606/61
2003/0167058	A1	9/2003	Shluzas	
2004/0097933	A1	5/2004	Lourdel et al.	
2004/0116929	A1	6/2004	Barker et al.	
2004/0138660	A1	7/2004	Serhan	
2004/0143265	A1	7/2004	Landry et al.	
2004/0153068	A1	8/2004	Janowski et al.	
2004/0158247	A1 *	8/2004	Sitiso et al.	606/61
2004/0162558	A1	8/2004	Hegde et al.	
2004/0204771	A1	10/2004	Swanson, Sr.	
2004/0215190	A1 *	10/2004	Nguyen et al.	606/61
2004/0236330	A1 *	11/2004	Purcell et al.	606/61
2004/0243126	A1	12/2004	Carbone et al.	
2004/0267264	A1	12/2004	Konieczynski et al.	
2005/0010221	A1	1/2005	Dalton	
2005/0025767	A1	2/2005	Nishihira	
2005/0080415	A1 *	4/2005	Keyer et al.	606/61
2005/0080420	A1	4/2005	Farris et al.	
2005/0131410	A1 *	6/2005	Lin	606/61
2005/0154391	A1	7/2005	Doherty et al.	
2005/0182407	A1 *	8/2005	Dalton	606/69
2005/0187548	A1 *	8/2005	Butler et al.	606/61
2005/0203515	A1	9/2005	Doherty et al.	
2005/0203516	A1	9/2005	Biedermann et al.	
2005/0234451	A1	10/2005	Markworth	
2005/0261687	A1 *	11/2005	Garamszegi et al.	606/61
2006/0025767	A1 *	2/2006	Khalili	606/61
2007/0118123	A1	5/2007	Strausbaugh et al.	
2007/0233063	A1	10/2007	Rezach	
2008/0004623	A1	1/2008	Ferrante et al.	
2008/0009682	A1	1/2008	Hernke	
2008/0009862	A1	1/2008	Hoffman	
2008/0077138	A1	3/2008	Cohen et al.	
2008/0108992	A1	5/2008	Barry et al.	
2008/0119857	A1	5/2008	Potash et al.	
2008/0125816	A1	5/2008	Jackson	
2008/0140135	A1	6/2008	Konieczynski et al.	
2008/0147129	A1	6/2008	Biedermann et al.	
2008/0154315	A1	6/2008	Jackson	
2008/0161853	A1	7/2008	Arnold et al.	
2008/0161863	A1	7/2008	Arnold et al.	
2008/0177260	A1	7/2008	McKinley et al.	
2008/0195159	A1	8/2008	Kloss et al.	
2008/0243193	A1	10/2008	Ensign et al.	
2008/0249570	A1	10/2008	Carson et al.	
2008/0262497	A1	10/2008	Nijenbanning et al.	
2008/0269809	A1	10/2008	Garamszegi	
2008/0312655	A1	12/2008	Kirschman et al.	
2009/0024155	A1	1/2009	Lee-Sepsick et al.	
2009/0036929	A1	2/2009	Reglos et al.	
2009/0076552	A1	3/2009	Tornier	
2009/0105769	A1	4/2009	Rock et al.	
2009/0182384	A1	7/2009	Wilcox et al.	
2009/0248025	A1	10/2009	Haidukewych et al.	
2010/0036426	A1	2/2010	Mitchell et al.	
2010/0087873	A1	4/2010	Null et al.	
2010/0100137	A1	4/2010	Justis et al.	
2010/0198272	A1	8/2010	Keyer et al.	
2010/0204735	A1	8/2010	Gephart et al.	
2010/0228293	A1	9/2010	Courtney et al.	
2010/0241170	A1	9/2010	Cammisa et al.	
2010/0268279	A1	10/2010	Gabelberger et al.	
2010/0305621	A1	12/2010	Wang et al.	
2010/0331889	A1	12/2010	Abdou	
2011/0093021	A1	4/2011	Fanger et al.	
2011/0106173	A1	5/2011	Lindemann et al.	
2011/0106175	A1	5/2011	Rezach	
2011/0106176	A1	5/2011	Jackson	

(56) **References Cited**

U.S. PATENT DOCUMENTS

2011/0106180	A1	5/2011	Miller et al.
2011/0137348	A1	6/2011	Jackson

FOREIGN PATENT DOCUMENTS

DE	19720782	A1	11/1998
EP	0441729	A1	8/1991
EP	1923011	A1	5/2008
WO	9702786	A1	1/1997
WO	9852482	A1	11/1998
WO	0115612	A1	3/2001
WO	2005122929	A1	12/2005
WO	2006009753	A1	1/2006
WO	2007047711	A2	4/2007
WO	2008042948	A2	4/2008
WO	2008057551	A2	5/2008
WO	2009055407		4/2009
WO	2009091686		7/2009
WO	2010090428	A2	8/2010

OTHER PUBLICATIONS

International Search Report and Written Opinion for PCT/US2010/054453 Mailed Jun. 28, 2011.

Medtronic, Vertex Max, Reconstruction System Surgical Technique Demonstrating Occipital Plate Rod and Occipital Keel Plate, 2009, pp. 1-44.

EBI Spine, Polaris, Surgical Technique, 2006, pp. 28.

Burkus, MD, Kenneth, Medtronic, TSRH-3D Spinal System, Surgical Technique, 2009, pp. 32.

EBI, A Biomet Company, Omega 21 Spinal Fixation System, EBI Spine System, 2001.

Non-Final Office Action for U.S. Appl. No. 12/614,734 Mailed Oct. 28, 2011.

International Search Report and Written Opinion for Application No. PCT/US2012/036234 mailed Nov. 16, 2012.

Extended European Search Report and European Search Opinion dated Sep. 9, 2013 for PCT Application No. PCT/US2010054453.

ST360° Spinal Fixation System; © 2005 Zimmer Spine, Inc. L1242 Rev. D04/05; 4 Pages.

PCT International Preliminary Report on Patentability for related Application No. PCT/US2012/036234; Nov. 21, 2013; 6 pages.

Supplemental European Search Report for EP Application No. EP 12 78 2522, dated May 28, 2015.

"European Application Serial No. 12782522.0, Extended European Search Report mailed May 28, 2015", 10 pgs.

* cited by examiner

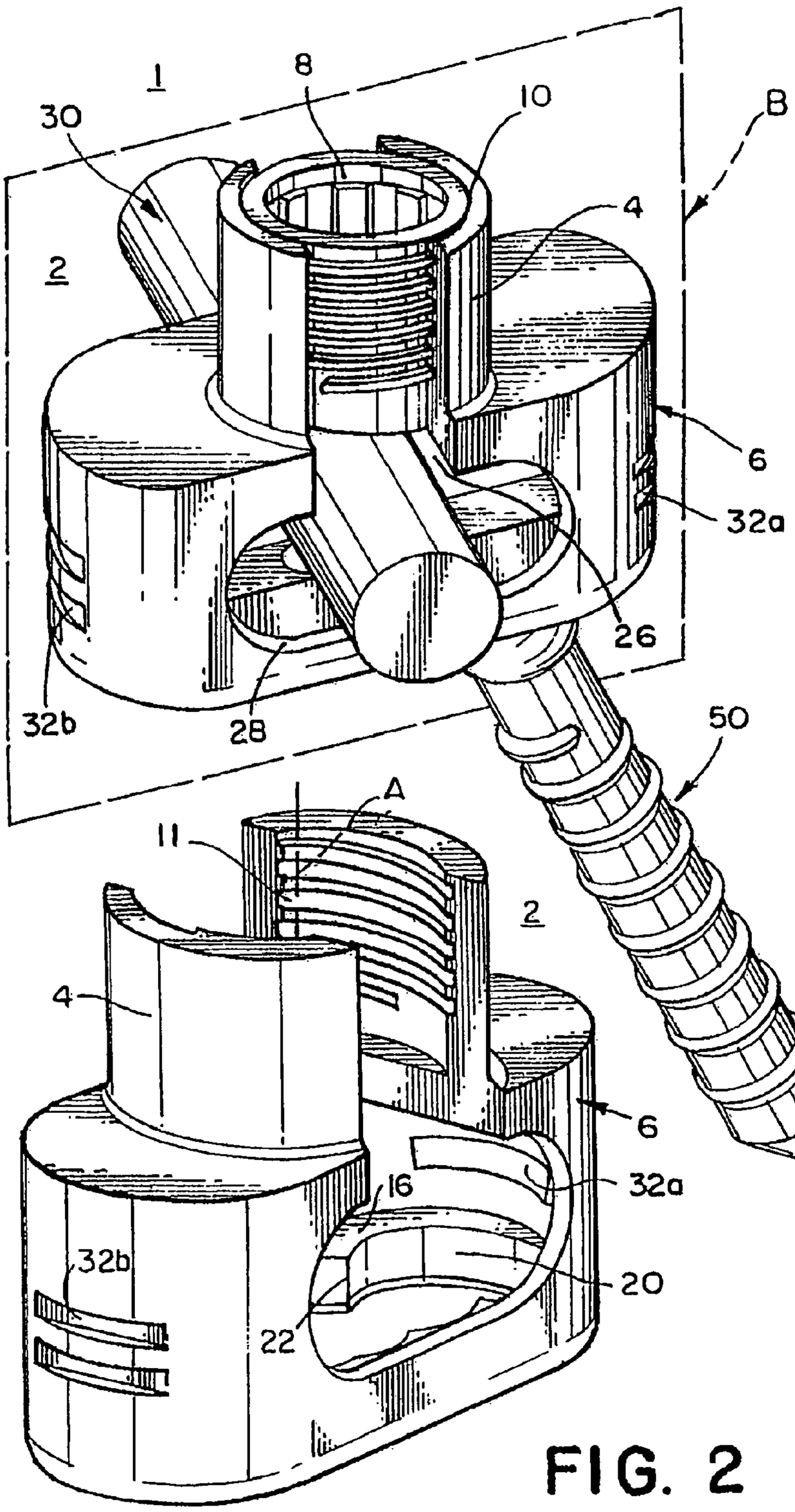


FIG. 1

FIG. 2

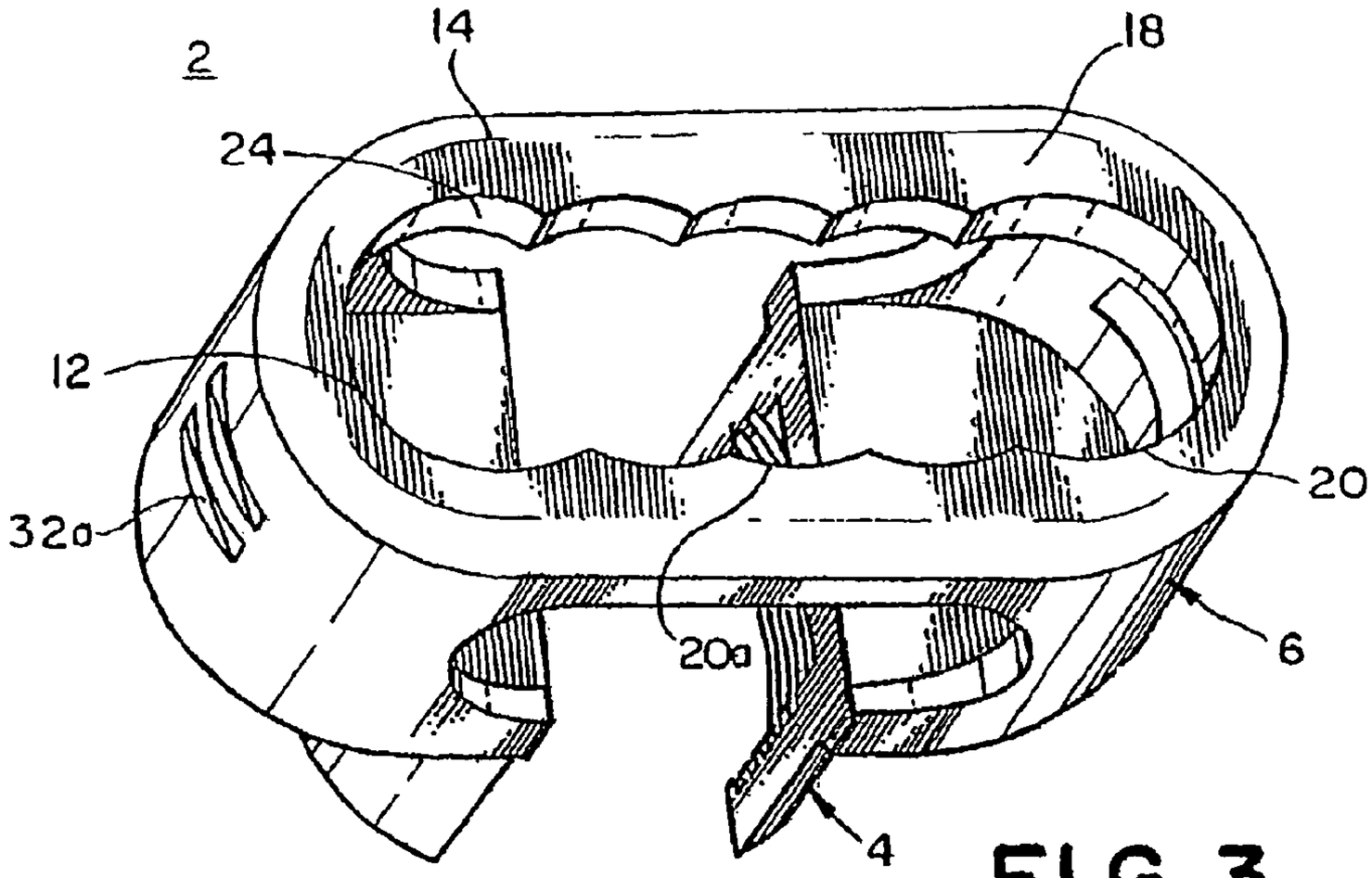


FIG. 3

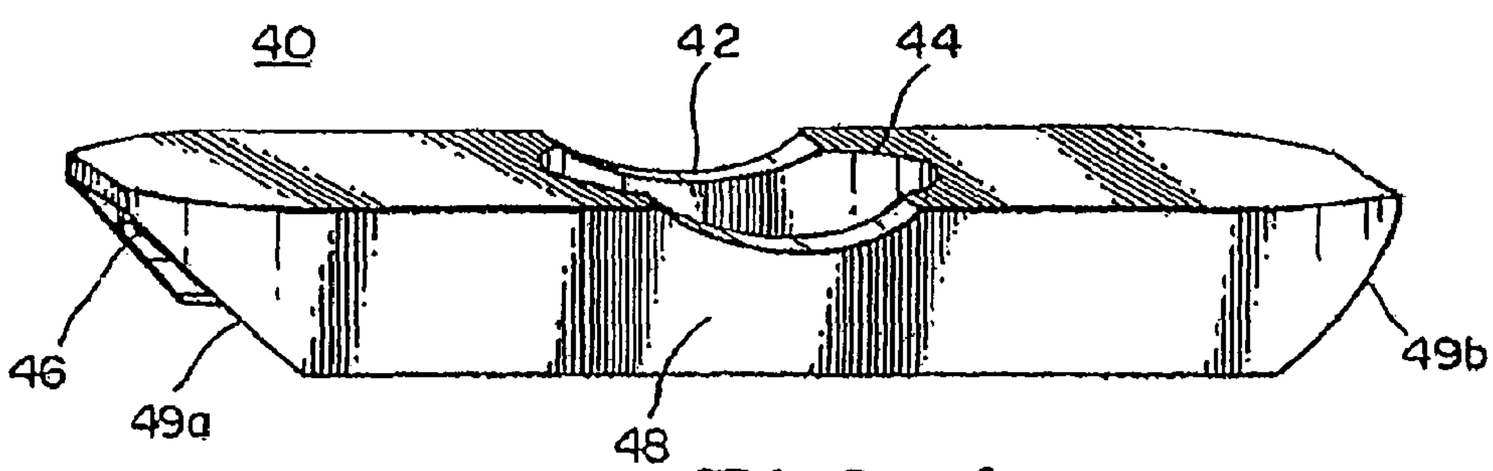


FIG. 4

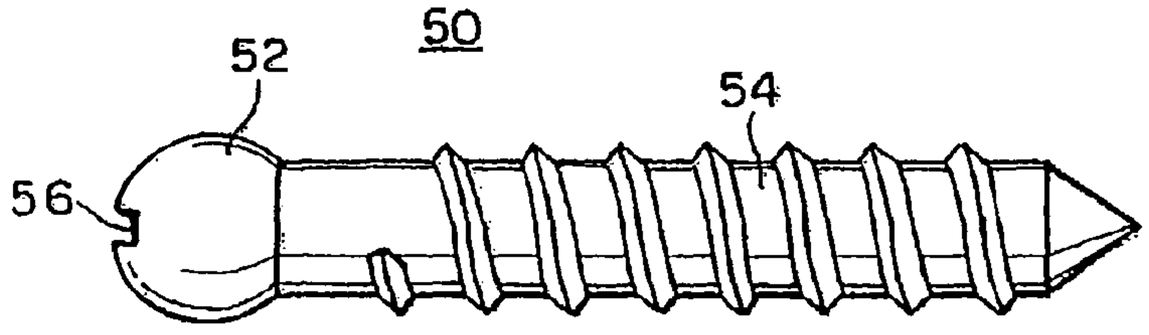


FIG. 5

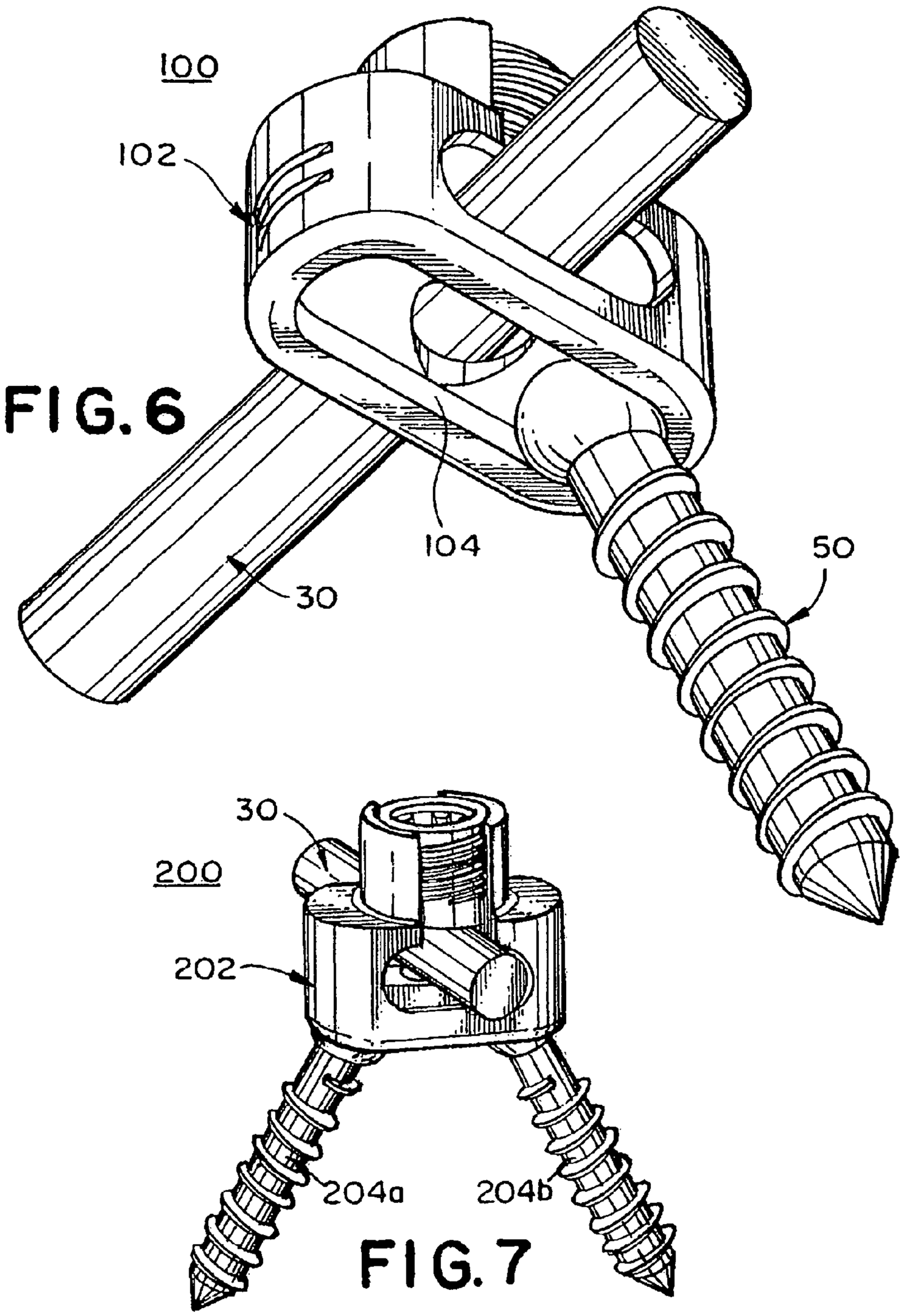


FIG. 6

FIG. 7

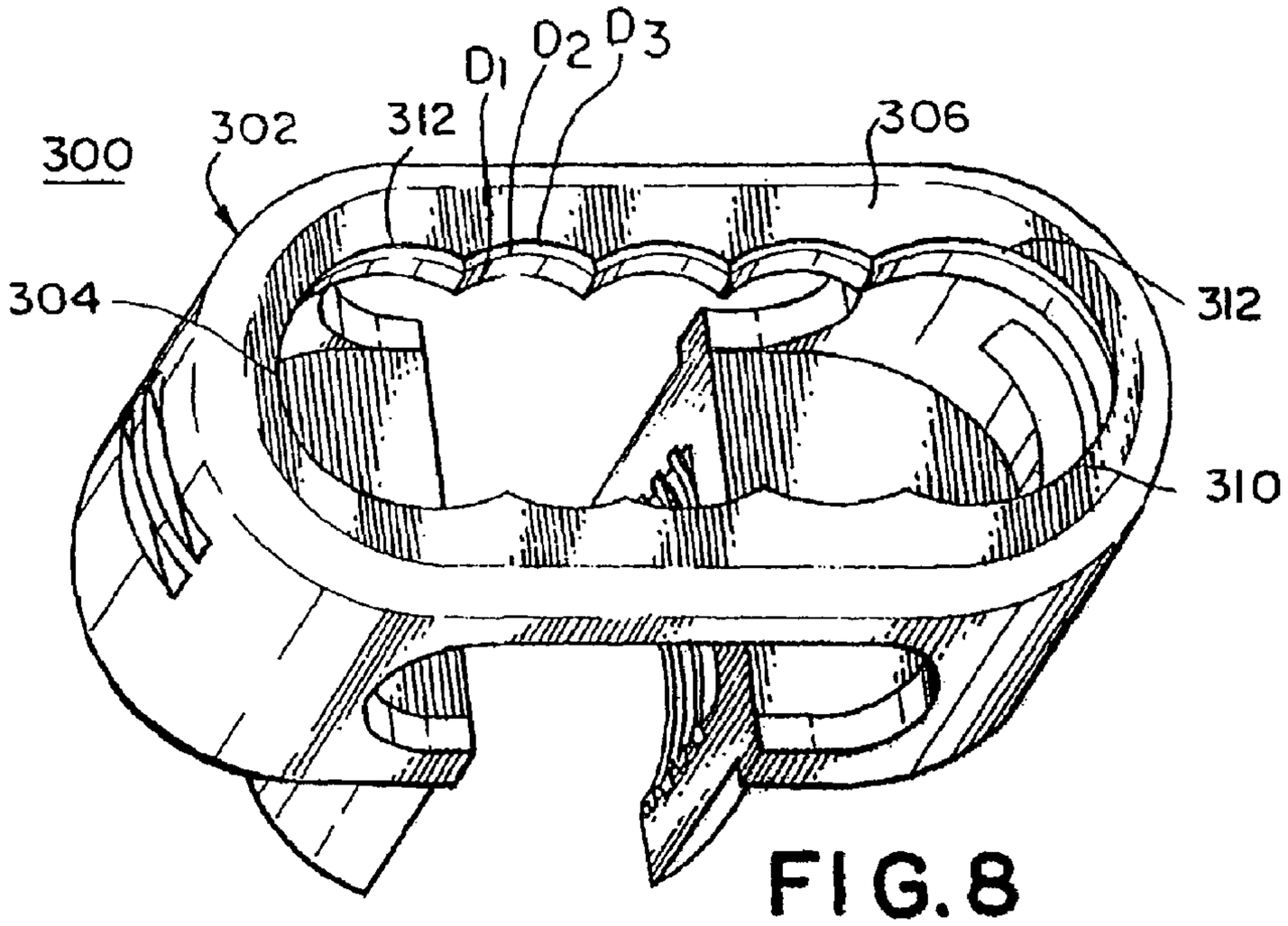


FIG. 8

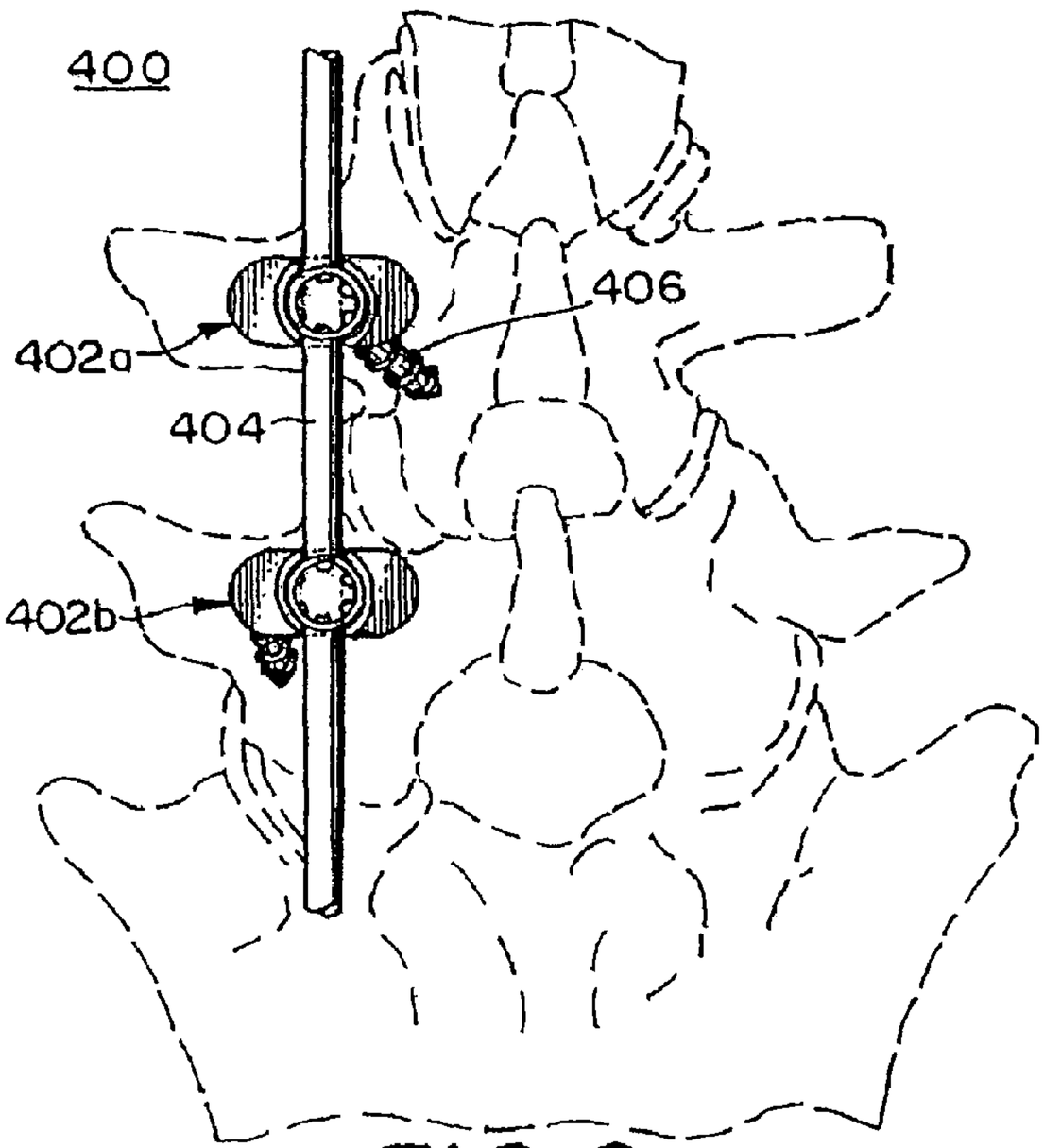


FIG. 9

BONE SCREW APPARATUS, SYSTEM AND METHOD

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue; a claim printed with strikethrough indicates that the claim was canceled, disclaimed, or held invalid by a prior post-patent action or proceeding.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an orthopedic implant. In particular, the present invention relates to a bone screw apparatus, system, and method.

2. Description of Related Art

Conventional bone screws and precursory polyaxial screws have found wide usage in orthopedic spinal surgery. Such devices are routinely used to address spinal instability and displacement, genetic or developmental irregularities, trauma, chronic stress, tumors, and disease. However, such designs are not without limitation. For example, conventional bone screws used with fixation rods , provide for minimal, if any variability in the placement of these rods relative to the position of the bone screw. Specifically, such conventional designs limit the positioning of the rod such that it is aligned with and/or above the screw. The rod itself makes direct contact with the screw head and is used to secure the screw into a coupling element in order to lock or secure the entire assembly into place. As a result, a surgeon is forced to try and position the screw taking into account the position of the rod and being generally unable to move the screw into the most optimal or strategic position. These limitations may cause the surgeon to reposition the bone screw in order to correctly align the system and as a result cause additional and unnecessary weakening of the bone due to, for example, additional screw holes created by the repositioning and/or stress on the bone screw interface by forcible repositioning. Further, while some bone screws allow for limited radial movement of the coupling element, medial-lateral variability of the placement of these rods relative to the screw is curtailed.

Accordingly, there exists a need for an improved bone screw alignment system that provides ease of use and modularity of assembly and that eliminates the problems set forth above.

BRIEF SUMMARY OF THE INVENTION

The present invention provides for an apparatus for coupling a bone screw to a connector, comprising; a housing that includes; an aperture for receiving a connector, a base having a slot configured for receiving at least one bone screw, and wherein the housing is configured to receive a fixation element.

The present invention also provides for a bone screw apparatus comprising; a coupling element that includes; a housing having; an aperture and a base having a slot; a connector extending through the aperture; a bone screw positioned within the slot; and a fixation element configured to secure the coupling element, connector, and bone screw in a fixed position.

The present invention further provides for a bone screw system comprising; a connector; and at least two bone screw apparatuses each comprising; a coupling element that includes; an aperture, wherein the connector extends through

the aperture, and a base having slot; a bone screw positioned within the slot; and a fixation element configured to secure the coupling element, connector, and bone screw in a fixed position.

The present invention furthermore provides for a method for aligning and placing a bone screw system in bone, wherein the bone screw system includes; a connector; and at least a first and a second bone screw apparatus, wherein each bone screw apparatus has a coupling element having an aperture; and a base having a slot; a bone screw positioned within the slot; and a fixation element, wherein the connector extends through the aperture and wherein the fixation element is configured to secure the coupling element, connector, and bone screw in a fixed position, comprising; (a) positioning the first bone screw of the first bone screw apparatus in the slot of the first coupling element, (b) screwing the first bone screw into bone, (c) positioning the second bone screw of the second bone screw apparatus in the slot of the second coupling element, (d) screwing the second bone screw into a second bone, (e) aligning the coupling elements relative to the first and second bone screws, (f) extending the connector through each of the aligned coupling elements, and (g) securing the alignment of the first and second bone screw apparatuses in a fixed position.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

The foregoing summary, as well as the following detailed description of the embodiments of the invention, will be better understood when read in conjunction with the appended drawings. It should be understood, however, that the invention is not limited to the precise arrangements and instrumentalities shown. In the drawings:

FIG. **1** is a perspective view of a bone screw apparatus embodiment of the present invention;

FIG. **2** is a perspective view of a coupling element of the bone screw apparatus of FIG. **1**;

FIG. **3** is an anterior perspective view of the coupling element of FIG. **2**;

FIG. **4** is a perspective view of an optional locking wedge for use with the bone screw apparatus of FIG. **1**;

FIG. **5** is a plan view of a polyaxial screw of the bone screw apparatus of FIG. **1**;

FIG. **6** is an anterior perspective view of a another embodiment of a bone screw apparatus of the present invention;

FIG. **7** is a perspective view of a further embodiment of the present invention;

FIG. **8** is an anterior perspective view of yet another embodiment of a bone screw apparatus of the present invention; and

FIG. **9** is an illustration of a bone screw system of the present invention affixed to bone.

DETAILED DESCRIPTION OF THE INVENTION

As used herein, the following definitional terms apply. The term "anterior" and "posterior" mean nearer to the front or the back of the body respectively. "Proximal" and "distal" mean nearer and farther from the center of the body respectively. "Medial" and "lateral" mean nearer or farther from the median plane respectively. The median plane is an imaginary, vertical plane that divides the body into a right and left half. A coronal plane is an imaginary, vertical plane that divides the body into a front half and a back half. "Superior" and "inferior" mean above or below respectively. "Sagittal" means a side profile.

The present invention provides for a bone screw apparatus, system, and method for attaching a connector to a vertebra.

In an embodiment, as illustrated in FIGS. **1-5**, the present invention provides for a bone screw apparatus **1** that includes a coupling element **2**, a fixation element **8**, a connector **30**, a locking wedge **40**, and a bone screw **50**.

As illustrated in FIG. **2**, the coupling element **2** includes an upper housing **4** and a lower housing **6**. A fixation element **8** as shown in FIG. **1** is inserted into the apparatus **1**. The coupling element **2**, can optionally be configured as a single housing only. In the present embodiment the fixation element is a locking screw **8** and the coupling element **2** has a connector **30** therethrough as shown in FIG. **1**.

The upper housing **4** and lower housing **6** units can be an integral one-piece unit or separate units connected together by any acceptable means (e.g., taper lock, mechanical locking mechanism, screw, dovetail, bonding, and the like). The upper housing **4** has a cross-sectional shape perpendicular to axis A that is generally circular in shape but can also be any shape consistent with the intended use, such as a square, rectangle, oval, or the like. Further, the outer cross-sectional shape can vary from the cross-sectional shape of hole **10** extending therethrough. The upper housing **4** is configured to accommodate the fixation element **8**. In this embodiment, the upper housing **4** is configured to have a hole **10** that can receive and accommodate a locking screw **8** (e.g., a set screw). It is preferred that the interior surface **11** defining the hole **10** is threaded, but other embodiments such as snap-fit, cross-threading, interlocking, and dovetailing can also be used.

The lower housing **6** can be wider or narrower measured perpendicular to axis A in the longest dimension of the device than the upper housing **4**. In the present embodiment, the lower housing **6** is wider than the upper housing **4** and is generally configured as illustrated in FIGS. **2** and **3**. However, the shape of the lower housing **6** can be any other shape consistent with the intended use, such as a cross-sectional shape perpendicular to axis A that is circular, oval, or square so long as it can accommodate a slot **12**.

The lower housing **6** includes a slot **12** as illustrated in FIG. **3**. The slot **12** can be positioned at the base **14** of the lower housing **6**. The base **14** can be integrally formed as part of the lower housing **14**, a separately formed and attached piece, or a prefabricated interchangeable insert having a slot **12**.

The base **14** has a posterior surface **16** (as shown in FIG. **2**) and an anterior surface **18**. The slot **12** is formed so as to extend between surfaces **16** and **18** and includes a plurality of slot positions **20**, including a center slot position **20**a. The slot **12** can alternatively include at least two slot positions, or a smooth peripheral, oval shaped or capsule shaped slot (i.e., a continuous slot). The slot **12** allows the coupling element **2** to be positioned more medially, laterally, superiorly, or inferiorly relative to the position of the bone screw **50**. This advantageously allows the surgeon to optimally position the bone screw **50** without being limited by the constraints of a connector's position.

In the present embodiment, the slot **12** includes five slot positions **20** and a center slot position **20**a positioned directly below the threaded hole **10**. The slot positions **20** are circular in shape but can be any other shape consistent with the intended use. As illustrated in FIG. **2**, the slot positions are overlapping and form notches **22**. The notches **22** facilitate positioning of the bone screw **50** into a bone by helping to prevent the bone screw **50** from moving to another slot position and guiding the bone screw **50** as the screw is being drilled into the bone. The notches **22** further provide for greater contact area between the bone screw **50** and the coupling element **2**, which improves the overall structural integrity of the bone screw apparatus **1** when in use.

The slot positions **20** and generally the edge of the slot **20** can optionally be configured to have or be contoured with a beveled edge **24** as shown in FIG. **3** or a round edge (not shown). The edge **24** can be complementary in shape to that of the screw head **52**. The contoured edge facilitates movement (e.g., polyaxial movement) of the bone screw **50** within the coupling element **2** due to its generally complementary configuration to that of the curvate polyaxial screw head **52** (as shown in FIG. **5**) of the bone screw **50**.

The lower housing **6** can include an aperture **26** as shown in FIG. **1**. The aperture **26** allows the placement of a connector, such as rod **30**, within the coupling element **2** such that the connector (e.g., rod **30**) is generally centered within the coupling element **2**, allowing for greater stability when fastening the locking screw **8** into place. The aperture **26** can be configured so as to allow the connector to be perpendicular to plane B or at an angle relative to plane B, as illustrated in FIG. **1**. The lower housing **6** can also include a visibility hole **28**. The visibility hole **28** advantageously allows the surgeon to be able to see the polyaxial screw **50** during assembly of the bone screw apparatus **1**.

As illustrated in FIG. **2**, the lower housing **6** can optionally include angled ridges **32**a, **32**b positioned on the interior surface of the lower housing **6** of coupling element **2** for mating with angled flats **49**a, **49**b of an optional locking wedge **40** (as shown in FIG. **4** and described below). Together, the angled flats **49**a, **49**b of the locking wedge **40** and angled ridges **32**a, **32**b form a wedge for mating and securing locking wedge **40** into place. The angled ridges **32**a, **32**b can be slightly steeper than the angled flats **49**a, **49**b. The angled flats **49**a, **49**b help locking wedge **40** remain level and parallel with the base **14** of the coupling element **2**, to facilitate maintaining the alignment of the rod **30**.

In the present embodiment, the fixation element is configured to be a locking screw **8** as shown in FIG. **1**. The fixation element, without limitation, can also be a cam lock, a taper lock, an interference fit, a locking tab, a tapered wedge, a locking collar, a dovetail, or any other configuration consistent with the intended use. The fixation element can be positioned anywhere within the coupling element **2** such that the fixation element provides a securing force to the bone screw apparatus **1** (e.g., secures the coupling element **2**, rod **30**, and the bone screw **50** in a fixed position). For example, the fixation element can be in an upper housing **4** or the lower housing **2** of the coupling element. Examples of such fixation elements are readily known in the art and a detailed explanation of such fixation elements is not necessary for a complete understanding of the present invention.

The present embodiment further includes a connector. In the present embodiment the connector is configured as a rod **30**. The connector, without limitation, can also be a cylindrical rod, a square rod, an oval rod, a rectangular rod, a hollow rod, or any other longitudinal member consistent with the intended use.

The present embodiment can optionally include a locking wedge **40** as configured and illustrated in FIG. **4**. The locking wedge **40** includes an optional connector channel **42**, a tool hole **44**, and a concave channel **46** defined by the downwardly extending sides **48** of the locking wedge **40**. The locking wedge **40** can optionally include angled flats **49**a, **49**b to mate with angled ridges **32**a, **32**b on the lower housing **6** of the coupling element as discussed above. The angle of the angled flats **49**a, **49**b can be from 0 to about 89 degrees, and prefer-

ably about 35 to about 55 degrees. The locking wedge **40** can be made from a metal, alloy, polymer, or any combination thereof.

The connector channel **42** is formed on the posterior side of the locking wedge **40** and is configured to cradle or support and preferably mate with the surfaces of the rod **30** as it extends or passes through the device. The connector channel **42** can be indented into the locking wedge **40** as illustrated in FIG. **4**. The configuration of the connector channel **42** allows the rod **30** to be positioned perpendicular to or at an angle relative to plane B, as shown in FIG. **1**. The tool hole **44** is configured to be a circular through hole but can, without limitation, be any shaped through hole. The tool hole **44** can be positioned at the center of the locking wedge **40**, which helps a surgeon better manipulate the bone screw **50**. The size of the tool hole **44** is configured to accommodate a range of motion for a surgical tool, such as a screwdriver or drill (not shown), such that the screw head **52** (as shown in FIG. **5**) can be accessed by the surgical tool even when the bone screw **50** is at its maximum angulation.

The bone screw **50** of the present embodiment is illustrated in FIG. **5**. Bone screw designs, like the surgical tools discussed above, are readily known in the art and a detailed explanation of them are not necessary for a complete understanding of the present invention. The present embodiment of the invention is not limited to polyaxial screws but can alternatively include non-polyaxial screws such as a posted bone screws or posted/polyaxial bone screws.

In the present embodiment, the bone screw **50** includes a head **52** and a threaded shaft **54**. The head **52** is configured to have a predominately curvate shape such as a spherical outer surface or a hemispherical shape. The head **52** further includes at least one recess **56** positioned on the top of the bone screw **50** to receive the application of a torque driving tool, such as a screw driver or drill. The recess **56** can alternatively be any configuration that cooperates with any suitable torque driving tool, such as a phillips head configuration, allen wrench, or the like. It is noted that the size of the head **52** and diameter of the threaded shaft can vary depending upon the individual circumstances and size requirements for a particular use or patient. As the size of the bone screw **50** changes, the size of other corresponding components of the bone screw apparatus **1** should change accordingly.

In an assembled state, the bone screw **50** is adjustably positioned within the lower housing **6** with its head **52** positioned within the lower housing **6** and in one of the slot positions **20**. The spherical shape of the screw head **52** allows the bone screw **50** to be angled relative to axis A. The locking wedge **40** is positioned within the lower housing **6** such that the concave channel **46** contacts the screw head **52**. The rod **30** is then positioned to extend through the coupling element **2** and in contact with or on the connector channel **42**. The shape of the connector channel **42** allows the rod **30** to be either perpendicular to or at an angle relative to the direction of the concave channel **46**. The locking screw **8** is then screwed (i.e. torqued down) into the threaded hole **10** of the upper housing **4** until sufficient contact is made with the rod **30**. As the locking screw **8** is screwed down, it pulls the coupling element **2** posteriorly. As the locking screw **8** is screwed down, it pushes anteriorly onto the rod **30** transmitting a securing force (e.g., an anteriorly directed force) onto the rod **30**. Thus, the locking screw **8** supplies an anterior force (i.e., a securing force) to the rod **30** which further transmits a securing force onto the locking wedge **40** which, as a result, secures the coupling element **2** and the bone screw **50** in a fixed position. Overall, the anterior force of the locking screw **8** and the resulting posterior force of the coupling element assembles the bone screw apparatus **1** into a secure and stable position regardless of which slot position **20** the bone screw **50** is located.

In operation, the coupling element **2** can be preassembled with the bone screw **50**, which is positioned loosely in a center slot position or the center of the slot **12**. Locking wedge **40** can be positioned inside the coupling element **2** such that angled flats **49**a, **49**b lie loosely on top of angled ridges **32**a, **32**b of coupling element **2**. The concave channel **46** of locking wedge **48** can contact the screw's head **52** as it is positioned in the coupling element **2**. A screw-driving tool (not shown) is then inserted through the coupling element **2** from above such that it passes through the upper housing **4** and through tool hole **44** of locking wedge **40**. The driving tool then secures bone screw **50** into the bone at a strategic place as determined by the surgeon. Once bone screw **50** is secured into the bone, coupling element **2** is able to move along a plane of the bone surface. That is, coupling element **2** is able to travel along the length of the slot **12** relative to the position of the bone screw **50**, and is able to rotate a full 360 degrees around the screw head **52**. Coupling element **2** can then be slid medio-laterally for optimal positioning, or rotated in the same plane if needed, so that upper housing **4** lines up with the rod **30** and the screw head **52** is positioned in one of the slot positions **20**.

Once screw head **52** is located in the proper slot position **20**, the surgeon then inserts rod **30** into the coupling element **2** via through hole **26**, wherein the rod **30** is positioned on connector channel **42** of locking wedge **40**. The surgeon can then use the screw-driving tool to fasten locking screw **8** onto the upper housing **4** of coupling element **2**. Locking screw **8** is then tightened or screwed down until locking wedge **40** engages the screw head **52** (e.g., by being compressed between rod **30** and the screw head **52**). Coupling element **2** is pulled upwards as locking screw **8** is tightened so that screw head **52** is secured inside slot position **20** of slot **12**.

To remove the bone screw apparatus **1**, locking screw **8** can be unfastened and rod **30** removed. Locking wedge **40** is loosened by insertion of a tool (not shown) through tool hole **44**. A gripping tool (not shown) may then be used to push down on coupling element **2** and the coupling element **2** slid such that screw head **52** can be located in a center slot position, allowing for the screw driving tool to access and loosen the bone screw **50**.

FIG. **6** illustrates another embodiment of the present invention. In this embodiment the bone screw apparatus **100** includes a coupling element **102** having a continuous slot **104**.

FIG. **7** illustrates a further embodiment of the present invention. In this embodiment, the bone screw apparatus **200** includes a coupling element **202** having two bone screws **204**a, **204**b for screwing into a bone.

FIG. **8** illustrates yet another embodiment of the present invention. In this embodiment, bone screw apparatus **300** includes a coupling element **302** having a slot **304** with an anterior surface **306** and a posterior surface **308** (not shown). The slot **304** includes five slot positions **310**. The slot **304** includes a continuous beveled edge **312** configured to have three diameters D**1**, D**2**, and D**3** positioned along the edge between surfaces **306**, **308**. D**1** is the largest diameter adjacent the posterior surface **308**. For illustrative purposes only, for a bone screw head having a 3.5 mm diameter head, D**1** can be 3.6 mm, which is larger than the diameter of the polyaxial screw head and allows the maximum amount of motion for the bone screw before it is secured into the bone. The beveled edge **312** then tapers down into a second diameter D**2** that measures, for example, 3.4 mm. This diameter D**2**, which is slightly smaller than that of the diameter of the polyaxial

screw head, helps prevents the screw head from slipping through the slot positions **310**. Located below diameter D**2** is diameter D**3**. The diameter D**3**, for illustrative purposes only, is 3.5 mm that allows the screw to retain about 30 degrees angulation relative to the vertical. To increase this angulation, the diameter D**3** can be increased.

The present invention also provides for a bone screw system **400** as shown in FIG. **9**. The bone screw system **400** includes a least two bone screw apparatuses **402**a, **402**b and a connector **404**. Each bone screw apparatus, for example **402**a, includes a coupling element having an aperture, a fixation element, an optional locking wedge, and at least one bone screw **406**. In operation, as shown in FIG. **9**, the connector **404**, is attached to and extends through at least two bone screw apparatuses **402**a, **402**b that are each independently affixed to a bone.

The present invention further provides for a method for placing and aligning a bone screw system (as describe above) in bone. The method includes positioning a bone screw in a slot of a coupling element (as described in any of the above embodiments), inserting the bone screw into the bone, repositioning the coupling element relative to the bone screw, and securing the alignment and position of the coupling element, and bone screw. The method can further include positioning a connector (as described in any of the above embodiments) through the coupling element, and securing the alignment and position of the connector, coupling element, and bone screw.

The present invention also provides for a method for aligning bones. The method includes providing a bone screw system. The bone screw system includes at least two bone screw apparatuses that each include a coupling element having a connector therethrough and a slot, and a bone screw positioned within the slot, wherein the connector transmits a securing force securing the coupling element and bone screw in a fixed position.

The present invention advantageously allows for additional positioning freedom between a bone screw and a connector in multiple degrees of freedom including the medial, lateral, superior, and inferior directions.

It will be appreciated by those skilled in the art that changes can be made to the embodiments described above without departing from the broad inventive concept thereof. It is understood, therefore, that this invention is not limited to the particular embodiments disclosed, but it is intended to cover modifications within the spirit and scope of the present invention as defined by the appended claims.

I claim:

1. An apparatus for coupling a bone screw to a connector, comprising:

a housing that includes:

an aperture for receiving a connector, and

a base having:

a generally flat anterior surface,

a generally flat posterior surface, and

a generally oblong opening formed by a substantially linear surface extending from the anterior surface to the posterior surface,

at least one polyaxial bone screw directly engaging the substantially linear surface forming the generally oblong opening, and

a fixation element adjustably mounted to the housing that engages both the connector and the at least one polyaxial bone screw to secure both the connector and the at least one polyaxial bone screw to the housing in a fixed position,

wherein the housing comprises:

a lower housing,

an upper housing, and

wherein the upper housing is configured to receive the fixation element.

[2. The apparatus of claim **1**, wherein the housing comprises:

a lower housing,

an upper housing, and

wherein the upper housing is configured to receive the fixation element.**]**

3. The apparatus of claim **1**, wherein the oblong opening includes a plurality of notches defining a plurality of slot positions.

4. The apparatus of claim **1**, wherein the aperture is an oblong aperture with a major axis of the oblong opening extending substantially parallel to a major axis of the oblong aperture.

5. A bone screw apparatus comprising:

a coupling element that includes:

a housing having:

an oblong aperture extending through the housing, and

a base having a generally oblong opening with a major axis of the oblong opening extending substantially parallel to a major axis of the oblong aperture,

a connector extending through the oblong aperture,

a head of a polyaxial bone screw positioned in direct engagement with a wall of the housing forming the oblong opening, and

a fixation element configured to secure the coupling element, connector, and bone screw in a fixed position.

6. The bone screw apparatus of claim **5**, wherein the fixation element is a locking screw, a cam lock, a taper lock, or an interference lock.

7. The bone screw apparatus of claim **5**, further comprising an elongated locking wedge securing the coupling element and the polyaxial bone screw in a fixed position.

8. The bone screw apparatus of claim **7**, wherein the elongated locking wedge comprises:

a posterior surface defining a connector channel thereon, and

an anterior surface defining an elongated concave channel extending substantially parallel with a major axis of the elongated locking wedge.

9. The bone screw apparatus of claim **8**, wherein the connector channel is configured to accept the connector such that the posterior surface is in facing engagement with the connector.

10. The bone screw apparatus of claim **9**, wherein the elongated concave channel is configured to contact the head of the bone screw.

11. The bone screw apparatus of claim **5**, wherein the connector is a cylindrical rod, a square rod, an oval rod, a rectangular rod, or a hollow rod.

12. The bone screw apparatus of claim **5**, wherein the oblong opening includes a plurality of notches defining a plurality of slot positions.

13. The bone screw apparatus of claim **10**, wherein the oblong opening includes at least five slot positions.

14. The bone screw apparatus of claim **5**, wherein the oblong opening is a continuous slot.

15. The bone screw apparatus of claim **5**, wherein the oblong opening comprises at least one of a beveled edge and a rounded edge.

16. The bone screw apparatus of claim **5**, wherein the bone screw apparatus comprises at least one additional polyaxial bone screw positioned within the oblong opening.

17. The bone screw apparatus of claim 16, wherein the polyaxial bone screws are posted polyaxial screws.

18. The bone screw apparatus of claim 5, wherein the polyaxial bone screw is a posted polyaxial screw.

19. The bone screw apparatus of claim 5, wherein the base includes:

a generally flat anterior surface; *and*

a generally flat posterior surface, [and]

wherein the oblong opening is formed by a substantially linear surface extending from the anterior surface to the posterior surface.

20. [A bone screw system comprising:

a connector, and

at least two bone screw apparatuses each comprising:

a coupling element that includes:

an] *The bone screw apparatus of claim 5, wherein the* oblong aperture [extending] *extends* through the coupling element and *is* configured to receive the connector in a plurality of positions about two dimensions within the aperture[, and

a base having an oblong slot,

a polyaxial bone screw positioned within the oblong slot, and

a fixation element adjustably mounted to the coupling element that secures the coupling element, connector, and polyaxial bone screw to the coupling element in a fixed position].

[21. A method for aligning and placing a bone screw system in bone, comprising:

(a) providing a bone screw system that includes;

a connector; and

at least a first and a second bone screw apparatus, wherein each bone screw apparatus has

a coupling element having

an aperture configured to allow the connector to be perpendicular to or at an angle relative to a plane extending generally parallel to the aperture; and

a base having an opening;

a bone screw positioned within the opening;

an elongated locking wedge for securing the coupling element and the bone screw in a fixed position; and

a fixation element that provides a securing force to the connector, the elongated locking wedge, and the bone screw,

wherein the connector extends through the aperture and wherein the fixation element is configured to secure the coupling element, elongated locking wedge, connector, and bone screw in a fixed position,

(b) positioning the first bone screw of the first bone screw apparatus in the opening of the first coupling element,

(c) screwing the first bone screw into bone,

(d) positioning the second bone screw of the second bone screw apparatus in the generally oblong opening of the second coupling element,

(e) screwing the second bone screw into bone,

(f) repositioning each of the first and second coupling elements relative to the first and second bone screws respectively, along the openings of the first and second coupling elements so as to align the first and second apertures of the first and second coupling elements;

(g) extending the connector through each of the aligned coupling elements and positioning the connector within the aperture of at least one of the first and second coupling elements perpendicular to or at an angle relative to the plane extending generally parallel to the aperture, and

(h) securing the alignment of the first bone screw apparatus and connector to the first bone screw by providing a securing force to the connector and the elongated locking wedge via the first fixation element, and

(i) securing the alignment of the second bone screw apparatuses and connector to the second bone screw by providing a securing force to the connector and the elongated locking wedge via the second fixation element.]

22. A bone screw for attachment to a vertebra, comprising:

a housing having a rod passage for accepting a rod into the housing, the rod having a longitudinal rod axis;

a bone screw carried by the housing and positionable relative to the housing from a first side of the longitudinal rod axis when the rod is in the housing to a second side of the longitudinal rod axis, along a direction generally perpendicular to the longitudinal rod axis, the housing having a surface that is complementary in shape to a head of the bone screw;

a fixation element configured to secure the bone screw to the housing in various positions along the direction generally perpendicular to the longitudinal rod axis, wherein the fixation element is carried by the housing and is configured to secure both the rod and the bone screw to the housing; and

a member, the member restricted in movement in response to rotation of the fixation element against the rod for limiting relative movement between the bone screw and the housing.

23. The bone screw of claim 22, wherein the head of the bone screw is disposed in the housing.

24. The bone screw of claim 22, wherein the bone screw is adjustably positionable in various positions within the housing along the direction generally perpendicular to the longitudinal rod axis.

25. The bone screw of claim 22, wherein the member limits relative translational movement between the housing and the head of the bone screw.

26. A method of aligning and placing a bone screw system in bone, the method comprising:

providing an apparatus including a bone fastener having a head, a housing with an aperture extending therethrough in a first direction, and a connecting rod received in the aperture and passing through the housing;

engaging the bone fastener with a bone;

selectively adjusting the housing relative to the head of the fastener along a line perpendicular to the first direction; and

securing both the head of the fastener and the connecting rod relative to the housing with a fixation element,

wherein the housing includes an open upper end and the method further comprises passing the connecting rod along a plane from the open upper end toward a lower portion of the housing, and

wherein adjusting the housing relative to the head includes positioning the head from a first side of the plane to a second side of the plane.

27. A method of aligning and placing a bone screw system in bone, the method comprising:

providing an apparatus including a bone fastener having a head, a housing with an aperture extending therethrough in a first direction, and a connecting rod received in the aperture and passing through the housing;

engaging the bone fastener with a bone;

selectively adjusting the housing relative to the head of the fastener along a line perpendicular to the first direction; and

securing both the head of the fastener and the connecting rod relative to the housing with a fixation element,

wherein the housing includes an open upper end and the method further comprises passing the connecting rod along a plane from the open upper end toward a lower portion of the housing, and

wherein securing both the head of the fastener and the connecting rod relative to the housing with a fixation element includes rotating the fixation element about an axis, the axis disposed in the plane.

28. The method of claim 27, wherein the apparatus further includes a member and the method further comprises limiting movement of the member in response to driving engagement of the fixation element against the connecting rod to thereby limit the head of the fastener relative to the housing.

29. An apparatus for a bone fixation procedure, the apparatus comprising:

a housing including an aperture extending through the housing in a first direction;

a connecting rod received in the aperture and passing through the housing;

a bone fastener including a head and an end adapted to engage a bone, the bone fastener carried by the housing such that the head of the bone fastener is adjustably positionable in various positions within the housing along a line perpendicular to the first direction prior to securing of the connecting rod to the housing, the housing having a surface that is complementary in shape to the head of the bone fastener; and

a fixation element carried by the housing for securing both the connecting rod and bone fastener relative to the housing,

wherein the housing includes an open upper end and a portion of the aperture proximate the open upper end defines a plane for passing the connecting rod from the open upper end toward a lower portion of the housing,

wherein the head of the bone fastener is disposed within the lower portion of the housing, and

wherein the head of the bone fastener is adjustably positionable from a first side of the plane to a second side of the plane.

30. An apparatus for a bone fixation procedure, the apparatus comprising:

a housing including an aperture extending through the housing in a first direction;

a connecting rod received in the aperture and passing through the housing;

a bone fastener including a head and an end adapted to engage a bone, the bone fastener carried by the housing such that the head of the bone fastener is adjustably positionable in various positions within the housing along a line perpendicular to the first direction prior to securing of the connecting rod to the housing, the housing having a surface that is complementary in shape to the head of the bone fastener; and

a fixation element carried by the housing for securing both the connecting rod and bone fastener relative to the housing,

wherein the housing includes an open upper end and a portion of the aperture proximate the open upper end defines a plane for passing the connecting rod from the open upper end toward a lower portion of the housing, and

wherein the fixation element is rotatable relative to the housing about an axis, the axis disposed in the plane.

31. The apparatus of claim 30, further comprising a member, the member restricted in movement in response to rotation of the fixation element for limiting movement of the head of the bone fastener relative to the housing.

32. A method of aligning and placing a bone screw system, the method comprising:

providing an apparatus including a bone fastener including a head, a housing with an aperture extending therethrough in a first direction, and a connecting rod received in the aperture and passing through the housing;

engaging the bone fastener with a bone; and

selectively adjusting a location of the head of the fastener within the housing by moving the head of the fastener along a line perpendicular to the first direction,

wherein the housing includes an open upper end and the method further comprises passing the connecting rod along a plane from the open upper end toward a lower portion of the housing, and

wherein adjusting the housing relative to the head includes positioning the head from a first side of the plane to a second side of the plane.

33. A method of aligning and placing a bone screw system, the method comprising:

providing an apparatus including a bone fastener including a head, a housing with an aperture extending therethrough in a first direction, and a connecting rod received in the aperture and passing through the housing;

engaging the bone fastener with a bone; and

selectively adjusting a location of the head of the fastener within the housing by moving the head of the fastener along a line perpendicular to the first direction,

wherein the housing includes an open upper end and the method further comprises passing the connecting rod along a plane from the open upper end toward a lower portion of the housing, and

wherein securing both the head of the fastener and the connecting rod relative to the housing with a fixation element includes rotating the fixation element about an axis, the axis disposed in the plane.

34. The method of claim 33, wherein the apparatus further includes a member and the method further comprises limiting movement of the member in response to driving engagement of the fixation element against the head of the fastener to limit movement of the head of the fastener relative to the housing.

35. A system for assisting in placement and alignment of a bone screw and for aligning bone, the system compromising:

an upper housing;

a lower housing;

a locking screw disposed within the upper housing, the locking screw engageable by a first tool for rotating the locking screw within the upper housing;

a connector inserted into the lower housing; and

a bone screw having a head located within the lower housing, the head of the bone screw able to be located at a plurality of different medio-lateral positions relative the lower housing, the bone screw engageable by a second tool to rotate the bone screw with respect to the bone, the lower housing defining a surface that is complementary in shape to the head of the bone screw,

whereby rotation of the locking screw by the first tool and rotation of the bone screw by the second tool secures the position of the upper housing, the lower housing and the connector with respect to the bone,

wherein the upper housing defines an aperture having an open upper end, the aperture proximate the open upper end defining a plane for passing the connector from the open upper end toward the lower housing, and

wherein at least a first position of the plurality of different medio-lateral positions is on a first side of the plane and at least a second position of the plurality of different medio-lateral positions is on a second side of the plane.

36. The system of claim 35, wherein the locking screw is rotatable by the first tool about an axis, the axis disposed in the plane.

37. The system of claim 35, further comprising a member, movement of the member relative to the housing being restricted in response to driving engagement of the locking screw against the connector for limiting movement of the head of the bone screw relative to the lower housing.

38. A bone screw apparatus comprising:

an upper housing;

a lower housing having a slot with a plurality of slot positions and including a center slot position;

a locking screw disposed within the upper housing;

a connector extending through the lower housing; and

a bone screw extending through the lower housing and being located at one of the plurality of slot positions, at least one of the plurality of slot positions being configured to inhibit movement of the bone screw along the slot,

wherein the upper housing defines an aperture having an open upper end, the aperture proximate the open upper end defining a plane for passing the connector from the open upper end toward the lower housing, and

wherein at least a first position of the plurality of slot positions is on a first side of the plane and at least a second position of the plurality of slot positions is on a second side of the plane.

39. A bone screw apparatus comprising:

an upper housing;

a lower housing having a slot with a plurality of slot positions and including a center slot position;

a locking screw disposed within the upper housing;

a connector extending through the lower housing; and

a bone screw extending through the lower housing and being located at one of the plurality of slot positions, at least one of the plurality of slot positions being configured to inhibit movement of the bone screw along the slot,

wherein the upper housing defines an aperture having an open upper end, the aperture proximate the open upper end defining a plane for passing the connector from the open upper end toward the lower housing, and

wherein the locking screw is rotatable relative to the upper housing about an axis, the axis disposed in the plane.

40. A system for assisting in placement and alignment of a bone screw and for aligning bone, the system compromising:

a first coupling element;

a second coupling element;

a connector inserted through the first coupling element and the second coupling element and connecting the first and second coupling elements;

a first bone screw having a head located within the first coupling element, the first coupling element having a first position relative to the first bone screw for permitting the first coupling element to slide with respect to the first bone screw and having a second position relative to the first bone screw for restricting movement of the first coupling element with respect to the first bone screw, the first coupling element having a first surface that is complementary in shape to the head of the first bone screw;

a second bone screw having a head located within the second coupling element, the second coupling element having a first position relative to the second bone screw to permit the second coupling element to slide with respect to the second bone screw and having a second position relative to the second bone screw for restricting movement of the second coupling element with respect to the second bone screw; and

a plurality of locking screws each disposed within one of the first and second coupling elements, each of the locking screws having a first position permitting the connector to move with respect to the one said locking screw, each of the locking screws having a second position locking movement of the connector with respect to the one said locking screw,

wherein the first coupling element defines an aperture having an open upper end, the aperture proximate the open upper end defining a plane for passing the connector from the open upper end toward a lower portion of the first coupling element, and

wherein the head is adjustable within the lower portion from a first side of the plane to a second side of the plane.

41. A system for assisting in placement and alignment of a bone screw and for aligning bone, the system compromising:

a first coupling element;

a second coupling element;

a connector inserted through the first coupling element and the second coupling element and connecting the first and second coupling elements;

a first bone screw having a head located within the first coupling element, the first coupling element having a first position relative to the first bone screw for permitting the first coupling element to slide with respect to the first bone screw and having a second position relative to the first bone screw for restricting movement of the first coupling element with respect to the first bone screw, the first coupling element having a first surface that is complementary in shape to the head of the first bone screw;

a second bone screw having a head located within the second coupling element, the second coupling element having a first position relative to the second bone screw to permit the second coupling element to slide with respect to the second bone screw and having a second position relative to the second bone screw for restricting movement of the second coupling element with respect to the second bone screw; and

a plurality of locking screws each disposed within one of the first and second coupling elements, each of the locking screws having a first position permitting the connector to move with respect to the one said locking screw, each of the locking screws having a second position locking movement of the connector with respect to the one said locking screw,

wherein the first coupling element defines an aperture having an open upper end, the aperture proximate the open upper end defining a plane for passing the connector from the open upper end toward a lower portion of the first coupling element, and

wherein the locking screw associated with the first coupling element is rotatable about an axis, the axis disposed in the plane.

42. A method for securing a connector to bone comprising:
driving a first bone screw having a head located within a first coupling element into the bone to a first position thereby permitting the first coupling element to slide with respect to the first bone screw;
driving a second bone screw having a head located within a second coupling element into the bone to a first position thereby permitting the second coupling element to slide with respect to the second bone screw;
selectively aligning the first and second coupling elements to receive a connector by sliding the first coupling element with respect to the first bone screw and sliding the second coupling element with respect to the second bone screw;
rotating a first locking screw located in the first coupling element into engagement with the connector to secure the connector with respect to the first coupling element; and
rotating a second locking screw located in the second coupling element into engagement with the connector to secure the connector with respect to the second coupling element,
wherein the first coupling element defines an aperture having an open upper end, the aperture proximate the open upper end defining a plane, and the method includes passing the connector along the plane from the open upper end toward a lower portion of the first coupling element, and
wherein aligning the first coupling element includes positioning the head of the first bone screw from a first side of the plane to a second side of the plane.

43. A method for securing a connector to bone comprising:
driving a first bone screw having a head located within a first coupling element into the bone to a first position thereby permitting the first coupling element to slide with respect to the first bone screw;
driving a second bone screw having a head located within a second coupling element into the bone to a first position thereby permitting the second coupling element to slide with respect to the second bone screw;
selectively aligning the first and second coupling elements to receive a connector by sliding the first coupling element with respect to the first bone screw and sliding the second coupling element with respect to the second bone screw;
rotating a first locking screw located in the first coupling element into engagement with the connector to secure the connector with respect to the first coupling element; and
rotating a second locking screw located in the second coupling element into engagement with the connector to secure the connector with respect to the second coupling element,
wherein the first coupling element defines an aperture having an open upper end, the aperture proximate the open upper end defining a plane, and the method includes passing the connector along the plane from the open upper end toward a lower portion of the first coupling element, and
wherein rotating the first locking screw includes rotating the first locking screw about an axis, the axis disposed in the plane.

44. A system for assisting in placement and alignment of a bone screw and for aligning bone, the system compromising:
an upper housing;
a lower housing;
a connector inserted through the lower housing;
a bone screw having a head located within the lower housing, the head of the bone screw permitting pivotal and sliding movement of the lower housing with respect to bone screw when the lower housing is in an unlocked position relative to the bone screw, the head of the bone screw restricting pivotal and sliding movement of the lower housing with respect to bone screw when the lower housing is in an locked position relative to the bone screw, the lower housing defining a surface that is complementary in shape to the head of the bone screw;
a locking screw located within the upper housing; and
a tool for adjusting the position of the locking screw so as to cause the lower housing to move between an unlocked position relative to the bone screw and a locked position relative to the bone screw.

45. The system of claim 44, wherein the locking screw is rotatable relative to the upper housing about an axis, the lower housing movable relative to the head of the bone screw such that the head of the bone screw is positionable along the axis.

46. The system of claim 45, wherein the upper and lower housings cooperatively define an aperture for receiving the connector.

47. The system of claim 46, wherein a portion of the aperture defined by the upper housing allows the connector to be received by an open upper end of the upper housing and pass toward the lower housing.

48. The system of claim 47, wherein the portion of the aperture defined by the upper housing restricts movement of the connector during passing of the connector from the open upper end toward the lower housing to a plane.

49. The system of claim 48, further comprising a fixation element carried by the upper housing for securing both the connecting rod and bone fastener relative to the upper housing, the fixation element rotatable relative to the upper housing about an axis, the axis disposed in the plane.

50. The system of claim 44, further comprising a member, the member restricted in movement in response to rotation of the locking screw for limiting movement of the head of the bone screw relative to the lower housing.

51. An apparatus for coupling a bone screw to a connector comprising:
a housing that includes:
an aperture for receiving a connector, and a base having:
a generally flat anterior surface;
a generally flat posterior surface; and
a generally oblong opening formed by a substantially linear surface
extending from the anterior surface to the posterior surface;
a polyaxial bone screw movably engaged along the substantially linear surface forming the generally oblong opening; and
a fixation element adjustably mounted to the housing that engages both the connector and the polyaxial bone screw to secure both the connector and the polyaxial bone screw to the housing in a fixed position, wherein an upper portion of the housing includes a pair of spaced apart arms for threadably receiving the fixation element.

52. The apparatus of claim 51, wherein the pair of spaced apart arms define a plane for passing the connector from an open upper end of the housing toward a lower end of the housing.

53. The apparatus of claim 52, wherein the fixation element is coupled to the housing for rotation about an axis, the axis disposed in the plane.

54. The apparatus of claim 51, further comprising a member, the member restricted in movement in response to rotation of the fixation element against the connector for limiting movement of a head of the bone screw relative to the housing.

55. A bone screw system comprising:

a connector; and

at least two bone screw apparatuses, each bone screw apparatus comprising:

a coupling element that includes:

a base having an oblong slot; and

an oblong aperture configured to allow the connector to be perpendicular to or at an angle relative to a plane extending generally parallel to the oblong slot;

a polyaxial bone screw positioned within the oblong slot; and

a single fixation element adjustably mounted to the coupling element that secures the connector and polyaxial bone screw to the coupling element in fixed position, wherein the coupling element of at least one of the bone screw apparatuses includes a housing having an upper portion and a lower portion, the upper and lower portions cooperatively defining the oblong aperture such that the oblong aperture is open at an upper end thereof.

56. The bone screw system of claim 55, wherein the polyaxial bone screw includes a head, the base of the coupling element movable relative to the head.

57. The bone screw system of claim 55, further comprising a member, the member restricted in movement in response to rotation of the fixation element against the connector for limiting relative movement between the bone screw and the connector.

58. A bone screw system comprising:

at least two bone screw housings, each housing including:

a base having an oblong slot; and

an aperture perpendicular to a first plane extending generally parallel to the slot;

a polyaxial bone screw engageable relative to the oblong slot, at least one of the housings being movable relative to the polyaxial screw;

a connector positionably engaged within the aperture to allow a connector to be perpendicular to or at an angle relative to a plane extending generally parallel to the slot; and

a pair of fixation elements, with one of the fixation elements adjustably mounted to each of the housings to secure the connector and bone screw to the respective housing in fixed positions,

wherein the connector is received into the housing a first direction, the first direction being perpendicular to the first plane, and

wherein the housing is movable relative to a head of the polyaxial bone screw such that the head is adjustably positionable on both a first side of the first plane and a second side of the first plane.

59. The bone screw system of claim 58, wherein the connector has a longitudinal axis and further wherein the at least one of the housings is movable relative to the polyaxial screw in a direction perpendicular to the longitudinal axis.

60. The bone screw system of claim 58, wherein the polyaxial bone screw has a head, the head disposed in one of the bone screw housings.

61. The bone screw system of claim 58, further comprising a member, the member restricted in movement in response to rotation of the fixation element against the connector for limiting relative movement between the bone screw and the housing.

62. An apparatus for coupling a bone screw to a connector comprising:

a housing having an aperture and an oblong slot;

a polyaxial screw positionable within the oblong slot, the housing having a surface that is complementary in shape to a head of the polyaxial screw;

a connector positionably engaged within the aperture, the aperture being configured to allow the connector to be perpendicular to or at an angle relative to a plane extending generally parallel to the slot; and

means for fixing the connector that engages the polyaxial screw to secure both the connector and the screw in a fixed position along the oblong slot,

wherein the housing includes an upper portion and a lower portion that cooperate to define the aperture, the aperture being open at an upper end to receive the connector in a first direction such that a longitudinal axis of the connector translates within a plane as the connector moves from the upper end toward the lower portion of the housing, and

wherein the housing is movable relative to the head of the polyaxial screw such that the head is adjustably positionable on both a first side of the plane and a second side of the plane.

63. A system for coupling a bone screw to a connector comprising:

a housing having an oblong slot and an aperture, the oblong slot being substantially perpendicular to the aperture;

a polyaxial screw engaged within the oblong slot, the housing being independently adjustable in relation to the polyaxial screw and having a surface that is complementary in shape to a head of the polyaxial screw; and

means for fixing the housing in relation to the polyaxial screw along multiple positions relative to the oblong slot, the means for fixing disposed in the aperture in a plane substantially perpendicular or at an angle to the oblong slot,

wherein the housing is movable relative to a head of the polyaxial screw such that the head is adjustably positionable on both a first side of the plane and a second side of the plane.

64. A bone screw for attachment to a vertebra, comprising:

a housing having an upper portion, a lower portion, and a rod-receiving passage from the upper portion toward the lower portion, the rod-receiving passage having a plane along which a rod travels from the upper portion toward the lower portion;

a bone screw carried by the lower portion of the housing and movable from a first side of the plane to a second side of the plane, the housing having a surface that is complementary in shape to a head of the bone screw; and

a fixation element configured to secure the bone screw to the housing in various positions as the bone screw is moved between the first and second sides of the plane.

65. The bone screw of claim 64, wherein the bone screw translates from the first side to the second side in a direction generally perpendicular to the plane.

66. The bone screw of claim 64, further comprising a set screw received in the rod-receiving passage.

67. The bone screw of claim 64, wherein the head of the bone screw is disposed in the lower portion of the housing.

68. The bone screw of claim 66, further comprising a member, the member restricted in response to rotation of the set screw against the rod for limiting movement between the bone screw and the housing.

69. An apparatus for a bone fixation procedure, the apparatus comprising:

a connecting rod;

a housing including an oblong aperture extending therethrough in a first direction;

the connecting rod received in the oblong aperture and passing through the housing;

a bone fastener including a head and an end adapted to engage a bone, the bone fastener carried by the housing such that the head of the bone fastener is adjustably positionable in various positions along a line perpendicular to the first direction prior to securing of the connecting rod to the housing, the housing having a surface that is complementary in shape to the head of the bone fastener; and

a fixation element carried by the housing for securing both the connecting rod and bone fastener relative to the housing,

wherein the housing includes an open upper end defining a rod-receiving passage through which the connecting rod passes within a plane from the open upper end toward a lower portion of the housing.

70. The apparatus of claim 69, wherein the head is movable relative to the housing from a first side of the plane to a second side of the plane.

71. The apparatus of claim 69, wherein the fixation element is a set screw received in the open upper end of the housing.

72. The apparatus of claim 69, wherein the open upper end of the housing includes a pair of spaced apart arms.

73. The apparatus of claim 69, further comprising a member, movement of the member relative to the housing is restricted in response to driving engagement of the fixation element against the connecting rod for limiting movement of the head of the bone fastener relative to the housing.

74. A bone screw for attachment to a vertebra, comprising:

a housing having a rod passage for accepting a rod into the housing, the rod having a longitudinal rod axis;

a bone screw including a head that is carried by the housing and a shank that extends from the head, wherein the head of the bone screw is positionable relative to the housing from a first side of the longitudinal rod axis when the rod is in the housing to a second side of the longitudinal rod axis, along a direction generally perpendicular to the longitudinal rod axis, without rotating the shank of the bone screw about the head and without rotating the housing relative to the head of the bone screw; and

a fixation element configured to secure the bone screw to the housing in various positions along the direction generally perpendicular to the longitudinal rod axis.

75. The bone screw of claim 74 wherein, when the rod is in the housing, the head of the bone screw is movable from one side of the rod to another side of the rod without rotating the shank of the bone screw about the head.

76. The bone screw of claim 74, wherein the housing includes an upper housing defining the rod passage and a lower housing having a base which defines an opening that receives the head of the bone screw.

77. The bone screw of claim 76, wherein upper housing of the housing is immovably coupled to the lower housing of the housing.

78. The bone screw of claim 76, wherein the opening in the base of the lower housing is a slot having a length that extends along the direction generally perpendicular to the longitudinal rod axis.

79. A bone screw for attachment to a vertebra, comprising:

a housing having a rod passage for accepting a rod into the housing, the rod having a longitudinal rod axis;

a bone screw including a head that is carried by the housing and a shank that extends from the head, wherein when the rod is in the housing, the head of the bone screw is translatable relative to the housing from a first side of the rod to a second side of the rod, along a direction generally perpendicular to the longitudinal rod axis; and

a fixation element configured to secure the bone screw to the housing in various positions as the head of the bone screw is translated between the first and second sides of the rod,

wherein the housing includes a base defining an opening that receives the head of the bone screw.

80. The bone screw of claim 79, wherein, when the rod is in the housing, the head of the bone screw is translatable from the first side of the rod to the second side of the rod without rotating the shank of the bone screw about the head.

81. The bone screw of claim 79, wherein the opening in the base of the housing is elongated in the direction generally perpendicular to the longitudinal rod axis to allow the head of the bone screw to translate from the first side of the rod to the second side of the rod.

82. The bone screw of claim 79, wherein the opening in the base of the housing has an edge that is complementary in shape to the head of the bone screw.

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UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : RE46,115 E
APPLICATION NO. : 13/911397
DATED : August 23, 2016
INVENTOR(S) : Todd J. Albert

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Claims

In Column 18, Line 66-67, in Claim 67, delete "67. The bone screw of claim 64, wherein the head of the bone screw is disposed in the lower portion of the housing." and insert --67. The bone screw of claim 66, further comprising a member, the member restricted in response to rotation of the set screw against the rod for limiting movement between the bone screw and the housing.--, therefor

In Column 19, Line 1-4, in Claim 68, delete "68. The bone screw of claim 66, further comprising a member, the member restricted in response to rotation of the set screw against the rod for limiting movement between the bone screw and the housing." and insert --68. The bone screw of claim 64, wherein the head of the bone screw is disposed in the lower portion of the housing.--, therefor

Signed and Sealed this
Nineteenth Day of June, 2018

Andrei Iancu
Director of the United States Patent and Trademark Office