United States Patent	12383311
Kind Code	B2
Date of Patent	August 12, 2025
Inventor(s)	Jackson; Roger P.

Pivotal bone anchor assembly and method for use thereof

Abstract

A pivotal bone anchor assembly is provided that includes a receiver, a shank, and a compression insert. The receiver can have a shank holding lower portion and an upper portion with a channel. The shank can have a head portion and an anchor portion attachable to bone. The compression insert can be positionable with the receiver, and can have an upper portion including at least one notch at least partially formed in an outer surface of the upper portion, and defining at least one resiliently deflectable upwardly-facing surface extending over or above the at least one notch. In one embodiment, the at least one resiliently deflectable upward facing surface being deflectable when the head portion of the shank and the compression insert are positioned in the receiver to provide a pre-lock friction fit in the assembly prior to securing a longitudinal connecting member in the channel with a closure.

Inventors: **Jackson; Roger P. (Prairie Village, KS)**

Applicant: **Jackson; Roger P.** (Prairie Village, KS)

Family ID: **1000008747570**

Appl. No.: **18/221348**

Filed: **July 12, 2023**

Prior Publication Data

Document Identifier	Publication Date
US 20230404629 A1	Dec. 21, 2023

Related U.S. Application Data

continuation parent-doc US 17033417 20200925 US 11717328 child-doc US 18221348
continuation parent-doc US 13068506 20110512 US 10792074 20201016 child-doc US 17033417
us-provisional-application US 61395692 20100514

Publication Classification

Int. Cl.: **A61B17/70** (20060101); **A61B17/86** (20060101)

U.S. Cl.:

CPC **A61B17/7037** (20130101); **A61B17/702** (20130101); **A61B17/705** (20130101); **A61B17/86** (20130101);

Field of Classification Search

USPC: None

References Cited

U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
2346346	12/1943	Anderson	N/A	N/A
2362999	12/1943	Elmer	N/A	N/A
2531892	12/1949	Reese	N/A	N/A
2813450	12/1956	Dzus	N/A	N/A
3013244	12/1960	Rudy	N/A	N/A
4033139	12/1976	Frederick	N/A	N/A
4759672	12/1987	Nilsen et al.	N/A	N/A
4790297	12/1987	Luque	N/A	N/A
4946458	12/1989	Harms et al.	N/A	N/A
5019080	12/1990	Hemer	N/A	N/A
5129388	12/1991	Vignaud et al.	N/A	N/A
5207678	12/1992	Harms et al.	N/A	N/A
5261912	12/1992	Frigg	N/A	N/A
5312404	12/1993	Asher et al.	N/A	N/A
5360431	12/1993	Puno et al.	N/A	N/A
5395371	12/1994	Miller et al.	N/A	N/A
5429639	12/1994	Judet	N/A	N/A
5443467	12/1994	Biedermann et al.	N/A	N/A
5466237	12/1994	Byrd, III et al.	N/A	N/A
5474555	12/1994	Puno et al.	N/A	N/A
5476462	12/1994	Allard et al.	N/A	N/A
5476464	12/1994	Metz-Stavenhagen et al.	N/A	N/A
5496321	12/1995	Puno et al.	N/A	N/A
5554157	12/1995	Errico et al.	N/A	N/A
5569247	12/1995	Morrison	N/A	N/A
5584834	12/1995	Errico et al.	N/A	N/A
5586984	12/1995	Errico et al.	N/A	N/A
5591166	12/1996	Bernhardt et al.	N/A	N/A
5601553	12/1996	Trebing et al.	N/A	N/A
5607426	12/1996	Ralph et al.	N/A	N/A
5647873	12/1996	Errico et al.	N/A	N/A

5669911	12/1996	Errico et al.	N/A	N/A
5672176	12/1996	Biedermann et al.	N/A	N/A
5681319	12/1996	Biedermann et al.	N/A	N/A
5683392	12/1996	Richelsoph	N/A	N/A
5690630	12/1996	Errico et al.	N/A	N/A
5716356	12/1997	Biedermann et al.	N/A	N/A
5725528	12/1997	Errico et al.	N/A	N/A
5728098	12/1997	Sherman et al.	N/A	N/A
5733286	12/1997	Errico et al.	N/A	N/A
5738685	12/1997	Halm et al.	N/A	N/A
5782833	12/1997	Haider	N/A	N/A
5797911	12/1997	Sherman et al.	N/A	N/A
5800435	12/1997	Errico et al.	N/A	N/A
5817094	12/1997	Errico et al.	N/A	N/A
5863293	12/1998	Richelsoph	N/A	N/A
5873878	12/1998	Harms et al.	N/A	N/A
5876402	12/1998	Errico et al.	N/A	N/A
5879350	12/1998	Sherman et al.	N/A	N/A
5879351	12/1998	Viart	N/A	N/A
5882350	12/1998	Ralph et al.	N/A	N/A
5885286	12/1998	Sherman et al.	N/A	N/A
5891145	12/1998	Morrison et al.	N/A	N/A
5938663	12/1998	Petreto	N/A	N/A
5954725	12/1998	Sherman et al.	N/A	N/A
5961517	12/1998	Biedermann et al.	N/A	N/A
5964760	12/1998	Richelsoph	N/A	N/A
6010503	12/1999	Richelsoph et al.	N/A	N/A
6019759	12/1999	Rogozinski	N/A	N/A
6022350	12/1999	Ganem	N/A	N/A
6053917	12/1999	Sherman et al.	N/A	N/A
6063090	12/1999	Schlapfer	N/A	N/A
6074391	12/1999	Metz-Stavenhagen et al.	N/A	N/A
6077262	12/1999	Schlapfer et al.	N/A	N/A
6086588	12/1999	Ameil et al.	N/A	N/A
6090110	12/1999	Metz-Stavenhagen	N/A	N/A
6090111	12/1999	Nichols	N/A	N/A
6099528	12/1999	Saurat	N/A	N/A
6110172	12/1999	Jackson	N/A	N/A
6113601	12/1999	Tatar	N/A	N/A
6132431	12/1999	Nilsson et al.	N/A	N/A
6132432	12/1999	Richetsoph	N/A	N/A
6132434	12/1999	Sherman et al.	N/A	N/A
6146383	12/1999	Studer et al.	N/A	N/A
6183472	12/2000	Lutz	N/A	N/A
6186718	12/2000	Fogard	N/A	N/A
6187005	12/2000	Brace et al.	N/A	N/A
6214012	12/2000	Karpman et al.	N/A	N/A
RE37161	12/2000	Michelson et al.	N/A	N/A

6224596	12/2000	Jackson	N/A	N/A
6248105	12/2000	Schlapfer et al.	N/A	N/A
6254602	12/2000	Justis	N/A	N/A
6273888	12/2000	Justis	N/A	N/A
6280442	12/2000	Barker et al.	N/A	N/A
6280445	12/2000	Morrison et al.	N/A	N/A
6287308	12/2000	Betz et al.	N/A	N/A
6287311	12/2000	Sherman et al.	N/A	N/A
6296642	12/2000	Morrison et al.	N/A	N/A
6302888	12/2000	Mellinger et al.	N/A	N/A
6309391	12/2000	Crandall et al.	N/A	N/A
6331179	12/2000	Freid et al.	N/A	N/A
6355040	12/2001	Richelsoph et al.	N/A	N/A
RE37665	12/2001	Ralph et al.	N/A	N/A
6368321	12/2001	Jackson	N/A	N/A
6371957	12/2001	Amrein et al.	N/A	N/A
6402752	12/2001	Schaffler-Wachter et al.	N/A	N/A
6440137	12/2001	Horvath et al.	N/A	N/A
6451021	12/2001	Ralph et al.	N/A	N/A
6471703	12/2001	Ashman	N/A	N/A
6471705	12/2001	Biedermann et al.	N/A	N/A
6485494	12/2001	Haider	N/A	N/A
6488681	12/2001	Martin et al.	N/A	N/A
6508818	12/2002	Steiner et al.	N/A	N/A
6520962	12/2002	Taylor et al.	N/A	N/A
6527804	12/2002	Gauchet et al.	N/A	N/A
6530929	12/2002	Jusis et al.	N/A	N/A
6533786	12/2002	Needham et al.	N/A	N/A
6547790	12/2002	Harkey, III et al.	N/A	N/A
6551320	12/2002	Lieberman	N/A	N/A
6554832	12/2002	Shluzas	N/A	N/A
6554834	12/2002	Crozet et al.	N/A	N/A
6558387	12/2002	Errico et al.	N/A	N/A
6562040	12/2002	Wagner	N/A	N/A
6565565	12/2002	Yuan et al.	N/A	N/A
6565567	12/2002	Haider	N/A	N/A
6582436	12/2002	Schlapfer et al.	N/A	N/A
6582466	12/2002	Gauchet	N/A	N/A
6585740	12/2002	Schlapfer et al.	N/A	N/A
6595992	12/2002	Wagner et al.	N/A	N/A
6595993	12/2002	Donno et al.	N/A	N/A
6610063	12/2002	Kumar et al.	N/A	N/A
6613050	12/2002	Wagner et al.	N/A	N/A
6623485	12/2002	Doubler et al.	N/A	N/A
6626907	12/2002	Campbell et al.	N/A	N/A
6626908	12/2002	Cooper et al.	N/A	N/A
6635059	12/2002	Randall et al.	N/A	N/A
6648885	12/2002	Friesem	N/A	N/A
6648887	12/2002	Ashman	N/A	N/A

6652526	12/2002	Arafiles	N/A	N/A
6656179	12/2002	Schaefer et al.	N/A	N/A
6656181	12/2002	Dixon et al.	N/A	N/A
6660004	12/2002	Barker et al.	N/A	N/A
6663632	12/2002	Frigg	N/A	N/A
6663635	12/2002	Frigg et al.	N/A	N/A
6673073	12/2003	Schafer	N/A	N/A
6676661	12/2003	Martin Benlloch et al.	N/A	N/A
6679833	12/2003	Smith	N/A	N/A
6682529	12/2003	Stahurski	N/A	N/A
6689133	12/2003	Morrison et al.	N/A	N/A
6689134	12/2003	Ralph et al.	N/A	N/A
6694975	12/2003	Schuster et al.	N/A	N/A
6695843	12/2003	Biedermann et al.	N/A	N/A
6695851	12/2003	Zdeblick et al.	N/A	N/A
6699249	12/2003	Schlapfer et al.	N/A	N/A
6706045	12/2003	Lin et al.	N/A	N/A
6712818	12/2003	Michelson	N/A	N/A
6716213	12/2003	Shitoto	N/A	N/A
6716214	12/2003	Jackson	606/266	N/A
6716247	12/2003	Michelson	N/A	N/A
6723100	12/2003	Biedermann et al.	N/A	N/A
6730093	12/2003	Saint Martin	N/A	N/A
6730127	12/2003	Michelson	N/A	N/A
6733502	12/2003	Altarac et al.	N/A	N/A
6736816	12/2003	Ritland	N/A	N/A
6736820	12/2003	Biedermann et al.	N/A	N/A
6740086	12/2003	Richelsoph	N/A	N/A
6746449	12/2003	Jones et al.	N/A	N/A
6755829	12/2003	Bono et al.	N/A	N/A
6755835	12/2003	Schultheiss et al.	N/A	N/A
6755836	12/2003	Lewis	N/A	N/A
6761723	12/2003	Buttermann et al.	N/A	N/A
6767351	12/2003	Orbay et al.	N/A	N/A
6770075	12/2003	Howland	N/A	N/A
6780186	12/2003	Errico et al.	N/A	N/A
6790209	12/2003	Beale et al.	N/A	N/A
6827719	12/2003	Ralph et al.	N/A	N/A
6830571	12/2003	Lenke et al.	N/A	N/A
6835196	12/2003	Biedermann et al.	N/A	N/A
6840940	12/2004	Ralph et al.	N/A	N/A
6843791	12/2004	Serhan	N/A	N/A
6858031	12/2004	Morrison et al.	N/A	N/A
6869432	12/2004	Schlapfer et al.	N/A	N/A
6869433	12/2004	Glascott	N/A	N/A
6872208	12/2004	McBride et al.	N/A	N/A
6896677	12/2004	Lin	N/A	N/A
6905500	12/2004	Jeon et al.	N/A	N/A
6932817	12/2004	Baynham et al.	N/A	N/A

6945972	12/2004	Frigg et al.	N/A	N/A
6945975	12/2004	Dalton	N/A	N/A
6953462	12/2004	Lieberman	N/A	N/A
6955677	12/2004	Dahners	N/A	N/A
6958065	12/2004	Ueyama et al.	N/A	N/A
6964664	12/2004	Freid et al.	N/A	N/A
6964665	12/2004	Thomas et al.	N/A	N/A
6974460	12/2004	Carbone et al.	N/A	N/A
6979334	12/2004	Dalton	N/A	N/A
6981973	12/2005	McKinley	N/A	N/A
RE39035	12/2005	Finn et al.	N/A	N/A
7018378	12/2005	Biedermann et al.	N/A	N/A
7018379	12/2005	Drewry et al.	N/A	N/A
7022122	12/2005	Amrein et al.	N/A	N/A
RE39089	12/2005	Ralph et al.	N/A	N/A
7066062	12/2005	Flesher	N/A	N/A
7066937	12/2005	Shluzas	N/A	N/A
7081116	12/2005	Carly	N/A	N/A
7083621	12/2005	Shaolian et al.	N/A	N/A
7087057	12/2005	Konieczynski et al.	N/A	N/A
7090674	12/2005	Doubler et al.	N/A	N/A
7121755	12/2005	Schlapfer et al.	N/A	N/A
7125426	12/2005	Moumene et al.	N/A	N/A
7128743	12/2005	Metz-Stavenhagen	N/A	N/A
7141051	12/2005	Janowski et al.	N/A	N/A
7144396	12/2005	Shluzas	606/266	A61B 17/7032
7163538	12/2006	Altarac et al.	N/A	N/A
7163539	12/2006	Abdelgany et al.	N/A	N/A
7166108	12/2006	Mazda et al.	N/A	N/A
7186255	12/2006	Baynham et al.	N/A	N/A
7204838	12/2006	Jackson	606/270	N/A
7211086	12/2006	Biedermann et al.	N/A	N/A
7211087	12/2006	Young	N/A	N/A
7214227	12/2006	Colleran et al.	N/A	N/A
7223268	12/2006	Biedermann	N/A	N/A
7264621	12/2006	Coates et al.	N/A	N/A
7270665	12/2006	Morrison et al.	N/A	N/A
7291151	12/2006	Alvarez	N/A	N/A
7291153	12/2006	Glascott	N/A	N/A
7294127	12/2006	Hawkins et al.	N/A	N/A
7294128	12/2006	Alleyne et al.	N/A	N/A
7294129	12/2006	Hawkins et al.	N/A	N/A
7306603	12/2006	Boehm, Jr. et al.	N/A	N/A
7306604	12/2006	Carli	N/A	N/A
7306606	12/2006	Sasing	N/A	N/A
7314467	12/2007	Howland	N/A	N/A
7316684	12/2007	Baccelli et al.	N/A	N/A

7322979	12/2007	Crandall et al.	N/A	N/A
7335201	12/2007	Doubler et al.	N/A	N/A
7335202	12/2007	Matthis et al.	N/A	N/A
7338490	12/2007	Ogilvie et al.	N/A	N/A
7377923	12/2007	Purcell et al.	N/A	N/A
7445627	12/2007	Hawkes et al.	N/A	N/A
7476228	12/2008	Abdou	N/A	N/A
7479156	12/2008	Lourdel et al.	N/A	N/A
7491218	12/2008	Landry et al.	N/A	N/A
7491221	12/2008	David	N/A	N/A
7503918	12/2008	Baccelli et al.	N/A	N/A
7503924	12/2008	Lee et al.	N/A	N/A
7524323	12/2008	Malandain	N/A	N/A
7527640	12/2008	Ziolo et al.	N/A	N/A
7530992	12/2008	Biedermann et al.	N/A	N/A
7559943	12/2008	Mjuwid	N/A	N/A
7563264	12/2008	Landry et al.	N/A	N/A
7563275	12/2008	Falahee et al.	N/A	N/A
7569061	12/2008	Colleran	N/A	N/A
7572279	12/2008	Jackson	N/A	N/A
7572280	12/2008	Dickinson et al.	N/A	N/A
7575587	12/2008	Rezach et al.	N/A	N/A
7588575	12/2008	Colleran et al.	N/A	N/A
7588588	12/2008	Spitler et al.	N/A	N/A
7588593	12/2008	Aferzon	N/A	N/A
7591839	12/2008	Biedermann et al.	N/A	N/A
7601166	12/2008	Biedermann et al.	N/A	N/A
7604655	12/2008	Warnick	N/A	N/A
7604656	12/2008	Shluzas	N/A	N/A
7611518	12/2008	Walder et al.	N/A	N/A
7615068	12/2008	Timm et al.	N/A	N/A
7621941	12/2008	Schlapfer et al.	N/A	N/A
7625394	12/2008	Molz, IV et al.	N/A	N/A
7641674	12/2009	Young	N/A	N/A
7645294	12/2009	Kalfasetd	N/A	N/A
7648522	12/2009	David	N/A	N/A
7674277	12/2009	Burd et al.	N/A	N/A
7678136	12/2009	Doubler et al.	N/A	N/A
7678139	12/2009	Garamszegi et al.	N/A	N/A
7682377	12/2009	Konieczynski et al.	N/A	N/A
7686833	12/2009	Muhanna et al.	N/A	N/A
7686834	12/2009	Saint Martin	N/A	N/A
7686835	12/2009	Warnick	N/A	N/A
7691129	12/2009	Felix	N/A	N/A
7691131	12/2009	Graf	N/A	N/A
7691132	12/2009	Landry et al.	N/A	N/A
7695497	12/2009	Cordaro et al.	N/A	N/A
7695498	12/2009	Ritland	N/A	N/A
7699872	12/2009	Farris et al.	N/A	N/A

7699875	12/2009	Timm	N/A	N/A
7699876	12/2009	Barry et al.	N/A	N/A
7704271	12/2009	Abdou	N/A	N/A
7713288	12/2009	Timm et al.	N/A	N/A
7717941	12/2009	Petit	N/A	N/A
7717942	12/2009	Schumacher	N/A	N/A
7717943	12/2009	Kirschman	N/A	N/A
7722646	12/2009	Ralph et al.	N/A	N/A
7722649	12/2009	Biedermann et al.	N/A	N/A
7722651	12/2009	Kwak et al.	N/A	N/A
7722652	12/2009	Justis et al.	N/A	N/A
7722654	12/2009	Taylor et al.	N/A	N/A
7727261	12/2009	Barker et al.	N/A	N/A
7731736	12/2009	Guenther et al.	N/A	N/A
7731749	12/2009	Biedermann et al.	N/A	N/A
7749258	12/2009	Biedermann et al.	N/A	N/A
7758618	12/2009	Walder et al.	N/A	N/A
7763057	12/2009	Abdelgany et al.	N/A	N/A
7766943	12/2009	Fallin et al.	N/A	N/A
7766944	12/2009	Metz-Stavenhagen	N/A	N/A
7766945	12/2009	Nilsson et al.	606/266	N/A
7766946	12/2009	Bailly	N/A	N/A
7776067	12/2009	Jackson	606/246	N/A
7780706	12/2009	Marino et al.	N/A	N/A
7785351	12/2009	Gordon et al.	N/A	N/A
7785354	12/2009	Biedermann et al.	N/A	N/A
7789900	12/2009	Levy et al.	N/A	N/A
7794477	12/2009	Melkent et al.	N/A	N/A
7794480	12/2009	Gordon et al.	N/A	N/A
7806913	12/2009	Fanger et al.	N/A	N/A
7811288	12/2009	Jones et al.	N/A	N/A
7811310	12/2009	Baker et al.	N/A	N/A
7819902	12/2009	Abdelgany et al.	N/A	N/A
7833251	12/2009	Ahlgren et al.	N/A	N/A
7875065	12/2010	Jackson	606/305	A61B 17/7035
7901436	12/2010	Baccelli	N/A	N/A
7951172	12/2010	Chao et al.	606/265	N/A
7967850	12/2010	Jackson	N/A	N/A
8100946	12/2011	Strausbaugh et al.	606/266	N/A
8100948	12/2011	Ensign et al.	606/267	N/A
8147522	12/2011	Warnick	606/267	N/A
8353932	12/2012	Jackson	N/A	N/A
8382805	12/2012	Wang et al.	N/A	N/A
8439922	12/2012	Arnold et al.	N/A	N/A
8663298	12/2013	Keyer et al.	N/A	N/A
8696711	12/2013	Jackson	N/A	N/A
8814911	12/2013	Jackson	N/A	N/A
8876869	12/2013	Schafer et al.	N/A	N/A

8986349	12/2014	German et al.	N/A	N/A
9526529	12/2015	Charvet	N/A	N/A
9572599	12/2016	Casey et al.	N/A	N/A
D799949	12/2016	Stevenson et al.	N/A	N/A
9788866	12/2016	Jackson	N/A	N/A
10058354	12/2017	Jackson et al.	N/A	N/A
10064660	12/2017	Jackson	N/A	N/A
10194951	12/2018	Jackson et al.	N/A	N/A
10278739	12/2018	Jackson	N/A	N/A
10335200	12/2018	Jackson	N/A	N/A
10363070	12/2018	Jackson et al.	N/A	N/A
10456173	12/2018	Casey et al.	N/A	N/A
10561444	12/2019	Jackson	N/A	N/A
10722273	12/2019	Jackson	N/A	N/A
10765455	12/2019	Jackson et al.	N/A	N/A
10792074	12/2019	Jackson	N/A	N/A
11219474	12/2021	Jackson	N/A	N/A
11234745	12/2021	Jackson	N/A	N/A
2001/0001119	12/2000	Lombardo	N/A	N/A
2002/0035366	12/2001	Walder et al.	N/A	N/A
2002/0045898	12/2001	Freid et al.	N/A	N/A
2002/0072751	12/2001	Jackson	N/A	N/A
2002/0082602	12/2001	Biedermann et al.	N/A	N/A
2002/0111626	12/2001	Ralph et al.	N/A	N/A
2002/0133159	12/2001	Jackson	N/A	N/A
2002/0143341	12/2001	Biedermann et al.	N/A	N/A
2002/0173789	12/2001	Howland	N/A	N/A
2002/0193795	12/2001	Gertzbein et al.	N/A	N/A
2003/0023240	12/2002	Amrein et al.	N/A	N/A
2003/0023243	12/2002	Biedermann et al.	N/A	N/A
2003/0073996	12/2002	Doubler et al.	N/A	N/A
2003/0093078	12/2002	Ritland	N/A	N/A
2003/0100896	12/2002	Biedermann et al.	N/A	N/A
2003/0105460	12/2002	Crandall et al.	N/A	N/A
2003/0125741	12/2002	Biedermann et al.	N/A	N/A
2003/0149432	12/2002	Frigg et al.	N/A	N/A
2003/0153911	12/2002	Shluzas	N/A	N/A
2003/0163133	12/2002	Altarac et al.	N/A	N/A
2003/0176862	12/2002	Taylor et al.	N/A	N/A
2003/0199873	12/2002	Richelsoph	N/A	N/A
2003/0208204	12/2002	Bailey et al.	N/A	N/A
2003/0216735	12/2002	Altarac et al.	N/A	N/A
2004/0006342	12/2003	Altarac et al.	N/A	N/A
2004/0092934	12/2003	Howland	N/A	N/A
2004/0097933	12/2003	Lourdel et al.	N/A	N/A
2004/0116929	12/2003	Barker et al.	N/A	N/A
2004/0138662	12/2003	Landry et al.	N/A	N/A
2004/0143265	12/2003	Landry et al.	N/A	N/A
2004/0147929	12/2003	Biedermann et al.	N/A	N/A
2004/0158247	12/2003	Sitiso et al.	N/A	N/A

2004/0172022	12/2003	Landry et al.	N/A	N/A
2004/0176766	12/2003	Shluzas	N/A	N/A
2004/0186473	12/2003	Cournoyer et al.	N/A	N/A
2004/0210216	12/2003	Farris et al.	N/A	N/A
2004/0225289	12/2003	Biedermann et al.	N/A	N/A
2004/0236330	12/2003	Purcell et al.	606/61	N/A
2004/0249380	12/2003	Glascott	N/A	N/A
2004/0267264	12/2003	Konieczynski et al.	N/A	N/A
2005/0027296	12/2004	Thramann et al.	N/A	N/A
2005/0055026	12/2004	Biedermann et al.	N/A	N/A
2005/0070899	12/2004	Doubler et al.	N/A	N/A
2005/0080415	12/2004	Keyer et al.	N/A	N/A
2005/0096654	12/2004	Lin	N/A	N/A
2005/0107788	12/2004	Beaurain et al.	N/A	N/A
2005/0113927	12/2004	Malek	N/A	N/A
2005/0131404	12/2004	Mazda et al.	N/A	N/A
2005/0131413	12/2004	O'Driscoll et al.	N/A	N/A
2005/0149023	12/2004	Ritland	N/A	N/A
2005/0154389	12/2004	Selover et al.	N/A	N/A
2005/0154391	12/2004	Doherty et al.	N/A	N/A
2005/0159750	12/2004	Doherty	N/A	N/A
2005/0165400	12/2004	Fernandez	N/A	N/A
2005/0171540	12/2004	Lim et al.	N/A	N/A
2005/0187548	12/2004	Butler et al.	N/A	N/A
2005/0187555	12/2004	Beidermann et al.	N/A	N/A
2005/0192580	12/2004	Dalton	N/A	N/A
2005/0203516	12/2004	Biedermann et al.	N/A	N/A
2005/0216003	12/2004	Beidermann et al.	N/A	N/A
2005/0228379	12/2004	Jackson	606/61	N/A
2005/0228501	12/2004	Miller et al.	N/A	N/A
2005/0234450	12/2004	Barker	N/A	N/A
2005/0234451	12/2004	Markworth	N/A	N/A
2005/0234452	12/2004	Malandain	N/A	N/A
2005/0240181	12/2004	Boomer et al.	N/A	N/A
2005/0240183	12/2004	Vaughan	N/A	N/A
2005/0251137	12/2004	Ball	N/A	N/A
2005/0251141	12/2004	Frigg et al.	N/A	N/A
2005/0260058	12/2004	Casagne, III	N/A	N/A
2005/0261687	12/2004	Garamszegi et al.	N/A	N/A
2005/0267474	12/2004	Dalton	N/A	N/A
2005/0273099	12/2004	Baccelli et al.	N/A	N/A
2005/0273101	12/2004	Schumacher	N/A	N/A
2005/0277919	12/2004	Slivka et al.	N/A	N/A
2005/0277925	12/2004	Mujwid	N/A	N/A
2005/0277928	12/2004	Boschert	N/A	N/A
2005/0283152	12/2004	Lindemann et al.	N/A	N/A
2005/0283157	12/2004	Coates et al.	N/A	N/A
2005/0283238	12/2004	Reiley	N/A	N/A
2005/0288669	12/2004	Abdou	N/A	N/A

2005/0288671	12/2004	Yuan et al.	N/A	N/A
2005/0288673	12/2004	Catbagan et al.	N/A	N/A
2006/0004357	12/2005	Lee et al.	N/A	N/A
2006/0004359	12/2005	Kramer et al.	N/A	N/A
2006/0004360	12/2005	Kramer et al.	N/A	N/A
2006/0004363	12/2005	Brockmeyer et al.	N/A	N/A
2006/0009769	12/2005	Lieberman	N/A	N/A
2006/0009770	12/2005	Speirs et al.	N/A	N/A
2006/0015104	12/2005	Dalton	N/A	N/A
2006/0025767	12/2005	Khalili	N/A	N/A
2006/0025768	12/2005	Iott et al.	N/A	N/A
2006/0025770	12/2005	Schlapfer et al.	N/A	N/A
2006/0036242	12/2005	Nilsson et al.	N/A	N/A
2006/0036252	12/2005	Baynham et al.	N/A	N/A
2006/0052783	12/2005	Dant et al.	N/A	N/A
2006/0052784	12/2005	Dant et al.	N/A	N/A
2006/0052786	12/2005	Dant et al.	N/A	N/A
2006/0058788	12/2005	Hammer et al.	N/A	N/A
2006/0074419	12/2005	Taylor et al.	N/A	N/A
2006/0079894	12/2005	Colleran et al.	N/A	N/A
2006/0079895	12/2005	McLeer	N/A	N/A
2006/0079899	12/2005	Ritland	N/A	N/A
2006/0084981	12/2005	Shluzas	N/A	N/A
2006/0084989	12/2005	Dickinson et al.	N/A	N/A
2006/0084993	12/2005	Landry et al.	N/A	N/A
2006/0084995	12/2005	Biedermann et al.	N/A	N/A
2006/0089643	12/2005	Mujwid	N/A	N/A
2006/0089644	12/2005	Felix	N/A	N/A
2006/0095037	12/2005	Jones et al.	N/A	N/A
2006/0106380	12/2005	Colleran et al.	N/A	N/A
2006/0106383	12/2005	Biedermann et al.	N/A	N/A
2006/0116677	12/2005	Burd et al.	N/A	N/A
2006/0129147	12/2005	Biedermann et al.	N/A	N/A
2006/0129149	12/2005	Iott et al.	N/A	N/A
2006/0142761	12/2005	Landry et al.	606/61	N/A
2006/0149232	12/2005	Sasing	N/A	N/A
2006/0149241	12/2005	Richelsoph et al.	N/A	N/A
2006/0149244	12/2005	Amrein et al.	N/A	N/A
2006/0155277	12/2005	Metz-Stavenhagen	N/A	N/A
2006/0155278	12/2005	Warnick	606/279	A61B 17/7037
2006/0161152	12/2005	Ensign et al.	N/A	N/A
2006/0166535	12/2005	Brumfiled et al.	N/A	N/A
2006/0167455	12/2005	Clement et al.	N/A	N/A
2006/0173454	12/2005	Spitler et al.	N/A	N/A
2006/0173456	12/2005	Hawkes et al.	N/A	N/A
2006/0195198	12/2005	Schumacher	N/A	N/A
2006/0200123	12/2005	Mueller	N/A	N/A
2006/0200131	12/2005	Chao et al.	N/A	N/A

2006/0200149	12/2005	Hoy et al.	N/A	N/A
2006/0212034	12/2005	Triplett et al.	N/A	N/A
2006/0217716	12/2005	Baker et al.	N/A	N/A
2006/0229614	12/2005	Foley et al.	N/A	N/A
2006/0229615	12/2005	Abdou	N/A	N/A
2006/0235389	12/2005	Albert et al.	N/A	N/A
2006/0235392	12/2005	Hammer et al.	N/A	N/A
2006/0235393	12/2005	Bono et al.	N/A	N/A
2006/0241593	12/2005	Sherman et al.	N/A	N/A
2006/0241595	12/2005	Molz, IV et al.	N/A	N/A
2006/0241599	12/2005	Konieczнski et al.	N/A	N/A
2006/0241600	12/2005	Ensign et al.	N/A	N/A
2006/0247624	12/2005	Banouskou et al.	N/A	N/A
2006/0247631	12/2005	Ahn et al.	N/A	N/A
2006/0247636	12/2005	Yuan et al.	N/A	N/A
2006/0247779	12/2005	Gordon et al.	N/A	N/A
2006/0264933	12/2005	Baker et al.	N/A	N/A
2006/0264936	12/2005	Partin et al.	N/A	N/A
2006/0276787	12/2005	Zubok et al.	N/A	N/A
2006/0276789	12/2005	Jackson	606/916	A61B 17/7032
2006/0276791	12/2005	Shluzas	N/A	N/A
2006/0276792	12/2005	Ensign et al.	N/A	N/A
2006/0282074	12/2005	Renaud et al.	N/A	N/A
2006/0293659	12/2005	Alvarez	N/A	N/A
2006/0293665	12/2005	Shluzas	N/A	N/A
2006/0293666	12/2005	Matthis et al.	N/A	N/A
2007/0016188	12/2006	Boehm, Jr. et al.	N/A	N/A
2007/0016198	12/2006	Boehm, Jr. et al.	N/A	N/A
2007/0021750	12/2006	Shluzas et al.	N/A	N/A
2007/0043355	12/2006	Bette et al.	N/A	N/A
2007/0043357	12/2006	Kirschman	N/A	N/A
2007/0043358	12/2006	Molz, IV et al.	N/A	N/A
2007/0043359	12/2006	Altarac et al.	N/A	N/A
2007/0043364	12/2006	Cawley et al.	N/A	N/A
2007/0049933	12/2006	Ahn et al.	N/A	N/A
2007/0055235	12/2006	Janowski et al.	N/A	N/A
2007/0055238	12/2006	Biedermann et al.	N/A	N/A
2007/0055239	12/2006	Sweeney et al.	N/A	N/A
2007/0055240	12/2006	Matthis et al.	N/A	N/A
2007/0055241	12/2006	Matthis et al.	N/A	N/A
2007/0055242	12/2006	Bailly	N/A	N/A
2007/0055244	12/2006	Jackson	N/A	N/A
2007/0073291	12/2006	Cordaro et al.	N/A	N/A
2007/0078460	12/2006	Frigg et al.	N/A	N/A
2007/0083199	12/2006	Baccelli	N/A	N/A
2007/0088357	12/2006	Johnson et al.	N/A	N/A
2007/0093817	12/2006	Barrus et al.	N/A	N/A
2007/0093818	12/2006	Biedermann et al.	N/A	N/A
2007/0093819	12/2006	Albert	N/A	N/A

2007/0093826	12/2006	Hawkes et al.	N/A	N/A
2007/0093827	12/2006	Warnick	N/A	N/A
2007/0093831	12/2006	Abdelgany et al.	N/A	N/A
2007/0100341	12/2006	Reglos et al.	N/A	N/A
2007/0118117	12/2006	Altarac et al.	N/A	N/A
2007/0118118	12/2006	Kwak et al.	N/A	N/A
2007/0118123	12/2006	Strausbaugh et al.	N/A	N/A
2007/0118124	12/2006	Biedermann et al.	N/A	N/A
2007/0123862	12/2006	Warnick	N/A	N/A
2007/0123864	12/2006	Walder et al.	N/A	N/A
2007/0123867	12/2006	Kirschman	N/A	N/A
2007/0123870	12/2006	Jeon et al.	N/A	N/A
2007/0161986	12/2006	Levy	N/A	N/A
2007/0161994	12/2006	Lowrey et al.	N/A	N/A
2007/0161995	12/2006	Trautwein et al.	N/A	N/A
2007/0161996	12/2006	Biedermann et al.	N/A	N/A
2007/0161999	12/2006	Biedermann et al.	N/A	N/A
2007/0167948	12/2006	Abdou	N/A	N/A
2007/0167949	12/2006	Altarac et al.	N/A	N/A
2007/0173819	12/2006	Sandlin	N/A	N/A
2007/0173820	12/2006	Trieu	N/A	N/A
2007/0173828	12/2006	Firkins et al.	N/A	N/A
2007/0191839	12/2006	Justis et al.	N/A	N/A
2007/0198014	12/2006	Graf et al.	N/A	N/A
2007/0208344	12/2006	Young	N/A	N/A
2007/0225707	12/2006	Wisnewski et al.	N/A	N/A
2007/0225711	12/2006	Ensign	N/A	N/A
2007/0233078	12/2006	Justis et al.	N/A	N/A
2007/0233080	12/2006	Na et al.	N/A	N/A
2007/0233086	12/2006	Harms et al.	N/A	N/A
2007/0233087	12/2006	Schlapfer	N/A	N/A
2007/0250061	12/2006	Chin et al.	N/A	N/A
2007/0260243	12/2006	Biedermann	N/A	N/A
2007/0270806	12/2006	Foley et al.	N/A	N/A
2007/0270807	12/2006	Armstrong et al.	N/A	N/A
2007/0270810	12/2006	Sanders	N/A	N/A
2007/0270813	12/2006	Garamszegi	N/A	N/A
2007/0270815	12/2006	Johnson et al.	N/A	N/A
2007/0270830	12/2006	Morrison	N/A	N/A
2007/0270831	12/2006	Dewey et al.	N/A	N/A
2007/0270832	12/2006	Moore	N/A	N/A
2007/0270835	12/2006	Wisnewski	N/A	N/A
2007/0270839	12/2006	Jeon et al.	N/A	N/A
2007/0288004	12/2006	Alvarez	N/A	N/A
2008/0009862	12/2007	Hoffman	N/A	N/A
2008/0009864	12/2007	Forton et al.	N/A	N/A
2008/0015578	12/2007	Erickson et al.	N/A	N/A
2008/0015579	12/2007	Whipple	N/A	N/A
2008/0015580	12/2007	Chao	N/A	N/A
2008/0015584	12/2007	Richelsoph	N/A	N/A

2008/0015586	12/2007	Krishna et al.	N/A	N/A
2008/0021454	12/2007	Chao et al.	N/A	N/A
2008/0021455	12/2007	Chao et al.	N/A	N/A
2008/0021462	12/2007	Trieu	N/A	N/A
2008/0021464	12/2007	Morin et al.	N/A	N/A
2008/0021473	12/2007	Butler et al.	N/A	N/A
2008/0027432	12/2007	Strauss et al.	N/A	N/A
2008/0039838	12/2007	Landry et al.	N/A	N/A
2008/0039843	12/2007	Abdou	N/A	N/A
2008/0045951	12/2007	Fanger et al.	N/A	N/A
2008/0045955	12/2007	Berrevoets et al.	N/A	N/A
2008/0045957	12/2007	Landry et al.	N/A	N/A
2008/0051780	12/2007	Vaidya et al.	N/A	N/A
2008/0058811	12/2007	Alleyne et al.	N/A	N/A
2008/0058812	12/2007	Zehnder	N/A	N/A
2008/0065073	12/2007	Perriello et al.	N/A	N/A
2008/0065075	12/2007	Dant	N/A	N/A
2008/0065077	12/2007	Ferree	N/A	N/A
2008/0071273	12/2007	Hawkes et al.	N/A	N/A
2008/0071274	12/2007	Enisgn	N/A	N/A
2008/0071277	12/2007	Warnick	N/A	N/A
2008/0077139	12/2007	Landry et al.	N/A	N/A
2008/0086131	12/2007	Daly et al.	N/A	N/A
2008/0086132	12/2007	Biedermann et al.	N/A	N/A
2008/0097441	12/2007	Hayes et al.	N/A	N/A
2008/0097457	12/2007	Warnick	N/A	N/A
2008/0108992	12/2007	Barry	606/258	A61B 17/7037
2008/0119858	12/2007	Potash	N/A	N/A
2008/0140075	12/2007	Ensign et al.	N/A	N/A
2008/0140136	12/2007	Jackson	606/328	N/A
2008/0154315	12/2007	Jackson	N/A	N/A
2008/0161859	12/2007	Nilsson	N/A	N/A
2008/0161863	12/2007	Arnold et al.	N/A	N/A
2008/0177321	12/2007	Drewry et al.	N/A	N/A
2008/0177322	12/2007	Davis et al.	N/A	N/A
2008/0177332	12/2007	Reiley et al.	N/A	N/A
2008/0183215	12/2007	Altarac et al.	606/265	N/A
2008/0183223	12/2007	Jeon et al.	N/A	N/A
2008/0188898	12/2007	Jackson	606/305	A61B 17/7035
2008/0195159	12/2007	Kloss et al.	N/A	N/A
2008/0200956	12/2007	Beckwith et al.	N/A	N/A
2008/0215095	12/2007	Biedermann et al.	N/A	N/A
2008/0228229	12/2007	Walder et al.	N/A	N/A
2008/0234734	12/2007	Walder et al.	N/A	N/A
2008/0234756	12/2007	Sutcliffe et al.	N/A	N/A
2008/0234759	12/2007	Marino	N/A	N/A
2008/0234761	12/2007	Jackson	606/309	N/A
2008/0249570	12/2007	Carson et al.	N/A	N/A

2008/0249576	12/2007	Wawkes et al.	N/A	N/A
2008/0262548	12/2007	Lange et al.	N/A	N/A
2008/0262556	12/2007	Jacofsky et al.	N/A	N/A
2008/0269742	12/2007	Levy et al.	N/A	N/A
2008/0269809	12/2007	Garamszegi	606/305	N/A
2008/0287994	12/2007	Perez-Cruet et al.	N/A	N/A
2008/0288002	12/2007	Crall et al.	N/A	N/A
2008/0306528	12/2007	Winslow et al.	N/A	N/A
2008/0306533	12/2007	Winslow et al.	N/A	N/A
2008/0306539	12/2007	Cain et al.	N/A	N/A
2008/0312655	12/2007	Kirschman et al.	N/A	N/A
2008/0312692	12/2007	Brennan et al.	N/A	N/A
2008/0312696	12/2007	Battlers et al.	N/A	N/A
2008/0312701	12/2007	Batters et al.	N/A	N/A
2009/0005787	12/2008	Crall et al.	N/A	N/A
2009/0005813	12/2008	Crall et al.	N/A	N/A
2009/0005814	12/2008	Miller et al.	N/A	N/A
2009/0012567	12/2008	Biedermann et al.	N/A	N/A
2009/0018591	12/2008	Hawkes et al.	N/A	N/A
2009/0024169	12/2008	Triplett et al.	N/A	N/A
2009/0030457	12/2008	Janowski et al.	N/A	N/A
2009/0036929	12/2008	Reglos et al.	N/A	N/A
2009/0036932	12/2008	Rouyer et al.	N/A	N/A
2009/0036934	12/2008	Biedermann et al.	N/A	N/A
2009/0048601	12/2008	Forton	606/100	A61B 17/1671
2009/0062860	12/2008	Fraiser et al.	N/A	N/A
2009/0062865	12/2008	Schumacher	N/A	N/A
2009/0062867	12/2008	Schumacher	N/A	N/A
2009/0062914	12/2008	Marino	N/A	N/A
2009/0069849	12/2008	Oh et al.	N/A	N/A
2009/0069852	12/2008	Farris et al.	N/A	N/A
2009/0069853	12/2008	Schumacher	606/301	N/A
2009/0076550	12/2008	Bernhardt, Jr. et al.	N/A	N/A
2009/0076552	12/2008	Tornier	N/A	N/A
2009/0082809	12/2008	Nguyen et al.	N/A	N/A
2009/0082812	12/2008	Lewis	N/A	N/A
2009/0082815	12/2008	Zylber et al.	N/A	N/A
2009/0082819	12/2008	Blain et al.	N/A	N/A
2009/0088799	12/2008	Yeh	N/A	N/A
2009/0088807	12/2008	Castaneda et al.	N/A	N/A
2009/0093843	12/2008	Lemoine et al.	N/A	N/A
2009/0105769	12/2008	Rock et al.	N/A	N/A
2009/0105770	12/2008	Berrevoets et al.	N/A	N/A
2009/0105771	12/2008	Lei et al.	N/A	N/A
2009/0118772	12/2008	Diederich et al.	N/A	N/A
2009/0131983	12/2008	Biedermann	N/A	N/A
2009/0138044	12/2008	Bergeron et al.	N/A	N/A
2009/0138052	12/2008	Biedermann et al.	N/A	N/A

2009/0143827	12/2008	Levy et al.	N/A	N/A
2009/0143829	12/2008	Shluzas	N/A	N/A
2009/0149887	12/2008	Schlaepfer et al.	N/A	N/A
2009/0163955	12/2008	Moumene et al.	N/A	N/A
2009/0163956	12/2008	Biedermann et al.	N/A	N/A
2009/0163961	12/2008	Kirschman	N/A	N/A
2009/0163963	12/2008	Berrevoets	N/A	N/A
2009/0182380	12/2008	Abdelgany	N/A	N/A
2009/0192548	12/2008	Jeon et al.	N/A	N/A
2009/0192551	12/2008	Cianfrani et al.	N/A	N/A
2009/0198280	12/2008	Spratt et al.	N/A	N/A
2009/0198289	12/2008	Manderson	N/A	N/A
2009/0198291	12/2008	Kevin et al.	N/A	N/A
2009/0204155	12/2008	Aschmann	N/A	N/A
2009/0216280	12/2008	Hutchinson	N/A	N/A
2009/0248030	12/2008	Butler et al.	N/A	N/A
2009/0248075	12/2008	Ogilvie et al.	N/A	N/A
2009/0248088	12/2008	Biedermann	N/A	N/A
2009/0254125	12/2008	Predick	N/A	N/A
2009/0259254	12/2008	Pisharodi	N/A	N/A
2009/0264896	12/2008	Biedermann et al.	N/A	N/A
2009/0264933	12/2008	Carts et al.	N/A	N/A
2009/0270916	12/2008	Ramsay et al.	N/A	N/A
2009/0270917	12/2008	Boehm	N/A	N/A
2009/0281571	12/2008	Weaver et al.	N/A	N/A
2009/0281572	12/2008	White	N/A	N/A
2009/0281573	12/2008	Biedermann et al.	N/A	N/A
2009/0287253	12/2008	Felix et al.	N/A	N/A
2009/0299415	12/2008	Pimenta	N/A	N/A
2009/0306719	12/2008	Meyer, III et al.	N/A	N/A
2009/0306720	12/2008	Doubler et al.	N/A	N/A
2009/0312804	12/2008	Gamache et al.	N/A	N/A
2009/0326582	12/2008	Songer et al.	N/A	N/A
2009/0326587	12/2008	Matthis et al.	N/A	N/A
2010/0004692	12/2009	Biedermann et al.	N/A	N/A
2010/0004694	12/2009	Little	606/308	N/A
2010/0010540	12/2009	Park	N/A	N/A
2010/0016898	12/2009	Shluzas	N/A	N/A
2010/0057125	12/2009	Viker	N/A	N/A
2010/0057126	12/2009	Hestad	N/A	N/A
2010/0063545	12/2009	Richelsoph	N/A	N/A
2010/0063546	12/2009	Miller et al.	N/A	N/A
2010/0063550	12/2009	Felix et al.	N/A	N/A
2010/0063551	12/2009	Richelsoph	N/A	N/A
2010/0063553	12/2009	Warnick	N/A	N/A
2010/0069963	12/2009	Eckman	N/A	N/A
2010/0069969	12/2009	Ampuero et al.	N/A	N/A
2010/0087861	12/2009	Lechmann et al.	N/A	N/A
2010/0087865	12/2009	Biedermann et al.	N/A	N/A
2010/0094343	12/2009	Pham et al.	N/A	N/A

2010/0094345	12/2009	Saidha et al.	N/A	N/A
2010/0094348	12/2009	Biedermann et al.	N/A	N/A
2010/0094349	12/2009	Hammer et al.	N/A	N/A
2010/0094352	12/2009	Iott et al.	N/A	N/A
2010/0094353	12/2009	Shim et al.	N/A	N/A
2010/0100136	12/2009	Won et al.	N/A	N/A
2010/0100137	12/2009	Justis et al.	N/A	N/A
2010/0106189	12/2009	Miller	N/A	N/A
2010/0114170	12/2009	Barrus et al.	N/A	N/A
2010/0114171	12/2009	Boachie-Adjei et al.	N/A	N/A
2010/0114180	12/2009	Rock et al.	N/A	N/A
2010/0125302	12/2009	Hammill, Sr.	606/308	A61B 17/7037
2010/0131017	12/2009	Farris et al.	N/A	N/A
2010/0131018	12/2009	Konieczynski et al.	N/A	N/A
2010/0137918	12/2009	Wilcox et al.	N/A	N/A
2010/0137920	12/2009	Hammill, Sr. et al.	N/A	N/A
2010/0145390	12/2009	McCarthy et al.	N/A	N/A
2010/0152776	12/2009	Keyer et al.	N/A	N/A
2010/0152785	12/2009	Forton et al.	606/301	N/A
2010/0152787	12/2009	Walsh et al.	N/A	N/A
2010/0152788	12/2009	Warnick	N/A	N/A
2010/0160965	12/2009	Viker	N/A	N/A
2010/0160974	12/2009	Viker	N/A	N/A
2010/0160980	12/2009	Walsh et al.	N/A	N/A
2010/0168796	12/2009	Eliasen et al.	N/A	N/A
2010/0168800	12/2009	Biedermann et al.	N/A	N/A
2010/0168801	12/2009	Biedermann et al.	N/A	N/A
2010/0174322	12/2009	Abdelgany et al.	N/A	N/A
2010/0179602	12/2009	Dauster et al.	606/308	N/A
2010/0179603	12/2009	Warnick	N/A	N/A
2010/0185247	12/2009	Richelsoph	N/A	N/A
2010/0191290	12/2009	Felix	N/A	N/A
2010/0198269	12/2009	Taylor et al.	N/A	N/A
2010/0198270	12/2009	Barker et al.	N/A	N/A
2010/0198272	12/2009	Keyer	606/302	A61B 17/7037
2010/0204735	12/2009	Gephart	606/264	A61B 17/7037
2010/0211114	12/2009	Jackson	606/302	N/A
2010/0222822	12/2009	Farris et al.	N/A	N/A
2010/0228293	12/2009	Courtney et al.	N/A	N/A
2010/0234891	12/2009	Freeman et al.	N/A	N/A
2010/0234902	12/2009	Biedermann et al.	606/305	N/A
2010/0241170	12/2009	Cammisa et al.	N/A	N/A
2010/0249846	12/2009	Simonson	N/A	N/A
2010/0249856	12/2009	Iott et al.	N/A	N/A
2010/0256681	12/2009	Hammer et al.	N/A	N/A

2010/0256682	12/2009	Fallin et al.	N/A	N/A
2010/0262196	12/2009	Barrus et al.	N/A	N/A
2010/0312287	12/2009	Jackson	606/302	N/A
2011/0009911	12/2010	Hammill, Sr.	606/308	A61B 17/7038
2011/0046683	12/2010	Biedermann et al.	606/305	N/A
2011/0098755	12/2010	Jackson et al.	606/305	N/A
2011/0106166	12/2010	Keyer et al.	606/264	N/A
2011/0160778	12/2010	Elsbury	606/305	A61B 17/7037
2011/0196430	12/2010	Walsh et al.	606/305	N/A
2011/0208251	12/2010	Hammill et al.	606/308	N/A
2012/0046699	12/2011	Jones et al.	606/305	N/A
2012/0046700	12/2011	Jackson	606/305	A61B 17/7037
2012/0179212	12/2011	Jackson	606/328	A61B 17/7032
2013/0103098	12/2012	Jackson	606/305	A61B 17/8605
2014/0025119	12/2013	Biedermann et al.	N/A	N/A
2019/0254718	12/2018	Jackson	N/A	A61B 17/7032
2019/0365425	12/2018	Casey et al.	N/A	N/A
2020/0146723	12/2019	Jackson	N/A	N/A

FOREIGN PATENT DOCUMENTS

Patent No.	Application Date	Country	CPC
19507141	12/1995	DE	N/A
102013204726	12/2013	DE	N/A
1121902	12/2000	EP	N/A
1190678	12/2001	EP	N/A
1210914	12/2001	EP	N/A
1570795	12/2004	EP	N/A
1579816	12/2004	EP	N/A
1634537	12/2005	EP	N/A
1925263	12/2007	EP	N/A
2729291	12/1995	FR	N/A
2796545	12/2000	FR	N/A
2856578	12/2002	FR	N/A
2865373	12/2003	FR	N/A
2865375	12/2003	FR	N/A
2865377	12/2003	FR	N/A
2857850	12/2003	FR	N/A
2865378	12/2003	FR	N/A
2925288	12/2008	FR	N/A
2365345	12/2001	GB	N/A
WO95/01132	12/1994	WO	N/A
WO01/10317	12/2000	WO	N/A
WO02/054966	12/2001	WO	N/A

WO03/068088	12/2002	WO	N/A
WO2004/041100	12/2003	WO	N/A
WO2004/089245	12/2003	WO	N/A
WO2004/107997	12/2003	WO	N/A
WO2005/000136	12/2004	WO	N/A
WO2005/000137	12/2004	WO	N/A
WO2005/020829	12/2004	WO	N/A
WO2005/072632	12/2004	WO	N/A
WO2005/082262	12/2004	WO	N/A
WO2005/099400	12/2004	WO	N/A
WO2006/005198	12/2005	WO	N/A
WO2006/012088	12/2005	WO	N/A
WO2006/017616	12/2005	WO	N/A
WO2006/028537	12/2005	WO	N/A
WO2006/119241	12/2005	WO	N/A
WO2007/118045	12/2006	WO	N/A
WO2007/124222	12/2006	WO	N/A
WO2007/0130835	12/2006	WO	N/A
WO2007/130840	12/2006	WO	N/A
WO2007/130941	12/2006	WO	N/A
WO2008/088731	12/2007	WO	N/A
WO2009/015100	12/2008	WO	N/A
2009055747	12/2008	WO	N/A

OTHER PUBLICATIONS

U.S. Appl. No. 18/045,113, filed Oct. 7, 2022, Jackson et al. cited by applicant
EBI Omega 21 Brochure, EBI Spine Systems, pub. 1999 Claris Instrumentation Brochure, G Med, pub. 1997. cited by applicant
Claris Instrumentation Brochure, G Med, pub. 1997. cited by applicant
VLS System Variable Locking Screw Brochure, Interpore Cross International, 1999. cited by applicant
CD Horizon M8 Multi Axial Screw Spinal System Brochure, Medtronic Sofamor Danek, no publish date. cited by applicant
Contour Spinal System Brochure, Ortho Development, no publish date. cited by applicant
Xia Spinal System Brochure, Stryker Howmedica Osteonics, no publish date. cited by applicant
The Rod Plate System Brochure, Stryker Howmedica Osteonics, pub. Oct. 1999. cited by applicant
Silhouette Spinal Fixation System Brochure, Sulzer Medica Spine-Tech, no publish date. cited by applicant
SDRS Surgical Dynamics Rod System Brochure, Surgical Dynamics, pub. 1998-99. cited by applicant
Versalok Low Back Fixation System Brochure, Wright Medical Technology, Inc., pub. 1997. cited by applicant
The Strength of Innovation Advertisement, Blackstone Medical Inc., no publish date. cited by applicant
The Moss Miami 6.0mm System Advertisement, author unknown, no publish date. cited by applicant

---

Primary Examiner: Matthews; Tessa M

Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS (1) This application is a continuation of U.S. patent application Ser. No. 17/033,417, filed Sep. 25, 2020, which is a continuation of U.S. patent application Ser. No. 13/068,506, filed May 12, 2011, which claims the benefit of Provisional Application No. 61/395,692, filed May 14, 2010, each of which is incorporated by reference in its entirety herein and for all purposes.

BACKGROUND OF THE INVENTION

(1) The present invention is directed to polyaxial bone screws for use in bone surgery, particularly spinal surgery and particularly to such screws with compression or pressure inserts.

(2) Bone screws are utilized in many types of spinal surgery in order to secure various implants to vertebrae along the spinal column for the purpose of stabilizing and/or adjusting spinal alignment. Although both closed-ended and open-ended bone screws are known, open-ended screws are particularly well suited for connections to rods and connector arms, because such rods or arms do not need to be passed through a closed bore, but rather can be laid or urged into an open channel within a receiver or head of such a screw.

(3) Typical open-ended bone screws include a threaded shank with a pair of parallel projecting branches or arms which form a yoke with a U-shaped slot or channel to receive a rod. Hooks and other types of connectors, as are used in spinal fixation techniques, may also include open ends for receiving rods or portions of other structure.

(4) A common mechanism for providing vertebral support is to implant bone screws into certain bones which then in turn support a longitudinal structure such as a rod, or are supported by such a rod. Bone screws of this type may have a fixed head or receiver relative to a shank thereof. In the fixed bone screws, the rod receiver head cannot be moved relative to the shank and the rod must be favorably positioned in order for it to be placed within the receiver head. This is sometimes very difficult or impossible to do. Therefore, polyaxial bone screws are commonly preferred.

(5) Open-ended polyaxial bone screws allow rotation of the head or receiver about the shank until a desired rotational position of the head is achieved relative to the shank. Thereafter, a rod or other longitudinal connecting member can be inserted into the head or receiver and eventually the receiver is locked or fixed in a particular position relative to the shank. During the rod implantation process it is desirable to utilize bone screws or other bone anchors that have components that remain within the bone screw and further remain properly aligned during what is sometimes a very lengthy, difficult procedure.

SUMMARY OF THE INVENTION

(6) A bone anchor assembly according to the invention includes a shank having an upper portion or head and a body for fixation to a bone; a receiver defining an upper open channel, a cavity and a lower opening; a compression insert; and a retainer for capturing the shank upper portion in the receiver, the retainer being in press fit engagement with the shank upper portion, the upper portion and attached retainer being pivotable with respect to the receiver prior to locking of the shank into a desired configuration. The press-fit engagement between the shank upper portion and the retainer may also be described as a cam capture, with the retainer and/or shank upper portion having a sloping or inclined surface. The shank and retainer cooperate in such a manner that a partial rotation between the retainer and the shank brings the shank and retainer structures into locking engagement. The illustrated compression insert operatively engages the shank upper portion and is spaced from the retainer. The compression insert frictionally engages the shank during assembly, providing non-floppy positioning of the shank with respect to the receiver and also subsequent independent locking of the shank with respect to the receiver. The non-floppy temporary frictional holding is provided by at least one resilient surface on the insert, compression of the resilient

surface toward the insert during the temporary frictional holding is by an inner surface of the receiver. When the insert is pressed downwardly into locking engagement with the shank upper portion or head, the resilient surface returns to a neutral or near neutral position, resiliently pressing out against the receiver and locking the insert against the receiver. Thereafter, further manipulation of a rod or other longitudinal connecting member is possible with the otherwise locked screw.
(7) Objects of the invention include providing apparatus and methods that are easy to use and especially adapted for the intended use thereof and wherein the tools are comparatively inexpensive to produce. Other objects and advantages of this invention will become apparent from the following description taken in conjunction with the accompanying drawings wherein are set forth, by way of illustration and example, certain embodiments of this invention.
(8) The drawings constitute a part of this specification and include exemplary embodiments of the present invention and illustrate various objects and features thereof.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) FIG. **1** is an exploded perspective view of a polyaxial bone screw assembly according to the present invention including a shank, a receiver, a retainer and a compression insert and also shown with a closure top and a longitudinal connecting member in the form of a rod.
(2) FIG. **2** is an enlarged top plan view of the shank of FIG. **1**.
(3) FIG. **3** is an enlarged and partial front elevational view of the shank of FIG. **1**.
(4) FIG. **4** is an enlarged and partial cross-sectional view taken along the line **4-4** of FIG. **2**.
(5) FIG. **5** is an enlarged and partial cross-sectional view taken along the line **5-5** of FIG. **2**.
(6) FIG. **6** is an enlarged top plan view of the receiver of FIG. **1**.
(7) FIG. **7** is an enlarged bottom plan view of the receiver of FIG. **1**.
(8) FIG. **8** an enlarged side elevational view of the receiver of FIG. **1**.
(9) FIG. **9** is an enlarged front elevational view of the receiver of FIG. **1**.
(10) FIG. **10** is an enlarged perspective view of the receiver of FIG. **1**.
(11) FIG. **11** is an enlarged cross-sectional view taken along the line **11-11** of FIG. **8**.
(12) FIG. **12** is an enlarged cross-sectional view taken along the line **12-12** of FIG. **9**.
(13) FIG. **13** is an enlarged cross-sectional view taken along the line **13-13** of FIG. **8**.
(14) FIG. **14** is an enlarged perspective view of the retainer of FIG. **1**.
(15) FIG. **15** is an enlarged top plan view of the retainer of FIG. **1**.
(16) FIG. **16** is an enlarged bottom plan view of the retainer of FIG. **1**.
(17) FIG. **17** is an enlarged cross-sectional view taken along the line **17-17** of FIG. **15**.
(18) FIG. **18** is an enlarged and partial front elevational view of the shank and retainer of FIG. **1** with portions broken away to show the detail thereof.
(19) FIG. **19** is an enlarged top plan view of the insert of FIG. **1**.
(20) FIG. **20** is an enlarged bottom plan view of the insert of FIG. **1**.
(21) FIG. **21** is an enlarged perspective view of the insert of FIG. **1**.
(22) FIG. **22** is an enlarged side elevational view of the insert of FIG. **1**.
(23) FIG. **23** is an enlarged front elevational view of the insert of FIG. **1**.
(24) FIG. **24** is an enlarged cross-sectional view taken along the line **24-24** of FIG. **23**.
(25) FIG. **25** is a front elevational view of the receiver and retainer of FIG. **1** with portions broken away to show the detail thereof and further showing a stage of assembly of the retainer in phantom.
(26) FIG. **26** is an enlarged and partial perspective view of the receiver, retainer and shank of FIG. **1** shown in an early stage of assembly.
(27) FIG. **27** is an enlarged and partial front elevational view of the receiver, retainer and shank of FIG. **1** shown in a stage of assembly subsequent to that shown in FIG. **26**, with portions broken

away to show the detail thereof and further showing cooperating portions of the shank and retainer in phantom.
(28) FIG. **28** is an enlarged and partial front elevational view of the receiver, retainer and shank of FIG. **1** shown in a stage of assembly subsequent to that shown in FIG. **27**, with portions broken away to show the detail thereof and further showing cooperating portions of the shank and retainer in phantom.
(29) FIG. **29** is a reduced front elevational view of the assembled receiver, retainer and shank of FIG. **28**, showing a stage of assembly with the insert of FIG. **1**, shown in a side elevational loading position.
(30) FIG. **30** is an enlarged cross-sectional view of the receiver, retainer and shank taken along the line **30**-**30** of FIG. **29** and further showing the insert of FIG. **29** in top plan view, being shown in a stage of assembly within the receiver.
(31) FIG. **31** is an enlarged cross-sectional view of the receiver, retainer and shank taken along the line **31**-**31** of FIG. **29** and further showing the insert of FIG. **29** in cross-section in a first factory assembled position within the receiver, and also showing in phantom the pair of receiver spring tabs being biased toward the insert.
(32) FIG. **32** is a reduced side elevational view of the receiver, retainer, shank and insert of FIG. **31** with portions broken away to show the detail thereof.
(33) FIG. **33** is a reduced side elevational view, with portions broken away, similar to FIG. **32**, further showing the shank pivoted at an angle with respect to the receiver.
(34) FIG. **34***a* is an enlarged and partial rear elevational view of the assembly of FIG. **32** with portions broken away to show the detail thereof, the insert being shown in the factory assembled position.
(35) FIG. **34***b* is an enlarged and partial rear elevational view of the assembly of FIG. **33** with portions broken away to show the detail thereof, the insert being shown in a subsequent second or locked position with respect to the receiver.
(36) FIG. **35** is a top plan view of the assembly of FIG. **34**, with portions broken away to show the detail thereof and further shown with the rod of FIG. **1**, the insert being pressable downwardly into the second or locked position by the rod.
(37) FIG. **36** is an enlarged and partial side elevational view of the assembly of FIG. **35**, further showing the closure top of FIG. **1** in a stage of assembly with the receiver with portions broken away to show the detail thereof.
(38) FIG. **37** is an enlarged and partial side elevational view of the assembly of FIG. **36** with portions broken away to show the detail thereof and showing the closure top engaging the rod.
(39) FIG. **38** is an enlarged and partial cross-sectional view taken along the line **38**-**38** of FIG. **37**.
(40) FIG. **39** is an enlarged and partial, partially exploded perspective view of the assembled receiver, shank, retainer and insert of FIGS. **32**-**34** further shown with an alternative deformable rod and an alternative closure top.
(41) FIG. **40** is a partial side elevational view of the assembly of FIG. **39**, shown fully assembled and with portions broken away to show the detail thereof.
(42) FIG. **41** is an enlarged and partial cross-sectional view taken along the line **41**-**41** of FIG. **40**.
(43) FIG. **42** is a reduced and partial perspective view showing the assembled receiver, shank, retainer and insert of FIGS. **32**-**34** with a cord, first and second spacers located on either side of the receiver, a threaded connecter, a rod and a closure top configured for slidable engagement with the cord.
(44) FIG. **43** is a perspective view of the cord and connector of FIG. **42** with portions broken away to show the detail thereof.
(45) FIG. **44** is an enlarged and partial cross-sectional view taken along the line **44**-**44** of FIG. **42**.
(46) FIG. **45** is a reduced and partial, partially exploded view, showing the assembled receiver, shank, retainer and insert of FIGS. **32**-**34** with a cord, a spacer and a closure top configured for

fixed engagement with the cord.
(47) FIG. **46** is an enlarged and partial cross-sectional view, taken along the line **46**-**46** of FIG. **45** and showing the spacer and closure top in an assembled position.
(48) FIG. **47** is an exploded perspective view of an alternative embodiment of a polyaxial bone screw assembly according to the present invention including a shank, a receiver, a retainer and a compression insert.
(49) FIG. **48** is an enlarged perspective view of the receiver of FIG. **47**.
(50) FIG. **49** is an enlarged side elevational view of the receiver of FIG. **47**.
(51) FIG. **50** is an enlarged front elevational view of the receiver of FIG. **47**.
(52) FIG. **51** is an enlarged cross-sectional view taken along the line **51**-**51** of FIG. **50**.
(53) FIG. **52** is an enlarged cross-sectional view taken along the line **52**-**52** of FIG. **49**.
(54) FIG. **53** is an enlarged perspective view of the insert of FIG. **47**.
(55) FIG. **54** is an enlarged side elevational view of the insert of FIG. **47**.
(56) FIG. **55** is an enlarged side elevational view of the insert of FIG. **47** opposite to that shown in FIG. **54**.
(57) FIG. **56** is an enlarged front elevational view of the insert of FIG. **47**.
(58) FIG. **57** is a cross-sectional view taken along the line **57**-**57** of FIG. **56**.
(59) FIG. **58** is a cross-sectional view taken along the line **58**-**58** of FIG. **54**.
(60) FIG. **59** is an enlarged and partial front elevational view of the assembled receiver, retainer and shank of FIG. **47**, shown in exploded view with the insert of FIG. **47**, the insert being in a side elevational loading position.
(61) FIG. **60** is an enlarged top plan view of the assembled receiver, retainer and shank of FIG. **47**, further showing the insert of FIG. **47** in top plan view, being shown in a stage of assembly within the receiver.
(62) FIG. **61** is an enlarged and partial perspective view of the assembled receiver, retainer, shank and insert of FIG. **47** with a portion of the receiver broken away to show the detail thereof.
(63) FIG. **62** is a reduced and partial cross-sectional view taken along the line **62**-**62** of FIG. **61**.
(64) FIG. **63** is a partial cross-sectional view taken along the line **63**-**63** of FIG. **62**.
(65) FIG. **64** is an enlarged and partial front elevational view of the assembly of FIG. **61**, with portions broken away to show the detail of an initial surface engagement between the insert and receiver.
(66) FIG. **65** is an enlarged and partial perspective view of the assembly of FIG. **47** shown assembled with a deformable rod and a closure top.
(67) FIG. **66** is an enlarged and partial front elevational view of the assembly of FIG. **65** with portions broken away to show the detail thereof.
(68) FIG. **67** is an enlarged and partial cross-sectional view taken along the line **67**-**67** of FIG. **65**.
DETAILED DESCRIPTION OF THE INVENTION
(69) As required, detailed embodiments of the present invention are disclosed herein; however, it is to be understood that the disclosed embodiments are merely exemplary of the invention, which may be embodied in various forms. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a basis for the claims and as a representative basis for teaching one skilled in the art to variously employ the present invention in virtually any appropriately detailed structure. It is also noted that any reference to the words top, bottom, up and down, and the like, in this application refers to the alignment shown in the various drawings, as well as the normal connotations applied to such devices, and is not intended to restrict positioning of the bone attachment structures in actual use.
(70) With reference to FIGS. **1**-**38** the reference number **1** generally represents a polyaxial bone screw apparatus or assembly according to the present invention. The assembly **1** includes a shank **4**, that further includes a body **6** integral with an upwardly extending upper portion or capture structure **8**; a receiver **10**; a retainer structure **12** and a compression or pressure insert **14**. The shank

4, receiver **10**, retainer **12** and compression insert **14** are typically factory assembled prior to implantation of the shank body **6** into a vertebra **13**, as will be described in greater detail below. FIG. **1** further shows a closure structure **18** of the invention for capturing a longitudinal member, for example, a rod **21** which in turn engages the compression insert **14** that presses against the shank upper portion **8** into fixed frictional contact with the retainer **12**, so as to capture, and fix the longitudinal connecting member **21** within the receiver **10** and thus fix the member **21** relative to the vertebra **13**. The illustrated rod **21** is hard, stiff, non-elastic and cylindrical, having an outer cylindrical surface **22**. It is foreseen (and also will be described with respect to other embodiments) that the rod **21** may be of a different stiffness, elastic, deformable and/or of a different cross-sectional geometry. The receiver **10** and the shank **4** cooperate in such a manner that the receiver **10** and the shank **4** can be secured at any of a plurality of angles, articulations or rotational alignments relative to one another and within a selected range of angles both from side to side and from front to rear, to enable flexible or articulated engagement of the receiver **10** with the shank **4** until both are locked or fixed relative to each other near the end of an implantation procedure. The assembly is advantageously configured and factory assembled to provide a surgeon with a bone anchor exhibiting sufficient frictional engagement between the compression insert and the shank upper portion that the shank is positionable to a desired angle with respect to the receiver during and after implantation if the shank and prior to locking of the polyaxial mechanism with the closure structure. In other words, the factory supplied assembly includes a shank that is not floppy or loose with respect to the receiver, allowing greater ease in handling and manipulation during the surgical process. Locking of the insert onto the shank upper portion may also be performed prior to locking with the closure top. Furthermore, inserts according to the invention are advantageously configured to allow for a squeeze release to easily provide for repositioning of the angle of the bone screw shank, as will be described in greater detail below.

(71) The shank **4**, best illustrated in FIGS. **1-5**, is elongate, with the shank body **6** having a helically wound bone implantable thread **24** (single or dual lead thread form) extending from near a neck **26** located adjacent to the upper portion or capture structure **8**, to a tip **28** of the body **6** and extending radially outwardly therefrom. During use, the body **6** utilizing the thread **24** for gripping and advancement is implanted into the vertebra **13** leading with the tip **28** and driven down into the vertebra with an installation or driving tool (not shown), so as to be implanted in the vertebra to near the neck **26**, as more fully described in the paragraphs below. The shank **4** has an elongate axis of rotation generally identified by the reference letter A.

(72) The neck **26** extends axially upward from the shank body **6**. The neck **26** may be of the same or is typically of a slightly reduced radius as compared to an adjacent upper end or top **32** of the body **6** where the thread **24** terminates. Further extending axially and outwardly from the neck **26** is the shank upper portion **8** that provides a connective or capture apparatus disposed at a distance from the upper end **32** and thus at a distance from the vertebra **13** when the body **6** is implanted in such vertebra.

(73) The shank upper portion **8** is configured for a pivotable connection between the shank **4** (with attached retainer **12**) and the receiver **10** prior to fixing of the shank **4** in a desired position with respect to the receiver **10**. The shank upper portion **8** has an outer, convex and substantially spherical lower surface **34** that extends outwardly and upwardly from the neck **26** and terminates at a substantially planar ledge or shelf **36** that is annular and disposed perpendicular to the shank axis A. The shelf **36** is sized and shaped to receive and seat the retainer **14** at a bottom surface thereof as will be described in greater detail below. The spherical lower surface **34** has an outer radius that is the same or substantially similar to an outer radius of the retainer **12** as will be described in greater detail below, the surface **34** as well as the retainer **12** outer surface participating in the ball and socket joint formed by the shank **4** and attached retainer **12** within the partially spherical surface defining an inner cavity of the receiver **10**. Extending upwardly from the ledge **36** is a cylindrical surface **38**, the surface **38** having a radius that is smaller than the radius of the lower spherical

surface **34**. Extending substantially radially outwardly from the cylindrical surface **38** are three evenly spaced cam projections or lugs **40**, each with a lower surface or ledge **41** that faces toward the ledge **36** and is disposed at a slight angle with respect thereto. As will be discussed in greater detail below, the lower ledge **36**, cylindrical surface **38** and upper ledges **41** cooperate to capture and fix the retainer **12** to the shank upper portion **8**, prohibiting movement of the retainer **12** along the axis A once the retainer **12** is located between the ledges **36** and **41**. It is noted that according to the invention, one, two, three or more cam projections **40** may be disposed about the cylindrical surface **38**. Each of the projections **40** further include an outer substantially cylindrical surface **42** bounded by opposed side surfaces **43**. A partially spherical or domed top surface **44** partially defines each of the projections **40**, terminating at the projection surfaces **42** and the cylindrical surface **38** located between each of the cam projections **40**. The spherical surface **44** has an outer radius configured for sliding cooperation and ultimate frictional mating with a substantially spherical concave surface of the compression insert **14** that has the same or substantially similar radius as the surface **44**. The radius of the surface **44** is smaller than the radius of the lower spherical surface **34**. Located near or adjacent to the surface **44** is an annular top surface **46**. A counter sunk substantially planar base or seating surface **49** partially defines an internal drive feature or imprint **50**. The illustrated internal drive feature **50** is an aperture formed in the top surface **46** and has a hex shape designed to receive a hex tool (not shown) of an Allen wrench type, into the aperture for rotating and driving the bone screw shank **4**. It is foreseen that such an internal tool engagement structure may take a variety of tool-engaging forms and may include one or more apertures of various shapes, such as a pair of spaced apart apertures or a multi-lobular or star-shaped aperture, such as those sold under the trademark TORX, or the like. The seat or base **49** of the drive feature **50** is disposed perpendicular to the axis A with the drive feature **49** otherwise being coaxial with the axis A. In operation, a driving tool is received in the internal drive feature **50**, being seated at the base **49** and engaging the six faces of the drive feature **50** for both driving and rotating the shank body **6** into the vertebra **13**, either before the shank **4** is attached to the receiver **10** or after the shank **4** is attached to the receiver **10**, with the shank body **6** being driven into the vertebra **13** with the driving tool extending into the receiver **10**.

(74) The shank **4** shown in the drawings is cannulated, having a small central bore **51** extending an entire length of the shank **4** along the axis A. The bore **50** is defined by an inner cylindrical wall of the shank **4** and has a circular opening at the shank tip **28** and an upper opening communicating with the internal drive **50** at the surface **49**. The bore **51** is coaxial with the threaded body **6** and the upper portion **8**. The bore **51** provides a passage through the shank **4** interior for a length of wire (not shown) inserted into the vertebra **13** prior to the insertion of the shank body **6**, the wire providing a guide for insertion of the shank body **6** into the vertebra **13**.

(75) To provide a biologically active interface with the bone, the threaded shank body **6** may be coated, perforated, made porous or otherwise treated. The treatment may include, but is not limited to a plasma spray coating or other type of coating of a metal or, for example, a calcium phosphate; or a roughening, perforation or indentation in the shank surface, such as by sputtering, sand blasting or acid etching, that allows for bony ingrowth or ongrowth. Certain metal coatings act as a scaffold for bone ingrowth. Bio-ceramic calcium phosphate coatings include, but are not limited to: alpha-tri-calcium phosphate and beta-tri-calcium phosphate (Ca.sub.3(PO.sub.4).sub.2′, tetra-calcium phosphate (Ca.sub.4P.sub.2O.sub.9), amorphous calcium phosphate and hydroxyapatite (Cato(PO.sub.4).sub.6(OH).sub.2). Coating with hydroxyapatite, for example, is desirable as hydroxyapatite is chemically similar to bone with respect to mineral content and has been identified as being bioactive and thus not only supportive of bone ingrowth, but actively taking part in bone bonding.

(76) With particular reference to FIGS. **1** and **6-13**, the receiver **10** has a generally U-shaped appearance with a partially discontinuous substantially cylindrical inner and outer profiles. The receiver **10** has an axis of rotation B that is shown in FIG. **1** as being aligned with and the same as

the axis of rotation A of the shank **4**, such orientation being desirable, but not required during assembly of the receiver **10** with the shank **4**. After the receiver **10** is pivotally attached to the shank **4**, either before or after the shank **4** is implanted in a vertebra **13**, the axis B is typically disposed at an angle with respect to the axis A, as shown, for example, in FIG. **33**.

(77) The receiver **10** includes a partially cylindrical and partially frusto-conical base **58** integral with a pair of opposed upstanding arms **60**A and **60**B, the arms forming a cradle and defining a U-shaped channel **62** between the arms **60**A and B with an upper opening, generally **63**, and a U-shaped lower seat **64**, the channel **62** having a width for operably snugly receiving the rod **21** between the arms **60**A and B. Each of the arms **60**A and **60**B has an interior surface, generally **66**, that has a cylindrical profile and further includes a partial helically wound guide and advancement structure **68** extending radially inwardly from the surface **66** and located adjacent top surfaces **69** of each of the arms **60**. In the illustrated embodiment, the guide and advancement structure **68** is a partial helically wound interlocking flangeform configured to mate under rotation with a similar structure on the closure structure **18**, as described more fully below. However, it is foreseen that the guide and advancement structure **68** could alternatively be a square-shaped thread, a buttress thread, a reverse angle thread or other thread-like or non-thread-like helically wound discontinuous advancement structure for operably guiding under rotation and advancing the closure structure **18** downward between the arms **60**, as well as eventual torquing when the closure structure **18** abuts against the rod **21**.

(78) An opposed pair of tool receiving and engaging features, generally **71**, are formed on outer surfaces **72** of the arms **60**A and **60**B. The illustrated features **71** are in a T-shape form and include and upper groove or recess **73** running substantially parallel to the respective top surface **69** that does not extend through the respective arm **60**A or **60**B and a connecting transverse, substantially rectangular lower recess or through bore **74** that does extend from each arm outer surface **72** to each interior surface **66**, providing access to laterally extending spring tabs **75** that bias against the pressure insert **14** to prohibit reverse (illustrated as counter-clockwise) rotational movement of the insert about the receiver axis once the insert is loaded in the receiver **10**, as will be described in greater detail below. The aperture feature **71** and alternatively, any additional tool receiving and engaging apertures may be formed in the receiver outer surfaces and used for holding the receiver **10** during assembly with the shank **4**, the retainer **12** and the insert **14**, during the implantation of the shank body **6** into a vertebra when the shank is preassembled with the receiver **10**, and during assembly of the bone anchor assembly **1** with the rod **21** and the closure structure **18**. It is foreseen that tool receiving grooves or apertures may be configured in a variety of shapes and sizes and be disposed at other locations on the receiver arms **60**A and **60**B.

(79) Returning to the interior surface **66** of the receiver arms **60**A and **60**B, located below the guide and advancement structure **68** on each of the arms is a discontinuous cylindrical surface **77**, having a diameter approximately the same as a greater diameter of the guide and advancement structure **68**. The space under the guide and advancement structure **68** that is defined in part by the cylindrical surface **77** forms a run-out area for the closure top **18**. With particular reference to FIG. **11**, on the arm **60**A, the cylindrical surface **77** is adjacent to an upper surface or ledge **76** that partially defines the flange form **68** run-out and also serves as an intermediate or temporary abutment feature (along with the cylindrical surface **77**) for the insert **14** as shown, for example, in FIG. **34***a*, and as will be discussed in greater detail below. Adjacent to and located below the cylindrical surface **77** is a discontinuous annular surface **78** that in turn is adjacent to a discontinuous substantially cylindrical surface **80**. The surface **80** extends from the surface **78** to an annular lip or ledge **81** that is disposed perpendicular to the axis B and extends radially inwardly toward the axis B. On each arm **60**A and **60**B, a portion of the ledge **81** is adjacent to and integral with a sloping or curved transition surface **83** that in turn is adjacent to and integral with an upper surface **84** of the respective spring tab **75**. Adjacent to the annular lip **81** is another partially discontinuous substantially cylindrical surface **86** that partially defines the arms **60**A and **60**B as

well as extends into the base **58**. Thus the surface **86** also partially defines the lower seat **64** of the U-shaped channel **62**. An inner surface **88** of the spring tab **75** is integral with the surface **86**. The surface **86** has a diameter smaller than the diameter of the cylindrical surface **80**, but larger than the diameter of the surface **77**; this diameter feature will come into play with respect to the cooperation between the insert **14** and the receiver inner surfaces **76**, **77**, **78** and **86** as will be described in detail below. As mentioned above, the surface **86** also partially defines an inner cavity, generally **90**, of the base **58** of the receiver **10**, the cavity **90** and the U-shaped channel **62** defining a through bore of the receiver **10** from the top surface **69** to a bottom surface **92** thereof. Moving downwardly further into the base cavity **90**, a substantially conical surface **94** is adjacent to the cylindrical surface **86** and terminates at a radiused or spherical seating surface **96**. It is noted that the surface **94** as well as portions of the surface **86** may be partially spherical or otherwise curved in some embodiments of the invention. The surface **96** is sized and shaped for slidably mating with the retainer structure **12** and ultimately frictionally mating therewith as will be described in greater detail below. The spherical seating surface **96** is adjacent a flared surface or as shown, a series of beveled surfaces that provide a neck **97** that forms a bottom opening, generally **98**, to the cavity **90** at the receiver bottom surface **92**. The neck **97** is sized and shaped to be smaller than an outer radial dimension of the retainer **12** when the retainer **12** is fixed to the shank upper portion **8**, so as to form a restriction to prevent the structure **12** and attached shank portion **8** from passing through the cavity **90** and out the lower exterior **92** of the receiver **10** during operation thereof.

(80) Returning to the surface **86**, with reference to FIGS. **12** and **13**, and in particular to the surface **86** that extends upwardly into the arms **60**A and **60**B, formed within each of the substantially cylindrical surfaces **86** and located directly beneath the annular lip **81** is a recess, generally **100**, partially defined by a rounded stop or abutment wall **102** and partially defined by a lower annular lip or ledge **103**. As will be described in greater detail below, the cooperating compression insert **14** includes a cooperating structure **104** that extends outwardly from each arm thereof that abuts against the respective abutment wall **102** of each of the receiver arms, providing a centering stop or block when the insert **14** is rotated into place in a clockwise manner as will be described below.

(81) Finally, returning to the laterally extending spring tabs **75**, that include top surfaces **84** and inner surfaces **88** previously described herein, each spring tab **75** further includes a bottom surface **108** and an end surface **109**. The surface **109** is adjacent to and extends between the surfaces **108** and **84**, the end surface **109** running substantially parallel to the receiver axis B. The end surfaces **109** of the opposing spring tabs **75** generally face in opposite directions. As described more fully below and shown, for example, in FIG. **31**, during assembly, the tabs **75** are pressed radially inwardly to engage the insert **14** and prohibit counter-clockwise motion of the insert **14** with respect to the receiver **10**.

(82) With particular reference to FIGS. **1** and **14-18**, the retainer **12** that operates to capture the shank upper portion **8** within the receiver **10** has a central axis that is operationally the same as the axis A associated with the shank **4** when the shank upper portion **8** and the retainer **12** are installed within the receiver **10**. The retainer **12** is typically made from a hard material, that also may be resilient, such as stainless steel or titanium alloy, for embodiments (not shown) having a slit or slot that would allow for top or bottom loading, so that the retainer **12** may be contracted or expanded during assembly. The retainer structure **12** has a central bore, generally **110**, that passes entirely through the retainer structure **12** from a top surface **112** to a bottom surface **114** thereof. The bottom surface **114** is substantially planar and disposed perpendicular to the axis A when the retainer is fixed to the shank **4** with the surface **114** abutting the shank surface **36** as shown, for example, in FIG. **18**. The top surface **112** is disposed at an angle with respect to the axis A when the retainer **12** is fixed to the shank **4**, the surface **112** sloping radially downwardly to provide space and clearance between the retainer **12** and the insert **14** when the assembly **1** is fully assembled and placed at any angle of inclination of the shank **4** with respect to the receiver **10**. A first inner cylindrical surface **116** defines a substantial portion of the bore **110**. The cylindrical surface **116** is

sized and shaped to be slidingly received about the cylindrical surface portion **38** of the shank upper portion **8**. Extending inwardly radially from the surface **116** are three evenly spaced cam projections or shelves **118** sized and shaped to cooperate with the cam projections **40** of the shank upper portion **8** for fixing the retainer **12** to the shank upper portion **8**. The cam shelves **118** extend from at or near the retainer bottom **114** to a location spaced from the retainer top **112**. The cam shelves **118** are sized and shaped to provide direct mating support with each shank projection **40**. The cam shelves **118** are also spaced from the top surface **112** to provide adequate space for loading rotation and placement of the cam projections of the shank upper portion **8** with respect to the retainer **12** during assembly within the receiver of the bone screw **1**. Each of the illustrated cam shelves **118** includes an upper, sloping or slanted seating surface **120** and an opposed bottom surface **122** that is flush and integral with the bottom surface **114** of the retainer **12**. The illustrated camming seating surfaces **120** are each disposed about midway between the top **112** and the bottom **114** of the retainer **12**, but may be located slightly higher or lower along the surface **116**. Each camming shelf **118** further includes opposed side surfaces **124** and **125** running from the bottom surface **114** to the seating surface **120**. Each of the surfaces **124** and **125** are curved and substantially concave. Each shelf includes an inner cylindrical surface **126** sized and shaped to slidingly mate with the surfaces **42** of the cam projections **40** of the shank upper portion **8**. The sloping seating surfaces **120** are sized to receive the lugs or projections **40** at the surfaces **41** thereof, with the surfaces **36** and **41** of the shank upper portion forming a cam track between which each camming shelf **118** slides and is captured and frictionally fixed. A degree of inclination of the surface **120** substantially matches a degree of inclination of the bottom surface **41** of the lug **40**. In the illustrated embodiment, the degree of inclination is about three degrees, but it is foreseen that it may be more or less than that illustrated. In some embodiments according to the invention, one or both the ramped surfaces **41** and **120** include a roughening, ridges or some other treatment to further aid frictional locking of the retainer **12** with respect to each lug **40**. Furthermore, in some embodiments of the invention, fixing engagement between the lugs **40** and the shelves **122** may be enhanced by a weld or adhesive. For example, the illustrated camming shelves **118** are slightly wider than the shank projections **40** at the side surfaces **124** and **125** so as to advantageously accommodate a spot weld or other fixing or adhering structure or substance.

(83) The retainer **12** also has a radially outer partially spherically shaped surface **129** sized and shaped to mate with the partial spherical shaped seating surface **96** of the receiver **10**. The surface **129** includes an outer radius that is larger than a radius of the lower opening **98** of the receiver **10**, thereby prohibiting the retainer **12** and the shank upper portion **8** from passing through the opening **98** once the retainer **12** is fixed to the shank upper portion **8** within the receiver cavity **90**. Although not required, it is foreseen that the outer partially spherically shaped surface **129** may be a high friction surface such as a knurled surface or the like.

(84) With particular reference to FIGS. **1** and **19-24**, the compression or pressure insert **14** is illustrated that is sized and shaped to be received by and down-loaded into the receiver **10** through the channel opening **66** as illustrated in FIGS. **29-31**. The compression insert **14** has an operational central axis that is the same as the central axis B of the receiver **10**. The compression insert **14** has a central channel or through bore, generally **130**, substantially defined by an inner substantially cylindrical surface **131** coaxial with an inner partially spherical surface **132**. The compression insert **14** through bore is sized and shaped to receive a driving tool (not shown) therethrough that engages the shank drive feature **50** when the shank body **6** is driven into bone with the receiver **10** attached. The surface **132** is sized and shaped to slidingly receive and ultimately frictionally engage the substantially spherical or domed surface **44** of the shank upper portion **8** such that the surface **44** initially frictionally slidingly and pivotally mates with the spherical surface **132** to create a ball-and-socket type joint. The surfaces **44** and/or **132** may include a roughening or surface finish to aid in frictional contact between them once a desired angle of articulation of the shank **4** with respect to the receiver **10** is reached.

(85) The compression insert **14** includes a substantially cylindrical base body **134** integral with a pair of upstanding arms **135**. The bore **130** is disposed primarily within the base body **134** and communicates with a generally U-shaped through channel **136** that is defined by the upstanding arms **135**. The channel **136** has a lower seat **138** sized and shaped to closely, snugly engage the rod **21**. It is foreseen that an alternative embodiment may be configured to include planar holding surfaces that closely hold a square or rectangular bar as well as hold a cylindrical rod-shaped or corded longitudinal connecting member. The arms **135** disposed on either side of the channel **136** extend outwardly and upwardly from the body **134**. The arms **135** are sized and configured for ultimate placement near the run-out below the receiver guide and advancement structure **68**. It is foreseen that in some embodiments of the invention, the arms may be extended and the closure top configured such the arms ultimately directly engage the closure top for locking of the polyaxial mechanism. In the present embodiment, the arms **135** include top surfaces **140** that are ultimately positioned in spaced relation with the closure top **18**, so that the closure top **18** frictionally engages and holds the rod **21**, pressing the rod **21** downwardly against the seating surface **138**, the insert **14** in turn pressing against the domed top **44** of the shank **4** to lock the polyaxial mechanism of the bone screw assembly **1**. The illustrated insert **14** further includes features that allow for a non-floppy frictional fit between the insert and the shank **4** during assembly and also for a locking of the insert **14** with respect to the shank **4** prior to locking down of the closure top **18**. These features include a key-hole like through slot **144** disposed within each arm **135** running substantially vertically from the top surface **140** and through the base body **134**. Furthermore, each arm **135** includes at least one radially projected upper portion **146** with an outer partially cylindrical surface **147** for engaging with the receiver **10** as will be described more fully below. It is foreseen that inserts **14** according to the invention may have at least one and up to a plurality of such portions **146**. The illustrated slots **144** open along opposed side surfaces **150** of the arms, the side surfaces **150** each also defining a portion of one of the projected upper portions **146**. Each slot **144** terminates at a cylindrical through bore **152** that also runs from the top surface **140** through the base body **134** and out a base surface **153**, the bore **152** being spaced from inner and outer surfaces of each of the arms **135**. Each slot **144** separates each arm **135** into an inner arm portion **154** and an outer arm portion **155** that includes the respective projected upper portion **146**, the portions **155** being compressible towards the portions **154** during assembly of the insert **14** within the receiver **10** as will be described in greater detail below. Each arm **135** further includes inner planar walls **158** and inner sloping lower surfaces **159**. Each outer arm portion **155** further includes a generally vertically extending recess or partial aperture **160** sized and shaped to receive holding tabs **75**, or, in some embodiments of the invention, crimped material from the receiver.

(86) The pressure insert body **134** located between the arms **135** has an outer diameter slightly smaller than a diameter between crests of the guide and advancement structure **68** of the receiver **10** allowing for top loading of the compression insert **14** into the receiver opening **63**, with the arms **135** of the insert **14** being located between the receiver arms **60**A and **60**B during insertion of the insert **14** into the receiver **10**. Once located between the guide and advancement structure above and the shank upper portion **8** below, the insert **14** is rotated into place about the receiver axis until the arms **135** are directly below the guide and advancement structure **68** as will be described in greater detail below. At some point in the assembly, a tool (not shown) may be inserted into the receiver apertures to press the tabs **75** into the insert recesses **160**. It is noted that assembly of the shank **4** with the retainer **12** within the receiver **10**, followed by insertion of the lower compression insert **14** into the receiver **10** are assembly steps typically performed at the factory, advantageously providing a surgeon with a polyaxial bone screw with the lower insert **14** already held in alignment with the receiver **10** and providing a non-floppy, but pivotable shank ready for insertion into a vertebra. The compression or pressure insert **14** ultimately seats exclusively on the surface **44** of the shank upper portion **8**, with the base surface **153** sloping upwardly and away from the shank upper portion **8**, providing clearance between the retainer **12** and the insert **14** during pivoting of

the shank **4** with respect to the receiver **10**. The assembly may be configured so that the insert **14** extends at least partially into the receiver U-shaped channel **62**.

(87) With reference to FIGS. **1** and **35**-**38**, the illustrated elongate rod or longitudinal connecting member **21** can be any of a variety of implants utilized in reconstructive spinal surgery, but is typically a cylindrical, elongate structure having the outer substantially smooth, cylindrical surface **22** of uniform diameter. The rod **21** may be made from a variety of metals, metal alloys and deformable and less compressible plastics, including, but not limited to rods made of elastomeric, polyetheretherketone (PEEK) and other types of materials.

(88) Longitudinal connecting members for use with the assembly **1** may take a variety of shapes, including but not limited to rods or bars of oval, rectangular or other curved or polygonal cross-section. The shape of the insert **14** may be modified so as to closely hold, and if desired, fix or slidingly capture the longitudinal connecting member to the assembly **1**. Some embodiments of the assembly **1** may also be used with a tensioned cord. Such a cord may be made from a variety of materials including polyester or other plastic fibers, strands or threads, such as polyethylene-terephthalate. Furthermore, the longitudinal connector may be a component of a longer overall dynamic stabilization connecting member, with cylindrical or bar-shaped portions sized and shaped for being received by the compression insert **14** of the receiver having a U-shaped channel (or rectangular- or other-shaped channel) for closely receiving the longitudinal connecting member. The longitudinal connecting member may be integral or otherwise fixed to a bendable or damping component that is sized and shaped to be located between adjacent pairs of bone screw assemblies **1**, for example. A damping component or bumper may be attached to the longitudinal connecting member at one or both sides of the bone screw assembly **1**. A rod or bar (or rod or bar component) of a longitudinal connecting member may be made of a variety of materials ranging from deformable plastics to hard metals, depending upon the desired application. Thus, bars and rods of the invention may be made of materials including, but not limited to metal and metal alloys including but not limited to stainless steel, titanium, titanium alloys and cobalt chrome; or other suitable materials, including plastic polymers such as polyetheretherketone (PEEK), ultra-high-molecular weight-polyethylene (UHMWP), polyurethanes and composites, including composites containing carbon fiber, natural or synthetic elastomers such as polyisoprene (natural rubber), and synthetic polymers, copolymers, and thermoplastic elastomers, for example, polyurethane elastomers such as polycarbonate-urethane elastomers.

(89) With reference to FIGS. **1** and **36**-**38**, the closure structure or closure top **18** shown with the assembly **1** is rotatably received between the spaced arms **60**A and **60**B. It is noted that the closure **18** can be any of a variety of different types of closure structures for use in conjunction with the present invention with suitable mating structure on the upstanding arms **60**A and **60**B. It is also foreseen that the closure top could be a twist-in or slide-in closure structure. The illustrated closure structure **18** is substantially cylindrical and includes an outer helically wound guide and advancement structure **162** in the form of a flange form that operably joins with the guide and advancement structure **68** disposed on the arms **60**A and **60**B of the receiver **10**. The flange form utilized in accordance with the present invention may take a variety of forms, including those described in Applicant's U.S. Pat. No. 6,726,689, which is incorporated herein by reference. It is also foreseen that according to the invention the closure structure guide and advancement structure could alternatively be a buttress thread, a square thread, a reverse angle thread or other thread like or non-thread like helically wound advancement structure for operably guiding under rotation and advancing the closure structure **18** downward between the arms **60**A and **60**B and having such a nature as to resist splaying of the arms when the closure structure **18** is advanced into the U-shaped channel **62**. The illustrated closure structure **18** also includes a top surface **164** with an internal drive **166** in the form of an aperture that is illustrated as a star-shaped internal drive such as that sold under the trademark TORX, or may be, for example, a hex drive, or other internal drives such as slotted, tri-wing, spanner, two or more apertures of various shapes, and the like. A driving tool

(not shown) sized and shaped for engagement with the internal drive **166** is used for both rotatable engagement and, if needed, disengagement of the closure **18** from the receiver arms **60**A and **60**B. It is also foreseen that the closure structure **18** may alternatively include a break-off head designed to allow such a head to break from a base of the closure at a preselected torque, for example, 70 to 140 inch pounds. Such a closure structure would also include a base having an internal drive to be used for closure removal. A base or bottom surface **168** of the closure is planar and further includes a point **169** and a rim **170** for engagement and penetration into the surface **22** of the rod **21** in certain embodiments of the invention. The closure top **18** may further include a cannulation through bore (not shown) extending along a central axis thereof and through the top and bottom surfaces thereof. Such a through bore provides a passage through the closure **18** interior for a length of wire (not shown) inserted therein to provide a guide for insertion of the closure top into the receiver arms **60**A and B.

(90) Preferably, the shank **4**, receiver **10**, the retainer **12** and the compression insert **14** are assembled at a factory setting that includes tooling for holding and alignment of the component pieces and compressing arm portions of the insert **14**. Assembly of the shank **4**, the receiver **10**, the retainer **12** and the compression insert **14** is shown in FIGS. **25-34***b*. With particular reference to FIG. **25**, the ring-like retainer **12** is typically first inserted or top-loaded through the opening **63** with the top **112** and bottom **114** surfaces aligned with the receiver axis B within the receiver U-shaped channel **62** and then into the cavity **90** to dispose the structure **12** within the receiver base **58**. Then, the retainer structure **12** is rotated approximately 90 degrees so as to be coaxial with the receiver **10** and then seated in sliding engagement with the seating surface **96** of the receiver **10**. With reference to FIGS. **26-28**, the shank capture structure **8** is then inserted or bottom-loaded into the receiver **10** through the opening **98**. The retainer structure **12**, now disposed in the receiver **10** is coaxially aligned with the shank capture structure **8** so that the camming lugs **40** are received by the retainer **12** and moved between and through the camming shelves **118** until the bottom surface **114** of the retainer **12** engages the surface **36** of the shank upper portion **8**. The retainer **12** is then partially rotated about the axis A of the shank **4** until the retainer shelves **118** are received in the cam track formed by the shank surface **36** and the shank projection camming or sloped surface **41**. With reference to FIGS. **27** and **28**, as the retainer **12** is rotated, the shank projection bottom surface **41** frictionally engages the ramped surface **120** of the camming shelf **118**, creating a press fit between the surfaces and frictionally locking the retainer **12** between the lugs or projections **40** and the shank upper portion **8** seat **36**, the retainer **12** now in fixed coaxial relationship with the shank **4**. Preferably, the shank **4** and or the retainer **12** are partially rotated to fully mate such structures at a factory setting that includes tooling for holding and precisely rotating the shank **4** and/or the retainer **12** until locking frictional engagement therebetween is accomplished. Although not shown, it is noted that the retainer structure **12** may also have tooling features, such as a pair of small apertures so that the retainer **12** is also securely held during the rotation with respect to the shank **4**. Permanent, rigid engagement of the capture structure **8** to the retainer structure **12** may be further supported by the use of adhesive, a spot weld, a deformation, or the like. At this time both the shank **4** and the retainer **12** are in loose, rotatable and swivelable engagement with the receiver **10**, while the shank upper portion **8** and the lower aperture or neck **97** of the receiver **10** cooperate to maintain the shank body **6** in swivelable relation with the receiver **10**. Only the retainer **12** is in slidable engagement with the receiver spherical seating surface **96**. The shank upper end **44** and the shank body **6** are in spaced relation with the receiver **10**. The shank body **6** can be rotated through a substantial angular rotation relative to the receiver **10**, both from side to side and from front to rear so as to substantially provide a universal or ball joint.

(91) With reference to FIGS. **29-34***b*, the compression insert **14** is downloaded into the receiver **10** through the upper opening **63** with the insert bottom surface **153** facing the receiver arm top surfaces **69** and the insert arms **135** located between the receiver arms **60**A and **60**B. The insert **14** is lowered toward the channel seat **64** until the insert **14** is located below the surface run-out feature

76 of the guide and advancement structure **68** and the spherical surface **132** engages the domed surface **44** of the shank **4**. Thereafter, the insert **14** is rotated in a clockwise manner as indicated by the arrow CL in FIG. **30** until the stop structures **104** of the insert **14** abut against the wall **102** of the recess stop **100** located on the receiver arms **60**A and **60**B (see FIG. **31**). During such rotation, the upper projections **146** also engage the receiver cylindrical surface **77**, compressing the outer arm portions **155** toward the inner arm portions **154** to provide a slidable friction fit between the insert **14** and the receiver **10** at the surface **77**. At this time, the insert **14** engages the shank upper portion **8** at the surface **44** in a manner that allows for pivoting of the shank with respect to the receiver **10** with effort, thus a frictional fit that advantageously allows for setting a desired angle of the shank **4** with respect to the receiver **10**, that nay be adjusted, but is not otherwise floppy or loosely movable. The surface **76** of the receiver prohibits the insert **14** from moving upwardly away from the shank surface **44**. With further reference to FIG. **31**, at this time, the spring tabs **75** may be pressed inwardly into the insert recesses **160**, preventing counter-clockwise movement of the insert **14** with respect to the receiver **10**. FIG. **34***a* best illustrates the position of the insert **14** with respect to the receiver **10** prior to implanting of the shank body **6** into the vertebra **13**.

(92) With reference to FIG. **32**, the assembly **1** made up of the assembled shank **4**, receiver **10**, retainer **12** and compression insert **14** is screwed into a bone, such as the vertebra **13**, by rotation of the shank **4** using a suitable driving tool (not shown) that operably arrives and rotates the shank body **6** by engagement thereof at the internal drive **50**. Specifically, the vertebra **13** may be pre-drilled to minimize stressing the bone and have a guide wire (not shown) inserted therein to provide a guide for the placement and angle of the shank **4** with respect to the vertebra. A further tap hole may be made using a tap with the guide wire as a guide. Then, the bone screw assembly is threaded onto the guide wire utilizing the cannulation bore **51** by first threading the wire into the opening at the bottom **28** and then out of the top opening at the drive feature **50**. The shank **4** is then driven into the vertebra using the wire as a placement guide. It is foreseen that the shank and other bone screw assembly parts, the rod **21** (also having a central lumen in some embodiments) and the closure top **18** (also with a central bore) can be inserted in a percutaneous or minimally invasive surgical manner, utilizing guide wires. At this time, the receiver **10** may be articulated to a desired position with respect to the shank **4** as shown, for example, in FIG. **33**.

(93) With reference to FIGS. **34***a*, **34***b* and also FIG. **35**, at this time, the insert **14** may be placed into a fixed or locked position with respect to the receiver **10** by pressing the insert **14** axially downwardly against the shank top surface **44**. This may be done by pressing the rod **35** into the insert **14** as shown in FIG. **35** or by tooling (not shown) that lowers the insert **14** to a location out of engagement with the cylindrical surface **77** as shown in FIG. **34***b*. At such time, the outer arm portion **155** resiliently moves or springs back toward a neutral position, and such action puts the outer arm portion **155** into a full, frictional engagement with the lower receiver surface **86**, locking the insert **14** against the shank upper portion **8**, the shank **4** no longer movable with respect to the receiver **10**. At this time the surgeon may make other adjustments in the rod **21** or other longitudinal connection assembly components with confidence that the shank **4** and the receiver **10** of the assembly **1** is fully locked into a desired angular position. If, however, an adjustment is desired, tools (not shown) may be inserted into the receiver aperture **74** and the insert outer arm portion **155** may be compressed inwardly radially toward the axis B, loosening the insert **14** from the receiver cylindrical surface **86**, and thus loosening engagement between the insert surface **132** and the shank upper portion surface **44**.

(94) With reference to FIGS. **36-38**, the rod **21** is eventually positioned in an open or percutaneous manner in cooperation with the at least two bone screw assemblies **1**. The closure structure **18** is then inserted into and advanced between the arms **60**A and **60**B of each of the receivers **10**. The closure structure **18** is rotated, using a tool engaged with the inner drive **166** until a selected pressure is reached at which point the rod **21** engages the insert **14**, biasing the insert spherical surface **132** against the shank spherical surface **44**.

(95) As the closure structure **18** rotates and moves downwardly into the respective receiver **10**, the point **169** and rim **170** engage and penetrate the rod surface **22**, the closure structure **18** pressing downwardly against and biasing the rod **21** into engagement with the insert **14** that urges the shank upper portion **8** toward the retainer **12** and into locking engagement therewith, the retainer **12** frictionally abutting the surface **96**. For example, about 80 to about 120 inch pounds of torque on the closure top may be applied for fixing the bone screw shank **6** with respect to the receiver **10**.
(96) If removal of the rod **21** from any of the bone screw assemblies **1** is necessary, or if it is desired to release the rod **21** at a particular location, disassembly is accomplished by using the driving tool (not shown) that mates with the internal drive **166** on the closure structure **18** to rotate and remove such closure structure from the cooperating receiver **10**. Disassembly is then accomplished in reverse order to the procedure described previously herein for assembly.
(97) With reference to FIGS. **39-41**, the assembly **1** is illustrated with an alternative rod **21′** and an alternative closure top **18′**, thus the resulting assembly is identified as an assembly V. The rod **21′** is substantially similar to the rod **21** in size and shape. However, the rod **21′** is made from a deformable material, illustrated as a plastic material. The closure top **18′** is substantially similar to the top **18** with the exception that the top **18′** includes an outer annular flat bottom surface **168′** adjacent to an otherwise curved bottom that further includes a central rounded point or projection **169′** located on a spherical or domed shape surface **170′**. As best shown in FIG. **41**, when assembled, the closure top surface **168′** engages the insert arm top surfaces **140**, pressing the insert **14** in a downward direction toward the shank upper portion **8**, providing locking of the insert **14** against the shank top surface **44** independent of any engagement between the closure top **18′** and the rod **21′**. The closure top surfaces **169′** and **170′** engage and penetrate the deformable rod **21′**.
(98) With reference to FIGS. **42-46**, the assembly **1** of the invention is shown with alternative closure tops **18″** and **18‴** as well as with a cord/cord coupler combination **180** and a cord **184**. With particular reference to FIGS. **42-44**, he assembly **1″** is identical to the assembly **1** previously described herein with the exception of the rod **21** is replaced by the cord/cord coupler combination **180** and the closure **18** is replaced by the closure **18″**. The cord/cord coupler combination **180** further includes a cord **184** with a lip **185** that is fixed within a coupler **187** that further includes inner threads **189** for attaching to a hard rod **190**. The illustrated assembly further includes spacers **192** and **193** that may be compressible or not. In operation, the cord **184** is placed in tension. The closure top **18″** includes a planar bottom surface **168″** sized and shaped to abut against the insert **14** top surface **140** as illustrated in FIG. **41** with respect to the assembly **1′**, providing independent locking of the shank **4** with respect to the receiver **10**. Alternatively, sufficient locking of the bone screw **1″** may be provided by the insert **14** outer arm portions pressing against the cylindrical surface **86** of the receiver **10** as illustrated in FIG. **34***b* with respect to the assembly **1**. The bottom surface **168″** of the closure **18″** allows for the cord **180** to slide with respect to the receiver **10**, the cord being fixed to the rod **190** at the coupler **187**. In such an arrangement, the cord **180** is also fixed to another bone screw **1** (not shown) or fixed to a fixing or blocking structure (not shown) engaging the cord **184** at a location opposite the spacer **193** or other cooperating bone screws.
(99) With reference to FIGS. **45** and **46**, the assembly **1‴** is identical to the assembly **1** with the exception that the rod **21** is replaced by the cord **184** and the closure **18** is replaced by the closure **18‴**. The closure **18‴** includes a planar bottom rim **168‴** as well as an extension or protrusion **169′** ″ that engages and penetrates the cord **184**, holding the cord **184** in fixed engagement with the bone screw assembly **1′**. Also illustrated is a spacer **194** that may be compressible or not. The cord **184** is preferably in tension. For example, the assembly **1″** may be used in combination with the assembly **1″** shown in FIGS. **42-44** with the spacer **193** located between the bone screw assemblies **1″** and **1′** ″, the cord **180** replacing the cord **184**. Thus, the cord **180** would be held in tension between the coupler **187** and the bone screw closure **169′″**.
(100) With reference to FIGS. **47-63**, an alternative embodiment of a bone anchor assembly according to the invention, generally **201** is illustrated. The assembly **201** includes a shank **204**

having a shank body **206** and an upper portion **208**, a receiver **210**, a cam retainer **212** and a compression or pressure insert **214**. The assembly **201** is substantially similar to the assembly **1** with the exception of certain features of the receiver **210** and the insert **214** as will be described in detail below. Unlike the receiver **14**, the receiver **214** includes a top surface, rather than an outer or side surface that frictionally engages the receiver **210** to place the insert **214** into frictional engagement with the shank upper portion **208** prior to placement of a rod **21** or other longitudinal connecting member into the receiver **210**. Somewhat similar to the insert **14**, the insert **214** includes an outer surface that engages a cylindrical surface of the receiver **210** to place the insert **214** into locking engagement with the shank upper portion **208** prior to ultimate locking with a closure top (not shown) that may be the closure top **18**, **18′**, **18″** or **18‴** previously described herein with respect to the assemblies **1**, **1′**, **1″** and **1‴**, the closure top chosen based upon the type of rod, cord or other longitudinal connecting member being placed within the receiver **210**. Similar to the insert **14**, the insert **214** may be compressed or squeezed to release locking engagement with the receiver **210** and the shank upper portion **208**. The insert **214** advantageously provides such a release-able locking engagement without the key hole slot feature of the insert **14** as will be described in greater detail below.

(101) With particular reference to FIGS. **47**, **62** and **63**, the shank **204** is identical or substantially similar to the shank **4** of the assembly **1** and therefore, among other things, includes a spherical surface **234**, a retainer seat **236**, three cam lugs or projections **240**, a domed top **244**, and an internal drive feature **250**, the same or similar to the respective spherical surface **34**, retainer seat **36**, cam lugs **40**, domed top **44** and internal drive **50** previously discussed herein with respect to the shank **4**. Similarly, the retainer **212** includes, among other things, a top **312**, bottom **314**, cam shelves **318** and outer spherical surface **329** that are the same or substantially similar to the respective top **112**, bottom **114**, cam shelves **118** and outer spherical surface **129** of the retainer **12** previously described herein with respect to the assembly **1**. The shank **204** and the retainer **212** are assembled within the receiver **210** in a manner the same or substantially similar to that described previously herein with respect to the shank **4**, retainer **12** and receiver **10** of the assembly **1**.

(102) Although substantially similar to the receiver **10**, the receiver **210** includes some features that are different than the receiver **10** and thus shall be described more fully herein. The receiver **210** includes a base **258**, arms **260**A and **260**B, a U-shaped channel **262**, a channel upper opening **263**, channel lower seat **264**, a guide and advancement structure **268**, and arm top surfaces **269**, that are the same or substantially similar to the respective base **58**, arms **60**A and U-shaped channel **62**, channel upper opening **63**, channel lower seat **64**, guide and advancement structure **68**, and arm top surfaces **69** previously described herein with respect to the receiver **10**. The receiver **210** further includes a T-shaped tool engagement feature **271** somewhat similar to the feature **71** of the receiver **10**. However, The feature **271** further includes a thin crimp wall **275** that provides alignment for the insert **214** similar to the tabs **75** of the receiver **10**. The crimp wall **275** is simply pressed inwardly radially toward the insert **214** to prohibit counterclockwise rotation of the insert **214** with respect to the receiver **210**. Similar to the receiver the receiver **210** includes a bottom abutment surface **276** of the guide and advancement run-out located on the arm **260**A, the surface **276** frictionally engaging a top surface of the insert **214** as will be described more fully below. Located beneath the surface **276** is a discontinuous cylindrical surface **278** that communicates with another discontinuous cylindrical surface **280** having a diameter smaller than a diameter of the surface **278**, the surface **280** cooperating with the insert **214** to lock the insert against the shank upper portion **208** as will be described more fully below. A receive cavity, generally **290** includes an upper cylindrical or slightly conical surface **294** and a spherical seating surface **296** for sliding and ultimate frictional mating with the retainer spherical surface **329**. The receiver **210** further includes a lower neck **297** forming an opening **298** at a bottom surface **292** of the receiver **210**. Formed in the arm cylindrical surface **280** is a pocket or stop **300** for receiving a projection **304** of the insert **214** to prohibit clockwise movement of the insert **214** with respect to the receiver **210** and thus provide alignment between

the insert **214** and the receiver **210** similar to what was previously described herein with respect to the insert **14** and the receiver **10**.
(103) The insert **214** includes a bore, **330**, an inner cylindrical surface **331**, an inner spherical surface **332**, a substantially cylindrical body **334**, upstanding arms **335**, a u-shaped channel **336**, a channel seat **338** and arm top surfaces **340** substantially similar to the respective bore, **130**, inner cylindrical surface **131**, inner spherical surface **132**, substantially cylindrical body **134**, upstanding arms **135**, u-shaped channel **136**, channel seat **138** and arm top surfaces **140** previously described herein with respect to the insert **14**. However, the insert **214** does not include the key-hole slot feature of the insert **214**. Instead, at least one or both of the top surfaces **240** includes an upwardly sloping surface feature **342** spaced from a notch **343** formed in the insert arm **335**. Thus, the notch **343** may be pressed downwardly toward the body **334**. FIG. **55** illustrates an embodiment wherein both surfaces **240** include the surface feature **342**, the second feature shown in phantom as **342′**. As best illustrated in FIG. **62**, the surface **342** engages the receiver surface **276** to hold the insert **214** against the shank upper surface **244** after assembly therewith, so that a friction-fit, non-floppy engagement between the insert **214** and the shank top **208** allows for placement of the angle of the shank **204** with respect to the receiver **210** during surgery and prior to the rod or other connecting member being placed in the receiver **210**. Furthermore, the arms **335** include upper portions **345** that flare outwardly and are sized and shaped to cooperate with the surface **280** of the receiver **210** (see FIG. **64**) for tight frictional, locking fit between the insert **214** and the shank upper portion **208** when the insert **214** is pushed downwardly toward the receiver base, either by a rod or by a tool. Such locking may be released by a inserting a tool (not shown) in the tool engagement feature **371** and pressing the insert **214** radially inwardly.
(104) The insert **214** is loaded into the receiver **210** in a manner similar to that described above with respect to the insert **14** and the receiver **10** of the assembly **1**. The assembly **201** is thereafter fitted with a rod **21** or other longitudinal connecting member and a closure top **18** or cooperating top as described above with respect to the assembly **1**.
(105) With reference to FIGS. **65**-**67**, the assembly **201** is shown with the deformable rod **21′** and the closure top **18′** previously described herein. Thus, the resulting assembly is identified as **210′**. As illustrated, the closure **18′** presses and locks down upon the insert **214** at the surface **340**, independently locking the assembly **201** when the assembly is used to capture the deformable rod **21′**. Further independent locking is provided by the insert **214** pressing against the receiver surface **280**.
(106) It is to be understood that while certain forms of the present invention have been illustrated and described herein, it is not to be limited to the specific forms or arrangement of parts described and shown.

Claims

1. A pivotal bone anchor assembly for securing a longitudinal connecting member to a bone of a patient via a closure, the bone anchor assembly comprising: a receiver having a lower opening and a shank holding lower portion with a bottom surface, and an upper portion with a channel configured to receive the longitudinal connecting member and including a helically wound guide and advancement structure, the lower opening communicating with a receiver central bore centered on a receiver longitudinal axis, and the receiver central bore including an integral downwardly-facing engagement surface below the helically wound guide and advancement structure; a shank having a head portion with an upper engagement surface and an anchor portion opposite the head portion configured for attachment to the bone, the head portion configured for being positionable within the shank holding lower portion of the receiver with the shank extending downwardly below the bottom surface; and a compression insert positionable with the receiver having a central opening centered on an insert longitudinal axis, a lower portion with a downwardly-facing surface,

and an upper portion including at least one notch at least partially formed in an outer surface of the upper portion of the compression insert and extending at least in part in a transverse direction relative to the insert longitudinal axis, and defining at least one resiliently deflectable upwardly-facing surface integral with the upper portion of the compression insert and extending over the at least one notch, the at least one resiliently deflectable upwardly-facing surface being deflectable in an axial direction relative to the insert longitudinal axis and engageable with the downwardly-facing engagement surface in the receiver central bore when the head portion of the shank and the compression insert are positioned in the receiver central bore, so as to provide an axially directed force for a pre-lock friction fit in the assembly prior to securing the longitudinal connecting member in the channel with the closure.

2. The pivotal bone anchor assembly of claim 1, wherein the compression insert further comprises upwardly-facing concave surfaces configured to engage the longitudinal connecting member.

3. The pivotal bone anchor assembly of claim 1, wherein the downwardly-facing surface of the lower portion of the compression insert directly engages the upper engagement surface of the head portion of the shank.

4. The pivotal bone anchor assembly of claim 1, wherein the compression insert is twisted into position within the receiver central bore with the at least one resilient deflectable upwardly-facing surface coming into contact with the downwardly-facing engagement surface in the receiver central bore.

5. The pivotal bone anchor assembly of claim 1, further comprising a separate retainer including an annular shape with an upper surface, a lower surface, and an interior cavity between the upper surface and the lower surface, the retainer being configured for capturing a portion of the head portion of the shank within the shank holding lower portion of the receiver.

6. The pivotal bone anchor assembly of claim 5, wherein the retainer is positionable within in the shank holding lower portion of the receiver so as to provide for pivotal motion between the receiver and the shank.

7. The pivotal bone anchor assembly of claim 1, wherein the shank holding lower portion and the upper portion of the receiver are integrally formed together.

8. A pivotal bone anchor assembly for securing a longitudinal connecting member to a bone of a patient via a fastener, the pivotal bone anchor assembly comprising: a receiver having a lower opening, a bottom surface, a receiver central bore centered about a vertical centerline axis and in communication with the bottom surface of the receiver through the lower opening, and an upper portion defining a channel configured to receive the longitudinal connecting member and including a mating structure engageable with the fastener, the channel communicating with the receiver central bore, and the receiver central bore including at least one non-threaded downwardly-facing surface below the mating structure and a lower at least partially spherical seating surface adjacent the lower opening; a shank having a head portion with a lower spherical engagement surface and an upper spherical engagement surface and an anchor portion opposite the head portion configured for attachment to the bone, the head portion configured for being positionable within a lower portion of the receiver central bore with the shank extending downwardly below the bottom surface and the lower spherical engagement surface pivotally engageable with the lower at least partially spherical seating surface; and a compression insert having a central opening centered on an insert longitudinal axis, an upwardly-facing surface configured to receive the longitudinal connecting member, at least one notch at least partially formed in an outer surface of the compression insert and extending at least in part in a traverse direction relative to the insert longitudinal axis, and an engagement surface extending above the notch, the engagement surface being resiliently downwardly deflectable in an axial direction relative to the insert longitudinal axis; wherein the compression insert is configured for axially biased overlapping engagement between the downwardly-facing surface of the receiver central bore and the engagement surface extending above the notch of the compression insert, so as to apply a downward frictional force on the head

portion of the shank prior to locking the assembly with the fastener.
9. The pivotal bone anchor assembly of claim 8, wherein the compression insert further comprises inwardly positioned concave surfaces configured to engage the longitudinal connecting member.
10. The pivotal bone anchor assembly of claim 8, wherein at least one of the downwardly-facing surface of the receiver central bore or the engagement surface of the compression insert includes a sloped portion operable to provide a cam action that urges a lower surface of the compression insert against the upper spherical engagement surface of the head portion of the shank.
11. The pivotal bone anchor assembly of claim 8, wherein the downwardly-facing surface of the receiver central bore is downwardly inclined.
12. The pivotal bone anchor assembly of claim 8, wherein the downwardly-facing surface of the receiver central bore is perpendicular to the vertical centerline axis of the receiver.
13. The pivotal bone anchor assembly of claim 8, further comprising a retainer including an annular shape with an upper surface, a lower surface, and an interior cavity between the upper surface and the lower surface, the interior cavity being configured for capturing a portion of the head portion of the shank within a lower portion of the receiver.
14. The pivotal bone anchor assembly of claim 13, wherein the retainer is positionable within the lower portion of the receiver and configured to engage the lower spherical engagement surface on the head portion to provide for pivotal motion between the receiver and the shank.
15. The pivotal bone anchor assembly of claim 8, wherein the mating structure is a helically wound guide and advancement structure.
16. The pivotal bone anchor assembly of claim 8, wherein the shank includes a central axial bore extending an entire length thereof along a shank longitudinal axis, the central axial bore of the shank having a width that is less than a most narrow width of a central non-slip tool engaging aperture formed into the head portion thereof.
17. The pivotal one anchor assembly of claim 8, wherein the upper portion of the receiver includes opposite outwardly facing recessed planar surfaces that are parallel with respect to each other and with the receiver longitudinal axis.
18. A method of using a bone anchor assembly configured to secure a longitudinal connecting member to a bone of a patient, the method comprising: providing: a receiver having an upper portion with a channel configured to receive the longitudinal connecting member, a shank holding lower portion including a lower opening, and a receiver central bore communicating with the lower opening and being centered on a receiver longitudinal axis and including a downwardly-facing engagement surface, a shank having a head portion and an anchor portion opposite the head portion configured for attachment to the bone, and a compression insert having a central opening centered on an insert longitudinal axis, a lower portion with a downwardly-facing surface, and an upper portion including at least one notch at least partially formed in an outer surface of the upper portion of the compression insert and extending at least in part transversely relative to the insert longitudinal axis, and defining at least one resiliently deflectable upwardly-facing surface integral with the upper portion of the compression insert and extending over the at least one notch, the at least one resiliently deflectable upwardly-facing surface being deflectable in an axial direction relative to the insert longitudinal axis; positioning the compression insert in the receiver central bore, and loading the head portion of the shank into the shank holding lower portion of the receiver; and engaging the at least one resiliently deflectable upwardly-facing surface of the compression insert with the downwardly-facing engagement surface of the receiver central bore to provide an axially directed force for a pre-lock friction fit prior to securing the longitudinal connecting member in the channel.
19. The method of claim 18, further comprising capturing the head portion of the shank in the shank holding lower portion within the receiver central bore with a retainer including an upper surface, a lower surface, and an interior cavity, the retainer configured to capture a portion of the head portion of the shank in the shank holding lower portion of the receiver.

20. The method of claim 19, further comprising engaging an outer spherical surface of the retainer with a spherical seating surface in the shank holding lower portion of the receiver to provide for pivotal movement of the receiver with respect to the shank.