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(54) **INTERVERTEBRAL IMPLANTS AND RELATED TOOLS**

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(56) **References Cited**

U.S. PATENT DOCUMENTS

5,123,926 A 6/1992 Pisharodi
5,375,823 A 12/1994 Navas
(Continued)

FOREIGN PATENT DOCUMENTS

EP 425542 B1 3/1995
EP 793463 A1 9/1997
(Continued)

OTHER PUBLICATIONS

International Search Report for International Application No. PCT/US2011/028731 (a PCT counterpart of the present application) dated May 18, 2011.
(Continued)

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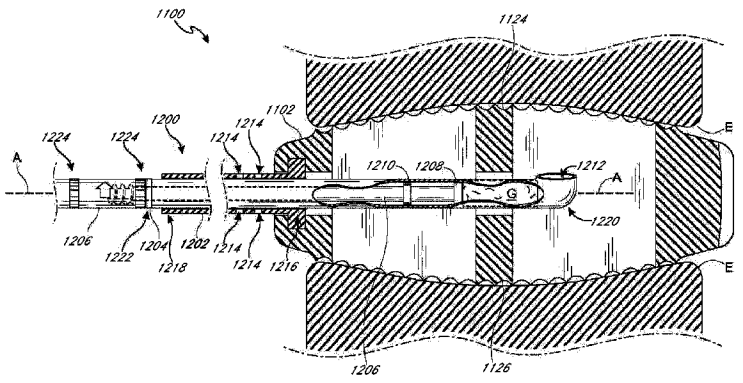
(57) **ABSTRACT**

According to some embodiments, a method for promoting spinal fusion using a spinal implant comprises providing a spinal implant, wherein the spinal implant comprises an anterior wall, a posterior wall and two lateral walls configured to extend between the anterior wall and the posterior wall. In some embodiments, the spinal implant further comprises at least one internal chamber generally positioned between the anterior wall, the posterior wall and the two lateral walls, wherein the internal chamber being is adapted to receive at least one graft and/or other fill material. In some embodiments, at least a portion of the graft and/or other fill material delivered into the internal chamber is configured to exit through the one or more of the openings of the anterior wall.

20 Claims, 27 Drawing Sheets



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(56) **References Cited**

U.S. PATENT DOCUMENTS

5,489,307	A		2/1996	Kuslich et al.
5,593,409	A		1/1997	Michelson
5,609,635	A		3/1997	Michelson
5,653,763	A		8/1997	Errico et al.
5,665,122	A		9/1997	Kambin
5,669,909	A		9/1997	Zdeblick et al.
5,683,394	A		11/1997	Rinner
5,702,455	A		12/1997	Saggar
5,716,415	A		2/1998	Steffee
5,749,916	A		5/1998	Richelsoph
5,766,253	A		6/1998	Brosnahan, III
5,772,661	A		6/1998	Michelson
5,776,199	A		7/1998	Michelson
5,782,919	A		7/1998	Zdeblick et al.
5,860,973	A	*	1/1999	Michelson 606/247
5,865,845	A		2/1999	Thalgott
5,865,848	A		2/1999	Baker
5,885,287	A		3/1999	Bagby
5,888,223	A		3/1999	Bray, Jr.
5,888,224	A		3/1999	Beckers et al.
5,888,227	A		3/1999	Cottle
5,895,427	A		4/1999	Kuslich et al.
5,906,616	A		5/1999	Pavlov et al.
5,910,315	A		6/1999	Stevenson et al.
5,928,284	A		7/1999	Mehdizadeh
5,947,971	A		9/1999	Kuslich et al.
5,968,098	A		10/1999	Winslow
5,976,187	A		11/1999	Richelsoph
5,984,967	A		11/1999	Zdeblick et al.
5,989,291	A		11/1999	Ralph et al.
6,010,502	A		1/2000	Bagby
6,019,792	A		2/2000	Cauthen
6,033,438	A		3/2000	Bianchi et al.
6,045,579	A		4/2000	Hochshuler et al.
6,056,749	A		5/2000	Kuslich
6,059,790	A		5/2000	Sand et al.
6,074,423	A		6/2000	Lawson
6,080,193	A		6/2000	Hochshuler et al.
6,090,143	A		7/2000	Meriwether et al.
6,096,080	A		8/2000	Nicholson et al.
6,102,950	A		8/2000	Vaccaro
6,106,557	A		8/2000	Robioneck et al.
6,113,638	A		9/2000	Williams et al.
6,117,174	A		9/2000	Nolan
6,123,705	A		9/2000	Michelson
6,126,689	A		10/2000	Brett
6,129,763	A		10/2000	Chauvin et al.
6,143,031	A		11/2000	Knothe et al.
6,146,420	A		11/2000	McKay
RE37,005	E		12/2000	Michelson et al.
6,159,244	A		12/2000	Suddaby
6,159,245	A		12/2000	Meriwether et al.
6,174,334	B1		1/2001	Suddaby
6,176,882	B1		1/2001	Biedermann et al.
6,190,414	B1		2/2001	Young et al.
6,193,756	B1		2/2001	Studer et al.
6,206,922	B1		3/2001	Zdeblick et al.
6,224,631	B1		5/2001	Kohrs
6,235,028	B1		5/2001	Brumfield et al.
6,241,733	B1		6/2001	Nicholson et al.
6,241,769	B1		6/2001	Nicholson et al.
6,241,770	B1		6/2001	Michelson
6,245,072	B1		6/2001	Zdeblick et al.
6,245,108	B1		6/2001	Biscup
6,258,094	B1		7/2001	Nicholson et al.
6,258,125	B1		7/2001	Paul et al.
6,283,968	B1		9/2001	Mehdizadeh
6,296,664	B1		10/2001	Middleton
6,306,170	B2		10/2001	Ray
6,332,894	B1		12/2001	Stalcup et al.
6,332,895	B1		12/2001	Suddaby
6,368,351	B1		4/2002	Glenn et al.
6,371,986	B1		4/2002	Bagby
6,371,987	B1		4/2002	Weiland et al.
6,371,988	B1		4/2002	Pafford et al.
6,371,989	B1		4/2002	Chauvin
6,375,655	B1		4/2002	Zdeblick et al.
6,395,035	B2		5/2002	Bresina et al.
6,409,766	B1		6/2002	Brett
6,419,705	B1		7/2002	Erickson
6,423,063	B1		7/2002	Bonutti
6,425,920	B1		7/2002	Hamada
6,428,542	B1		8/2002	Michelson
6,428,575	B2		8/2002	Koo et al.
6,432,106	B1		8/2002	Fraser
6,432,107	B1		8/2002	Ferree
6,436,139	B1		8/2002	Shapiro et al.
6,436,140	B1		8/2002	Liu et al.
6,440,170	B1		8/2002	Jackson
6,443,989	B1		9/2002	Jackson
6,447,544	B1		9/2002	Michelson
6,447,547	B1		9/2002	Michelson
6,454,805	B1		9/2002	Baccelli et al.
6,454,806	B1		9/2002	Cohen et al.
6,454,807	B1		9/2002	Jackson
6,458,159	B1		10/2002	Thalgott
6,461,359	B1		10/2002	Tribus
6,471,724	B2		10/2002	Zdeblick et al.
6,478,823	B1		11/2002	Michelson
6,482,233	B1		11/2002	Aebi et al.
6,488,710	B2		12/2002	Besselink
6,491,724	B1		12/2002	Ferree
6,500,205	B1		12/2002	Michelson
6,517,580	B1		2/2003	Ramadan et al.
6,527,803	B1		3/2003	Crozet et al.
6,530,926	B1		3/2003	Davison
6,530,929	B1		3/2003	Justis et al.
6,558,424	B2		5/2003	Thalgott
6,562,041	B1		5/2003	Yonemura et al.
6,562,074	B2		5/2003	Gerbec et al.
6,576,016	B1		6/2003	Hochshuler et al.
6,582,431	B1		6/2003	Ray
6,582,437	B2		6/2003	Dorchak et al.
6,582,467	B1		6/2003	Teitelbaum et al.
6,592,586	B1		7/2003	Michelson
6,599,292	B1		7/2003	Ray
6,610,089	B1		8/2003	Liu et al.
6,613,091	B1		9/2003	Zdeblick et al.
6,616,695	B1		9/2003	Crozet et al.
6,641,614	B1		11/2003	Wagner et al.
6,645,206	B1		11/2003	Zdeblick et al.
6,648,915	B2		11/2003	Sazy
6,652,584	B2		11/2003	Michelson
6,660,038	B2		12/2003	Boyer, II et al.
6,666,888	B1		12/2003	Jackson
6,676,703	B2		1/2004	Biscup
6,685,742	B1		2/2004	Jackson
6,699,288	B2		3/2004	Moret
6,709,458	B2		3/2004	Michelson
6,716,247	B2		4/2004	Michelson
6,719,760	B2		4/2004	Dorchak et al.
6,719,794	B2	*	4/2004	Gerber et al. 623/17.11
6,719,796	B2		4/2004	Cohen et al.
6,723,096	B1		4/2004	Dorchak et al.
6,723,126	B1		4/2004	Berry
6,726,722	B2		4/2004	Walkenhorst et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,730,127 B2 5/2004 Michelson
6,740,093 B2 5/2004 Hochschuler et al.
6,743,255 B2 6/2004 Ferree
6,746,484 B1 6/2004 Liu et al.
6,767,366 B2 7/2004 Lee et al.
6,767,367 B1 7/2004 Michelson
6,770,096 B2 8/2004 Bolger et al.
6,773,460 B2 8/2004 Jackson
6,783,545 B2 8/2004 Castro et al.
6,793,679 B2 9/2004 Michelson
RE38,614 E 10/2004 Paul et al.
6,800,092 B1 10/2004 Williams et al.
6,800,093 B2 10/2004 Nicholson et al.
6,808,537 B2 10/2004 Michelson
6,814,756 B1 11/2004 Michelson
6,821,298 B1 11/2004 Jackson
6,824,564 B2 11/2004 Crozet
6,830,589 B2 12/2004 Erickson
6,835,206 B2 12/2004 Jackson
6,852,129 B2 2/2005 Gerbec et al.
6,855,166 B2 2/2005 Kohrs
6,855,168 B2 2/2005 Crozet
6,855,169 B2 2/2005 Boyer, II et al.
6,863,673 B2 3/2005 Gerbec et al.
6,890,355 B2 5/2005 Michelson
6,893,464 B2 5/2005 Kiester
6,893,465 B2 5/2005 Huang
6,899,716 B2 5/2005 Cragg
6,899,734 B2 5/2005 Castro
6,902,581 B2 6/2005 Walkenhorst et al.
6,916,320 B2 7/2005 Michelson
6,923,830 B2 8/2005 Michelson
6,926,737 B2 8/2005 Jackson
6,936,050 B2 8/2005 Michelson
6,936,051 B2 8/2005 Michelson
6,942,697 B2 9/2005 Lange et al.
6,942,698 B1 9/2005 Jackson
6,945,933 B2 9/2005 Branch et al.
6,953,477 B2 10/2005 Berry
6,955,691 B2 10/2005 Chae et al.
6,962,606 B2 11/2005 Michelson
6,969,390 B2 11/2005 Michelson
6,972,035 B2 12/2005 Michelson
6,974,480 B2 12/2005 Messerli et al.
7,008,422 B2 3/2006 Foley et al.
7,008,453 B1 3/2006 Michelson
7,014,659 B2 3/2006 Boyer, II et al.
7,018,414 B2 3/2006 Brau et al.
7,018,415 B1 3/2006 McKay
7,018,416 B2 3/2006 Hanson et al.
7,022,138 B2 4/2006 Mashburn
7,029,498 B2 4/2006 Boehm et al.
7,044,971 B2 5/2006 Suddaby
7,044,972 B2 5/2006 Mathys, Jr. et al.
7,056,321 B2 6/2006 Pagliuca et al.
7,060,073 B2 6/2006 Frey et al.
7,060,097 B2 6/2006 Fraser et al.
7,070,621 B2 7/2006 Castro et al.
7,087,058 B2 8/2006 Cragg
7,094,257 B2 8/2006 Mujwid et al.
7,105,023 B2 9/2006 Eckman
7,105,025 B2 9/2006 Castro et al.
7,112,206 B2 9/2006 Michelson
7,112,222 B2 9/2006 Fraser et al.
7,112,224 B2 9/2006 Liu et al.
7,118,598 B2 10/2006 Michelson
7,125,424 B2 10/2006 Banick et al.
7,128,760 B2 10/2006 Michelson
7,128,762 B2 10/2006 Middleton
7,137,997 B2 11/2006 Paul
7,156,874 B2 1/2007 Paponneau et al.
7,156,875 B2 1/2007 Michelson
7,166,129 B2 1/2007 Michelson
7,179,293 B2 2/2007 McKay
7,182,782 B2 2/2007 Kirschman
7,192,446 B2 3/2007 Shapiro et al.
7,192,447 B2 3/2007 Rhoda
7,195,643 B2 3/2007 Jackson
7,201,775 B2 4/2007 Gorensek et al.
7,207,949 B2 4/2007 Miles et al.
7,214,243 B2 5/2007 Taylor
7,217,293 B2 5/2007 Branch, Jr.
7,220,282 B2 5/2007 Kuslich
7,223,292 B2 5/2007 Messerli et al.
7,226,480 B2 6/2007 Thalgott
7,226,483 B2 6/2007 Gerber et al.
7,229,477 B2 6/2007 Biscup
7,232,463 B2 6/2007 Falahee
7,235,105 B2 6/2007 Jackson
7,238,186 B2 7/2007 Zdeblick et al.
7,238,203 B2 7/2007 Bagga et al.
7,238,206 B2 7/2007 Lange et al.
7,285,134 B2 10/2007 Berry et al.
7,285,135 B2 10/2007 McKay et al.
7,303,583 B1 12/2007 Schär et al.
7,303,584 B2 12/2007 Castro et al.
7,316,686 B2 1/2008 Dorchak et al.
7,316,714 B2 1/2008 Gordon et al.
7,326,248 B2 2/2008 Michelson
D564,095 S 3/2008 Blain
7,361,193 B2 4/2008 Frey et al.
7,384,431 B2 6/2008 Berry
7,396,365 B2 7/2008 Michelson
7,402,176 B2 7/2008 Malek
7,410,501 B2 8/2008 Michelson
7,431,735 B2 10/2008 Liu et al.
7,435,261 B1 10/2008 Castro
7,445,636 B2 11/2008 Michelson
7,455,672 B2 11/2008 Michelson
7,455,692 B2 11/2008 Michelson
7,462,196 B2 12/2008 Fraser
7,465,305 B2 12/2008 Liu et al.
7,470,236 B1 12/2008 Kelleher et al.
7,470,273 B2 12/2008 Dougherty-Shah
7,473,276 B2 1/2009 Aebi et al.
7,473,277 B2 1/2009 Boyer, II et al.
7,476,251 B2 1/2009 Zucherman et al.
7,481,766 B2 1/2009 Lee et al.
7,485,120 B2 2/2009 Ray
7,500,991 B2 3/2009 Bartish, Jr. et al.
7,503,933 B2 3/2009 Michelson
7,509,183 B2 3/2009 Lin et al.
7,534,254 B1 5/2009 Michelson
7,540,882 B2 6/2009 Michelson
7,544,208 B1 6/2009 Mueller et al.
7,569,074 B2 8/2009 Eisermann et al.
7,575,601 B2 8/2009 Dickson
7,582,058 B1 9/2009 Miles et al.
7,588,599 B2 9/2009 Sweeney
7,591,852 B2 9/2009 Prosser
7,594,931 B2 9/2009 Louis et al.
7,608,105 B2 10/2009 Pavlov et al.
7,608,107 B2 10/2009 Michelson
7,618,454 B2 11/2009 Bentley et al.
7,621,938 B2 11/2009 Molz
7,621,950 B1 11/2009 Globerman et al.
7,621,960 B2 11/2009 Boyd et al.
7,637,953 B2 12/2009 Branch et al.
7,641,690 B2 1/2010 Abdou
7,655,010 B2 2/2010 Serhan et al.
7,655,027 B2 2/2010 Michelson
7,655,043 B2 2/2010 Peterman et al.
7,655,046 B2 2/2010 Dryer et al.
7,662,186 B2 2/2010 Bagga et al.
7,670,359 B2 3/2010 Yundt
7,674,296 B2 3/2010 Rhoda et al.
7,674,297 B2 3/2010 Falahee
7,678,148 B2 3/2010 Peterman
7,682,394 B2 3/2010 Recoules-Arche et al.
7,695,515 B2 4/2010 Sweeney
7,708,778 B2 5/2010 Gordon et al.
7,713,302 B2 5/2010 Ralph et al.
7,722,674 B1 5/2010 Grotz
7,723,395 B2 5/2010 Ringelsen et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,727,280 B2 6/2010 McLuen
7,731,751 B2 6/2010 Butler et al.
7,749,270 B2 7/2010 Peterman
7,753,958 B2 7/2010 Gordon et al.
7,758,644 B2 7/2010 Trieu
7,763,079 B2 7/2010 McKay
7,771,473 B2 8/2010 Thramann
7,776,093 B2 8/2010 Wolek et al.
7,776,095 B2 8/2010 Peterman et al.
7,780,732 B2 8/2010 Abernathie
7,799,081 B2 9/2010 McKinley
7,803,191 B2 9/2010 Biedermann et al.
7,811,327 B2 10/2010 Hansell et al.
7,819,921 B2 10/2010 Grotz
7,824,427 B2 11/2010 Perez-Cruet et al.
7,824,445 B2 11/2010 Biro et al.
7,828,848 B2 11/2010 Chuvin et al.
7,837,732 B2 11/2010 Zucherman et al.
7,837,735 B2 11/2010 Malone
7,846,210 B2 12/2010 Perez-Cruet
7,850,733 B2 12/2010 Baynham et al.
7,850,734 B2 12/2010 Oh et al.
7,850,736 B2 12/2010 Heinz
7,875,075 B2 1/2011 Schwab
7,875,078 B2 1/2011 Wysocki et al.
7,879,098 B1 2/2011 Simmons, Jr.
7,887,596 B2 2/2011 Douget et al.
7,892,286 B2 2/2011 Michelson
7,914,581 B2 3/2011 Dickson et al.
7,922,729 B2 4/2011 Michelson
7,951,180 B2 5/2011 Moskowitz et al.
7,951,199 B2 5/2011 Miller
7,967,863 B2 6/2011 Frey et al.
7,967,867 B2 6/2011 Barreiro et al.
7,981,156 B2 7/2011 Pafford et al.
7,985,256 B2 7/2011 Grotz et al.
7,985,258 B2 7/2011 Zdeblick et al.
8,002,832 B2 8/2011 Castro
8,002,833 B2 8/2011 Fabris Monterumici et al.
8,007,534 B2 8/2011 Michelson
8,016,887 B1 9/2011 Castro
8,034,110 B2 10/2011 Garner et al.
8,034,111 B2 10/2011 Hsu et al.
8,043,376 B2 10/2011 Falahee
8,043,377 B2 10/2011 Guyer et al.
8,057,548 B2 11/2011 Abernathie et al.
8,062,366 B2 11/2011 Melkent
8,062,368 B2 11/2011 Heinz et al.
8,062,375 B2 11/2011 Glerum et al.
8,070,812 B2 12/2011 Keller
8,070,813 B2 12/2011 Grotz et al.
8,070,816 B2 12/2011 Taylor
8,075,621 B2 12/2011 Michelson
8,083,744 B2 12/2011 Dorchak et al.
8,083,799 B2 12/2011 Baynham et al.
8,088,163 B1 1/2012 Kleiner
8,097,034 B2 1/2012 Michelson
8,100,972 B1 1/2012 Bruffey et al.
8,105,382 B2 1/2012 Olmos et al.
8,110,004 B2 2/2012 Valdevit et al.
8,118,870 B2 2/2012 Gordon et al.
8,118,871 B2 2/2012 Gordon et al.
8,123,810 B2 2/2012 Gordon et al.
8,128,700 B2 3/2012 Delurio et al.
8,137,401 B2 3/2012 Stad et al.
8,142,503 B2 3/2012 Malone
8,142,508 B1 3/2012 Bruffey et al.
RE43,317 E 4/2012 Fraser et al.
8,147,550 B2 4/2012 Gordon et al.
8,147,556 B2 4/2012 Louis et al.
8,152,851 B2 4/2012 Mueller et al.
8,152,852 B2 4/2012 Biyani
8,157,865 B2 4/2012 Hochschuler et al.
8,167,946 B2 5/2012 Michelson
8,172,903 B2 5/2012 Gordon et al.
8,172,905 B2 5/2012 Baynham et al.
8,177,844 B2 5/2012 Tsuang et al.
8,177,848 B2 5/2012 McKay
8,182,535 B2 5/2012 Kraus
8,182,538 B2 5/2012 O'Neil et al.
8,187,304 B2 5/2012 Malek
8,187,331 B2 5/2012 Strohkirch, Jr. et al.
8,187,332 B2 5/2012 McLuen
8,192,357 B2 6/2012 Miles et al.
8,192,495 B2 6/2012 Simpson et al.
8,197,546 B2 6/2012 Doubler et al.
8,221,501 B2 7/2012 Eisermann et al.
8,221,502 B2 7/2012 Branch, Jr.
8,226,718 B2 7/2012 Castro
8,241,294 B2 8/2012 Sommerich et al.
8,241,358 B2 8/2012 Butler et al.
8,241,359 B2 8/2012 Davis et al.
8,241,363 B2 8/2012 Sommerich et al.
8,246,683 B2 8/2012 Castro
8,252,059 B2 8/2012 Overes et al.
8,257,436 B2 9/2012 Jackson
8,257,440 B2 9/2012 Gordon et al.
8,257,442 B2 9/2012 Edie et al.
8,262,737 B2 9/2012 Bagga et al.
8,273,124 B2 9/2012 Renganath et al.
8,273,128 B2 9/2012 Oh et al.
8,277,510 B2 10/2012 Kleiner
8,282,683 B2 10/2012 McLaughlin et al.
8,287,599 B2 10/2012 McGuckin, Jr.
8,292,928 B2 10/2012 Cragg et al.
8,292,958 B1 10/2012 Bruffey et al.
8,292,960 B2 10/2012 Kleiner
8,292,963 B2 10/2012 Miller et al.
8,303,658 B2 11/2012 Peterman
8,303,662 B2 11/2012 Landry et al.
8,303,663 B2 11/2012 Jimenez et al.
8,303,879 B2 11/2012 Bertele et al.
8,308,802 B2 11/2012 Rhoda et al.
8,308,805 B2 11/2012 Lynn et al.
8,323,341 B2 12/2012 Lambrecht et al.
8,323,345 B2 12/2012 Sledge
8,333,804 B1 12/2012 Wensel
8,337,558 B2 12/2012 Lindner
8,337,559 B2 12/2012 Hansell et al.
8,343,224 B2 1/2013 Lynn et al.
8,353,961 B2 1/2013 McClintock et al.
8,361,149 B2 1/2013 Castro
8,361,153 B2 1/2013 Ralph et al.
8,366,774 B1 2/2013 Bruffey et al.
8,372,151 B2 2/2013 Hsu et al.
8,377,132 B2 2/2013 Wing et al.
8,377,139 B2 2/2013 Laubert et al.
8,382,841 B2 2/2013 Yundt
8,382,842 B2 2/2013 Greenhalgh et al.
8,388,667 B2 3/2013 Reiley et al.
8,394,143 B2 3/2013 Grotz et al.
8,398,713 B2 3/2013 Weiman
8,403,990 B2 3/2013 Dryer et al.
8,403,991 B2 3/2013 Ullrich, Jr. et al.
8,409,285 B2 4/2013 Keller
8,409,286 B2 4/2013 McKay
8,409,287 B2 4/2013 Braddock, Jr. et al.
8,409,288 B2 4/2013 Davis et al.
8,414,651 B2 4/2013 Tyber et al.
8,419,795 B2 4/2013 Sweeney
8,419,797 B2 4/2013 Biedermann et al.
8,425,612 B2 4/2013 Perez-Cruet
8,430,930 B2 4/2013 Hunt
8,435,296 B2 5/2013 Kadaba et al.
8,435,298 B2 5/2013 Weiman
8,435,299 B2 5/2013 Chauvin et al.
8,435,300 B2 5/2013 Messerli et al.
8,435,302 B2 5/2013 Ulrich, Jr. et al.
8,444,692 B2 5/2013 Michelson
8,449,613 B2 5/2013 Crozet
8,454,695 B2 6/2013 Grotz et al.
8,460,385 B1 6/2013 Wensel
8,475,533 B1 7/2013 Castro
8,480,741 B2 7/2013 Grotz et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,480,745 B2 7/2013 Liu et al.
8,480,748 B2 7/2013 Poulos
8,480,749 B2 7/2013 Ullrich, Jr. et al.
8,486,148 B2 7/2013 Butler et al.
8,486,149 B2 7/2013 Saidha et al.
8,491,653 B2 7/2013 Zucherman et al.
8,491,657 B2 7/2013 Attia et al.
8,491,659 B2 7/2013 Weiman
8,496,706 B2 7/2013 Ragab et al.
8,496,710 B2 7/2013 Bagga et al.
RE44,417 E 8/2013 Bartish, Jr. et al.
8,506,629 B2 8/2013 Weiland
8,512,407 B2 8/2013 Butler et al.
8,518,120 B2 8/2013 Glerum et al.
8,523,908 B2 9/2013 Malone
8,523,909 B2 9/2013 Hess
8,523,944 B2 9/2013 Jimenez et al.
8,535,380 B2 9/2013 Greenhalgh et al.
8,540,770 B2 9/2013 Woodburn, Sr.
8,545,568 B2 10/2013 Ulrich, Jr. et al.
8,551,176 B2 10/2013 Ullrich, Jr. et al.
8,556,979 B2 10/2013 Glerum et al.
8,562,683 B2 10/2013 McKinley
8,562,684 B2 10/2013 Ullrich, Jr. et al.
8,562,685 B2 10/2013 Ullrich, Jr. et al.
8,568,481 B2 10/2013 Olmos et al.
8,568,482 B2 10/2013 Kraus et al.
8,574,297 B2 11/2013 Stad et al.
8,574,299 B2 11/2013 Barreiro et al.
8,574,300 B2 11/2013 McManus et al.
8,579,976 B2 11/2013 Attia
8,579,979 B2 11/2013 Edie et al.
8,579,983 B2 11/2013 Garner et al.
8,585,761 B2 11/2013 Theofilos
8,585,765 B2 11/2013 Ullrich, Jr. et al.
8,585,766 B2 11/2013 Ullrich, Jr. et al.
8,585,767 B2 11/2013 Ullrich, Jr. et al.
8,591,585 B2 11/2013 McLaughlin et al.
8,591,588 B2 11/2013 Fraser et al.
8,591,590 B2 11/2013 Ullrich, Jr. et al.
8,597,360 B2 12/2013 McLuen et al.
8,603,170 B2 12/2013 Cipoletti et al.
8,603,174 B2 12/2013 Haines
8,617,246 B2 12/2013 Malone
8,617,248 B2 12/2013 Ullrich, Jr. et al.
8,628,575 B2 1/2014 Muhanna et al.
8,628,576 B2 1/2014 Triplett et al.
8,632,595 B2 1/2014 Weiman
8,641,763 B2 2/2014 Yue
8,641,765 B2 2/2014 Muhanna
8,641,769 B2 2/2014 Malandain
8,647,386 B2 2/2014 Gordon et al.
8,663,329 B2 3/2014 Ernst
8,663,330 B2 3/2014 McClintock et al.
8,663,331 B2 3/2014 McClellan, III et al.
8,668,740 B2 3/2014 Rhoda et al.
8,668,741 B2 3/2014 Michelson
8,673,004 B2 3/2014 Michelson
8,673,006 B2 3/2014 Castro
8,673,011 B2 3/2014 Theofilos et al.
8,673,012 B2 3/2014 Smith et al.
8,679,183 B2 3/2014 Glerum
8,679,184 B2 3/2014 Kube, II
8,685,031 B2 4/2014 Kleiner et al.
8,685,095 B2 4/2014 Miller et al.
8,685,098 B2 4/2014 Glerum et al.
8,685,102 B2 4/2014 McKay
8,685,104 B2 4/2014 Lee et al.
8,690,949 B2 4/2014 Messerli et al.
8,696,751 B2 4/2014 Ashley et al.
8,696,752 B2 4/2014 Shih et al.
8,709,042 B2 4/2014 Greenhalgh et al.
8,709,083 B2 4/2014 Duffield et al.
8,709,086 B2 4/2014 Glerum
8,715,351 B1 5/2014 Pinto
8,715,353 B2 5/2014 Bagga et al.
8,715,355 B2 5/2014 Kleiner
8,721,723 B2 5/2014 Hansell et al.
8,728,160 B2 5/2014 Globerman et al.
8,734,447 B1 5/2014 Michaelson
8,734,519 B2 5/2014 de Villiers
8,734,521 B2 5/2014 Freeman et al.
8,734,822 B2 5/2014 Koblish et al.
8,753,398 B2 6/2014 Gordon et al.
8,753,399 B2 6/2014 Sharifi-Mehr
8,771,358 B2 7/2014 Michelson
8,771,360 B2 7/2014 Jimenez et al.
8,771,368 B2 7/2014 McKay
8,778,025 B2 7/2014 Ragab et al.
8,778,027 B2 7/2014 Medina
8,808,305 B2 8/2014 Kleiner
8,808,385 B1 8/2014 Smith et al.
8,834,571 B2 9/2014 Bagga et al.
8,840,620 B2 9/2014 Recoules-Arche et al.
8,840,666 B2 9/2014 Crozet
8,840,669 B2 9/2014 Farris et al.
8,845,733 B2 9/2014 O'Neil et al.
8,852,278 B2 10/2014 Bellasw
2001/0001129 A1 5/2001 McKay et al.
2001/0010020 A1 7/2001 Michelson
2001/0047208 A1 11/2001 Michelson
2001/0051829 A1 12/2001 Middleton
2002/0040243 A1 4/2002 Attali et al.
2002/0045945 A1 4/2002 Liu et al.
2002/0049394 A1 4/2002 Roy et al.
2002/0082697 A1 6/2002 Damien
2002/0103540 A1 8/2002 Cooper et al.
2002/0111684 A1 8/2002 Ralph et al.
2002/0111687 A1 8/2002 Ralph et al.
2002/0123750 A1 9/2002 Eisermann et al.
2002/0128652 A1 9/2002 Ferree
2002/0128712 A1 9/2002 Michelson
2002/0138146 A1 9/2002 Jackson
2002/0138147 A1 9/2002 Cohen
2002/0143401 A1 10/2002 Michelson
2002/0161444 A1 10/2002 Choi
2002/0169507 A1 11/2002 Malone
2002/0193880 A1 12/2002 Fraser
2002/0198598 A1 12/2002 Pepper
2003/0069640 A1 4/2003 Ferreira et al.
2003/0083746 A1 5/2003 Kuslich
2003/0083748 A1 5/2003 Lee et al.
2003/0105527 A1 6/2003 Bresina
2003/0114854 A1 6/2003 Pavlov et al.
2003/0114930 A1 6/2003 Lim et al.
2003/0171812 A1 9/2003 Grunberg et al.
2003/0171813 A1 9/2003 Kiester
2003/0181979 A1 9/2003 Ferree
2003/0195520 A1 10/2003 Boyd et al.
2003/0208275 A1 11/2003 Michelson
2004/0034421 A1 2/2004 Errico et al.
2004/0034430 A1 2/2004 Falahee
2004/0059420 A1 3/2004 Michelson
2004/0073314 A1 4/2004 White et al.
2004/0082953 A1 4/2004 Petit
2004/0122424 A1 6/2004 Ferree
2004/0127993 A1 7/2004 Kast et al.
2004/0143330 A1 7/2004 Sazy
2004/0153160 A1 8/2004 Carrasco
2004/0186483 A1 9/2004 Bagby
2004/0220670 A1 11/2004 Eisermann et al.
2004/0220671 A1 11/2004 Ralph et al.
2004/0249461 A1 12/2004 Ferree
2004/0254643 A1 12/2004 Jackson
2004/0254644 A1 12/2004 Taylor
2005/0027362 A1 2/2005 Williams et al.
2005/0033431 A1 2/2005 Gordon et al.
2005/0033432 A1 2/2005 Gordon et al.
2005/0033439 A1 2/2005 Gordon et al.
2005/0043802 A1 2/2005 Eisermann et al.
2005/0049587 A1 3/2005 Jackson
2005/0049590 A1 3/2005 Alleyne et al.
2005/0065605 A1 3/2005 Jackson
2005/0065611 A1 3/2005 Huppert et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2005/0070900 A1 3/2005 Serhan et al.
2005/0119751 A1 6/2005 Lawson
2005/0119753 A1 6/2005 McGahan et al.
2005/0131548 A1 6/2005 Boyer et al.
2005/0149192 A1 7/2005 Zucherman et al.
2005/0159816 A1 7/2005 Walkenhorst et al.
2005/0177173 A1 8/2005 Aebi et al.
2005/0177237 A1 8/2005 Shappley et al.
2005/0192669 A1 9/2005 Zdeblick et al.
2005/0209697 A1 9/2005 Paponneau et al.
2005/0216082 A1 9/2005 Wilson et al.
2005/0216089 A1 9/2005 Michelson
2005/0222681 A1 10/2005 Richley et al.
2005/0278027 A1 12/2005 Hyde
2005/0283245 A1 12/2005 Gordon et al.
2005/0283248 A1 12/2005 Gordon et al.
2006/0041314 A1 2/2006 Millard
2006/0047341 A1 3/2006 Trieu
2006/0064170 A1 3/2006 Smith et al.
2006/0084985 A1 4/2006 Kim
2006/0095136 A1 5/2006 McLuen
2006/0116767 A1 6/2006 Magerl et al.
2006/0122701 A1 6/2006 Kiester
2006/0122703 A1 6/2006 Aebi et al.
2006/0173543 A1 8/2006 Brau et al.
2006/0190081 A1 8/2006 Kraus et al.
2006/0195192 A1 8/2006 Gordon et al.
2006/0224241 A1 10/2006 Butler et al.
2006/0229729 A1 10/2006 Gordon et al.
2006/0241774 A1 10/2006 Attali et al.
2007/0050029 A1 3/2007 Carrasco
2007/0050030 A1 3/2007 Kim
2007/0055252 A1 3/2007 Blain et al.
2007/0067035 A1 3/2007 Falahee
2007/0073291 A1 3/2007 Cordaro et al.
2007/0073400 A1 3/2007 Paul
2007/0073406 A1 3/2007 Gordon et al.
2007/0118222 A1 5/2007 Lang
2007/0168038 A1 7/2007 Trieu
2007/0168039 A1 7/2007 Trieu
2007/0185580 A1 8/2007 Posel
2007/0191951 A1 8/2007 Branch
2007/0225810 A1 9/2007 Colleran et al.
2007/0233254 A1 10/2007 Grotz et al.
2007/0233263 A1 10/2007 Melkent
2007/0244485 A1 10/2007 Greenhalgh et al.
2007/0260314 A1 11/2007 Biyani
2007/0276377 A1 11/2007 Yundt
2007/0282443 A1 12/2007 Globerman et al.
2007/0293948 A1 12/2007 Bagga et al.
2007/0293949 A1 12/2007 Salerni et al.
2008/0009880 A1 1/2008 Warnick et al.
2008/0015701 A1 1/2008 Garcia et al.
2008/0021462 A1 1/2008 Trieu
2008/0021556 A1 1/2008 Edie
2008/0021559 A1 1/2008 Thramann
2008/0039948 A1 2/2008 Biedermann et al.
2008/0051902 A1 2/2008 Dwyer
2008/0051903 A1 2/2008 Dwyer
2008/0058931 A1 3/2008 White et al.
2008/0065217 A1 3/2008 Hurlbert et al.
2008/0065219 A1 3/2008 Dye et al.
2008/0071284 A1 3/2008 Lechmann et al.
2008/0077247 A1* 3/2008 Murillo et al. 623/17.16
2008/0091211 A1 4/2008 Gately
2008/0091270 A1 4/2008 Miller et al.
2008/0097610 A1 4/2008 Guyer et al.
2008/0114454 A1 5/2008 Peterman et al.
2008/0125856 A1* 5/2008 Perez-Cruet et al. 623/1.23
2008/0133015 A1 6/2008 Lechmann et al.
2008/0147194 A1 6/2008 Grotz et al.
2008/0154374 A1 6/2008 Labrom
2008/0154377 A1 6/2008 Voellmicke
2008/0161927 A1 7/2008 Savage et al.
2008/0161933 A1 7/2008 Grotz et al.
2008/0172127 A1 7/2008 Perez-Cruet et al.
2008/0172128 A1* 7/2008 Perez-Cruet et al. 623/17.16
2008/0177387 A1 7/2008 Parimore et al.
2008/0195209 A1 8/2008 Garcia et al.
2008/0208345 A1 8/2008 Hurlbert et al.
2008/0215093 A1 9/2008 Lin et al.
2008/0221694 A1 9/2008 Warnick et al.
2008/0221695 A1 9/2008 Jacofsky et al.
2008/0243252 A1 10/2008 Hansen et al.
2008/0249622 A1 10/2008 Gray
2008/0249627 A1 10/2008 Moehlenbruck et al.
2008/0262623 A1 10/2008 Bagga et al.
2008/0269901 A1 10/2008 Baynham et al.
2008/0269902 A1 10/2008 Baynham et al.
2008/0281424 A1 11/2008 Parry et al.
2008/0288071 A1 11/2008 Biyani et al.
2008/0288076 A1 11/2008 Soo et al.
2008/0312742 A1 12/2008 Abernathie
2009/0005870 A1 1/2009 Hawkins et al.
2009/0012620 A1 1/2009 Youssef et al.
2009/0024218 A1 1/2009 Frigg et al.
2009/0030519 A1 1/2009 Falahee
2009/0036985 A1 2/2009 Whiting
2009/0043394 A1 2/2009 Zdeblick et al.
2009/0054983 A1 2/2009 Wuisman et al.
2009/0054987 A1 2/2009 Chin et al.
2009/0054991 A1 2/2009 Biyani et al.
2009/0062917 A1 3/2009 Foley et al.
2009/0080997 A1 3/2009 Johnson
2009/0082775 A1 3/2009 Altarac et al.
2009/0088765 A1 4/2009 Butler et al.
2009/0088849 A1 4/2009 Armstrong et al.
2009/0099659 A1 4/2009 Oh et al.
2009/0105830 A1 4/2009 Jones et al.
2009/0105832 A1 4/2009 Allain et al.
2009/0125066 A1 5/2009 Kraus et al.
2009/0132053 A1 5/2009 Sears et al.
2009/0138083 A1 5/2009 Biyani
2009/0138091 A1 5/2009 Ray
2009/0143860 A1 6/2009 Burd et al.
2009/0149957 A1 6/2009 Burd et al.
2009/0157187 A1 6/2009 Richelsoph
2009/0164015 A1 6/2009 Liu et al.
2009/0164017 A1 6/2009 Sommerich et al.
2009/0164018 A1 6/2009 Sommerich et al.
2009/0164019 A1 6/2009 Hsu et al.
2009/0182428 A1 7/2009 McClellan, III et al.
2009/0182430 A1 7/2009 Tyber et al.
2009/0182431 A1 7/2009 Butler et al.
2009/0192613 A1 7/2009 Wing et al.
2009/0198338 A1 8/2009 Phan
2009/0198339 A1* 8/2009 Kleiner et al. 623/17.16
2009/0210061 A1 8/2009 Sledge
2009/0210062 A1 8/2009 Thalgott et al.
2009/0216331 A1 8/2009 Grotz et al.
2009/0234277 A1 9/2009 Wei et al.
2009/0248163 A1* 10/2009 King et al. 623/17.16
2009/0265007 A1 10/2009 Colleran
2009/0276049 A1 11/2009 Weiland
2009/0299478 A1 12/2009 Carls et al.
2009/0299479 A1* 12/2009 Jones et al. 623/17.16
2009/0326657 A1 12/2009 Grinberg et al.
2010/0004747 A1 1/2010 Lin
2010/0010633 A1 1/2010 Kohm
2010/0042219 A1 2/2010 Antonacci et al.
2010/0049325 A1 2/2010 Biedermann et al.
2010/0057207 A1 3/2010 Ray et al.
2010/0063510 A1 3/2010 Arlet et al.
2010/0070036 A1 3/2010 Implicito
2010/0070037 A1 3/2010 Parry et al.
2010/0070041 A1 3/2010 Peterman et al.
2010/0076559 A1 3/2010 Bagga et al.
2010/0087924 A1 4/2010 Arlet
2010/0106250 A1 4/2010 Abdou
2010/0114105 A1 5/2010 Butters et al.
2010/0145455 A1 6/2010 Simpson et al.
2010/0161057 A1 6/2010 Berry et al.
2010/0168798 A1 7/2010 Clineff et al.
2010/0179594 A1 7/2010 Theofilos et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2010/0179658 A1 7/2010 Freeman et al.
2010/0185289 A1 7/2010 Kirwan et al.
2010/0191336 A1 7/2010 Greenhalgh
2010/0204795 A1 8/2010 Greenhalgh
2010/0222884 A1 9/2010 Greenhalgh
2010/0234952 A1 9/2010 Peterman
2010/0241231 A1 9/2010 Marino et al.
2010/0249935 A1 9/2010 Slivka et al.
2010/0268345 A1 10/2010 Ralph et al.
2010/0274358 A1 10/2010 Mueller et al.
2010/0280616 A1 11/2010 Frasier
2010/0286777 A1 11/2010 Errico et al.
2010/0286780 A1 11/2010 Dryer et al.
2010/0298942 A1 11/2010 Ransell et al.
2010/0305707 A1 12/2010 Biedermann et al.
2010/0324684 A1 12/2010 Eisermann et al.
2011/0015742 A1 1/2011 Hong
2011/0015747 A1 1/2011 McManus et al.
2011/0046740 A1 2/2011 Chen et al.
2011/0046743 A1 2/2011 Perez-Cruet et al.
2011/0077741 A1 3/2011 Heinz
2011/0087294 A1 4/2011 Reiley
2011/0093074 A1 4/2011 Glerum et al.
2011/0137420 A1 6/2011 Michelson
2011/0144753 A1 6/2011 Marchek et al.
2011/0153020 A1 6/2011 Abdelgany et al.
2011/0172775 A1 7/2011 Flickinger et al.
2011/0184518 A1 7/2011 Trieu
2011/0196495 A1 8/2011 Hunt
2011/0202135 A1 8/2011 Baek et al.
2011/0202137 A1 8/2011 Keith et al.
2011/0208312 A1 8/2011 Moskowitz et al.
2011/0208313 A1 8/2011 Michelson
2011/0218633 A1 9/2011 Frey et al.
2011/0230965 A1 9/2011 Schell et al.
2011/0230968 A1 9/2011 Perisic
2011/0251692 A1 10/2011 McLaughlin et al.
2011/0264219 A1 10/2011 Rouben
2011/0282392 A1 11/2011 Murphy et al.
2011/0282453 A1 11/2011 Greenhalgh et al.
2011/0282454 A1 11/2011 Ullrich, Jr. et al.
2011/0282457 A1 11/2011 Dan ièle et al.
2011/0295371 A1 12/2011 Moskowitz et al.
2011/0301709 A1 12/2011 Kraus et al.
2011/0301710 A1 12/2011 Mather et al.
2011/0319995 A1 12/2011 Voellmicke et al.
2011/0319999 A1 12/2011 O'Neil et al.
2011/0320000 A1 12/2011 O'Neil et al.
2012/0004730 A1 1/2012 Castro
2012/0035729 A1 2/2012 Glerum et al.
2012/0059470 A1 3/2012 Weiman
2012/0071981 A1 3/2012 Farley et al.
2012/0071983 A1 3/2012 Ray, III et al.
2012/0078373 A1 3/2012 Gamache et al.
2012/0095559 A1 4/2012 Woods et al.
2012/0109305 A1 5/2012 Park
2012/0109319 A1 5/2012 Perisic
2012/0123546 A1 5/2012 Medina
2012/0130496 A1 5/2012 Duffield et al.
2012/0136442 A1* 5/2012 Kleiner 623/17.11
2012/0150304 A1 6/2012 Glerum et al.
2012/0150305 A1 6/2012 Glerum et al.
2012/0158143 A1 6/2012 Shapiro
2012/0158145 A1 6/2012 Ralph et al.
2012/0158146 A1 6/2012 Glerum et al.
2012/0158147 A1 6/2012 Glerum et al.
2012/0158148 A1 6/2012 Glerum et al.
2012/0179260 A1 7/2012 Nottingham
2012/0185047 A1 7/2012 Wooley
2012/0191196 A1 7/2012 Louis et al.
2012/0197401 A1 8/2012 Duncan et al.
2012/0215315 A1 8/2012 Hochschuler et al.
2012/0226356 A1 9/2012 Hirschl
2012/0232660 A1 9/2012 Davenport
2012/0245695 A1 9/2012 Simpson et al.
2012/0265307 A1 10/2012 Guyer et al.
2012/0265311 A1 10/2012 Mather et al.
2012/0271424 A1 10/2012 Crawford
2012/0277866 A1 11/2012 Kalluri et al.
2012/0277868 A1 11/2012 Walters
2012/0277869 A1 11/2012 Siccardi et al.
2012/0277878 A1 11/2012 Sommerich et al.
2012/0290090 A1 11/2012 Glerum
2012/0296433 A1 11/2012 Farin
2012/0310349 A1 12/2012 Gordon et al.
2012/0310356 A1 12/2012 Davis et al.
2012/0323327 A1 12/2012 McAfee
2012/0330419 A1 12/2012 Moskowitz et al.
2012/0330421 A1 12/2012 Weiman
2012/0330426 A1 12/2012 McLaughlin et al.
2013/0006360 A1 1/2013 Aferzon et al.
2013/0006361 A1 1/2013 Glerum et al.
2013/0006365 A1 1/2013 Pepper et al.
2013/0018465 A1 1/2013 Yue
2013/0018468 A1 1/2013 Moskowitz et al.
2013/0018469 A1 1/2013 Moskowitz et al.
2013/0018470 A1 1/2013 Moskowitz et al.
2013/0018471 A1 1/2013 Davenport et al.
2013/0023991 A1 1/2013 Moskowitz et al.
2013/0023992 A1 1/2013 Moskowitz et al.
2013/0053893 A1 2/2013 Gamache et al.
2013/0053894 A1 2/2013 Gamache et al.
2013/0053962 A1 2/2013 Moskowitz et al.
2013/0060339 A1 3/2013 Duffield et al.
2013/0073044 A1 3/2013 Gamache
2013/0085572 A1 4/2013 Glerum et al.
2013/0116791 A1 5/2013 Theofilos
2013/0123923 A1 5/2013 Pavlov et al.
2013/0123924 A1 5/2013 Butler et al.
2013/0123935 A1 5/2013 Hunt et al.
2013/0131812 A1 5/2013 Ganey
2013/0138214 A1 5/2013 Greenhalgh et al.
2013/0150967 A1 6/2013 Shih et al.
2013/0158667 A1 6/2013 Tabor et al.
2013/0158668 A1 6/2013 Nichols et al.
2013/0158669 A1 6/2013 Sungarian et al.
2013/0173004 A1 7/2013 Greenhalgh et al.
2013/0178904 A1 7/2013 Arcenio et al.
2013/0178940 A1 7/2013 Farley
2013/0184822 A1 7/2013 Kleiner
2013/0184826 A1 7/2013 Thaiyananthan
2013/0190880 A1 7/2013 Schaller
2013/0197642 A1 8/2013 Ernst
2013/0197647 A1 8/2013 Wolters et al.
2013/0204371 A1 8/2013 McLuen et al.
2013/0204373 A1 8/2013 Lambrecht et al.
2013/0204374 A1 8/2013 Milella
2013/0211525 A1 8/2013 McLuen et al.
2013/0218275 A1 8/2013 Caballes
2013/0245763 A1 9/2013 Mauldin
2013/0245765 A1 9/2013 Lowry et al.
2013/0247357 A1 9/2013 Bertele et al.
2013/0253650 A1 9/2013 Ashley et al.
2013/0261748 A1 10/2013 Ashley et al.
2013/0268079 A1 10/2013 Castro
2013/0274883 A1 10/2013 McLuen et al.
2013/0274890 A1 10/2013 McKay
2013/0282126 A1 10/2013 Saidha et al.
2013/0304213 A1 11/2013 Aflatoon et al.
2013/0310940 A1 11/2013 Chauvin et al.
2013/0317615 A1 11/2013 Jimenez et al.
2013/0345813 A1 12/2013 Frank et al.
2013/0345814 A1 12/2013 Walkenhorst et al.
2014/0012383 A1 1/2014 Triplett et al.
2014/0018921 A1 1/2014 Stad et al.
2014/0018922 A1 1/2014 Marino et al.
2014/0018924 A1 1/2014 McManus et al.
2014/0031936 A1 1/2014 Weiman
2014/0031942 A1 1/2014 Ullrich et al.
2014/0039622 A1 2/2014 Glerum et al.
2014/0039627 A1 2/2014 Weiland
2014/0046373 A1 2/2014 Brennan
2014/0046445 A1 2/2014 Brennan
2014/0052252 A1 2/2014 Weiman

(56) **References Cited**

U.S. PATENT DOCUMENTS

2014/0052253 A1 2/2014 Perlott et al.
2014/0052254 A1 2/2014 Glerum et al.
2014/0052258 A1 2/2014 Ball et al.
2014/0052259 A1 2/2014 Garner et al.
2014/0052260 A1 2/2014 McKenny et al.
2014/0058446 A1 2/2014 Bernstein
2014/0058512 A1 2/2014 Petersheim
2014/0058513 A1 2/2014 Gahman et al.
2014/0058514 A1 2/2014 Berry et al.
2014/0058515 A1 2/2014 Hawkins et al.
2014/0058516 A1 2/2014 Glerum et al.
2014/0058518 A1 2/2014 Niemiec et al.
2014/0058519 A1 2/2014 Glerum et al.
2014/0058520 A1 2/2014 Crozet
2014/0058521 A1 2/2014 McLuen et al.
2014/0058522 A1 2/2014 Rhoda
2014/0067071 A1 3/2014 Weiman et al.
2014/0074241 A1 3/2014 McConnell
2014/0088708 A1 3/2014 Mclaughlin et al.
2014/0088710 A1 3/2014 Etminan
2014/0088711 A1 3/2014 Chin et al.
2014/0088715 A1 3/2014 Ciupik
2014/0094916 A1 4/2014 Glerum
2014/0094917 A1 4/2014 Salerni
2014/0094918 A1 4/2014 Vishnubholta et al.
2014/0094922 A1 4/2014 Abdou
2014/0100657 A1 4/2014 McCormack et al.
2014/0107785 A1 4/2014 Geisler et al.
2014/0107786 A1 4/2014 Geiser et al.
2014/0114134 A1 4/2014 Theofilos et al.
2014/0114417 A1 4/2014 Theofilos et al.
2014/0114420 A1 4/2014 Robinson
2014/0114421 A1 4/2014 Ullrich et al.
2014/0114422 A1 4/2014 Malandain
2014/0121773 A1 5/2014 Patel et al.
2014/0121774 A1 5/2014 Glerum et al.
2014/0121777 A1 5/2014 Rosen et al.
2014/0128977 A1 5/2014 Glerum et al.
2014/0135930 A1 5/2014 Georges
2014/0135932 A1 5/2014 Davis et al.
2014/0135933 A1 5/2014 McClintock et al.
2014/0142701 A1 5/2014 Weiman
2014/0142704 A1 5/2014 Ralph et al.
2014/0142709 A1 5/2014 Kube, II
2014/0148904 A1 5/2014 Robinson
2014/0156007 A1 6/2014 Pabst et al.
2014/0156008 A1 6/2014 Flickinger et al.
2014/0163686 A1 6/2014 Frasier et al.
2014/0172103 A1 6/2014 O'Neil et al.
2014/0172106 A1 6/2014 To et al.
2014/0180419 A1 6/2014 Dmuschewsky
2014/0188225 A1 7/2014 Dmuschewsky
2014/0188228 A1 7/2014 Thibodeau
2014/0194991 A1 7/2014 Jimenez
2014/0194992 A1 7/2014 Medina
2014/0200669 A1 7/2014 Berger et al.
2014/0207235 A1 7/2014 Drapeau
2014/0207238 A1 7/2014 Theofilis et al.
2014/0222151 A1 8/2014 Refai et al.
2014/0228955 A1 8/2014 Weiman
2014/0236296 A1 8/2014 Wagner et al.
2014/0236297 A1 8/2014 Iott et al.
2014/0236298 A1 8/2014 Pinto
2014/0243983 A1 8/2014 Galea et al.
2014/0249589 A1 9/2014 Reiley et al.
2014/0249628 A1 9/2014 Weiman
2014/0249629 A1 9/2014 Moskowitz et al.
2014/0257484 A1 9/2014 Flower et al.
2014/0257485 A1 9/2014 Matthis et al.
2014/0257486 A1 9/2014 Alheidt
2014/0277139 A1 9/2014 Vrionis et al.
2014/0277464 A1 9/2014 Richter et al.
2014/0277471 A1 9/2014 Gray et al.
2014/0277472 A1 9/2014 Gray et al.
2014/0277473 A1 9/2014 Perrow
2014/0277474 A1 9/2014 Robinson et al.
2014/0277475 A1 9/2014 De Villiers et al.
2014/0277484 A1 9/2014 Prevost et al.
2014/0277497 A1 9/2014 Bennett et al.
2014/0277498 A1 9/2014 Ainsworth et al.
2014/0277499 A1 9/2014 Ainsworth et al.
2014/0277508 A1 9/2014 Baynham
2014/0288652 A1 9/2014 Boehm et al.
2014/0296982 A1 10/2014 Cheng
2014/0296983 A1 10/2014 Fauth et al.
2014/0296984 A1 10/2014 Etminan
2014/0303731 A1 10/2014 Glerum

FOREIGN PATENT DOCUMENTS

EP 646366 B1 12/1997
EP 834295 A1 4/1998
EP 369603 B1 5/1998
EP 498816 B1 11/1998
EP 966929 A2 12/1999
EP 760639 B1 4/2000
EP 1043002 A2 10/2000
EP 1082950 A1 3/2001
EP 857041 B1 4/2001
EP 1099429 A1 5/2001
EP 844856 B1 10/2001
EP 1138285 A1 10/2001
EP 871419 B1 11/2001
EP 720455 B1 1/2002
EP 734703 B1 2/2002
EP 781113 B1 3/2002
EP 716840 B1 5/2002
EP 784967 B1 11/2002
EP 1175878 B1 3/2003
EP 1147751 B1 5/2003
EP 1328217 A2 7/2003
EP 855887 B1 8/2003
EP 1006955 B1 8/2003
EP 977526 B1 9/2003
EP 831759 B1 3/2004
EP 1014899 B1 8/2004
EP 1033941 B1 8/2004
EP 1132061 B1 8/2004
EP 1063949 B1 9/2004
EP 1011481 B1 10/2004
EP 1051133 B1 10/2004
EP 1107711 B1 10/2004
EP 1272130 B1 11/2004
EP 888099 B1 1/2005
EP 1278486 B1 3/2005
EP 836454 B1 4/2005
EP 1255516 B1 4/2005
EP 1364617 B1 8/2005
EP 1124511 B1 9/2005
EP 1139930 B1 9/2005
EP 1350489 B1 10/2005
EP 853932 B1 11/2005
EP 1076536 B1 11/2005
EP 891169 B1 12/2005
EP 1164979 B1 12/2005
EP 1233732 B1 5/2006
EP 1280481 B1 7/2006
EP 1189557 B1 8/2006
EP 1211985 B1 9/2006
EP 1009338 B1 10/2006
EP 1481654 B1 10/2006
EP 1351610 B1 12/2006
EP 1374806 B1 12/2006
EP 1138267 B1 3/2007
EP 1504732 B1 5/2007
EP 1009337 B1 6/2007
EP 1023010 B1 6/2007
EP 1284689 B1 6/2007
EP 1532949 B1 7/2007
EP 1464307 B1 8/2007
EP 1585466 B1 8/2007
EP 1698305 B1 8/2007
EP 1148849 B1 12/2007
EP 1523963 B1 12/2007

(56) **References Cited**

FOREIGN PATENT DOCUMENTS

EP	1554995	B1	12/2007
EP	1504735	B1	1/2008
EP	1123069	B1	2/2008
EP	1330188	B1	2/2008
EP	1290985	B1	4/2008
EP	1391189	B1	6/2008
EP	1567096	B1	7/2008
EP	1194087	B1	8/2008
EP	1437105	B1	10/2008
EP	1139936	B1	12/2008
EP	1389978	B1	1/2009
EP	1011503	B1	4/2009
EP	1341491	B1	4/2009
EP	1469800	B1	4/2009
EP	1925271	B1	8/2009
EP	1506753	B1	9/2009
EP	1554994	B1	9/2009
EP	1645248	B1	9/2009
EP	1829503	B1	9/2009
EP	1011545	B1	12/2009
EP	1841385	B1	3/2010
EP	1843723	B1	3/2010
EP	1408889	B1	6/2010
EP	1774926	B1	6/2010
EP	2111823	B1	8/2010
EP	1706075	B1	1/2011
EP	1762202	B1	1/2011
EP	1301149	B1	2/2011
EP	1903994	B1	2/2011
EP	1372541	B1	3/2011
EP	1321115	B1	7/2011
EP	1400221	B1	9/2011
EP	2108340	B1	9/2011
EP	2368528	A1	9/2011
EP	1385457	B1	10/2011
EP	1732480	B1	2/2012
EP	2157938	B1	2/2012
EP	2327377	B1	3/2012
EP	1478309	B1	4/2012
EP	1699389	B1	4/2012
EP	2018827	B1	5/2012
EP	2234564	B1	5/2012
EP	2237748	B1	9/2012
EP	2194929	B1	10/2012
EP	1430858	B1	11/2012
EP	1463465	B1	11/2012
EP	2340776	B1	1/2013
EP	1838248	B1	3/2013
EP	2055267	B1	4/2013
EP	2361572	B1	4/2013
EP	1198208	B1	7/2013
EP	2632391	A1	9/2013
EP	2249747	B1	12/2013
EP	2083760	B1	1/2014
EP	2677971	A2	1/2014
EP	2065016	B1	4/2014
EP	2376026	B1	4/2014
EP	2729091	A1	5/2014
EP	2142147	B1	7/2014
EP	2207504	B1	7/2014
EP	2376030	B1	8/2014
EP	2760376	A1	8/2014
EP	2764851	A1	8/2014
EP	2777633	A2	9/2014
EP	2779953	A2	9/2014
FR	2 841 124		12/2003
WO	WO9614809	A1	5/1996
WO	WO9622747	A1	8/1996
WO	WO9723174	A1	7/1997
WO	WO 97/32547		9/1997
WO	WO 97/37619		10/1997
WO	WO9842269	A1	10/1998
WO	WO0209597	A2	2/2002
WO	WO2004000176	A1	12/2003
WO	WO2006134262	A1	12/2006
WO	WO2008044057	A1	4/2008
WO	WO2008112607	A2	9/2008
WO	WO2008152499	A2	12/2008
WO	WO2009040840	A1	4/2009
WO	WO2009064787	A2	5/2009
WO	WO2009091775	A2	7/2009
WO	WO2010148112	A1	12/2010
WO	WO2011056172	A1	5/2011
WO	WO2011/116136		9/2011
WO	WO2011142761	A1	11/2011
WO	WO2012056119	A1	5/2012
WO	WO2012117312	A2	9/2012
WO	WO2013007888	A1	1/2013
WO	WO2013008111	A1	1/2013
WO	WO2013048000	A2	4/2013
WO	WO2013142480	A1	9/2013
WO	WO2013158294	A1	10/2013
WO	WO2013175147	A1	11/2013
WO	WO2013184946	A1	12/2013
WO	WO2014035835	A1	3/2014
WO	WO2014063255	A1	5/2014
WO	WO2014118291	A1	8/2014
WO	WO2014144696	A1	9/2014
WO	WO2014158619	A1	10/2014
WO	WO2014159739	A1	10/2014
WO	WO2014159762	A1	10/2014

OTHER PUBLICATIONS

Butterman et al., *Interbody device endplate engagement effects on motion segment biomechanics*, The Spine Journal, 9(7):pp. 564-573, Jul. 2009.

Product information in 1 page for an implant named *Cross-Fuse® Lateral Option System* by Pioneer Surgical Technology, Inc. (dated 2011 and retrieved on or about Aug. 2012 from www.pioneersurgical.com/international/index.php?option=com_content&view=article&id=72&Itemid=72).

Product information in 1 page for an implant named *TransContinental® Spacer System* by Globus Medical, Inc. (retrieved on or about Aug. 2012 from www.globusmedical.com/intervertebral-fusion/220-transcontinental).

Product information in 1 page for an implant named *CoRoent® Interbody/VBR Implant* by NuVasive, Inc. (retrieved on or about Aug. 2012 as a partial image (screenshot) capture from www.nuvasive.com/health-providers/innovative-solutions/).

Wright, N.M., MD, *Biomechanical Testing of XLIF Constructs—Stand-Alone Interbody Versus Interbody Supplemented with Lateral or Posterior Instrumentation*, Digital Poster presented at the Congress of Neurological Surgeons (CNS) Annual Conference 2005 in Boston, Massachusetts (Oct. 8, 2005-Oct. 13, 2005), which illustrates and discusses, inter alia, an implant named CoRoent by NuVasive, Inc.

DeWald, R.L., "Spinal Deformities: The Comprehensive Text," (partial excerpt from book), published Mar. 15, 2003.

* cited by examiner

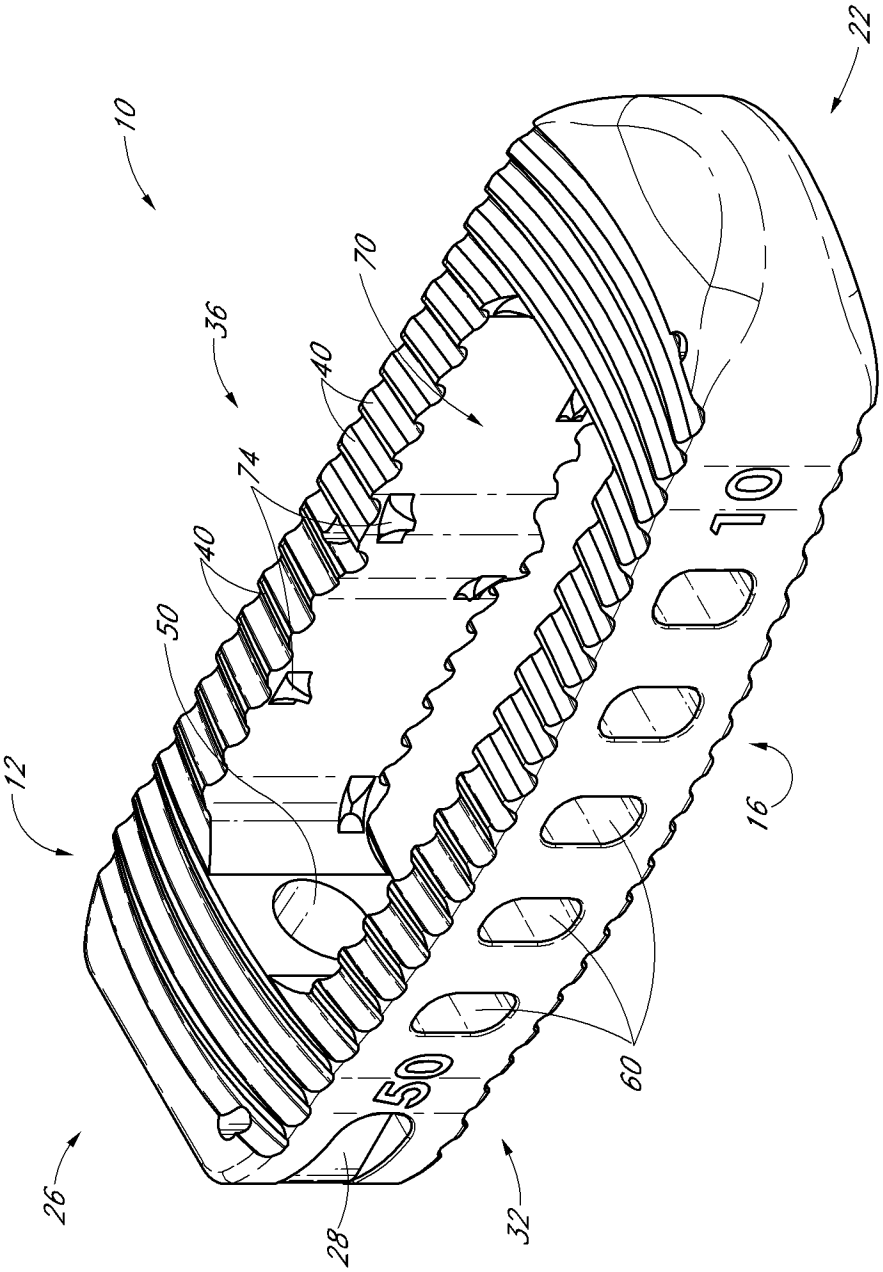


FIG. 1A

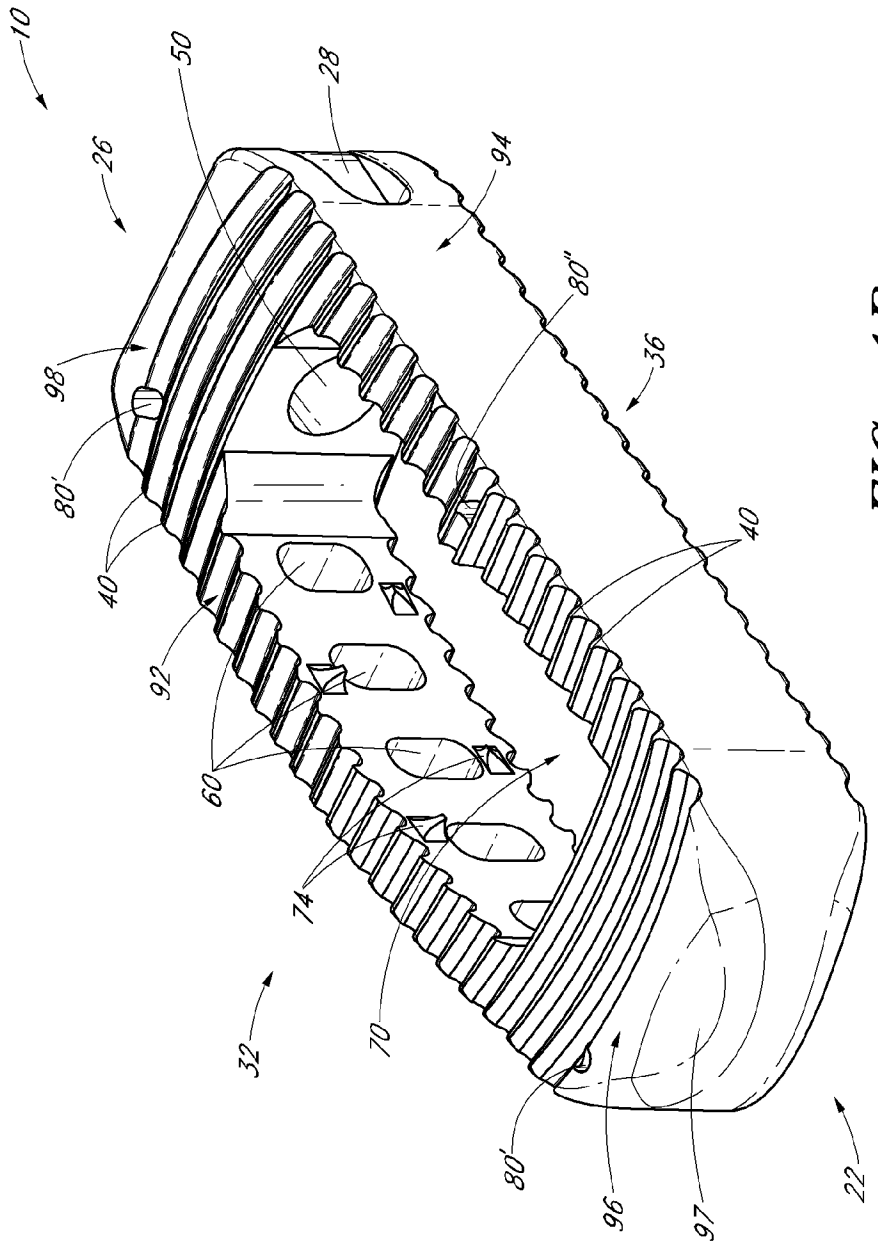


FIG. 1B

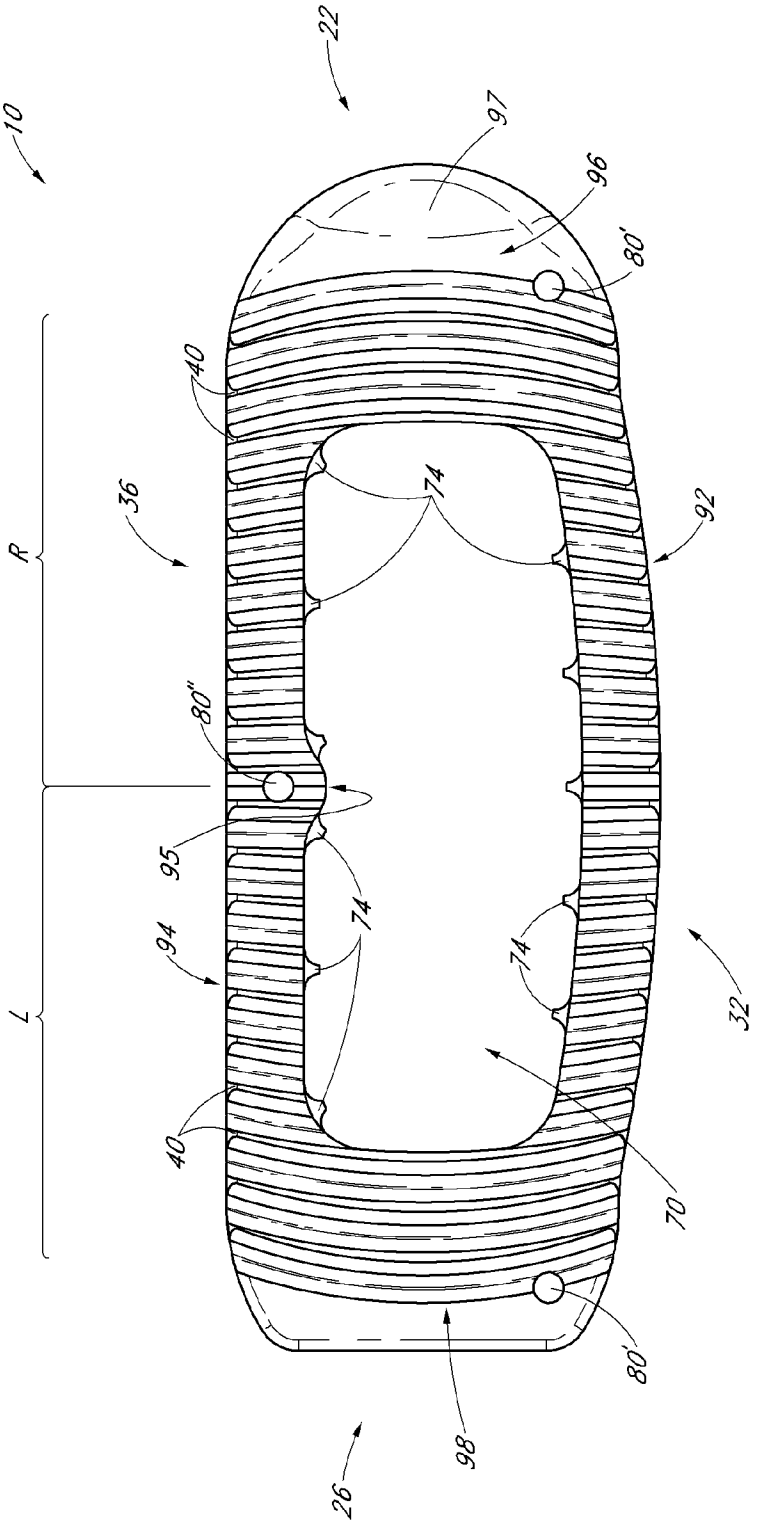


FIG. 2

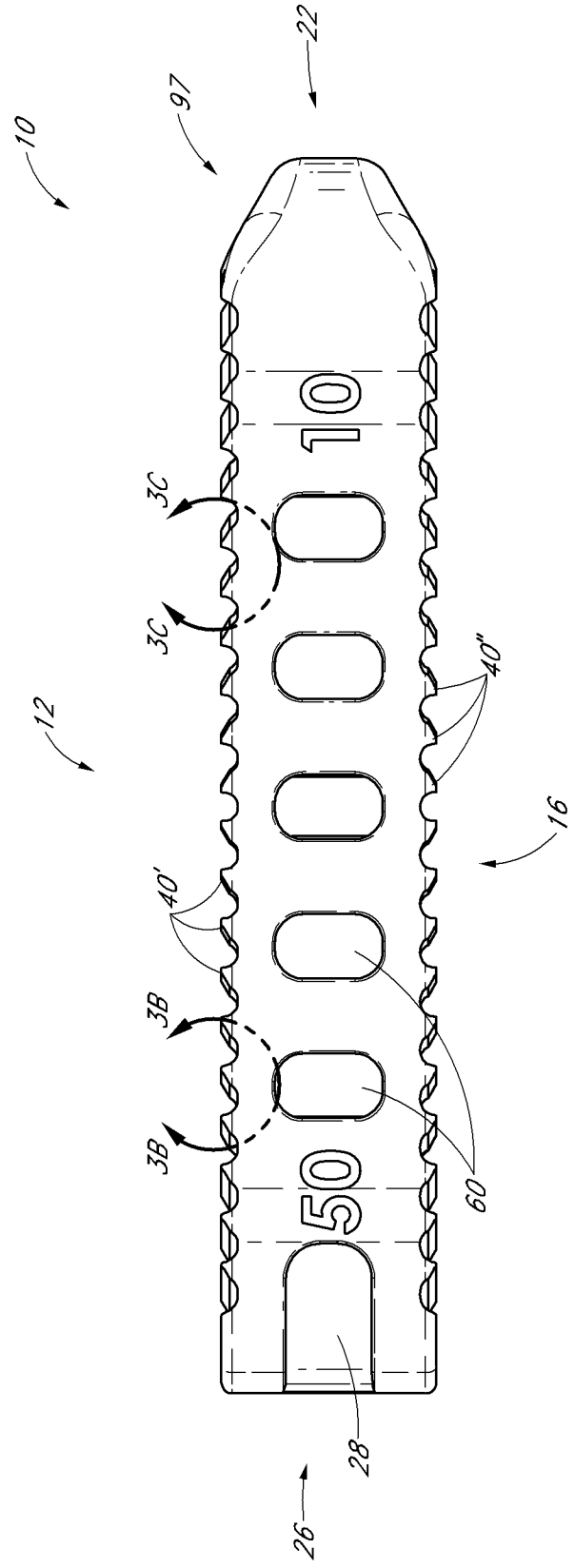


FIG. 3A

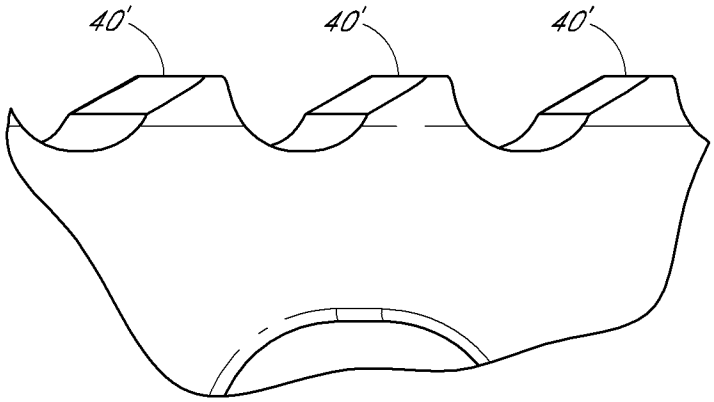


FIG. 3B

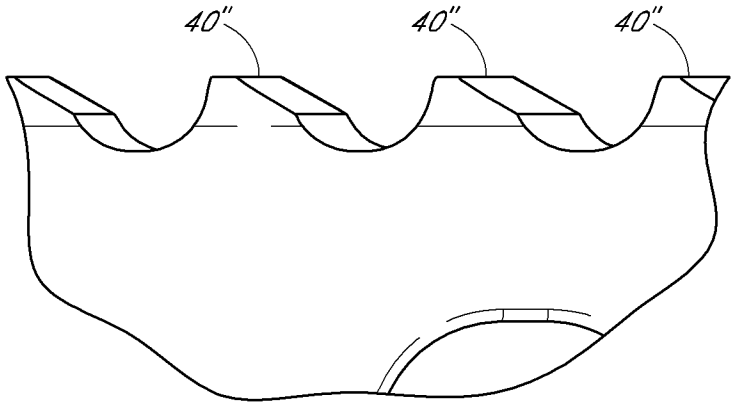


FIG. 3C

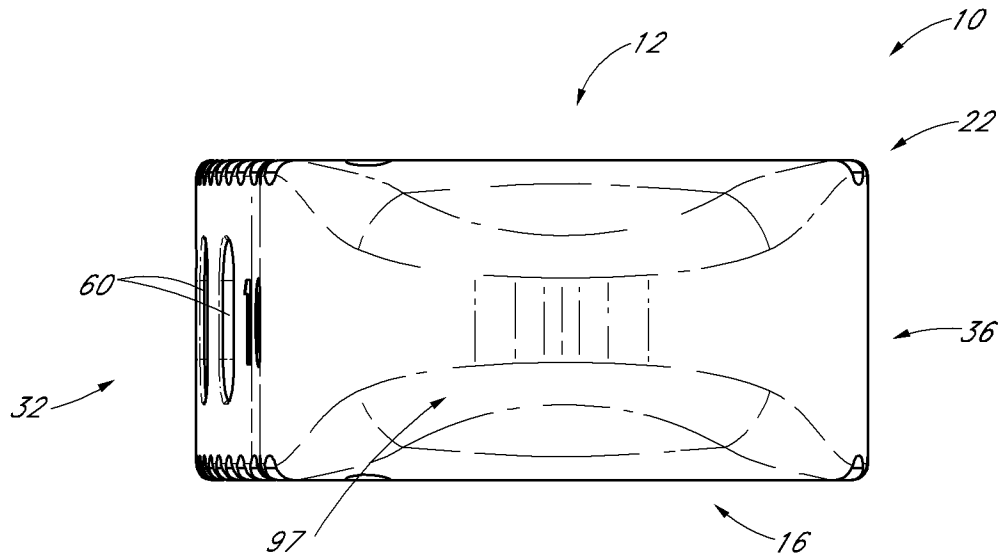


FIG. 4

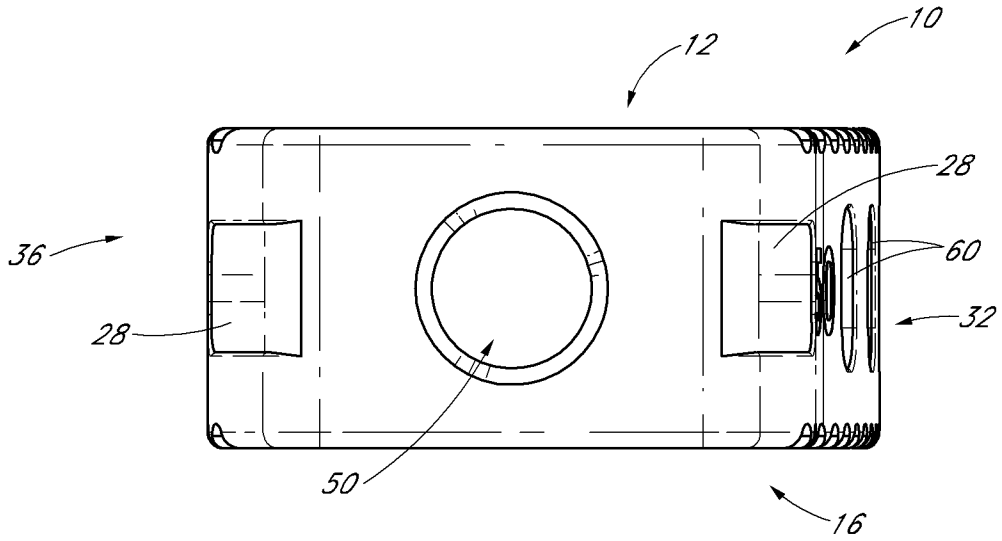


FIG. 5

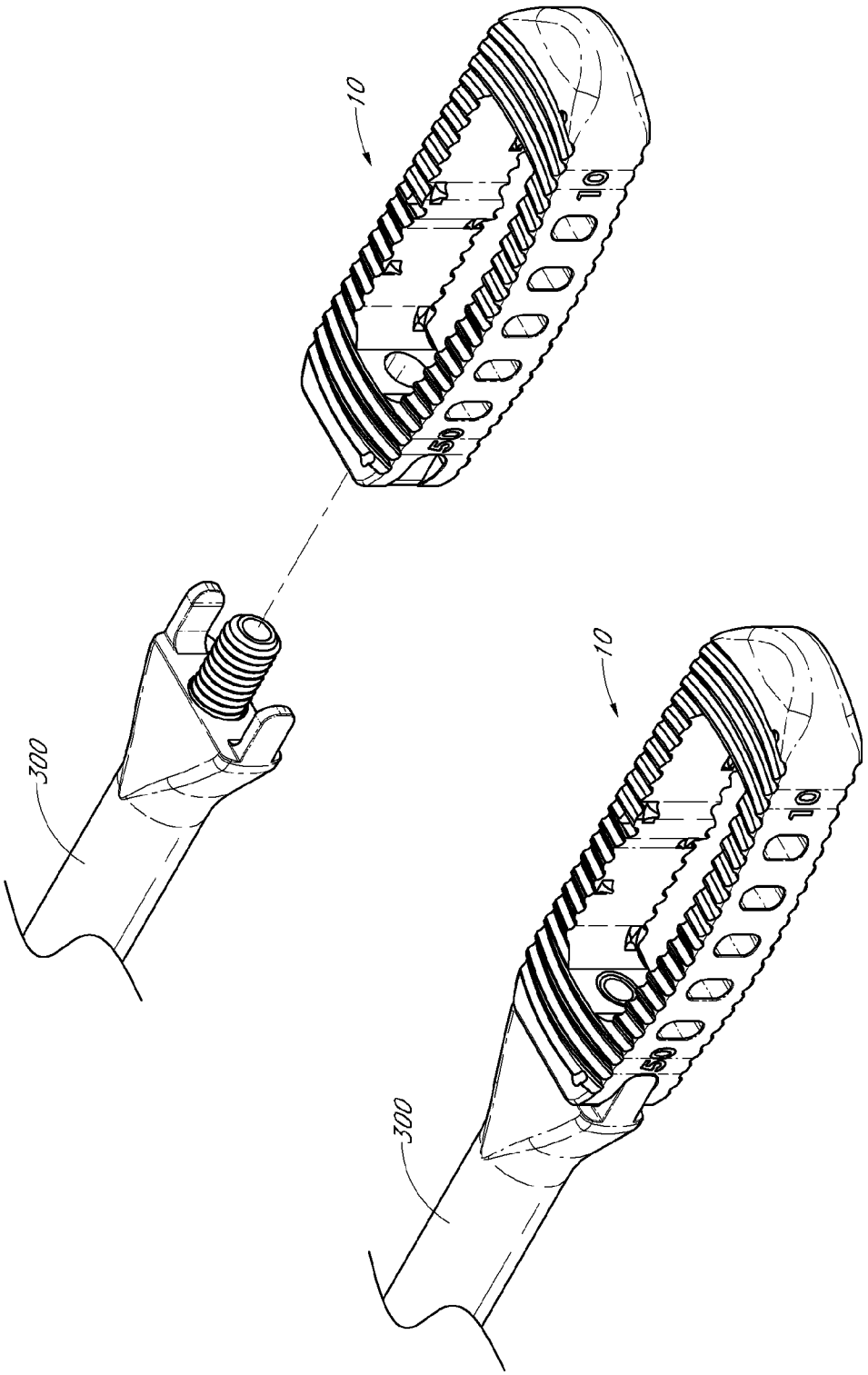


FIG. 6A

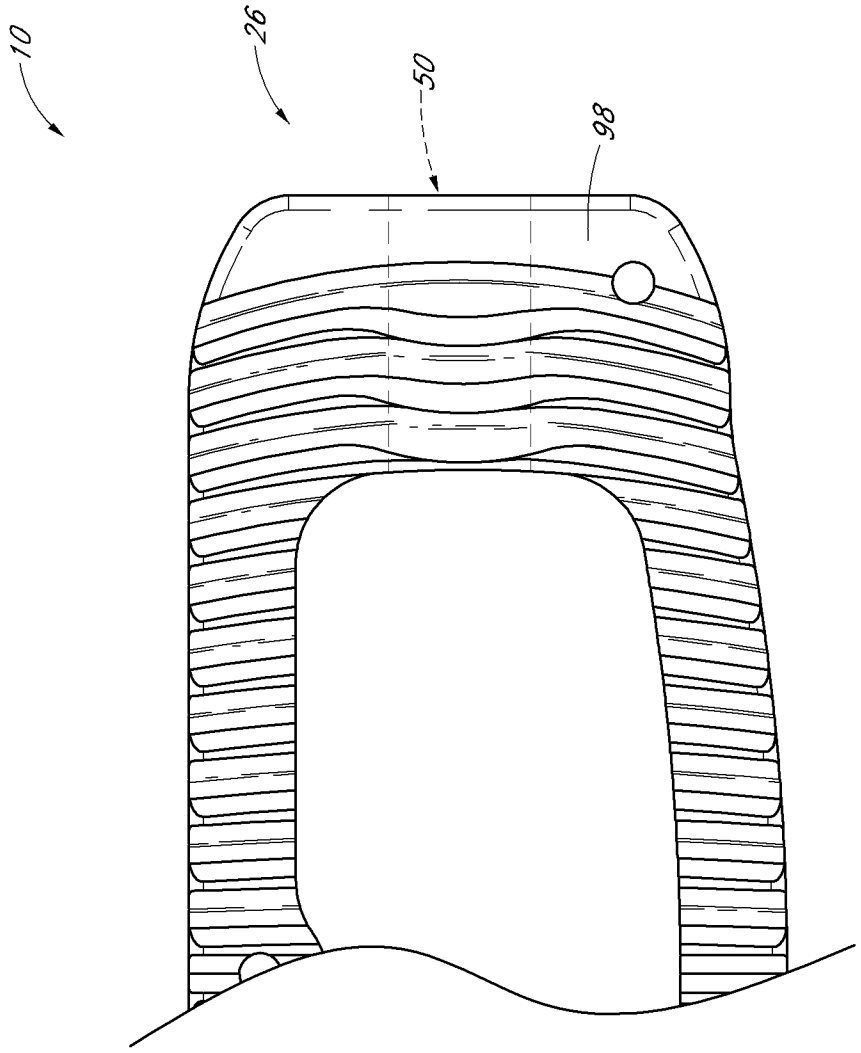


FIG. 6B

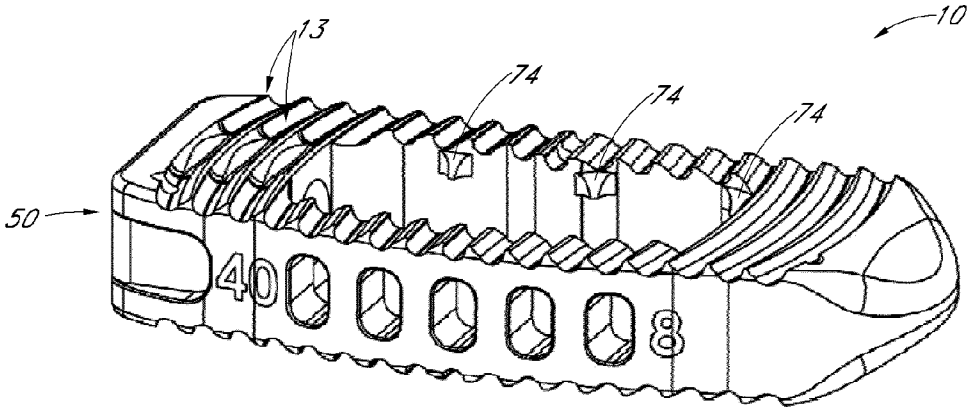


FIG. 6C

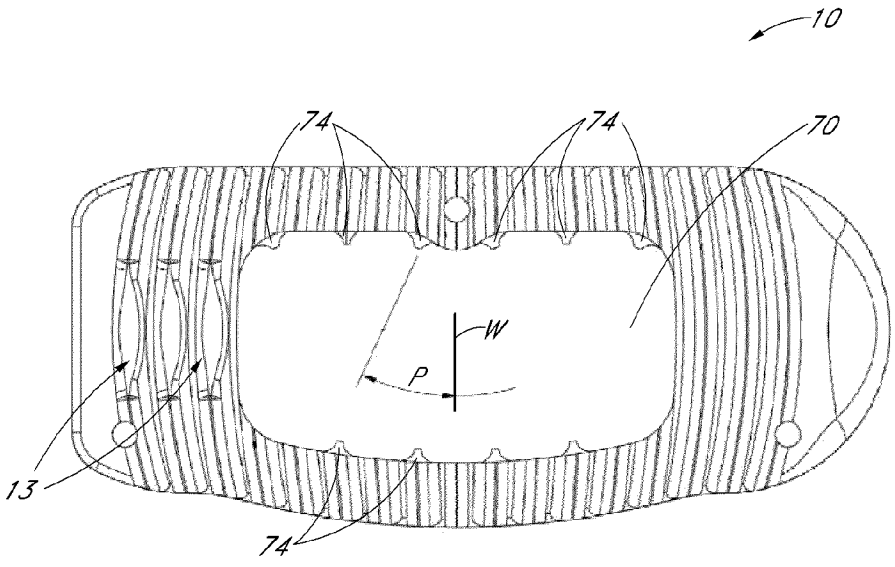


FIG. 6D

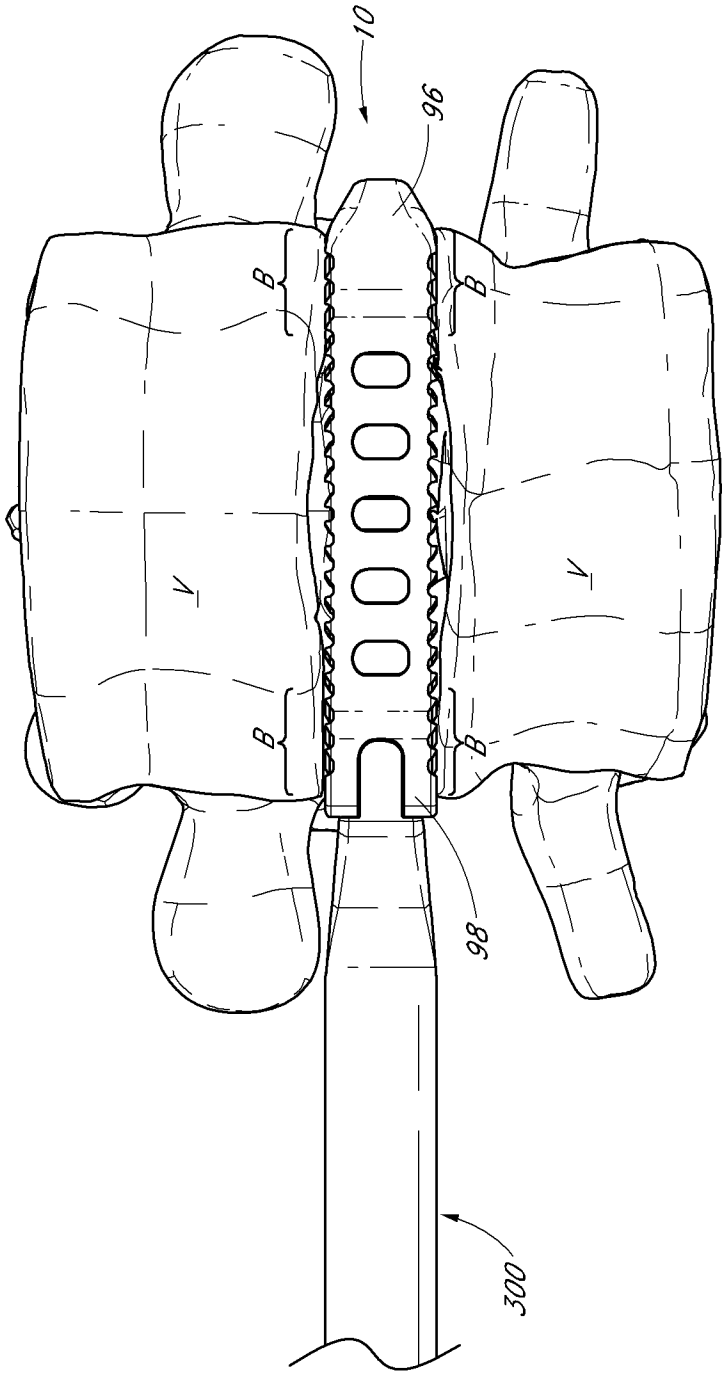


FIG. 7A

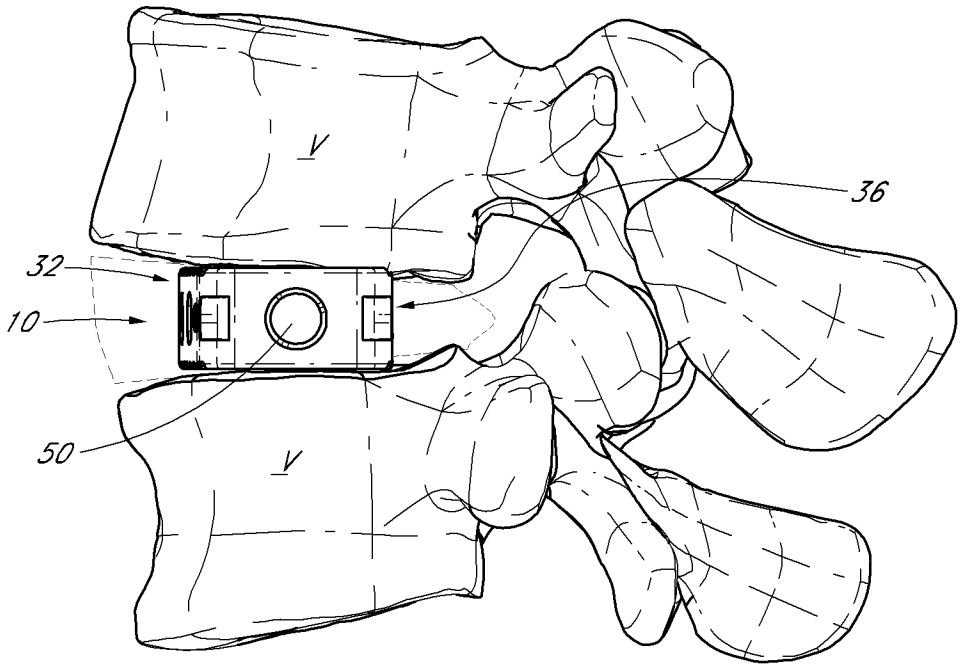
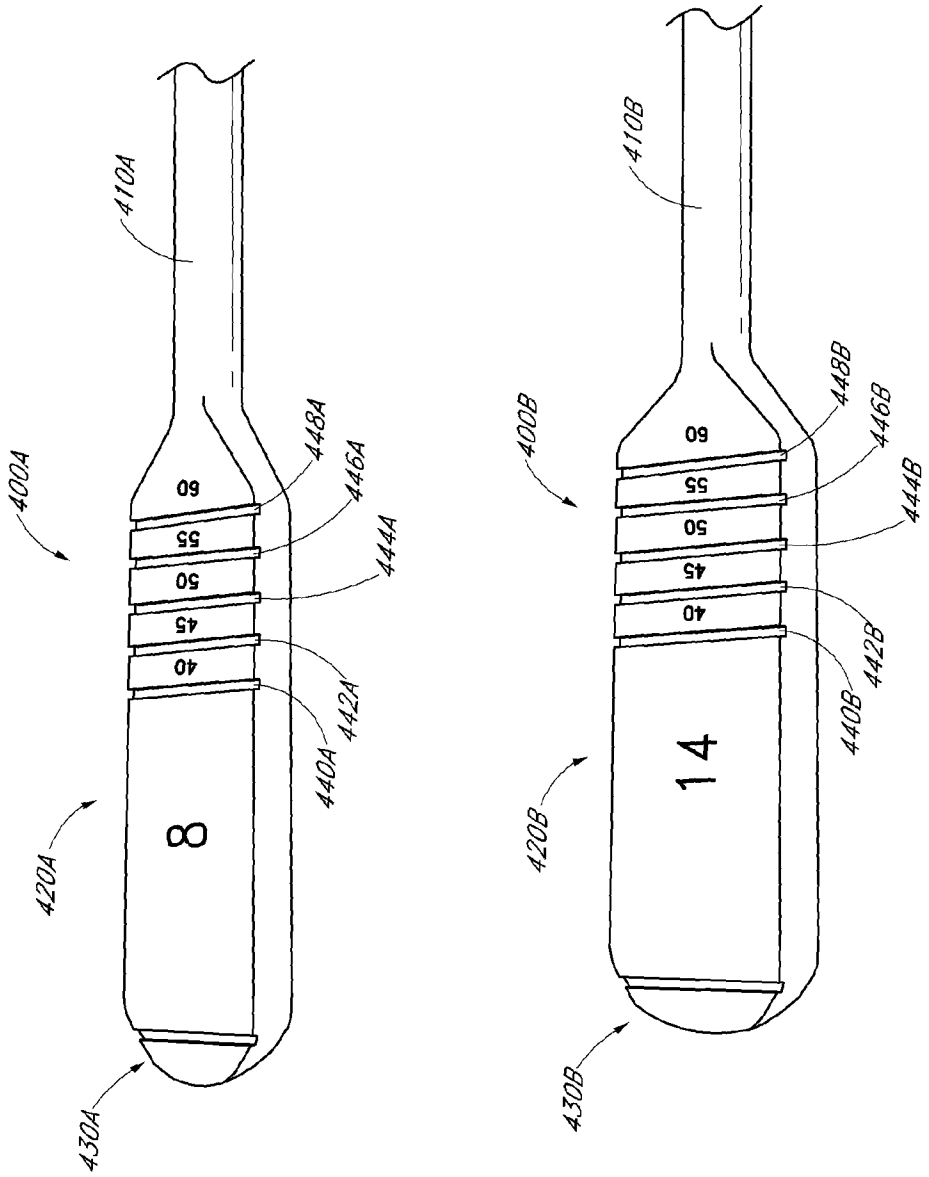


FIG. 7B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430B
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FIG. 8

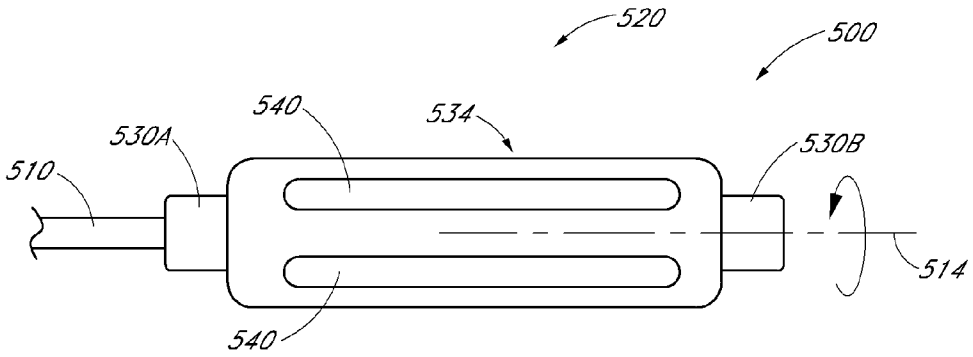

FIG. 9

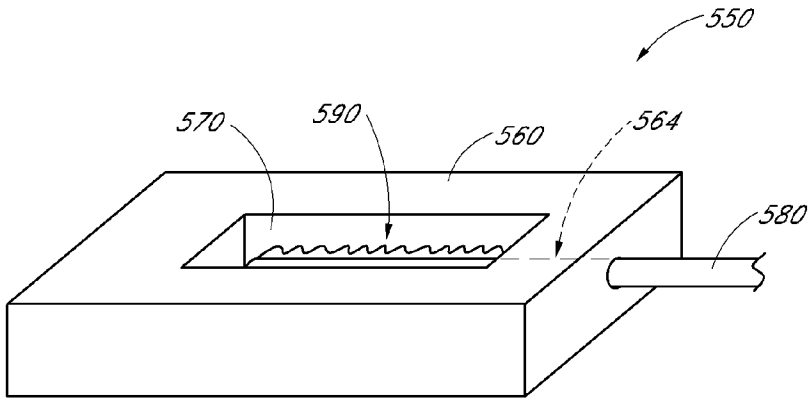

FIG. 10A

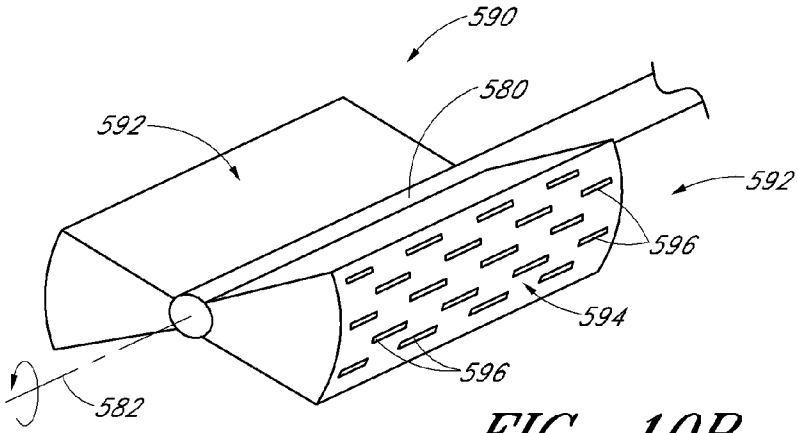

FIG. 10B

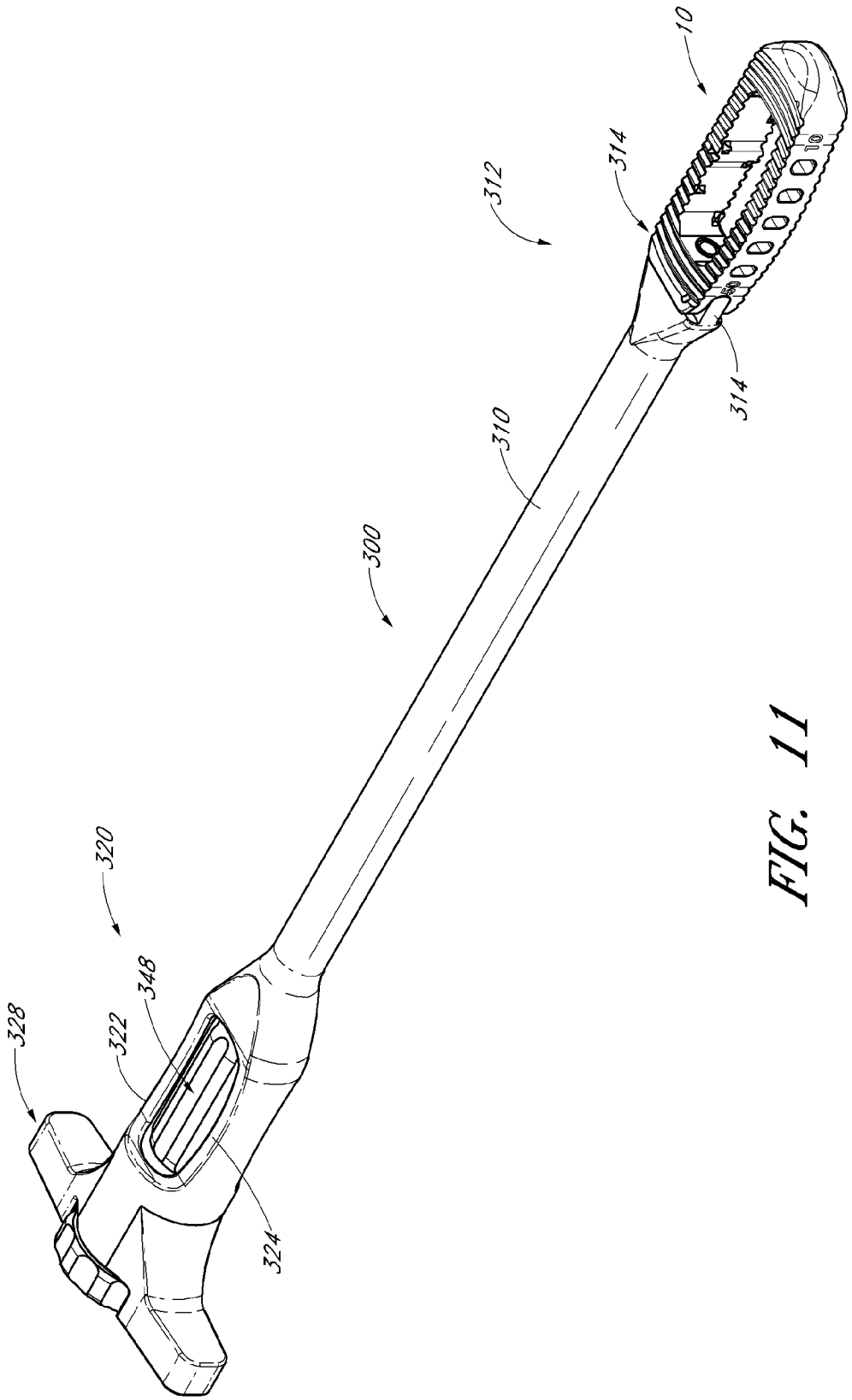

FIG. 11

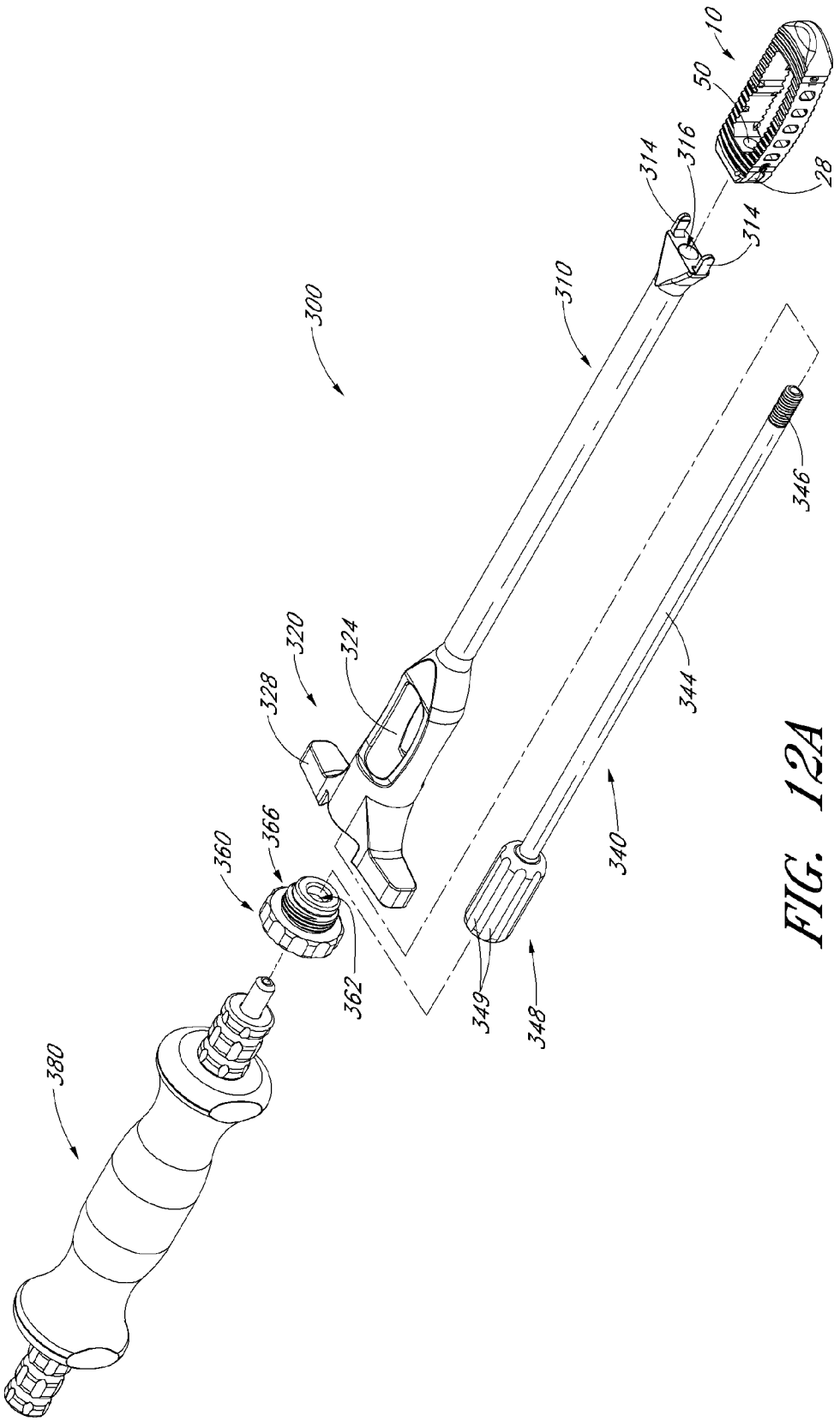
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FIG. 12A

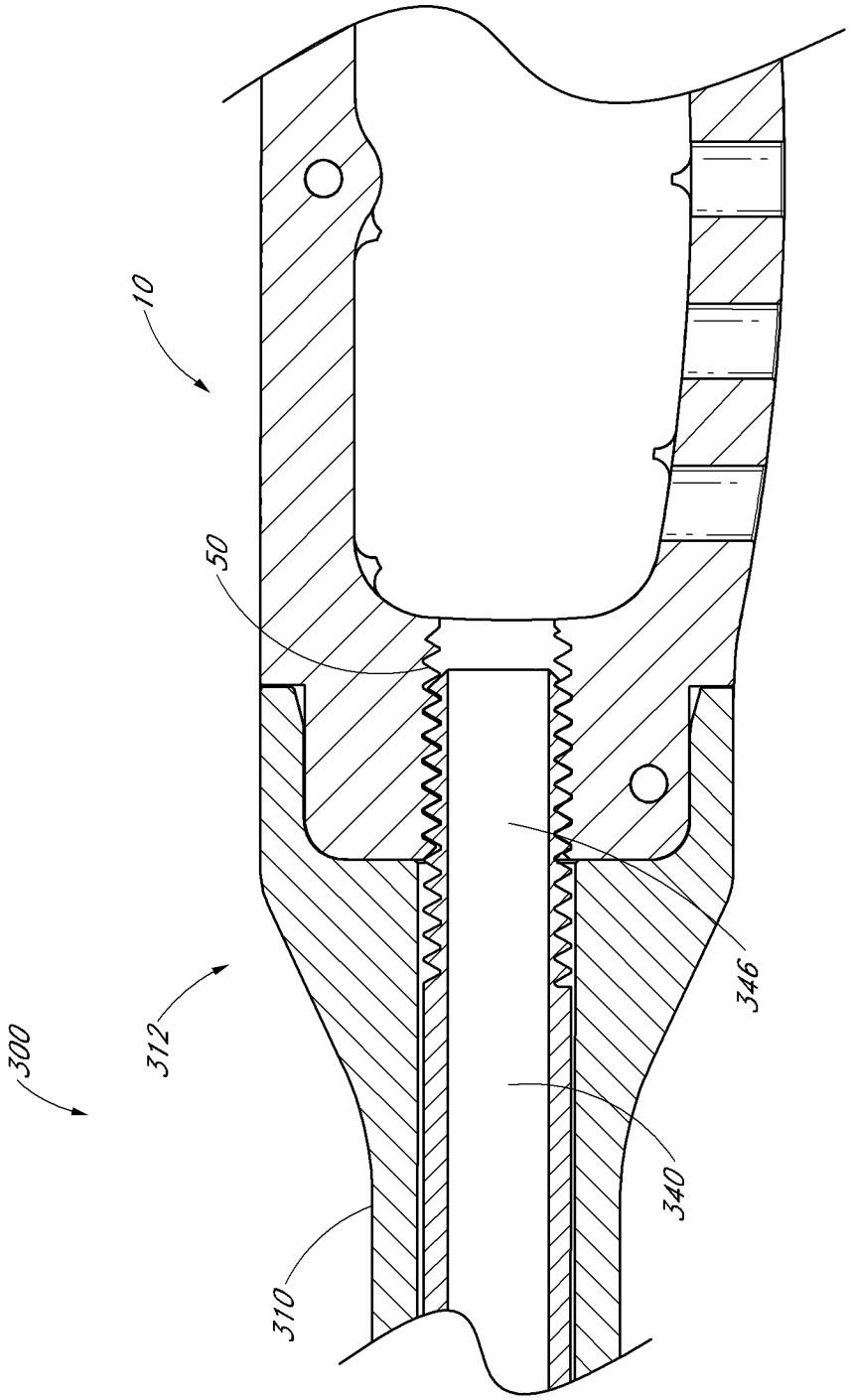

FIG. 12B

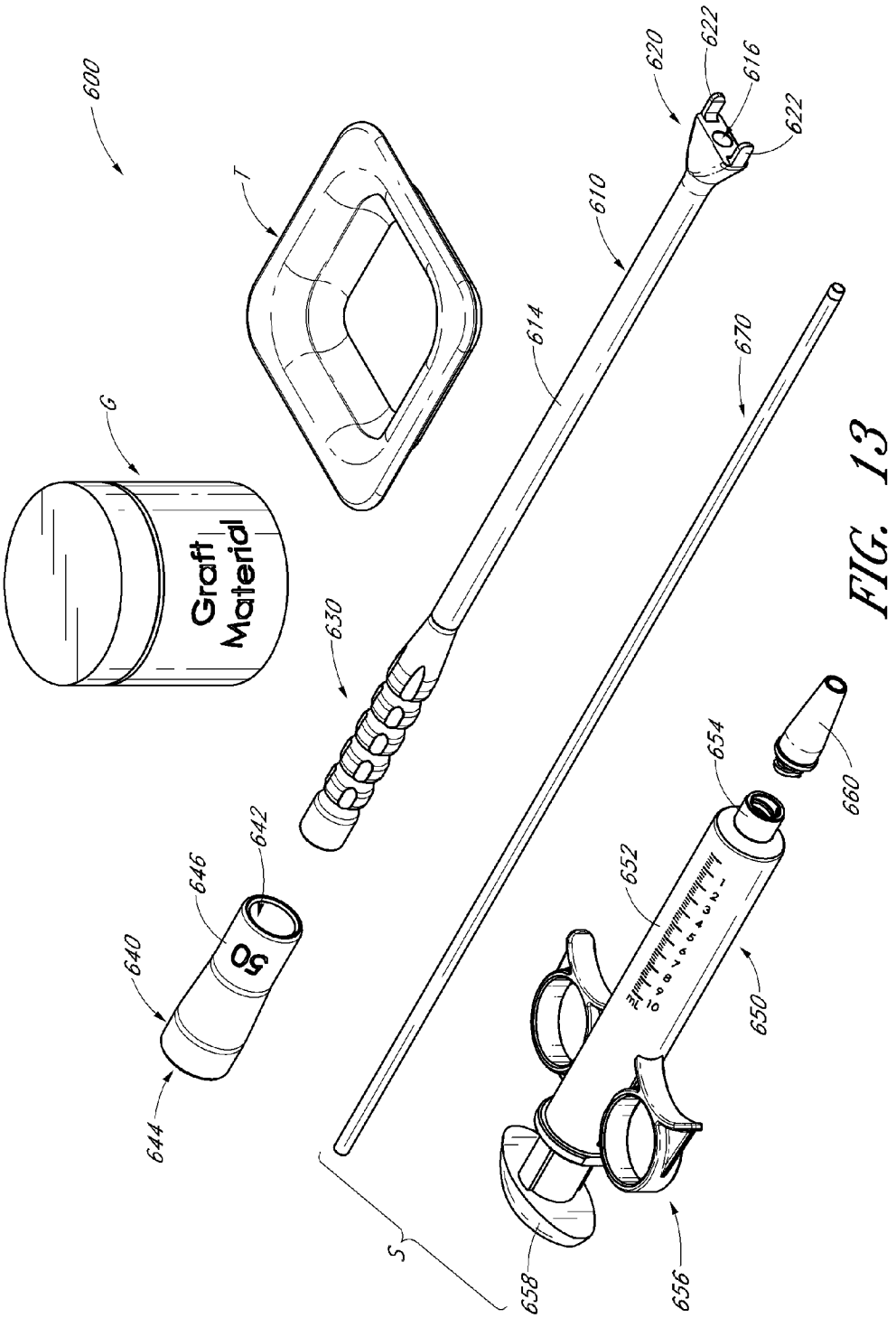
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FIG. 13

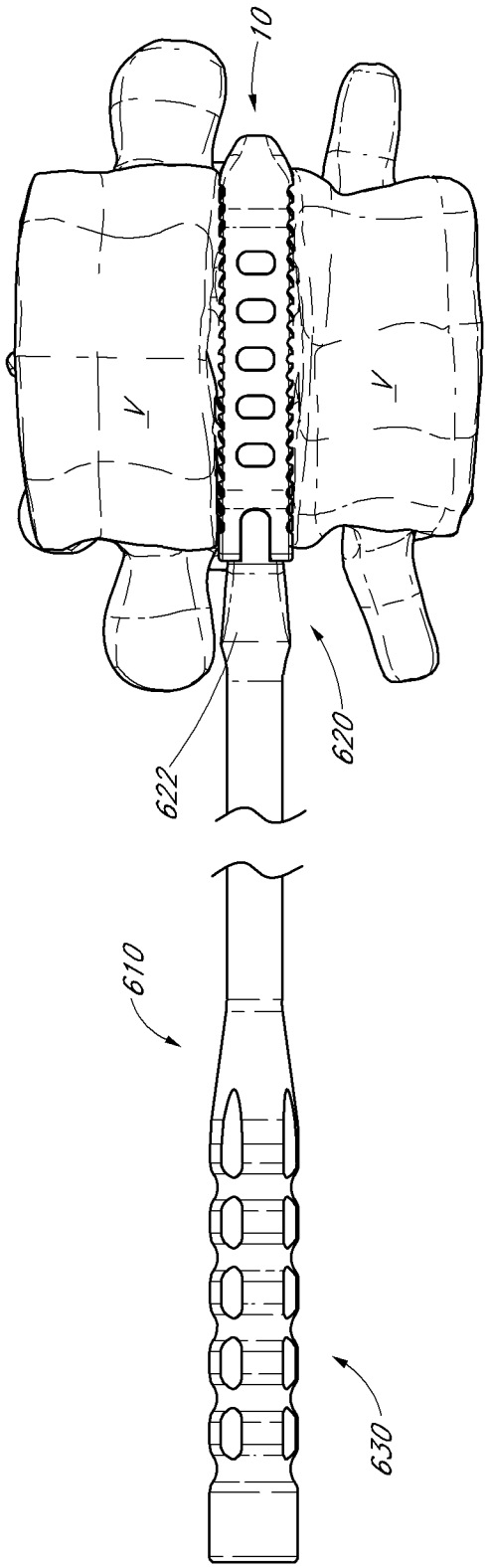
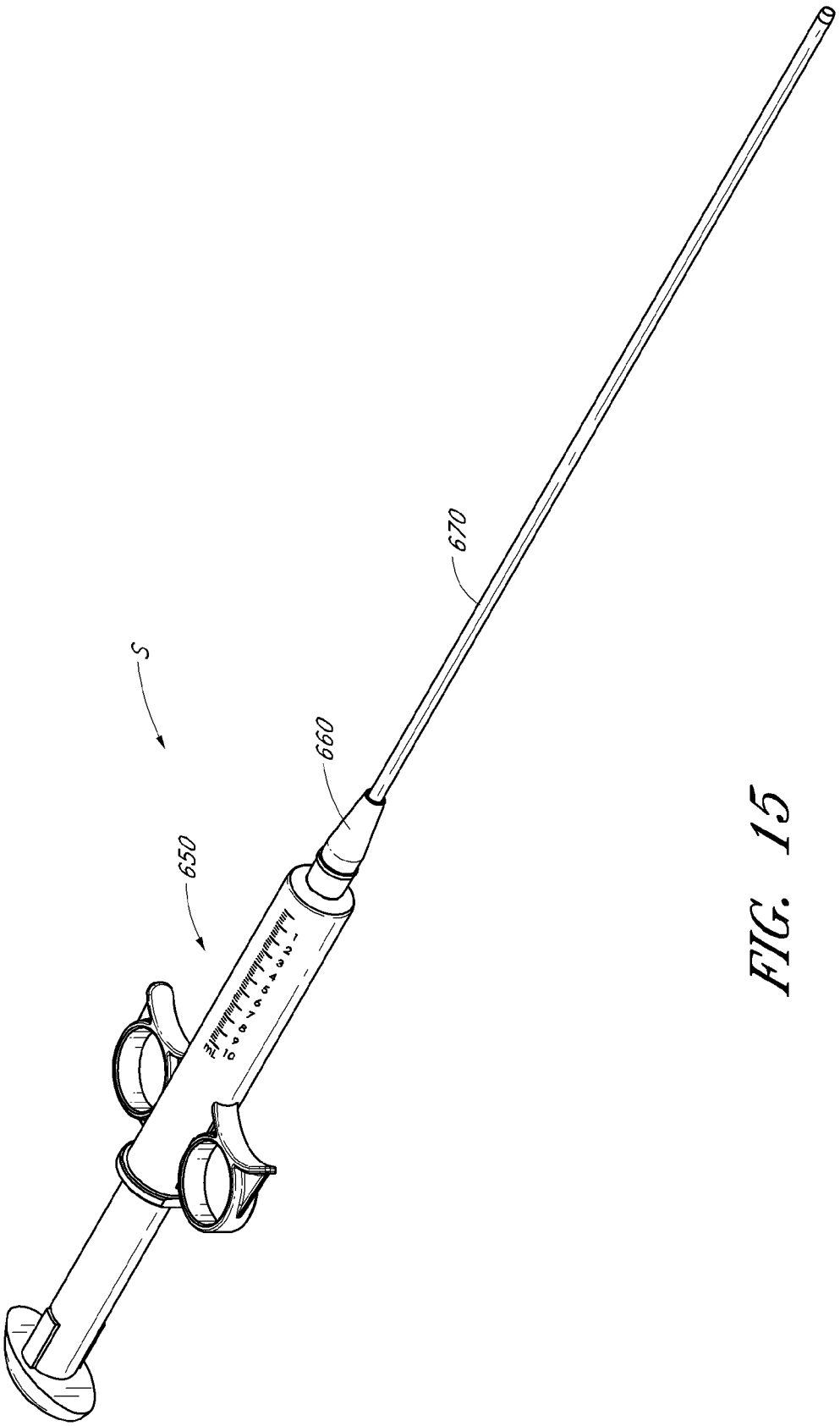


FIG. 14



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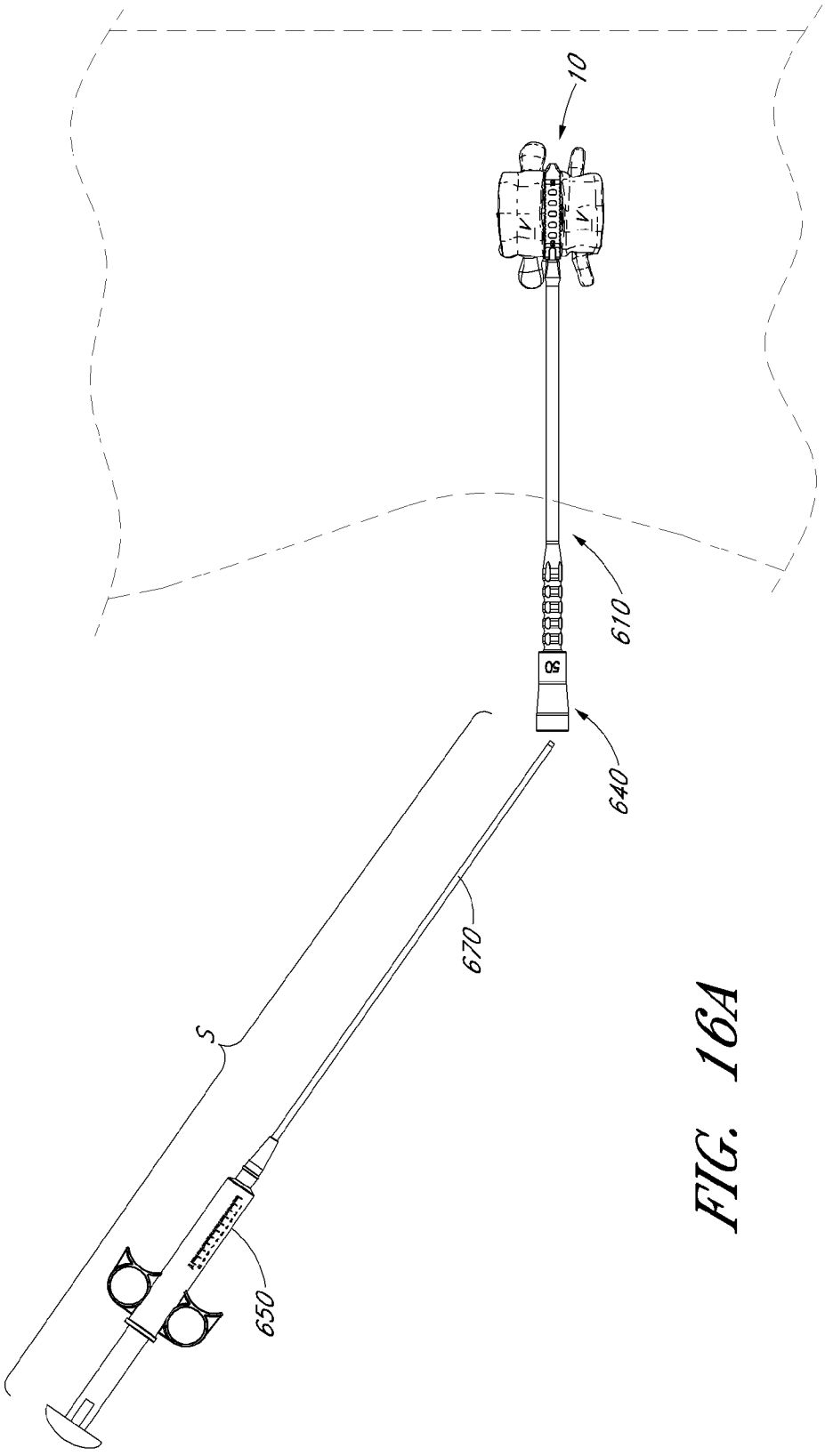


FIG. 16A

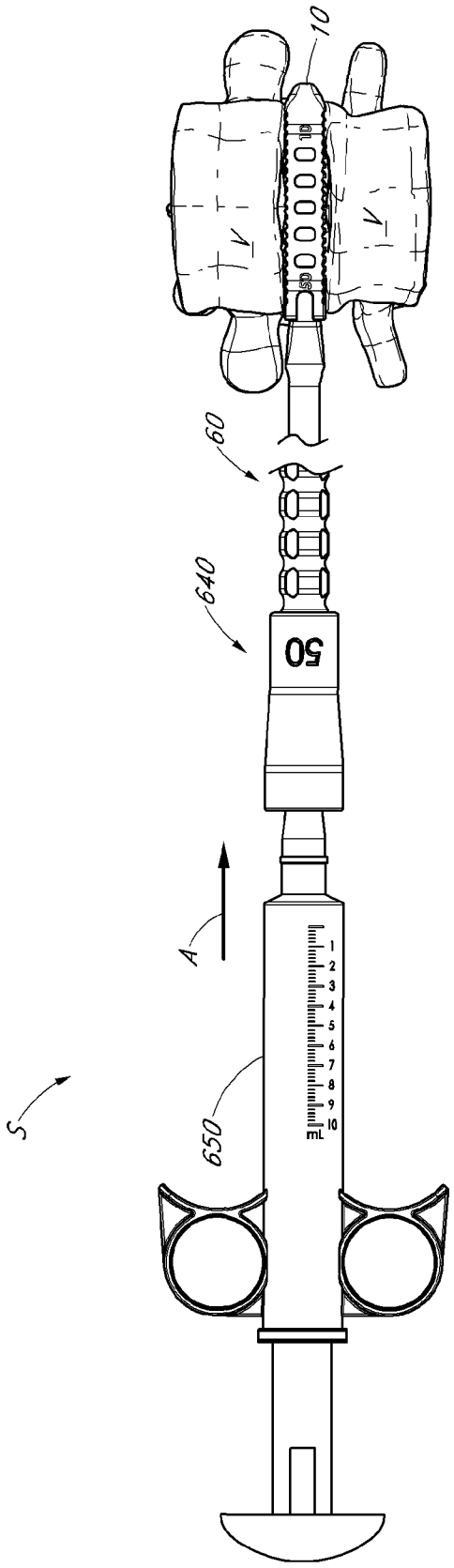


FIG. 16B

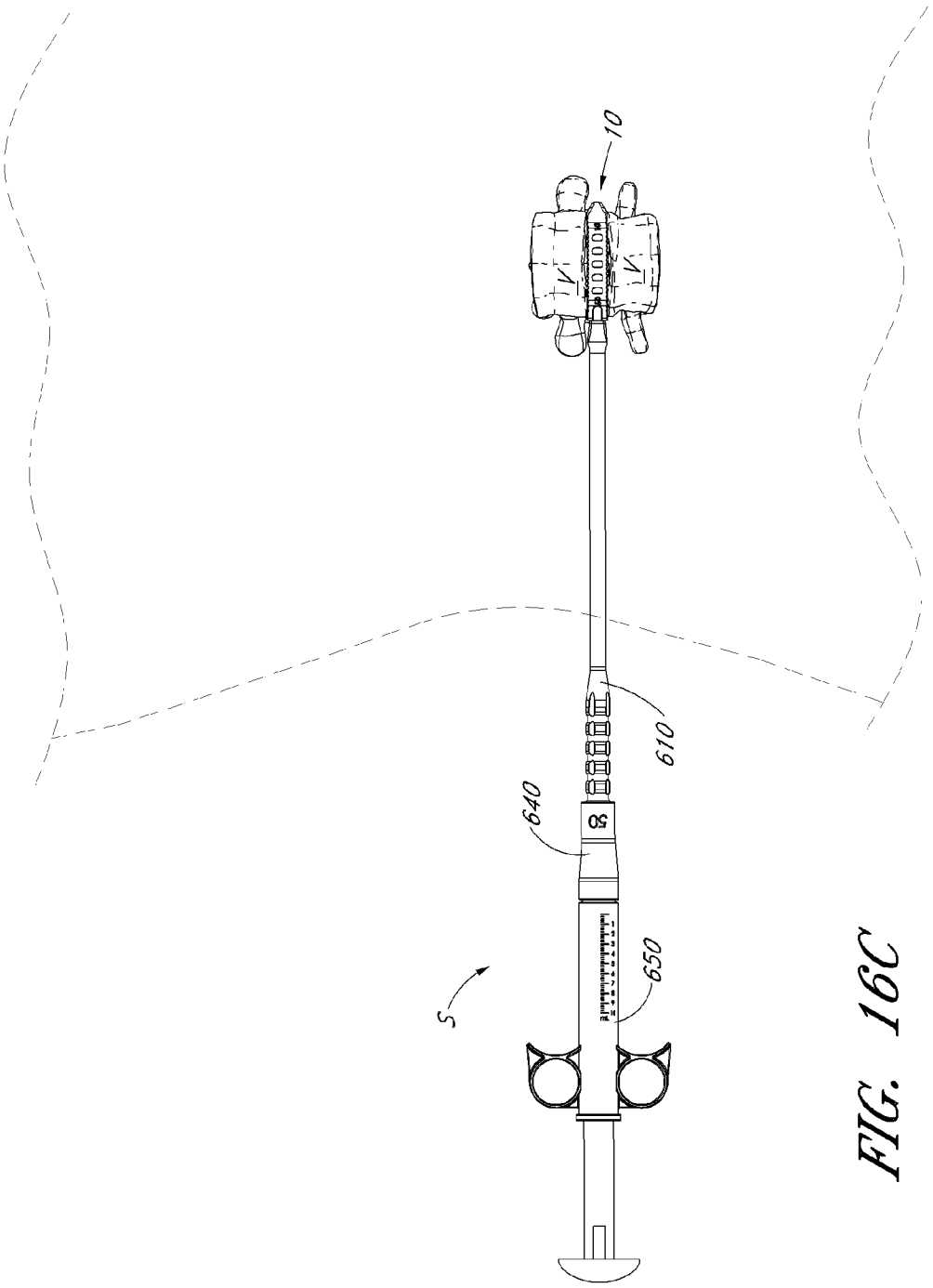


FIG. 16C

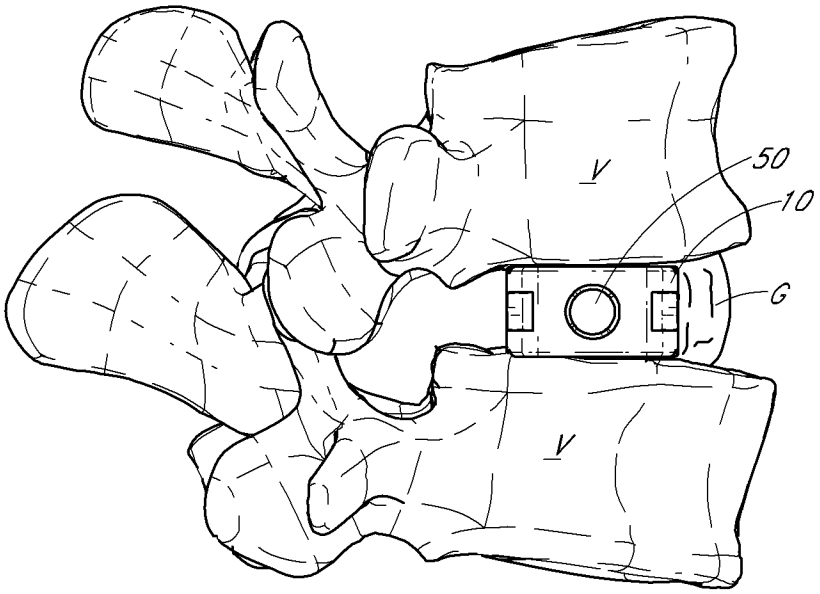


FIG. 17A

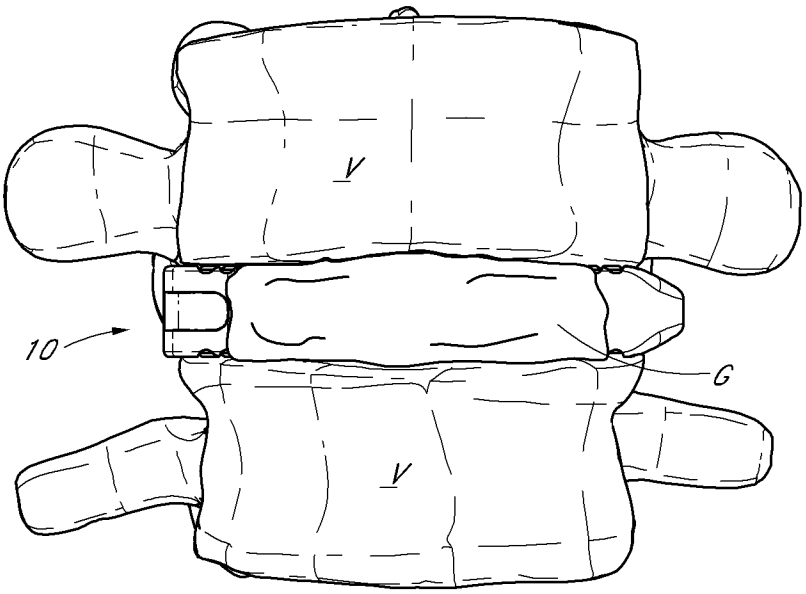


FIG. 17B

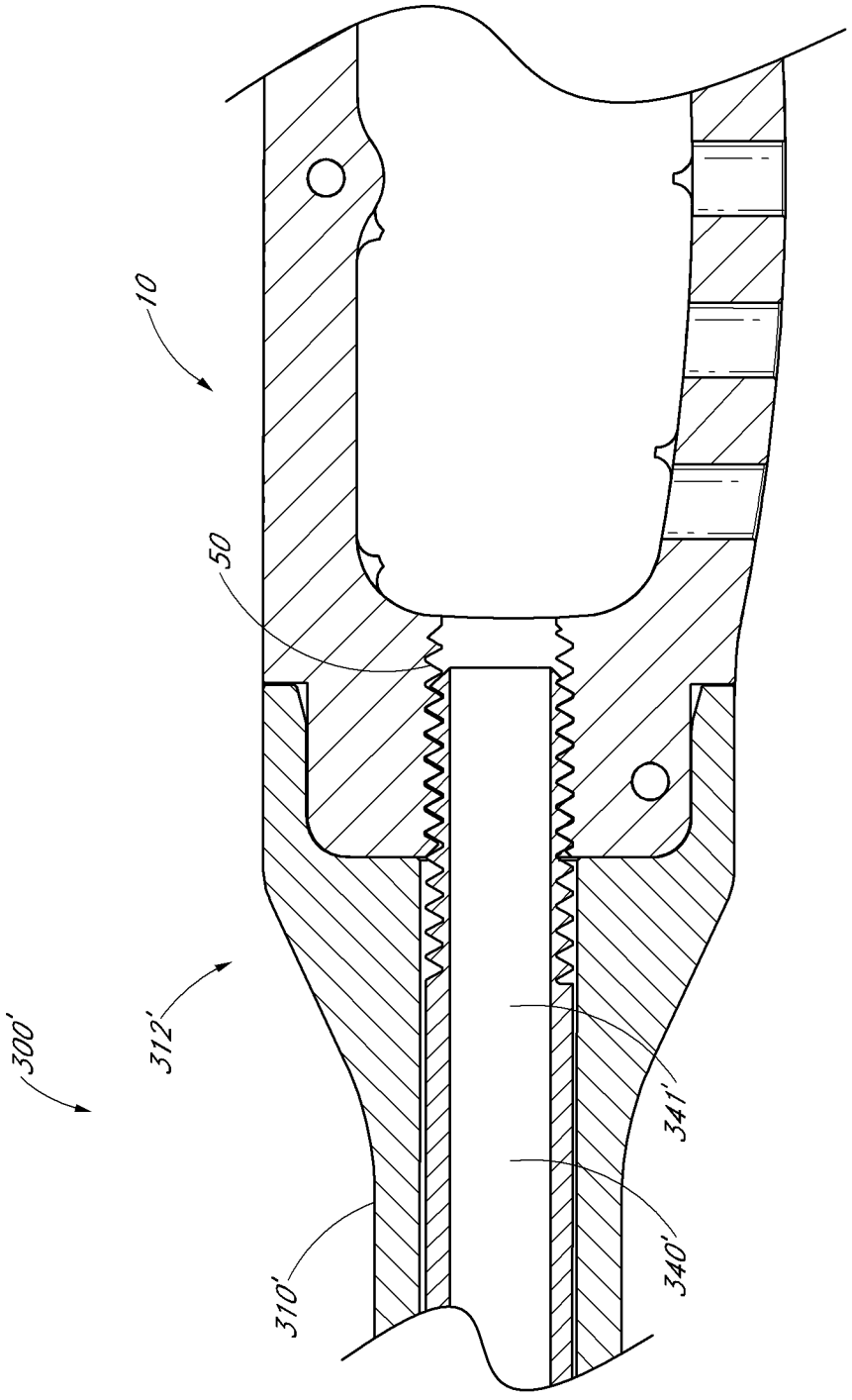
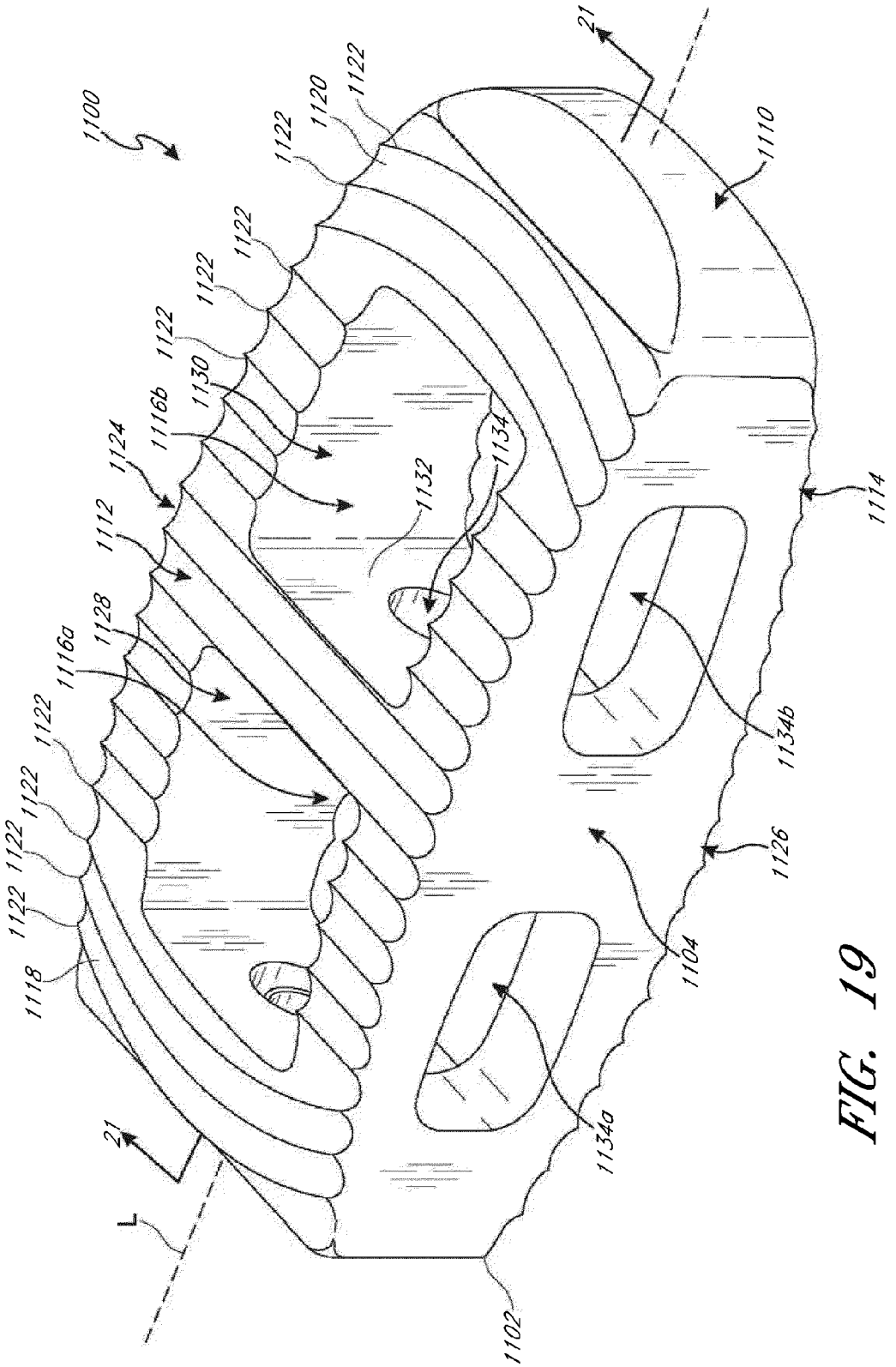


FIG. 18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1116b
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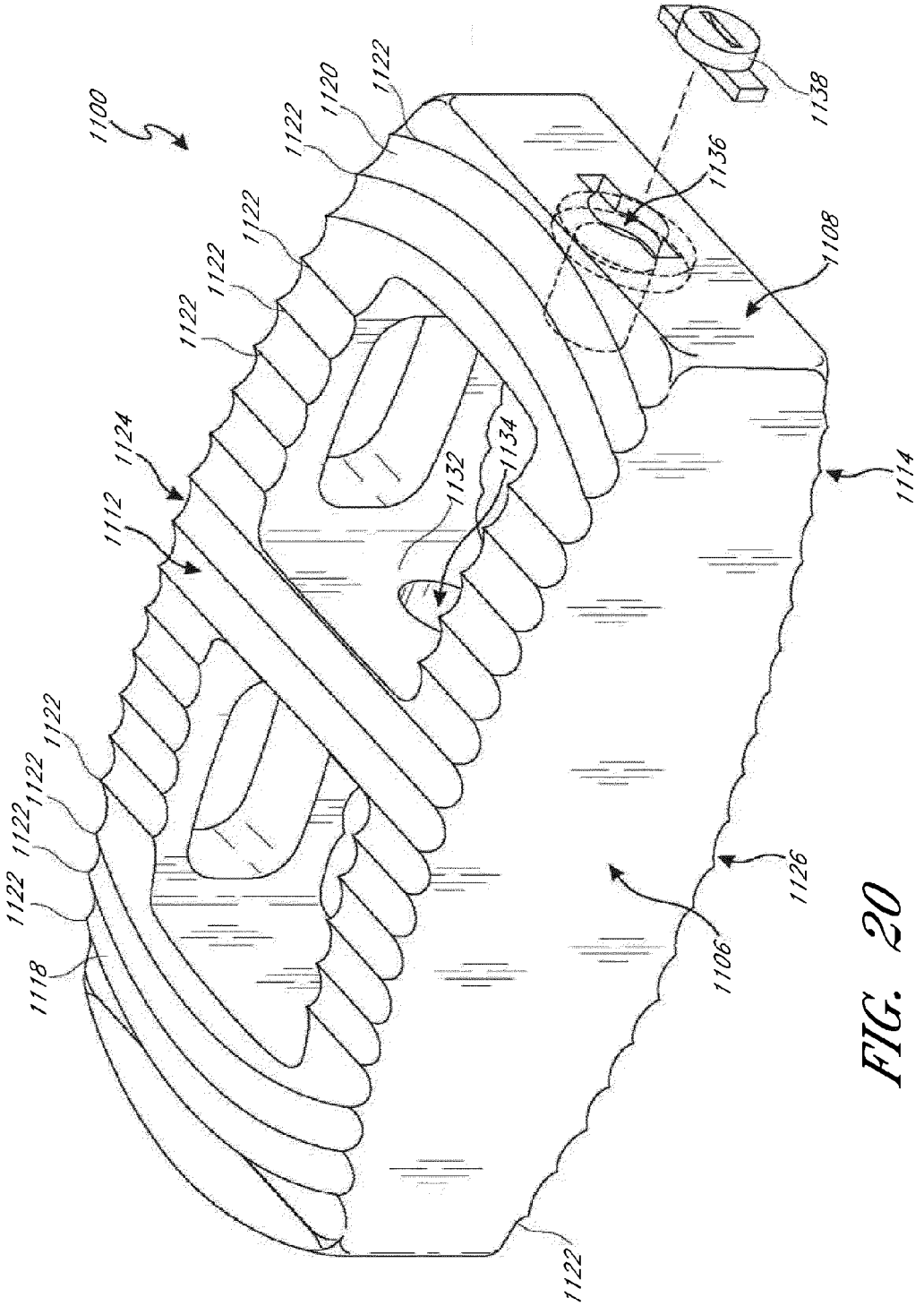
FIG. 19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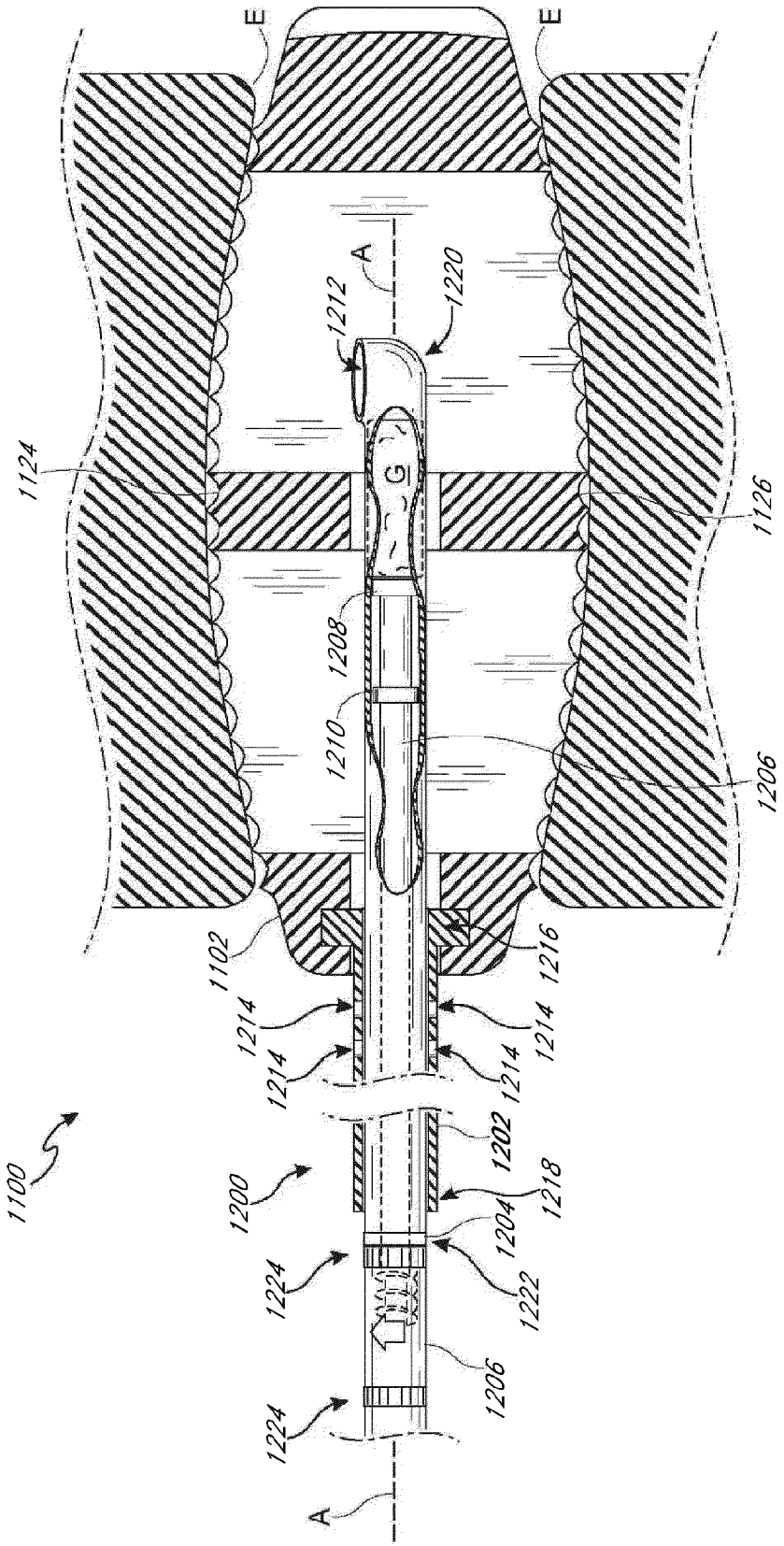
1118
1106
1122

FIG. 20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1202
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FIG. 21

INTERVERTEBRAL IMPLANTS AND RELATED TOOLS

PRIORITY DATA

This application is a continuation application of U.S. application Ser. No. 13/725,933, filed Dec. 21, 2012, which is a continuation of Ser. No. 13/049,693, filed Mar. 16, 2011, now U.S. Pat. No. 8,343,224, which claims the priority benefit under 35 U.S.C. §119(e) of U.S. Provisional Application No. 61/314,509, filed Mar. 16, 2010, and U.S. Provisional Application No. 61/389,671, filed Oct. 4, 2010. The entire contents of all of the foregoing applications are hereby incorporated by reference herein.

BACKGROUND

1. Field

This application generally relates to spinal fusion, and more specifically, to spinal implants and related systems, tools and methods.

2. Description of the Related Art

Intervertebral discs can degenerate or otherwise become damaged over time. In some instances, an intervertebral implant can be positioned within a space previously occupied by a disc. Such implants can help maintain a desired spacing between adjacent vertebrae and/or promote fusion between adjacent vertebrae. The use of bone graft and/or other materials within spinal implants can facilitate the fusion of adjacent vertebral bodies. Accordingly, a need exists for an improved intervertebral implant, as well as related instrumentation, tools, systems and methods.

SUMMARY

According to some embodiments, a spinal implant configured for placement within an intervertebral space of a patient comprises an anterior wall, a posterior wall, a first lateral wall and a second lateral wall, such that the first and second lateral walls generally extend between the anterior wall and the posterior wall. The spinal implant additionally comprises at least one internal chamber defined, at least in part, by the anterior wall, the posterior wall and the first and second lateral walls. In some embodiments, the implant comprises a top surface having a plurality of teeth configured to at least partially engage a lower surface of a first vertebral body and/or a bottom surface comprising a plurality of teeth configured to at least partially engage an upper surface of a second vertebral body, the second vertebral body being adjacent to said first vertebral body. In some embodiments, the at least one internal chamber extends at least partially from the top surface to the bottom surface of the implant. The implant further comprises at least one opening extending through the anterior wall, wherein such an opening is in fluid communication with the internal chamber. In some embodiments, the spinal implant additionally comprises at least one access port located in the anterior wall, the first lateral wall and/or the second lateral wall. In some embodiments, the implant is configured to releasably secure to an insertion tool using the access port. In some embodiments, the implant is configured to span across an entire width or substantially an entire width of the adjacent vertebral bodies. In one embodiment, the access port is configured to receive at least one graft material delivered into the at least one internal chamber. In some embodiments, the posterior wall does not comprise any openings.

According to some embodiments, excess graft material delivered into the at least one internal chamber through the access port is configured to exit the implant through one or more openings of the anterior wall. In one embodiment, the access port is threaded, so that a delivery tool comprising a corresponding thread pattern can be selectively attached and detached to the spinal implant. In some embodiments, the implant comprises one or more recesses and/or other features configured to mate with corresponding flanges or other protruding members of an implant delivery tool. In one embodiment, each of the first and second lateral walls is configured to generally align with peripheral bearing areas of the adjacent vertebral members. In other embodiments, the teeth along the top and/or bottom surfaces of the implant are configured to slant toward a lateral center of the implant. In some embodiments, the slanted teeth help retain the implant within the target intervertebral space after implantation and/or help reduce the likelihood the migration of grafting materials out of the at least one internal chamber of the implant along the top and bottom surfaces of the implant.

According to some embodiments, the first lateral wall and/or the second lateral wall comprises a tapered portion to facilitate insertion of the implant into the intervertebral space. In one embodiment, the spinal implant further comprises a plurality of prongs that extend into the internal chamber for retaining a graft or other member positioned therein. In some embodiments, such prongs are configured to retain at least one of a sponge, a porous foam and cured grafting materials within the at least one internal chamber of the implant. In some embodiments, the implant is configured for placement within a lumbar or thoracic portion of a patient's spine. In some embodiments, the implant is configured for lateral or anterior insertion into the intervertebral space. In several embodiments, the implant comprises polyether etherketone (PEEK) and/or any other material.

According to some embodiments, the length of each of the first and second lateral walls is approximately 10% to 20% of an overall length of the implant. In other embodiments, the length of each of the first and second lateral walls is less than about 10% or greater than about 20% of an overall length of the implant. In one embodiment, the teeth along at least one of the top and/or bottom surfaces of the implant are oriented, at least in part, in a concentric manner. In one embodiment, a radius of curvature of the teeth along at least one of the top and bottom surfaces of the implant increases with increasing distance from a center of the implant. In some arrangements, the top and/or bottom surfaces of the implant are generally planar. In other embodiments, the top and/or bottom surfaces of the implant are generally curved, fluted, rounded and/or non-planar.

According to some embodiments, the implant comprises a lordotic implant, such that a height of the first lateral wall is greater than a height of the second lateral wall. In some embodiments, the internal chamber does not comprise any interior walls or baffles. In alternative embodiments, the internal chamber comprises at least two internal sub-chambers divided by at least one interior wall or baffle. In one embodiment, the implant comprises at least one radio-opaque marker. In several embodiments, the access port is generally circular. In other embodiments, the access port is non-circular (e.g., square, other rectangular or polygonal, oval, elliptical, irregular, etc.).

According to some embodiments, the access port comprises a minimum diameter of approximately 6 mm. In other embodiments, the diameter or other cross-sectional dimension of the access port is greater or less than about 6 mm (e.g., 4 mm, 5 mm, 7 mm, 8 mm, etc.). In some embodiments, the access port is adapted to receive a fill tube, catheter or other conduit therethrough, wherein such fill tube, catheter or other

conduit is configured to selectively deliver a grafting or fill material into the internal chamber of the implant. In some embodiments, a ratio of a diameter of the at least one access port to a height of the first or second lateral wall through which the at least one access port is located is between approximately 0.4 and 0.8 (e.g., about 0.4, 0.45, 0.5, 0.55, 0.6, 0.65, 0.7, 0.75, 0.8, 0.85, 0.9, etc.). In one embodiment, a minimum ratio of a diameter of the at least one access port to a height of the first or second lateral wall through which the at least one access port is located is approximately 0.5, 0.6, 0.7 or 0.8.

According to some embodiments, the access port comprises a valve or other flow blocking device or feature to help retain grafting materials within the at least one internal chamber of the implant. In some embodiments, an exterior profile of the anterior wall is generally curved. In some arrangements, an exterior profile of the posterior wall is generally planar.

According to some embodiments, a method for promoting spinal fusion comprises providing a spinal implant (e.g., such as one of the implants disclosed herein or equivalents thereof) and positioning the spinal implant between two adjacent vertebral bodies or vertebrae of a patient. The method further comprises directing at least one graft material into the internal chamber of the spinal implant through a port of the implant. In some embodiments, at least a portion of the graft and/or other filler material (e.g., materials in excess of the capacity of the implant) delivered into the at least one internal chamber is configured to exit through one or more openings of the anterior wall when a sufficient amount of the at least one graft material has been delivered into the at least one internal chamber.

According to some embodiments, positioning the spinal implant between two adjacent vertebrae comprises removably securing the spinal implant to the distal end of an insertion tool assembly, wherein the insertion tool assembly is secured to, at least in part, to the access port of the spinal implant. In some embodiments, the access port is used to both secure the implant to an implant delivery tool and to deliver grafting and/or other materials to the inside of the implant. In some embodiments, directing graft and/or other materials into the internal chamber comprises passing such materials through a cannulated portion of the insertion tool assembly. In other embodiments, directing the material into the internal chamber comprises passing the materials through a separate conduit adapted to be removably positioned within the access port of the spinal implant. In one embodiment, directing the graft and/or other materials into the internal chamber comprises injecting such materials through tubing using a syringe.

According to some embodiments, the tubing is routed through an internal passage of a fill tube assembly, wherein fill tube assembly is configured to engage at least a portion of the spinal implant while the graft and/or other materials are directed into the internal chamber of the implant. In some embodiments, at least a portion of the graft material delivered into the internal chamber is configured to exit through an interface between the upper and/or lower surface of the implant and the adjacent endplate surfaces of the vertebral bodies. In some embodiments, at least a portion of the internal chamber comprises a graft material prior to positioning the spinal implant between the two adjacent vertebrae. In some embodiments, an additional volume of a graft material is delivered into the internal chamber of the implant after the spinal implant has been secured between the two adjacent vertebrae.

According to some embodiments, the method further includes preparing at least one adjacent vertebral body surface for the delivery of the spinal implant, wherein preparing an adjacent vertebral body surface comprises abrading said surface using a rasping and/or other abrading or roughening tool. In some embodiments, such tools comprise one or more roughened surfaces or features configured to abrade bone and/or other tissue. In some embodiments, the method additionally comprises placing a sizing tool within a target intervertebral space prior to positioning the spinal implant between two adjacent vertebrae of a patient in order to determine the appropriate size of said spinal implant. In some embodiments, the sizing tool is configured to distract the adjacent vertebrae by a desired distance.

According to some embodiments, a kit includes a spinal implant (e.g., such as any of those disclosed herein or equivalents thereof), an implant delivery tool configured to removably secure to the spinal implant and a graft material delivery system configured to selectively deliver at least one graft and/or other filler material into an interior (e.g., internal chamber) of the spinal implant. In some arrangements, the graft material delivery system comprises a syringe, a sizing tool and a conduit configured to pass through the at least one access port of the spinal implant.

According to some embodiments, a method for promoting spinal fusion using a spinal implant comprises providing a spinal implant, wherein the spinal implant comprises an anterior wall, a posterior wall and two lateral walls configured to extend between the anterior wall and the posterior wall. In some embodiments, the spinal implant further comprises at least one internal chamber generally positioned between the anterior wall, the posterior wall and the two lateral walls, wherein the internal chamber being is adapted to receive at least one graft and/or other fill material. In some arrangements, the anterior wall of the spinal implant comprises at least one opening or hole that places the internal chamber in fluid communication with an exterior area or portion of the spinal implant. In one embodiment, at least one of the two lateral walls comprises an access port. The method additionally includes positioning the spinal implant between two adjacent vertebrae of a patient and directing at least one graft and/or other fill material into the internal chamber of the spinal implant through the access port. In some embodiments, at least a portion of the graft and/or other fill material delivered into the internal chamber is configured to exit through the one or more of the openings of the anterior wall.

In some embodiments, positioning the spinal implant between two adjacent vertebrae comprises removably securing the spinal implant to the distal end of an insertion tool assembly, wherein the insertion tool assembly is secured to, at least in part, to the access port of the spinal implant. In one embodiment, directing the graft material into the internal chamber comprises passing the graft material through a cannulated portion of the insertion tool assembly. In some embodiments, directing the graft material into the internal chamber comprises injecting one or more graft materials through flexible tubing using a syringe. In some embodiments, the flexible tubing is routed through an internal passage of a fill tube assembly, wherein the fill tube assembly is configured to engage at least a portion of the spinal implant while the graft material is being directed into the internal chamber. In some arrangements, at least a portion of the graft and/or other fill material delivered into the internal chamber is configured to exit through an interface between the upper surface and/or lower surface of the spinal implant and an adjacent endplate surface of a vertebral body. In one embodiment, at least a portion of the internal chamber comprises a graft material prior to positioning the spinal implant between the two adjacent vertebrae. In some embodiments, such a

pre-loaded graft material or item comprises a graft, an absorbent sponge or other member and or the like.

According to some embodiments, an implant configured for placement within an intervertebral space of a patient comprises an anterior wall, a posterior wall, a first lateral wall and a second lateral wall, wherein the first and second lateral walls are configured to extend between the anterior wall and the posterior wall. The implant further includes a top surface having a plurality of teeth adapted to at least partially engage a lower surface of a first vertebral body and a bottom surface having a plurality of teeth adapted to at least partially engage an upper surface of a second vertebral body, wherein the second vertebral body is adjacent to the first vertebral body. The implant further comprises one or more internal chambers positioned between the anterior wall, the posterior wall, the first lateral wall and the second lateral wall, wherein the internal chamber at least partially extends from the top surface to the bottom surface of the implant.

In some embodiments, the implant additionally includes at least one opening extending through the anterior wall, wherein the opening is in fluid communication with the internal chamber. In one embodiment, the implant further comprises at least one access port located in the anterior wall, the first lateral wall and/or the second lateral wall, wherein the implant is configured to releasably secure to an insertion tool using the access port. In some embodiments, the access port is configured to receive a graft material that is delivered into the internal chamber after the implant has been secured within the intervertebral space. In one embodiment, the posterior wall does not comprise any openings. In some arrangements, the graft material delivered into the internal chamber is configured to exit the implant through at least one opening of the anterior wall.

According to some embodiments, the implant comprises polyether etherketone (PEEK). In several arrangements, the length of each of the first and second lateral walls is approximately 10-20% of the overall length of the implant. In some embodiments, each of the first and second lateral walls is configured to generally align with the peripheral bearing areas of the adjacent vertebral members. In some embodiments, the plurality of teeth situated along the top and/or bottom surfaces of the implant are configured to slant to toward a lateral center of the implant. In one embodiment, the first lateral wall and/or the second lateral wall comprises a tapered portion to facilitate insertion of the implant into the intervertebral space. In some arrangements, the implant is configured for lateral, anterior or posterior insertion into the targeted intervertebral space. In some embodiments, the implant is configured for placement within a lumbar or thoracic portion of a patient's spine. In one embodiment, the implant additional comprises a plurality of prongs extending into the interior chamber for retaining a graft or other member positioned therein.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features, aspects and advantages of the present application are described with reference to drawings of certain embodiments, which are intended to illustrate, but not to limit, the present disclosure. It is to be understood that these drawings are for the purpose of illustrating concepts of the present disclosure and may not be to scale.

FIG. **1**A illustrates a front perspective view of a spinal implant according to one embodiment;

FIG. **1**B illustrates a rear perspective view of the implant of FIG. **1**A;

FIG. **2** illustrates a top view of the implant of FIG. **1**A;

FIG. **3**A illustrates a side view of the implant of FIG. **1**A;

FIGS. **3**B and **3**C illustrate detailed side views of the implant of FIG. **1**A;

FIGS. **4** and **5** illustrate different side views of the implant of FIG. **1**A;

FIG. **6**A illustrates perspective views of an implant and an insertion tool configured to engage the implant according to one embodiment;

FIG. **6**B illustrates a partial top view of a spinal implant according to one embodiment;

FIG. **6**C illustrates a perspective view of a spinal implant according to one embodiment;

FIG. **6**D illustrates a top view of a spinal implant according to one embodiment;

FIG. **7**A illustrates an anterior side view of an implant within a targeted intervertebral space and secured to an insertion tool assembly, according to one embodiment;

FIG. **7**B illustrates lateral side view of the implant of FIG. **7**A;

FIG. **8** illustrates two embodiments of sizing and distraction tools;

FIG. **9** illustrates one embodiment of a rasping or abrading tool for use as a preparatory tool in advance of implantation of a spinal implant;

FIGS. **10**A and **10**B illustrate perspective views of another embodiment of a rasping or abrading tool for preparing an intervertebral space;

FIG. **11** illustrates a perspective view of an insertion tool assembly attached to a spinal implant, according to one embodiment;

FIG. **12**A illustrates an exploded perspective view of the insertion tool assembly and implant of FIG. **11**;

FIG. **12**B illustrates a partial cross-sectional view of an insertion tool assembly secured to an implant, according to one embodiment;

FIG. **13** illustrates a perspective view of various components of a graft fill kit, according to one embodiment;

FIG. **14** illustrates an anterior side view of a fill tool assembly engaged with a spinal implant positioned within a targeted intervertebral space, according to one embodiment;

FIG. **15** illustrates a syringe assembly configured for post-filling a spinal implant with graft and/or other fill materials, according to one embodiment;

FIGS. **16**A-**16**C illustrate various view of time-sequential steps related to positioning a syringe assembly within a fill tool assembly, according to one embodiment;

FIGS. **17**A and **17**B illustrates different side views of excess graft and/or other fill material that has exited the interior chamber of a spinal implant, according to one embodiment;

FIG. **18** illustrates a partial cross-sectional view of an insertion tool assembly having a cannulated threaded rod and secured to an implant, according to one embodiment;

FIGS. **19** and **20** illustrate different top perspective view of a spinal implant according to one embodiment; and

FIG. **21** illustrates a cross-sectional view of the implant of FIGS. **19** and **20**.

DETAILED DESCRIPTION

A variety of embodiments and examples described herein illustrate various configurations that may be employed to achieve desired improvements. The particular embodiments and examples are only illustrative and not intended in any way to restrict the general nature of the inventions presented and the various aspects and features of and relating to these inventions.

Spinal Implant

FIG. **1** illustrates one embodiment of a spinal implant **10** configured for placement between adjacent vertebrae of a patient. According to certain arrangements, the implant **10** is sized, shaped and otherwise adapted for placement with an intervertebral space along the lumbar region of spine. Alternatively, however, the implants and/or the methods disclosed herein can be modified for placement in any other portion of the spine, such as, for example, the thoracic or cervical region. In any of the embodiments disclosed herein, the implant can be inserted into a target intervertebral space using a lateral delivery approach (e.g., XLIF or TLIF), an anterior approach (e.g., ALIF), a posterior approach (e.g., PLIF) and/or any other approach or technique.

With continued reference to FIG. **1**, the implant **10** can include a generally rectangular shape. However, in alternative configurations, the implant **10** includes another shape, as desired or required by a particular application or use. For example, one or more of the implant's surfaces or sides can be more or less tapered and/or rounded (e.g., curved, convex, etc.). Further, the implant can comprise a completely different overall shape (e.g., as viewed from the top, bottom, one or more sides, etc.), such as, for example, round, oval, elliptical, other polygonal, irregular and/or the like.

According to some embodiments, the top surface **12** and/or the bottom surface **16** of the implant **10** comprise one or more teeth **40**, protruding members and/or other features that are sized, shaped and otherwise configured to contact and engage adjacent surfaces of the vertebral endplates once the implant has been positioned within the intervertebral space. In one embodiment, only the top surface **12** comprises teeth or similar engagement features. In another embodiment, only the bottom surface **16** comprises teeth or similar engagement features. However, in some embodiments, both the top and the bottom surfaces **12**, **16** comprise teeth or similar engagement features.

The teeth **40** or other engagement members or features can be distributed either completely or partially along the top surface **12** and/or bottom surface **16** of the implant **10**. For example, the teeth or other engagement features **40** can cover the entire or substantially the entire top and/or bottom surfaces of the implant. In other arrangements, the teeth **40** are located along only selected portions of the top and/or bottom surfaces, as desired or required. As illustrated in FIGS. **1** and **2**, the teeth **40** can extend, at least partially, from the anterior end **32** to the posterior end **36** of the implant. In some embodiments, at least some of the teeth **40** are generally parallel to each other. However, in other arrangements, at least some of the teeth or similar engagement features **40** of an implant intersect with one another or are otherwise non-parallel relative to each other.

With continued reference to FIGS. **1** and **2**, the teeth or other engagement features **40** can be symmetrically disposed along the top surface **12** and/or bottom surface **16** of the implant **10**. Alternatively, however, the tooth pattern along the top and/or bottom surfaces of the implant can be asymmetrical in one or more directions. In the illustrated embodiment, the teeth **40** are generally straight along the middle portion of the implant **10** and generally curved (e.g., circular, oval, etc.) along each of the lateral ends **22**, **26** of the implant **10**. Thus, the radius of curvature of the teeth **40** along the lateral ends **22**, **26** of the implant is greater than the curvature of the teeth along the middle, center or interior portion of the implant. In some arrangements, the radius of curvature of the rows of teeth **40** or other engagement features can increase with increasing distance from the center of the implant **10**.

The teeth or other engagement features **40** along the top surface **12** and/or the bottom surface **16** of the implant **10** can be bi-directional or unidirectional, as desired or required. Such teeth or other engagement features **40** can help ensure that the implant **10** does not migrate or otherwise undesirably move after implantation within a target intervertebral space. In addition, as discussed in greater detail herein, the teeth **40** can assist in maintaining graft and/or other fill materials within or near the implant **10** (e.g., within an internal chamber of the implant, between the endplates of adjacent vertebral members, etc.), thereby improving and/or facilitating spinal fusion. The type, quantity, shape (e.g., curvature along the top and/or bottom surfaces of the implant, the cross-sectional shape of the teeth, etc.), size (height, length, etc.), orientation, spacing and/or other details of the teeth or other engagement features **40** can vary, as desired or required.

With reference to the top view of FIG. **2**, the implant **10** can include a left lateral side L and a right lateral side S. According to some embodiments, the teeth **40** along the top and/or bottom surfaces **12**, **16** of the implant **10** are unidirectional. For example, the teeth **40** along the left side L of the implant are generally curved, sloped, slanted or otherwise pointed in a first direction, whereas the teeth **40** along the right side R of the implant are generally curved, sloped, slanted or otherwise pointed in a second direction, which in some arrangements, is generally opposite of the first direction.

Further, as illustrated in the side view of FIG. **3**A, in some embodiments, the teeth **40'**, **40"** along the upper and/or lower surfaces **12**, **16** of the implant **10** are sloped or slanted toward the horizontal center of the implant. As noted above, such a configuration can help ensure that the implant **10** engages adjacent portions of a patient's spine (e.g., vertebral endplate surfaces) and does not inadvertently migrate or otherwise move after implantation. Further, such embodiments can help ensure that the likelihood that grafting agents and/or other fill materials delivered into the interior chambers of the implant **10** undesirably escape from within or near the implant (e.g., between the upper and/or lower surfaces **12**, **16** and the adjacent endplate surfaces of the patient's vertebrae) is advantageously reduced or minimized. For example, with such a tooth orientation, the implant **10** needs to migrate or otherwise shift against the tooth grain (e.g., in one or more directions) in order to move laterally away from the target intervertebral space following implantation. In addition, according to some embodiments, the inwardly oriented shape of the teeth **40** makes it more difficult for grafting and/or other filler materials to flow or otherwise move at or near the implant-endplate interface.

As illustrated in FIG. **3**A, the implant **10** can include generally planar top and/or bottom surfaces **12**, **16**, at least partially along its length and/or width. In other embodiments, however, the top surface **12** and/or the bottom surface **16** of the implant **10** comprises one or more portions that are non-planar. Such non-planar areas or portions can extend only partially along the length and/or width of the implant. In other embodiments, the entire top and/or bottom surface of the implant can be generally non-planar.

For example, the top and/or bottom surfaces can be generally concave, rounded or otherwise curved (e.g., in the vertical direction so that the thickness of the implant varies along one or more regions of the implant). Such configurations can provide for a tighter fit between the implant **10** and the adjacent endplates or other surfaces or portions of the vertebral members. In some arrangements, such configurations can help improve or enhance the spinal fusion process. In yet other arrangements, the implants can be generally planar but non-horizontal (e.g., from anterior to posterior ends). For

instance, as discussed in greater detail herein, "lordotic" implant designs can include a generally higher anterior wall relative to the posterior wall.

In some embodiments, one or both lateral ends of an implant can be tapered. A tapered lateral end **22**, as illustrated in FIG. **3**A, can facilitate insertion of the device **10** within the target intervertebral space during an implantation procedure. In the depicted arrangement, the leading end **97** along the right lateral end **22** of the implant **10** includes both a vertical taper and a rounded profile when viewed from the top. In some embodiments, as discussed in greater detail below, at least a portion of such a "bullet" or tapered leading lateral end of the device can be configured to extend outside the intervertebral space into which the implant is implanted. According to some embodiments, one or both lateral ends of the implant comprise a rounded or curved contour. Such a rounded or curved contour or profile can be included in the vertical direction, in the horizontal direction or in both the vertical and horizontal directions, as desired or required.

In addition, as best illustrated in FIG. **2**, the exterior surface of the implant's posterior side **36** can be generally flat or planar when viewed from the top. Such a design can help ensure that a proper clearance is provided between the posterior end of the implant **10** and sensitive portions of the patient's spine (e.g., nerve roots, spinal cord, etc.). Further, the exterior surface of the implant's anterior side **32** can include a rounded or other non-planar shape. In some embodiments, such a rounded or other non-planar shape is relatively gradual or slight. Likewise, as shown, the exterior of the implant's lateral sides **22**, **26** can be either generally planar (e.g., flat) or rounded, as desired or required. In other embodiments, the exterior shape of the implant's sides can be different than illustrated and discussed herein.

In order to help perform an implantation procedure and to facilitate the delivery of an implant to a targeted location within a patient's spine, the implant **10** can include one or more insertion tool receiving ports **50**, slots and/or other features. For example, in the embodiment illustrated in, inter alia, FIGS. **1**A, **1**B, **2** and **3**B, a single port **50** is positioned along one of the lateral ends **26** of the implant **10**. However, in other configurations, the port **50** can be positioned along any other portion of the device. The location of the port **50** can depend, at least in part, on the desired method by which the implant **10** will be inserted into the patient's spine (e.g., laterally, anteriorally, posterially, etc.). For example, in the illustrated arrangement, the port **50** is positioned along a lateral end **26**, primarily because the implant **10** is designed to be inserted into the target intervertebral space laterally. Therefore, in other configurations, an insertion tool receiving port **50** can be included along the anterior side **32**, posterior side **36** and/or any other portion of the implant.

According to some embodiments, the insertion tool receiving port **50** is configured to releasably engage a corresponding insertion tool using a threaded connection. For instance, the port **50** can include internal threads that are sized, shaped and otherwise adapted to match external threads of an insertion tool **300** (FIG. **6**A). In other arrangements, however, other types of connection features or devices are used to releasably secure an insertion tool to the implant, such as for example, a press-fit or friction fit connection, a snap-fit connection, a tabbed connection, any other standard or non-standard coupling and/or the like. In some embodiments, as discussed in greater detail herein, the port **50** also serves as an inlet into the implant's interior chambers through which grafting and/or other fill materials can be selectively delivered within the implant. Thus, is such embodiments, a single port **50** is used both an implant delivery mechanism and a graft material passage. In some embodiments, the port **50** comprises one or more valves (e.g., check valve, other one-way valve, etc.), other flow-regulating devices or features and/or one or more other sealing members to help prevent or reduce the likelihood of the inadvertent loss of grafting and/or other fill materials from within the interior of an implant through such a port **50**.

The port **50** can be threaded or non-threaded, as desired or required. In some embodiments, the port comprises one or more other engagement or other features, such as for example, alignment slots, tabs, teeth, other protruding members and/or the like. Such features can extend inwardly (e.g., in the direction of the port's opening) from the wall or other surface defining the port **50**. According to some embodiments, the shape (e.g., cross-sectional shape) of the port is generally circular. However, the port can include one or more other shapes, such as, for example, oval, elliptical, square, rectangular, other polygonal, irregular and/or the like.

According to some embodiments, the threaded port **50** along a lateral end **26** of the implant is configured to pass at least partially through the implant's lateral wall **98**. For example, in one embodiment, the port **50** passes through the entire lateral wall **98** and extends into one or more internal chambers **70**, cavities or other openings of the implantable device **10**. According to some embodiments, the port **50** is sized to permit a catheter, syringe, tubing, other tube, conduit and/or other delivery device to be passed therethrough. Such a catheter or other delivery tube or device can be sized and configured to allow grafting and/or other materials to be selectively injected or otherwise administered into one or more chambers of the implant. In one embodiment, the port is sized to permit a catheter or other tube of size French 12 or French 15 (e.g., per the standard French gauge scale) to be passed therethrough. Thus, in such arrangements, the port **50** can include a minimum inside diameter of about 4 mm or about 5 mm. In other embodiments, however, the port **50** can be sized, shaped and otherwise configured to permit the passage of larger catheters, tubes or other conduits therethrough. For instance, in some embodiments, an implant is configured to permit a catheter, tube or other conduit having an outer diameter as large as about 5 mm through 8 mm (e.g., approximately 5 mm, 5.5 mm, 6 mm, 6.5 mm, 7 mm, 7.5 mm, 8 mm, sizes between the foregoing, etc.) to pass through its port **50**. In other embodiments, the port is sized and shaped to allow conduits having an outer diameter larger than 8 mm (e.g., approximately 8 mm, 8.5 mm, 9 mm, larger than about 9 mm, etc.) to pass therethrough.

In some embodiments, the threaded port **50** or access hole comprises an M6×1.0 configuration. However, as noted above, the port can comprise a nominal diameter that is greater than or less than about 6 mm, such as, for example, approximately 4 mm, 5 mm, 7 mm, 8 mm, 9 mm, 10 mm, greater than 10 mm, sizes between the foregoing values, etc.). Further, in embodiments that comprise a threaded port, the thread along the inside of the port can differ from that in an M6×1.0 configuration, as desired or required. For example, the thread type, pattern, height and/or other characteristics of the thread can vary.

According to some embodiments, the spinal implants disclosed herein or equivalents thereof comprise a generally closed structure along their sides. For example, in some arrangements, the only openings along the outer sidewalls (e.g., lateral, posterior, anterior) of an implant are one or more ports **50** (e.g., used to engage the implant with a delivery tool and/or used to pass a graft delivery tube to the interior of the implant) and/or one or more openings that permit excess grafting materials to exit an interior chamber or other cavity

of the implant (e.g., openings **60** along the anterior side wall of the implant, as illustrated in FIG. **3**A).

According to some embodiments, the port **50** or other openings through a wall of the implant is configured to be as large as possible for a given implant. This can permit a larger device (e.g., catheter, syringe, tubing, other conduit or device, etc.) to be positioned therein. For example, as discussed in greater detail herein, the port **50** can be advantageously adapted to receive a tube that is configured to transfer grafting and/or other fill materials from a syringe (or other supply source) to the interior of the implant. Therefore, in such embodiments, the inside diameter (or other cross-sectional clearance dimension) of the port **50** is slightly larger than the outer diameter (or other outer dimension) of the fill catheter or other conduit.

In some embodiments, the port comprises a diameter of approximately 6 mm to 8 mm (e.g., about 6 mm, 6.5 mm, 7 mm, 7.5 mm, 8 mm, diameters between the foregoing values, etc.). Alternatively, however, the diameter or other cross-sectional dimension of the port **50** can be smaller than about 6 mm (e.g., approximately 4 mm, 4.5 mm, 5 mm, 5.5 mm, 5.9 mm, diameters between the foregoing values, etc.) or larger than about 8 mm (e.g., approximately 8.1 mm, 8.5 mm, 9 mm, 9.5 mm, diameters between the foregoing values, larger than about 9.5 mm, etc.), as desired or required. In some embodiments, a target diameter or other cross-sectional dimension of the port **50** is generally maintained, irrespective of the size of the implant (e.g., 6 mm, 8 mm, 10 mm, 12 mm tall implants). This can help ensure that a surgeon or other clinician can insert a desired fill tube or other conduit within an interior of an implant (e.g., to delivery grafting and/or other fill materials during a post-fill procedure). Accordingly, as noted herein with reference to the embodiments illustrated in FIGS. **6**B-**6**D, one or more implant walls through which the port **50** passes (e.g., lateral side walls) may need to be reinforced or otherwise strengthened to accommodate a desired port diameter (e.g., 6 mm, 8 mm, etc.) in light of the implant's thickness.

By maintaining a relatively large port diameter or other dimension, a larger fill tube or conduit can be advantageously positioned through such a port. Accordingly, the friction associated with passing grafting and/or other fill materials through the fill tube can be reduced. This allows for less strenuous delivery of grafting and/or other fill materials into the interior of an implant (e.g., during a post-fill procedure). Accordingly, the surgeon or other clinician performing a fill procedure can more easily deliver the necessary materials through the fill tube. Therefore, although it is somewhat counterintuitive to include a relatively large port or other openings along one or more walls of the implant (e.g., because of the likelihood of grafting and/or other filler materials leaking out of the implant), such an oversized port can provide one or more benefits and advantages during a fill procedure.

According to some embodiments, the ratio of the port diameter (or other port opening size) to the height of the implant wall through which the port is located (e.g., lateral wall) is between about 0.4 and about 0.9 (e.g., approximately 0.4, 0.45, 0.5, 0.55, 0.6, 0.65, 0.7, 0.75, 0.8, 0.85, 0.9, ratios between the foregoing values, etc.), depending on the size of the implant. For example, in some embodiments, the port diameter is approximately 6 mm and the height of the corresponding implant wall is 8 mm, 10 mm, 12 mm or the like. Thus, the ratio can be approximately 0.75, 0.6, 0.5 and/or the like. In some embodiments, the ratio of the port diameter (or other port opening size) to the height of the implant wall through which the port is located (e.g., lateral wall) is at least about 0.5, 0.55, 0.6, 0.65, 0.7, 0.75, 0.8, 0.85, 0.9, greater than about 0.9 and/or the like.

In some embodiments, the area of the port **50** is at least about 10%, 15%, 20%, 25% or 30% of the overall area of the wall (e.g., lateral implant wall) through which the port is positioned. However, the port area can be smaller than about 10% or greater than about 25% of the overall area of the wall through which the port is positioned, as desired or required.

As discussed in greater below, the implants disclosed herein can be provided in a variety of shapes, sizes and configurations in order to better accommodate the intervertebral spaces into which they will be inserted and secured. Thus, in some embodiments, the various types of implants that are supplied to a surgeon or other clinician comprise an identical port **50** (e.g., having an identical diameter, shape, thread pattern, etc.), regardless of the actual size, shape and other details of the devices. Accordingly, a surgeon or other clinician can use a single insertion tool and/or a single set of other instruments to engage and manipulate the various types of implants provided. Further, as noted above, in addition to serving as a securement site and/or other engagement means for a tool used during the delivery of the implant through a patient's anatomy, the port **50** can also be used as a passageway for a catheter, syringe, tube or other conduit. Such conduits can be passed through the port **50** to selectively deliver grafting agents, other filler materials and/or any other device or substance within an interior chamber, cavity or other portion of the implant. In some embodiments, the passage of catheters and/or other conduits through the port is performed after the implant has been securely positioned within a target intervertebral site and after one or more delivery tools have been detached from the implant. In other embodiments, as disclosed herein, the graft delivery catheter or other conduit can be passed through the port **50** to reach an interior portion of the implant while an implant delivery tool is secured to the port. For example, such a catheter or conduit can be passed through an interior lumen or other passage of a cannulated implant delivery tool.

In order to maintain an identical threaded or other type of port **50**, one or more portions of smaller implants (e.g., implants that have a smaller height, such as, for example, 6 mm, 8 mm or 10 mm devices) may be reinforced with additional material and/or other support along or near an area surrounding the port **50**. For example, as depicted in the embodiment illustrated in FIGS. **6**B-**6**D, additional implant material **13** (e.g., PEEK, other polymeric or other material, etc.) is included along the top and/or bottom surfaces of the implant **10** along or near the port **50**. This can advantageously permit the manufacture of implants of various sizes that include a single type of port **50**, while maintaining the requisite structural and functional integrity of the implant. For instance, the use of additional material or other reinforcement **13** along the top and/or bottom surface of the implant **10** can provide the requisite resistance to the forces and moments to which the implant may be subjected during delivery and/or use. As shown in FIGS. **6**B-**6**D, in arrangements where additional reinforcing material **13** is provided along the top and/or bottom surfaces, such additional material can be positioned within at least of the grooves that help define the teeth **40** or other engagement features of the implant **10**. Thus, the depth and general configuration of the teeth **40** along such reinforced areas may vary from adjacent areas of the implant.

Further, the implant **10** can include one or more additional features that facilitate engagement with a corresponding insertion tool. According to some embodiments, as depicted, for example, in FIG. **3**, the implant comprises two recesses or

slots **28** along one of the lateral ends **26** (e.g., along the lateral end that includes the insertion tool receiving port **50**). Such recesses or other features **28** can be sized, shaped, positioned, spaced, oriented and/or otherwise adapted to align and mate with corresponding wings, tabs or other portions of an insertion tool. The recesses, slots and/or other engagement features **28** can help a surgeon or other clinician to manipulate (e.g., rotate) the implant during surgery or other procedure involving moving or repositioning the implant. Further, such engagement features **28** can help ensure that the corresponding implant insertion tool (and/or graft fill tool, as discussed in greater detail herein) is properly positioned relative to the implant.

With continued reference to the embodiments depicted in, inter alia, FIGS. **1**A, **1**B and **2**, the spinal implant **10** can include one or more internal chambers **70**. In one embodiment, the implant comprises only a single chamber. However, in alternative embodiments, the implant comprises two or more chambers. As shown, such internal chambers **70** can extend across the entire implant depth (e.g., from the top surface **12** to the bottom surface **16**) and across a majority of the implant's length and width. For example, in some arrangements, the chamber **70** spans approximately 60-70% of the implant length and width. However, in other embodiments, the chamber **70** can extend less than about 60% of the implant length and/or width (e.g., approximately 30%, 35%, 40%, 45%, 50%, 55%, 60%, less than 30%, percentages between the aforementioned values, etc.), or more than about 70% of the implant length and/or width (e.g., approximately 70%, 75%, 80%, 85%, more than about 90%, percentages between the aforementioned values, etc.), as desired or required by a particular application or use.

In some embodiments, an implant comprises two or more chambers. For example, the implants illustrated in FIGS. **1**A-**5** can include one or more dividing walls (not shown) that extend across the chamber **70** generally between the anterior and posterior walls **92**, **94**. Such dividing walls or other separators, which may be integrally formed with adjacent portions of the implant, can effectively create two or more sub-chambers or cavities in the implant. In implant arrangements having two or more chambers, sub-chambers, cavities and/or other openings, such chambers or sub-chambers can be of equal or different shape and/or size. Further, one or more openings can be included in the dividing wall or other separators to permit the chambers to be in fluid communication with one another. This may be particularly important when the filling the implant with grafting and/or other materials (e.g., to help ensure that such fill materials are delivered into all of the chambers).

As depicted in FIGS. **1**A and **1**B, a spinal implant **10** can include one or more openings **60** that extend through its anterior wall **92**, but no openings along its posterior wall **94**. The openings **60** can be in fluid communication with the implant's chamber(s) **70**. Thus, as is discussed in greater detail below, excess grafting and/or other fill materials delivered into the chamber(s) **70** (e.g., through a fill port **50** and/or other opening in the implant) can exit through the openings **60** toward the anterior portion of the spine. By eliminating openings along the posterior wall, the passage of fill materials along the posterior side of the implant can be generally reduced or prevented. Thus, a majority (or almost all) of excess grafting agent and/or filler material delivered within such an implant can be configured to exit the interior of the implant through the anterior openings **60**. For example, in some arrangements, more than approximately 70% (e.g., more than about 70%, 75%, 80%, 85%, 90%, 95%, etc.) of excess fill materials delivered into an implant exit through the openings **60**. In some embodiments, this can advantageously help prevent or reduce the likelihood of migration of grafting and/or other fill materials toward nerve roots, spinal cord and other sensitive regions of the spine.

With continued reference to the side view of the embodiment illustrated in FIG. **3**A, an implant **10** can include a total of five openings **60** that are generally equally sized and equally spaced apart from each other along the anterior wall. In the depicted configuration, the openings **60** comprise an oval shape or a generally rectangular shape with rounded corners. Alternatively, the openings **60** can include any other shape (e.g., circular, square, rectangular, other polygonal, irregular, etc.). Further, the quantity, spacing, relative size, orientation and/or other characteristics of the openings **60** can be different than illustrated and discussed herein. For example, depending on the implant's size, design bearing capacity and/or other properties, additional (e.g., six, seven, eight, nine, ten, more than ten, etc.) or fewer openings (e.g., four, three, two, one) can be provided.

In addition, as illustrated in, among other places, the top view of FIG. **2**, the implant **10** can comprise one or more internal prongs or other protruding members **74** that extend into the chamber **70**. As with other features of the implant, such prongs **74** can be formed as a unitary structure with adjacent portions of the implant. Alternatively, the internal prongs **74** can be separate members that are subsequently secured to the implant using one or more connection devices or methods, such as for example, screws, rivets, other fasteners, adhesives and/or the like. The prongs **74** can be positioned along various locations of the implant's interior surface. For example, in some embodiments, as illustrated in FIGS. **6**A and **6**C, the prongs are positioned along various lateral portions near the top and/or bottom of the implant. However, the internal prongs or other engagement member can be situated along any other portion or area of the chamber **70**, either in addition to or in lieu of the top and/or bottom portions of the implant.

According to some embodiments, as depicted in FIG. **6**D, the prongs **74** are directed toward the interior chamber or cavity **70** of the implant **10**. The prongs **74** can be aligned generally perpendicularly relative to the interior vertical wall that defines the chamber **70** and from which the prongs extend inwardly. Thus, one or more of the prongs can be positioned along a line that is offset from the lengthwise or widthwise centerline of the implant **10**. For example, as shown in FIG. **6**D, one or more prongs **74** are offset by angle P relative to the widthwise centerline W of the implant **10**. In some embodiments, such an angle P is approximately 20-25% (e.g., about 20%, 25%, 30%, etc.). Further, as illustrated in FIG. **6**D, the prongs **74** can comprise a generally conical, wedge-like, truncated cone-like, triangular, pyramid-like and/or any other shape (e.g., when viewed from the top). However, the shape, size, spacing, orientation and/or other characteristics of the prongs **74** can be different than illustrated and discussed herein.

Regardless of their exact quantity, size, shape, spacing, orientation and/or other characteristics, such prongs or other features **74** can help ensure that grafting agents and/or other fill materials are properly retained within the internal chamber(s) **70** of the implant **10**. For example, in some embodiments, a solid graft, a porous foam structure, a sponge and/or other solid or non-flowable member is positioned within the chamber **70** of the implant, either before or after implantation into a patient. Thus, the prongs **74** can help engage such items and maintain them within the implant. In some embodiments, the prongs **74** help secure grafting and/or other filler materials

within a chamber **70** of the implant only after such materials have become adequately hardened or solidified.

As illustrated in FIGS. **1A-5**, the thickness (e.g., vertical height) and width (e.g., anterior-posterior distance) of the implant **10** can be generally consistent throughout its entire length. Alternatively, one lateral end of the implant can comprise a larger thickness than the opposite lateral end. Such arrangements can be advantageously used when inserting an implant along to a lordotic portion of the spine. For example, the height difference between opposing ends in such lordotic implants can differ by about 2 mm. In other embodiments, the height difference is less or greater than about 2 mm (e.g., approximately 0.5 mm, 1 mm, 1.5 mm, 2.5 mm, 3 mm, 3.5 mm, 4 mm, greater than 4 mm, distances between the aforementioned values, etc.), as desired or required for a particular patient or fusion procedure.

According to some embodiments, the horizontal width of the implant's lateral walls **96**, **98** can be configured to enhance the implant's ability to withstand the bearing forces, moments and other loads to which it will be subjected once properly implanted into a patient's spine. For example, as illustrated in the anterior-posterior view of FIG. **7**A, the lateral walls **96**, **98** of the implant **10** can be configured to align with portions B of the adjacent vertebrae V through which the highest concentration of bearing forces are transferred to the implant **10**. In general, such high bearing load areas or portions B are situated near the lateral or circumferential ends of the vertebrae V. Typically, as depicted in FIG. **7**A, the endplates of the vertebrae V move further away from the adjacent intervertebral space near the center of the vertebral body. Thus, most of the bearing load created by the adjacent vertebrae V is expected to be concentrated toward the peripheral ends of the implant **10**.

Accordingly, in order to improve its load bearing capacity, the implant **10** can include lateral walls **96**, **98** that are generally reinforced and otherwise adapted to safely handle the bearing loads imposed upon the implant following implantation. For example, the lateral walls **96**, **98** can be wider (e.g., horizontally) than the anterior and/or posterior walls **92**, **94** of the implant. In some embodiments, the horizontal length (e.g., along the longer axis of the implant) of each of the lateral walls **96**, **98** is at least about two times greater than the horizontal width of the anterior or posterior wall. For instance, in some embodiments, the horizontal length of one or both of the lateral walls **96**, **98** is approximately at least two, three, four or more than four times the horizontal width of the anterior wall or the posterior wall of the implant. In some embodiments, the horizontal length of one or both of the lateral walls **96**, **98** is approximately 10 to 20% (e.g., about 10%, 12%, 14%, 16%, 18%, 20%, percentages between the foregoing values, etc.) of the overall horizontal length of the implant (e.g., along the longer axis of the implant). Alternatively, however, the horizontal length of the one or both of the lateral walls **96**, **98** can be greater than about 20% or less than about 10% of the overall horizontal length of the implant **10**, as desired or required. Consequently, one or both of the implant's lateral ends **22**, **26** can be configured to better withstand the bearing forces and moments to which the implant it will be subjected once inserted and secured within a targeted intervertebral space of the patient's spine.

According to some embodiments, a spinal implant is sized to generally span across the entire width of the adjacent vertebral members V. Thus, as discussed above, the lateral walls of the implant can be generally aligned with the load bearing portions of the inferior and superior vertebral members. In some embodiments, as discussed above with reference to FIG. **7**A, the implant contacts the adjacent vertebral members primarily or only along the lateral ends of the implant. Thus, portions of the implant that are interior to the lateral ends of the implant are configured to encounter less or no forces from the adjacent vertebral members.

According to some embodiments, the implant **10** comprises one or more radio-opaque markers **80**. Such markers **80** can facilitate a surgeon or other clinician to properly position the implant within the target intervertebral space, especially when minimally invasive surgery is utilized. By way of example, as illustrated in FIGS. **1**A, **1**B and **2**, the implant **10** can include a total of three tantalum or other types of radio-paque markers **80'**, **80"**. In the depicted arrangement, two markers **80'** are located at or near the lateral ends **22**, **26**, while a third marker **80"** is located at or near the horizontal center of the implant **10**. In one embodiment, the lateral or horizontal location of the middle marker **80"** is exactly between the two lateral markers **80"**. The quantity, type, location, orientation, spacing and/or other details of the markers can be varied, in accordance with the specific requirements of an application or use.

As illustrated in the top view of FIG. **2**, the posterior wall **94** of the implant **10** can include a bump or other reinforced region **95** in order to accommodate the center radio-opaque marker **80"**. In addition to providing additional material that can surround a marker, such bumps **95** or similar features can advantageously improve the implant's strength and/or other structural characteristics.

The various configurations of the implants disclosed herein can include one or more materials. For example, in some embodiments, the implants comprise polyether etherketone (PEEK), other radiolucent materials, other thermoplastics, metals, alloys and/or any other materials having the desired structural (e.g., rigidity), mechanical, chemical and thermal resistance and/or other properties.

As discussed in greater detail herein, the size of the implant can be selected based, at least in part, on the patient's weight, height, age, the amount of intervertebral distraction that the implant should provide and/or any other factor or consideration. For example, in some embodiments, the implant is precisely selected based on the size of the patient's intervertebral space into which the implant will be placed. For instance, the vertical height of the implant can vary between approximately 8 and 14 mm (e.g., 8 mm, 10 mm, 12 mm, 14 mm, values between such ranges, etc.). As noted herein, the vertical height of the implant can be consistent from the anterior end to the anterior end. Alternatively, the vertical height of the implant can vary in one or more horizontal directions (e.g., anterior-posterior direction, lateral direction, etc.).

In some embodiments, the implant includes a concave or other non-planar (e.g., domed, curvate, etc.) upper surface and/or lower surface. Such a configuration can help provide improved contact between the implant and the endplate surfaces of the adjacent vertebrae. Further, the height of the implant can vary along the anterior-posterior direction. For example, in some embodiments, the vertical height of the anterior wall of the implant is approximately 2 mm higher than the vertical height of the posterior wall. Such a configuration can be advantageously used when performing fusion to a lordotic portion of the spine. Therefore, as noted above, any of the fusion implants disclosed herein can have vertical dimensions that vary along their longitudinal direction. As a result, a variety of different lordotic implants can be provided, such as, for example, 8 mm by 10 mm (e.g., posterior height by anterior height), 10 mm by 12 mm, 12 mm by 14 mm implants and/or the like.

Moreover, the implant can be provided in a variety of horizontal dimensions in order to better accommodate the targeted intervertebral space into which the implant will be inserted and secured. For instance, the length of the implant (e.g., from one lateral end to the other) can vary between 40 mm and 60 mm. In some embodiments, the implant is provided in a variety of different lengths, such as, for example, 40 mm, 45 mm, 50 mm, 55 mm, 60 mm, lengths between the foregoing values, etc. Alternatively, the length of an implant can be greater than 60 mm or smaller than 40 mm, as desired or required. Likewise, the width (e.g., the distance between the anterior and posterior ends) of the implant can vary, both from implant to implant and within a specific implant design. For example, in some embodiments, the width of the implant is between about 19 mm and 21 mm. As discussed above with reference to FIG. **2**, the width can vary along an implant's length. In some embodiments, such a variation in width results from rounded or curved anterior and/or posterior surfaces. Thus, in some embodiments, the implant comprises a width of approximately 21 mm at its longitudinal center (e.g., at or near the location of the middle marker **80"** is located in the arrangement depicted in FIG. **2**) and a width of approximately 19 mm at or near the lateral ends **22**, **26**. The implants can include any other shape, size or orientation, irrespectively of the specific examples provided herein.

Implantation into Targeted Intervertebral Space

The initial surgical steps in preparing a patient for a spinal fusion procedure can include, among other things, making an incision along the patient's skin and accessing a targeted region of the spine (e.g., lumbar region) using one or more dilators, retractors and/or other instruments or tools. Depending on the state of the diseased intervertebral disc or space, one or more preparatory steps may be necessary or recommended prior to delivery of the implant within the patient's anatomy. For example, at least some of the native disc material can be removed in order to provide the necessary space for the subsequent insertion of the implant. In some arrangements, a distraction tool is used to separate the vertebrae between which the implant will be positioned.

Further, the surgeon or other clinician performing the procedure may choose to size the target intervertebral space prior to implantation. For example, such a step can be performed in order to more accurately select a properly sized implant. In addition, a surgeon may choose to prepare one or more native surfaces of the vertebrae that will be adjacent to the implant. For instance, one or more coarsening or abrading tools can be used to selectively roughen one or more portions of the vertebral endplates adjacent to the implant. Under certain circumstances, such a roughening step can promote healing and can accelerate the fusion process following delivery of the implant within the spine.

FIG. **8** illustrates two different arrangements of a distraction and sizing tool **400**A, **400**B that can be used in advance of the delivery of an implant during a spinal fusion procedure. As shown, the distraction and sizing tool **400**A, **400**B can include a proximal handle **410**A, **410**B (which is only partially depicted in FIG. **8**) and a distal head **420**A, **420**B. In the depicted embodiments, the two tools **400**A, **400**B are substantially similar to each other in overall design; however, their distal heads **420**A, **420**B vary in size (e.g., vertical thickness, length, etc.). A plurality of such distraction and sizing tools may be provided to a surgeon in order to allow him or her to determine what type of implant should be inserted into targeted intervertebral space. Such tools **400**A, **400**B can also be used to precisely distract or separate adjacent vertebrae in preparation for implantation.

In some embodiments, the sizing and distraction tool **400**A, **400**B comprises stainless steel, other metals or alloys and/or one or more other rigid material that are adequate for insertion into a patient's anatomy and configured to withstand the anticipated forces, moments and/or other conditions (e.g., pH, temperature, etc.) to which they will be subjected. With continued reference to FIG. **8**, the sizing and distraction tool **400**A, **400**B can include a baseline marker **430**A, **430**B at or near the distal end of the head **420**A, **420**B. In some arrangements, the surgeon can insert the tool's head **420**A, **420**B within the target intervertebral space and advance the tool (e.g., under the guidance of x-ray, ultrasound, fluoroscopy and/or other imaging technology) until the baseline marker **430**A, **430**B exactly or approximately aligns with the peripheral distal edge of the adjacent vertebral bodies. Once the distal end of the head has been aligned, the surgeon can use the proximal markings **440**A, **442**A, **444**A, **446**A, **448**A to determine the appropriate length of the intervertebral space. For example, the length can be determined based on the proximal marking that is closest to the peripheral proximal edge of the adjacent vertebral bodies. Thus, the markings **440**A, **442**A, **444**A, **446**A, **448**A can be visualized using one or more imaging technologies to determine the proper implant size for the targeted intervertebral space.

Likewise, the surgeon can attempt to position tools **400**A, **400**B of varying head thickness into a targeted intervertebral space in order to determine a desired implant height. Accordingly, the sizing and distraction tool **400**A, **400**B can be used to select a well-suited implant for insertion into the patient's spine. In some embodiments, such a tool **400**A, **400**B can be used to create a desired level of vertical distraction within the targeted intervertebral space, especially if the adjacent vertebral bodies are undesirably close to one another (e.g., due to severe disc degeneration and/or disease).

FIG. **9** schematically illustrates one embodiment of a shaver **500** configured to selectively rasp, abrade and/or otherwise compromise or remove tissue. In some arrangements, the shaver **500** is inserted into an intervertebral space to remove disc tissue and/or prepare the vertebral endplate surfaces for the subsequent delivery of a spinal implant. As shown, the shaver **500** can comprise an abrading assembly **520** positioned along a distal end of a longitudinal shaft **510**. The abrading assembly **520** can include a center or main portion **534** located between a pair of tapered outer portions **530**A, **530**B. In some embodiments, the center portion **534** comprises one or more abrading members **540** that are adapted to contact and at least partially remove, abrade or otherwise affect tissue. Thus, as the shaft **510** is rotated about a longitudinal axis **514**, the abrading member **540** can help remove native disc tissue and/or attack the endplate wall in preparation for the subsequent implantation of the fusion device. In some embodiments, as illustrated in FIG. **9**, the shaver **500** comprises tapered or lower profile outer portions **530**A, **530**B so as to reduce or prevent damage to the peripheral bearing areas B of the vertebral members V (see FIG. **7**A). By avoiding or reducing the likelihood of damage to these native load bearing portions B of adjacent vertebrae, the structural integrity of the patient's spine, and thus the fusion procedure, can be maintained.

A different embodiment of a shaver instrument **550** is schematically illustrated in FIGS. **10**A and **10**B. As shown, the shaver **550** comprises a main portion **560** that is shaped, sized and otherwise configured for delivery into a targeted intervertebral space. The upper and lower surfaces of the main portion may or may not include teeth or other engaging features or members. In some arrangements, the main portion **560** includes a central chamber or other opening **570** that

generally extends from the top to the bottom surface of the main portion **560**. As depicted in FIG. **10**A, an access port or opening **564** can provide access from a lateral side of the main portion **560** to the interior of the central chamber **570**. An abrading assembly **590** can be positioned along the distal end of an elongated member **580**. The elongated member **580** can be sized, shaped and otherwise adapted for passage through the access port **564** of the main body. Likewise, the abrading assembly **590** can be configured for placement within the chamber **570** of the main portion **560**. According to some embodiments, the abrading assembly **590** is configured for selective movement within the central chamber **570** as the elongated member **580** is rotated about a longitudinal axis **582**.

With continued reference to FIG. **10**B, the abrading assembly **590** can comprise a generally horizontal configuration. As shown, the abrading assembly **590** can include one or more lateral wing portions **592** positioned on either side of the elongated member **580**. In some embodiments, the outer surface **594** of each wing portion **592** can include one or more abrasive members or features **596** that are adapted to contact and at least partially remove or damage tissue. In some arrangements, the abrading assembly **590** is fully retained within the central chamber **570** when in the illustrated low profile or stowed orientation. Thus, the shaver **550** can be delivered to the patient's spine without interference by the abrading assembly **590**. Once properly positioned within the target intervertebral space, the surgeon or other clinician can selectively rotate the elongated member **580** to move the distal wing portions **592** toward the adjacent tissue (e.g., native disc tissue, endplate surfaces, etc.). Thus, continued and repetitive rotation of the abrading assembly **590** can cause a desired amount of abrasion to the adjacent vertebral members in preparation for delivering the implant device to the intervertebral space. In some embodiments, the central chamber **570** of the shaver **550** generally aligns with a central portion of the adjacent vertebrae between the peripheral bearing areas B (FIG. **7**A). Thus, damage to the load bearing areas B of the vertebrae can be reduced or avoided, as the abrading assembly **590** will be generally confined to a limited central portion of the adjacent vertebral members. Consequently, as noted above, the structural integrity of the adjacent bearing areas of the vertebral members can be advantageously maintained.

FIG. **11** illustrates a perspective view of a spinal implant **10**, identical or similar to those disclosed herein, secured to a distal end of an insertion tool assembly **300** according to one embodiment. An exploded view of the insertion tool assembly **300** of FIG. **11** is provided in FIG. **12**A. As shown in FIGS. **11** and **12**A, the insertion tool **300** can include an outer elongated member **310** having a distal end **312** that is adapted to releasably engage a spinal implant **10**. In some embodiments, the distal end **312** of the outer elongated member **310** comprises a pair of wings or tabs **314** that are sized, shaped and otherwise configured to engage corresponding recesses or slots **28** (FIG. **1**A) of an implant **10**.

With continued reference to FIGS. **11** and **12**A, the outer elongated member **310** can include an inner passage **316** that extends from the proximal end **320** to the distal end **312** of the insertion tool assembly **300**. Thus, in some embodiments, the outer elongated member **310** is cannulated. The proximal portion **320** of the assembly **300** can include a handle **322** and a flared end **328**. According to some embodiments, the outer elongated member **310** includes one or more windows **324** at or near the handle. As discussed in greater detail below, such a window can permit access to a thumbwheel or other movable control member that daylights or is exposed through the window **324**.

As depicted in FIGS. **11** and **12**A, the outer elongated member **310** can be configured to slidably receive a threaded rod **340** within its inner passage or opening **316**. In some embodiments, the threaded rod **340** comprises a main elongated portion **344** having a threaded distal end **346**. The threaded distal end **346** can be shaped, sized and otherwise adapted to engage a corresponding port **50** of a spinal implant (FIG. **1**A). A partial cross-sectional view of such threaded engagement between the distal end **346** of the rod **340** and the port **50** of the implant **10** is illustrated in FIG. **12**B. When the main elongated portion **344** is properly inserted within the cannulated opening of the outer member **310**, the threaded distal end **346** can extend through the distal end of the opening **316**, generally between the wings or tabs **314** of the outer member **310**.

As depicted herein, the proximal end of the threaded rod **340** can comprise a generally cylindrical thumbwheel **348** that includes a larger diameter than the adjacent main elongated portion **344**. According to some embodiments, at least a portion of the thumbwheel **348** is accessible through the window(s) **324** of the outer elongated member **310** when the insertion tool assembly **300** is properly assembled for use. Thus, a surgeon or other clinician can selectively rotate the thumbwheel **348** while grasping the insertion tool assembly **300** to either engage or release the implant from the assembly's distal end. The thumbwheel **348** can include a plurality of longitudinal grooves **349** and/or other features that can facilitate rotation of the threaded rod relative to the outer elongated member **310**.

With continued reference to FIGS. **11** and **12**A, a hammer or strike pad **360** can be secured to the proximal end of the outer elongated member **310** once the threaded rod **340** has been properly positioned therein. According to some embodiments, the hammer pad **360** includes distal threads **366** or other engagement features that are configured to engage corresponding threads or features of the outer elongated member **310**. Thus, the hammer pad **360** can be releasably attached to the outer elongated member **310**.

Once the targeted intervertebral space has been prepared (e.g., in accordance with a desired or required protocol), a spinal implant **10** can be secured to the distal end **312** of the insertion tool assembly **300**. For example, as discussed above, the threaded distal end **346** of the rod **344** can threadably secure to the access port or opening **50** along a lateral end of the implant **10**. Further, the tabs or wings **314** of the outer elongated member can engage corresponding recesses **28** of the implant **10**. The insertion tool assembly **300** and the implant **10** can include one or more other types of corresponding mating or engaging features or members, either in lieu of or in addition to those disclosed herein.

Once the implant has been properly secured to the distal end of the insertion tool assembly **300**, the surgeon or other clinician can drive the implant **10** into the targeted intervertebral space. In some embodiments, the insertion tool assembly **300** can be advanced into the anatomy (e.g., against any resistive forces) by impacting the proximal end of assembly **300** with a slap hammer assembly **380**, a mallet or any other tool or instrument. The implantation procedure can be performed under real-time visualization in order to ensure that the implant is properly advanced and positioned.

The various components of the insertion tool assembly **300** disclosed herein, including the outer elongated member **310**, the threaded rod **340** and the hammer pad **360**, can comprise one or more rigid materials, such as, for example, hardened

stainless steel, other types or grades of steel, titanium, other metals or alloys, composites, other natural or synthetic materials and/or the like. Such components can be reusable (e.g., sterilizable) or disposable, as desired or required.

Filling of the Implant

Once the implant has been properly positioned within the targeted intervertebral space, the internal chamber(s) of the implant can be at least partially filled with one or more grafting materials, other fill materials and/or the like. For example, the various materials that can be delivered to the internal chamber(s) of an implant include, but are not limited to: bone forming cells, demineralized bone matrix (DBM), bone morphogenetic protein (BMP), collagen matrix, bone cement, other flowable grafting agents or materials, flaky or other non-flowable grafting agents or materials, other biological or non-biological materials or substances and/or any other grafting or filler material.

As noted herein, in some embodiments, the implant is at least partially prefilled with one or more grafting agents, other fillers and/or any other material or item prior to implantation. For example, in some arrangements, a sponge, foam, other porous structure or member or other absorbent member is positioned within the implant's chamber prior to advancing the implant within the anatomy. Such an absorbent member can initially include one or more graft materials and/or can be configured to absorb or otherwise retain graft materials that are delivered into the chamber after the implant has been positioned with the targeted intervertebral space. In other arrangements, one or more graft materials and/or other fill materials can be provided in solid or partially-solid form within the implant's internal chamber(s) prior to implantation. Regardless of what items or materials are positioned within the implant prior to its delivery within a patient's spine, one or more internal prongs **74** (FIG. **2**), other protruding members and/or other retaining features can be used to securely maintain such items or materials within the implant. As discussed herein, such prongs or other protruding members are configured to engage and retain materials contained within an internal chamber or cavity of the implant after such materials have at least partially solidified or cured.

According to some embodiments, once the spinal implant has been properly implanted, the insertion tool assembly **300** (FIGS. **11** and **12**A) is decoupled from the implant and the assembly **300** is removed. In some embodiments, a fill tool assembly is subsequently inserted into anatomy in order to engage the implant and selectively deliver graft and/or other types of materials into the implant's internal chamber. Such a fill tool assembly can include a catheter, tube, syringe and/or other conduit that is sized, shaped and otherwise adapted to be positioned through one or more ports of the implant. As discussed in greater detail herein, such a port **50** can be identical to the port that is also used to secure the implant to the distal end of a delivery tool during delivery of the implant within the patient's anatomy. One embodiment of a kit **600** that comprises, among other things, a fill tool assembly **610** is illustrated in FIG. **13**.

As illustrated in FIG. **13**, a fill kit **600** can include one or more of the following items: a fill tool assembly **610**, a coupler **640**, a syringe assembly S, a mixing tray T, a container of graft or other fill material G and/or the like. As noted above, the graft and/or other types of fill materials can be selected by the surgeon or other clinician according to a desired or required protocol or procedure. The mixing tray T can be used to combine, mix, dilute or otherwise process the various graft and/or other fill materials that will be selectively transferred within or near the implant. The various components included in the kit **600** can be disposable or reusable, as desired or required. Thus, such components can include one or more rigid, semi-rigid and/or flexible materials, including metals or alloys (e.g., stainless steel), polymeric or thermoplastic materials, rubber or other elastomeric materials, composites, other natural or synthetic materials and/or the like.

According to some embodiments, as depicted in FIG. **13**, the fill tool assembly **610** includes an elongated cannulated shaft **614** that terminates in a distal end **620**. The distal end **620** can include a discharge opening **616** that is in fluid communication with the internal passage of the shaft **614**. Further, the distal end **620** of the fill tool assembly **610** can comprise one or more tabs or wings **622** that are sized, shaped and otherwise configured to engage corresponding recesses **28** or other features of the implant **10** (FIG. **1**B). Although such tabs **622**, wings or other alignment features are not necessary, they can provide assurance that the fill tool assembly has been properly positioned relative to the implant in anticipation of the subsequent filling steps. The proximal end **630** of the fill tool assembly **610** can include a handle. In the depicted embodiment, the proximal end **630** comprises a number of ring shaped portions. One embodiment of a fill tool assembly **610** aligned and engaged with an implant **10** that has been properly secured within a targeted intervertebral space is illustrated in FIG. **14**.

With continued reference to FIG. **13**, graft or other fill materials can be loaded into a syringe **650** of a syringe assembly S. As shown, the syringe **650** can include a barrel portion **652** into which the graft and/or other fill materials are placed. Further, the syringe **640** can include a plunger **658** that can be selectively advanced within the barrel **652** in order to help urge the graft and/or other fill materials out of the distal exit opening **654** of the syringe **650**. In addition, the syringe can include a pair of grasping members **656** to facilitate handling and manipulation during use. Further, one or more mechanical tools can be used to assist the surgeon or other clinician in slidably displacing the plunger or similar movable member within the barrel. The use of such syringe/plunger configurations can be particularly helpful when transferring graft and/or other fill materials that are relatively thick, dense, concentrated, viscous or otherwise difficult to move.

As shown in the exploded view of FIG. **13**, a discharge coupling **660** can be used to attach the distal end of the syringe **650** to a length of flexible catheter, tubing or other conduit **670**. In some embodiments, the tubing **670** is cable-lined and/or otherwise reinforced to reduce the likelihood of kinking during use. Such cable-lined tubing can also be used to confirm its location within the anatomy during use, as the cable lining can be visualized using one or more visualization technologies. The coupling **600** can be permanently or removably secured to the syringe **650** and/or the tubing **670** using one or more types of connection methods or devices, such as, for example, luer connections, threaded connections, friction fit or press fit connections, other types of fasteners, adhesives and/or the like. A perspective view of one embodiment of a fully-assembled syringe assembly S is illustrated in FIG. **15**.

According to some embodiments, the flexible tubing or other conduit **670** and/or other components of the syringe assembly S retain the same characteristics, irrespective of the type of spinal implant that will be filled. For example, the length of the tubing **670** and coupling can be maintained consistent or substantially consistent in all kits **600**. Thus, in some embodiments, a coupler **640** can be used to ensure that a volume of graft and/or fill material is adequately, accurately and consistently delivered to the implant.

As illustrated in FIG. **13**, the coupler **640** can be configured to receive and engage the proximal end of the fill tool assem-

bly **610** through its distal opening **642**. Likewise, the coupler **640** can receive and engage a distal end of the syringe assembly S through its proximal opening **644**. In some arrangements, the coupler **640** is selected based on the size and/or type of spinal implant that will be filled. Such a configuration can help ensure that the distal end of the syringe assembly's tubing, catheter or other conduit **670** is properly positioned within the implant's internal chamber at the initiation of the graft filling stage. For example, according to some embodiments, the coupler **640** is generally longer for the filling of smaller (e.g., shorter) implants, and generally shorter for the filling of larger (e.g., longer) implants. A kit **600** can be provided with a number of differently sized couplers **640** from which a clinician can choose (e.g., depending on the type of implant that will be at least partially filled). Further, the couplers **640** can include a size identifier **646**, such as, for example, the length of the implant to be filled.

FIGS. **16**A-**16**C illustrate three time-sequential steps performed in preparation for a post filling procedure, in which grafting and/or other fill materials are delivered within an interior portion of a spinal implant following implantation. In FIG. **16**A, the fill tool assembly **610** has been properly secured to the implant **10**. For example, as noted above, the tabs or wings along the distal end of the fill tool assembly **610** can be aligned with and mated with corresponding recesses of the implant. As shown, a properly selected coupler **640** can be positioned along the proximal end of the fill tube assembly **610**. In some arrangements, one or more engagement members or features are positioned within the distal end of the coupler **640** to ensure that the proximal end of the fill tube assembly **610** has been properly positioned therein.

Next, as illustrated in the side view of FIG. **16**B, the syringe assembly S is inserted within and advanced (e.g., in a direction generally represented by arrow A) relative to the coupler **640** and the fill tool assembly **610**. FIG. **16**C shows the syringe assembly S advanced to its full distal position relative to the coupler **640**. Accordingly, in some embodiments, if the appropriately sized coupler **640** was used, the distal end of the tubing should be properly positioned within the chamber of the implant **10**. Accordingly, the coupler assists the surgeon to accurately position the distal end of the conduit or other tubing within an internal chamber, along a specific longitudinal location of the implant. Thus, the surgeon can reliably and confidently begin injecting the graft and/or other filler materials loaded into the syringe **650** into a chamber or other interior portion of the implant **10**.

According to some post fill arrangements, the surgeon can select a desired volume of graft and/or other filler materials that will be transferred to the chamber of the implant **10** according to his or her own requirements and protocols. In some embodiments, the maximum internal volume of each type of implant is provided to the clinician in corresponding printed literature, on the implant itself, using graduation marks on the syringe and/or the like.

According to some embodiments, the surgeon or clinician continues to inject the graft and/or other filler material into the interior chamber of the implant by manipulating the syringe plunger and/or by actuating some other mechanical device (e.g., hand-operated ratchet, other motorized device, etc.) that facilitates much manipulation of the plunger. The surgeon can choose to slowly, either incrementally or continuously, retract the syringe assembly S, and thus the distal end of the tubing, catheter or other conduit, while the graft and/or other fill material is delivered to the implant **10**. This can facilitate and promote more even distribution of the graft and/or fill material within the internal chamber. In some embodiments, the syringe barrel, the coupler and/or any other component or features of the syringe assembly S comprise graduation marks or other indicia to assist the clinician in determining how much and/or at what rate to retract the tubing during use.

In some arrangements, the amount of graft and/or other fill materials delivered to the implant generally exceeds the internal capacity of the chamber. Thus, at some point, excess graft and/or other fill material G can be expected to begin discharging out of one or more implant openings **60** (e.g., openings located along anterior wall of the implant). This is illustrated in the embodiment depicted in FIGS. **17**A and **17**B. As noted above, in some embodiments, the posterior wall of the implant does not comprise any openings. Further, excess graft and/or other fill material can also be directed at the upper and/or lower interfaces of the implant and the adjacent vertebral endplate surfaces. According to some arrangements, as discussed herein, the orientation of the teeth or other engagement members along the upper and/or lower surfaces of the implant can help prevent, reduce the likelihood of and/or slow down the flow of excess graft and/or other fill material across the implant-endplate interfaces.

According to some embodiments, excess graft and/or other fill material G can generally fill any gap that exists between the vertebral endplates and the adjacent surfaces of the implant. This can result in improved spinal fusion. Further, spinal fusion can benefit from the excess graft and/or other fill material that exits through the openings **60** along the anterior wall of the implant **10**. As illustrated in the embodiment of FIGS. **17**A and **17**B, such material G can fill any gaps that exist between the implant and the remaining disc material and/or other tissue along the anterior end of the spine. For example, excess graft and/or other fill material G can at least partially cover the anterior face of the implant, can span the vertical gap between adjacent vertebral V endplates along the anterior side of the implant and/or can migrate to other portions along the anterior end and/or the lateral ends of the implant to help improve fusion. As noted above, similar openings along the posterior wall of the implant can be eliminated in order to prevent or reduce the likelihood of excess graft and/or other fill materials from migrating to nerve roots, the spinal cord and/or other sensitive portions of the patient's spine.

According to some embodiments, as illustrated in the partial cross sectional view of FIG. **18**, the threaded rod **340'** of the insertion tool assembly **300'** can be cannulated. Thus, the insertion tool **300'** can be used to both deliver the implant to its proper intervertebral position and to subsequently fill the interior chamber(s) of the implant **10** with one or more graft and/or other fill materials. For example, in the depicted arrangement, the internal passage **341'** of the cannulated threaded rod **340'** can be sized, shaped and otherwise configured to receive a flexible tube, catheter or other conduit of a syringe assembly. Accordingly, the need to disengage the implant **10** from the distal end of the insertion tool assembly **300'** and engage a separate fill tool assembly (as discussed herein with reference to several embodiments) can be eliminated. Instead, the insertion tool assembly **300'** can remain engaged to the implant **10** while a fill tube or other conduit is inserted within the internal passage **341'** of the cannulated rod **340'**. Once the desired or required amount of grafting agents and/or other fill materials has been transferred to the implant, the fill conduit and the insertion tool assembly can be removed from the patient anatomy. In some embodiments, the hammer or strike plate **360** (FIG. **12**A) can include a corresponding opening through which the tubing can be routed to reach the passage **341'** of the cannulated rod **340'**. Accordingly, the cannulated rod **340'**, as with any other components of the insertion tool and/or fill assemblies, can be disposable.

As discussed in relations to several embodiments disclosed herein, a spinal fusion procedure can comprise an initial implant delivery step followed by a subsequent filling step. Thus, in some embodiments, the implant is delivered within the patient's anatomy with its internal chambers or cavities either empty or only partially filled with grafting agents, other filler materials and/or other components. For example, as discussed above, an implant can comprise a porous foam, a sponge and/or one or more other absorbent devices or materials prior to its delivery within a target intervertebral space. In such an embodiment, no other materials (e.g., grafting agents, other filler materials, etc.) are present within the implant prior to or during delivery of the implant. In other arrangements, an interior chamber or other cavity of the implant is only partially filled with graft and/or other filler materials prior to or during delivery to the target interbody space.

In accordance with the various embodiments and examples disclosed herein, one or more biological and/or non-biological grafting and/or other fill materials can be injected or otherwise delivered within or near the implant following implantation. Such a procedure can help ensure that grafting and/or other filler materials are not lost during the delivery of the implant within the patient (e.g., due to hammering or other impact forces imparted on the implant during such delivery protocols). Further, by delivering excess fill materials within or near the implant, as discussed herein, more enhanced fusion of the implant to adjacent spinal surfaces (e.g., endplate surfaces) can be advantageously provided.

Yet another embodiment of a spinal implant **1100** is illustrated in FIGS. **19-21**. As shown, the implant **1100** can include top and bottom surfaces **1112**, **1114** having one or more teeth **1122** and/or other features configured to engage corresponding portions of the patient's vertebral members (e.g., adjacent endplate surfaces). In addition, as discussed herein with respect to other embodiments, the depicted implant **1100** comprises one or more anterior holes or openings **1134***a*, **1134***b* through which excess grafting and/or other filler materials can exit the interior chambers or cavities **1116***a*, **1116***b* of the implant **1100**. Further, in some embodiments, the posterior wall of the implant does not comprise any openings, thereby preventing or reducing the likelihood that excess grafting and/or other fill materials will move in that direction.

With continued reference to FIGS. **19** and **20**, as with any embodiments disclosed herein, the implant **1100** can comprise one or more interior walls **1132** or baffles that divide an interior chamber or cavity into two or more areas. In some embodiments, such separate interior chambers, cavities or areas **1116***a*, **1116***b* can be in fluid communication with one another via one or more openings **1134** or other orifices within the interior wall or baffle **1132**. However, in some embodiments, an implant does not comprise any interior walls or baffles. Thus, an implant can include only a single relatively large interior chamber or cavity, while maintaining a desired load bearing capacity and other structural design criteria.

As with other embodiments disclosed herein, the implant **1100** can be advantageously sized, shaped and otherwise configured to span or extend across the entire or substantially the entire width of the inferior and superior vertebral members between which it is to be placed and secured. Further, the lateral ends **1118**, **1120** of the implant **1100** can comprise relatively large walls that generally coincide with load bearing portions of the adjacent vertebral members (see, for example, FIGS. **7**A and **21**).

As noted herein with regards to other implant arrangements, the depicted implant **1100** can comprise one or more ports **1136** along one or more of its surfaces. For example, as illustrated in FIGS. **19-21**, a single port **1136** can be provided along one of the lateral side walls of the implant **1100**. As discussed in greater detail herein, such a port **1136** can be configured to receive an implant delivery tool (e.g., to assist a surgeon in moving the implant through the patient's anatomy to a target intervertebral space) and/or to pass one or more fill tubes or conduits for post-filling, at least partially, an interior chamber or cavity of the implant with grafting agents and/or other fill materials. In any of the implant embodiments disclosed herein, or equivalents thereof, such a port that can serve a dual purpose related to implant positioning and graft delivery can be located along any side wall (e.g., lateral, anterior, posterior) of the implant.

In addition, as illustrated in FIG. **20**, a cap or other sealing member **1138** can be secured to the port **1136**. Such a cap **1138** can help ensure that grafting and/or filler materials delivered or otherwise positioned within the interior of the implant do not escape through the port **1136**. In other embodiments, the port can comprise one or more valves or other flow blocking members to help reduce the inadvertent escape of materials from the interior of the implant.

With reference to the side cross-sectional view of FIG. **21**, the implant port can be sized, shaped and otherwise configured to receive a fill tube or other conduit **1200**. Such a fill tube **1200** can be passed through the port and into one or more interior chambers or other cavities of the implant **1100**. As shown, a distal end **1220** of the fill tube **1200** can be angled so that the outlet **1212** is oriented generally perpendicular to the axis A of the port and the fill tube **1200**. In other embodiments, the face of the outlet **1212** can be oriented along a different angle (e.g., between 0 and 90 degrees relative the longitudinal axis A), as desired or required. In some embodiments, a plunger assembly **1206** can be positioned within the fill tube or can be operatively coupled to it. Accordingly, such a plunger assembly **1206** can be selectively actuated in order to provide the necessary driving force to move grafting material G through the tube **1200** and into an interior area of the implant.

According to some embodiments, as illustrated in FIG. **21**, the top and/or bottom surfaces of a spinal implant can be generally curved or rounded. In such arrangements, the curvature of the top and/or bottom surface can be configured to match or generally align with the shape of the adjacent endplates E or other native tissue of the patient. However, as discussed above with reference to the implant embodiment illustrated in FIGS. **1**A and **1**B, the top and/or bottom surfaces can be generally planar.

To assist in the description of the disclosed embodiments, words such as upward, upper, bottom, downward, lower, rear, front, vertical, horizontal, upstream, downstream have been used above to describe different embodiments and/or the accompanying figures. It will be appreciated, however, that the different embodiments, whether illustrated or not, can be located and oriented in a variety of desired positions.

Although the subject matter provided in this application has been disclosed in the context of certain specific embodiments and examples, it will be understood by those skilled in the art that the inventions disclosed in this application extend beyond the specifically disclosed embodiments to other alternative embodiments and/or uses of the subject matter disclosed herein and obvious modifications and equivalents thereof. In addition, while a number of variations of the inventions have been shown and described in detail, other modifications, which are within the scope of these inventions,

will be readily apparent to those of skill in the art based upon this disclosure. It is also contemplated that various combinations or subcombinations of the specific features and aspects of the embodiments may be made and still fall within the scope of the inventions disclosed herein. Accordingly, it should be understood that various features and aspects of the disclosed embodiments can be combine with or substituted for one another in order to form varying modes of the disclosed inventions. Thus, it is intended that the scope of the subject matter provided in the present application should not be limited by the particular disclosed embodiments described above, but should be determined only by a fair reading of the claims that follow.

What is claimed is:

1. A spinal fusion system for placing an implant and graft material within a target intervertebral space, the system comprising:

(i) an implant comprising:

a first wall and a second wall, the second wall being generally opposite of the first wall;

first and second side walls configured to extend between the first wall and the second wall;

a top surface configured to at least partially engage a lower surface of a first vertebral body;

a bottom surface configured to at least partially engage an upper surface of a second vertebral body, the second vertebral body being adjacent to the first vertebral body;

at least one internal chamber defined, at least in part, by the first wall, the second wall, the first side wall and the second side wall, wherein the at least one internal chamber extends from the top surface to the bottom surface of the implant; and

an access port extending through the first wall and being in fluid communication with the at least one internal chamber;

wherein graft material is configured to be passed through the access port so at least a volume of graft material is selectively delivered into the at least one internal chamber;

(ii) an implant insertion tool sized and configured to position the implant to a target intervertebral space; and

(iii) a graft material delivery system for delivering a volume of graft material into the at least one internal chamber of the implant, the graft material delivery system comprising a conduit, wherein a volume of graft material is configured to be delivered to the at least one internal chamber of the implant via the conduit;

wherein, after delivery of the implant within the target intervertebral space, the first and second walls and the first and second sidewalls of the implant are configured to extend between superior and inferior vertebral members adjacent the target intervertebral space; and

wherein the walls and sidewalls of the implant form a continuous peripheral boundary around the at least one chamber upon implantation into the target intervertebral space such that the at least one chamber contains graft material delivered through the access port, thereby enabling the at least one internal chamber to be filled such that graft material is in flush contact with endplate surfaces of the adjacent superior and inferior vertebral members.

2. The system of claim **1**, wherein the conduit is configured to pass through the access port of the implant to position the conduit within the at least one internal chamber of the implant.

3. The system of claim **1**, wherein the graft material delivery system additionally comprises a fill tool assembly, the fill tool assembly being configured to selectively engage at least a portion of the implant, wherein the fill tool assembly comprises a cannulated shaft.

4. The system of claim **3**, wherein the fill tool assembly is configured to ensure that a distal end of the conduit routed through the cannulated shaft of the fill tool assembly is properly positioned within the at least one internal chamber of the implant.

5. The system of claim **3**, wherein graft material is configured to be delivered through the fill tool assembly, either directly through the cannulated shaft or via the conduit, wherein the conduit is removably positioned through the cannulated shaft.

6. The system of claim **5**, wherein the fill tool assembly comprises at least one alignment feature configured to engage at least a portion of the implant, wherein at least one alignment feature provides assurance that the fill tool assembly is properly positioned relative to the implant.

7. The system of claim **6**, wherein the last one alignment feature comprises at least one of a tab and a wing.

8. The system of claim **1**, wherein the implant insertion tool is configured to releasably secure to the access port.

9. The system of claim **1**, wherein at least one of the first and second side walls of the implant does not comprise any openings.

10. The system of claim **1**, wherein the implant comprises at least one of polyether etherketone (PEEK), a metal and an alloy.

11. The system of claim **1**, wherein at least one of the top and bottom surfaces of the implant is generally planar.

12. The system of claim **1**, wherein at least one of the top and bottom surfaces of the implant is generally curved.

13. The system of claim **1**, wherein the implant comprises a lordotic implant, such that a height of the first wall is different than a height of the second wall.

14. The system of claim **1**, wherein the implant comprises a lateral implant, a TLIF implant, an ALIF implant or a PLIF implant.

15. The system of claim **1**, wherein the fill tube assembly further comprises a plunger assembly configured to be positioned within the conduit, wherein the plunger assembly is selectively actuated in order to provide the necessary driving force to move a volume of graft material through the conduit and into the at least one internal chamber of the implant.

16. A spinal fusion system for placing an implant and graft material within a target intervertebral space, the system comprising:

(i) an implant comprising:

a first wall and a second wall, the second wall being generally opposite of the first wall;

side walls configured to extend between the first wall and the second wall;

a top surface configured to at least partially engage a lower surface of a first vertebral body;

a bottom surface configured to at least partially engage an upper surface of a second vertebral body, the second vertebral body being adjacent to the first vertebral body;

at least one internal chamber defined, at least in part, by the first wall, the second wall and the side walls, wherein the at least one internal chamber extends from the top surface to the bottom surface of the implant, wherein the first and second walls and side walls form a continuous peripheral boundary around

the at least one chamber upon implantation into a target intervertebral space; and

an access port extending through the first wall and being in fluid communication with the at least one internal chamber;

wherein graft material is configured to be passed through the access port for delivery into the at least one internal chamber;

(ii) an implant insertion tool sized and configured to position the implant to a target intervertebral space; and

(iii) a graft material delivery system for delivering graft material into the at least one internal chamber of the implant, the graft material delivery system comprising a conduit, wherein a volume of graft material is configured to be delivered to the at least one internal chamber of the implant via the conduit;

wherein, after delivery of the implant within the target intervertebral space, the first and second walls and the first and second sidewalls of the implant are configured to extend between superior and inferior vertebral members adjacent the target intervertebral space; and

wherein the at least one internal chamber is configured to contain graft material enabling the at least one internal chamber to be filled such that graft material is in flush contact with endplate surfaces of the adjacent superior and inferior vertebral members.

17. The system of claim **16**, wherein the graft material delivery system additionally comprises a fill tool assembly, the fill tool assembly being configured to selectively engage at least a portion of the implant, wherein the fill tool assembly comprises a cannulated shaft.

18. The system of claim **17**, wherein the fill tool assembly is configured to ensure that a distal end of the conduit routed through the cannulated shaft of the fill tool assembly is properly positioned within the at least one internal chamber of the implant.

19. The system of claim **17**, wherein graft material is configured to be delivered through the fill tool assembly, either directly through the cannulated shaft or via the conduit, wherein the conduit is removably positioned through the cannulated shaft.

20. The system of claim **16**, wherein the fill tube assembly further comprises a plunger assembly configured to be positioned within the conduit, wherein the plunger assembly is selectively actuated in order to provide the necessary driving force to move a volume of graft material through the conduit and into the at least one internal chamber of the implant.

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