US012383319B2

(12) **United States Patent**
Prandi et al.

(10) **Patent No.: US 12,383,319 B2**
(45) **Date of Patent: *Aug. 12, 2025**

(54) **RESORPTIVE INTRAMEDULLARY IMPLANT BETWEEN TWO BONES OR TWO BONE FRAGMENTS**

(71) Applicant: **Stryker European Operations Holdings LLC**, Portage, MI (US)

(72) Inventors: **Bernard Prandi**, Rennes (FR); **Marc Augoyard**, Tassin la Demi Lune (FR); **Thomas Ledermann**, Eschenbach (CH); **Tristan Meusnier**, Saint-Etienne (FR); **Jacques Peyrot**, Tassin la Demi Lune (FR); **Judith Fellmann**, Stafa (CH)

(73) Assignee: **Stryker European Operations Holdings LLC**, Portage, MI (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **19/023,889**

(22) Filed: **Jan. 16, 2025**

(65) **Prior Publication Data**

US 2025/0160913 A1 May 22, 2025

Related U.S. Application Data

(60) Continuation of application No. 18/770,767, filed on Jul. 12, 2024, which is a continuation of application

(Continued)

(30) **Foreign Application Priority Data**

Sep. 9, 2008 (FR) 0856035

(51) **Int. Cl.**

A61B 17/68 (2006.01)
A61B 17/16 (2006.01)

(Continued)

(52) **U.S. Cl.**

CPC ***A61B 17/8605*** (2013.01); ***A61B 17/1655*** (2013.01); ***A61B 17/68*** (2013.01);

(Continued)

(58) **Field of Classification Search**

None

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

321,389	A	6/1885	Schirmer
1,095,054	A	4/1914	Wiesenfeld

(Continued)

FOREIGN PATENT DOCUMENTS

CA	2551021	A1	3/2005
CA	2243699	C	1/2006

(Continued)

OTHER PUBLICATIONS

Collins English Dictionary Excerpt (Jun. 2007), 6 pages. [Exhibit No. 2001 to Patent Owner's Preliminary Response, IPR2022-00486 of U.S. Pat. No. 9,168,074 filed May 16, 2022].

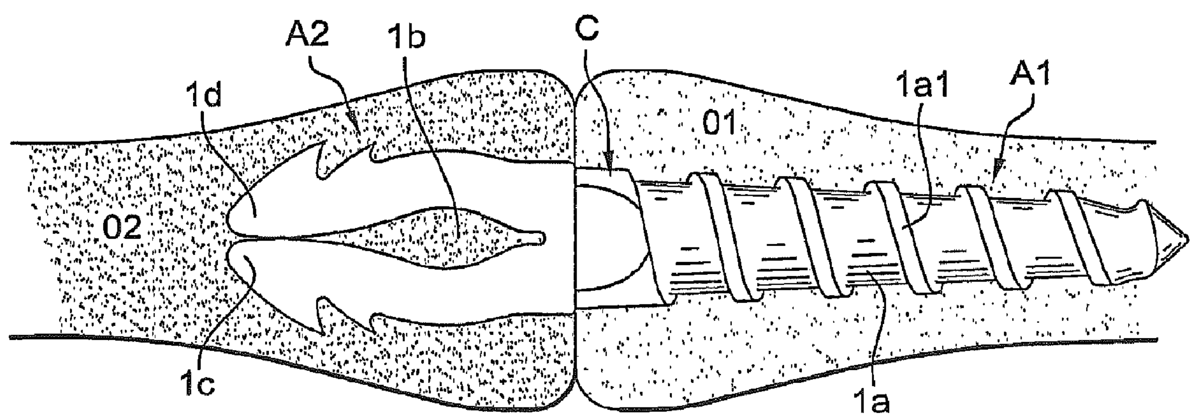
(Continued)

Primary Examiner — Ellen C Hammond

(57) **ABSTRACT**

The invention relates to a resorptive intramedullary implant between two bones or two bone fragments. The implant includes a single-piece body (**1**) having a generally elongate shape and having, at each end, areas for anchoring to the bone portions in question, characterized in that one of said areas (**A1**) has a cylindrical cross-section while the other area (**A2**) has a flat cross-section.

20 Claims, 4 Drawing Sheets



Related U.S. Application Data

No. 16/506,353, filed on Jul. 9, 2019, now Pat. No. 12,059,186, which is a continuation of application No. 14/858,855, filed on Sep. 18, 2015, now Pat. No. 10,383,671, which is a division of application No. 13/795,946, filed on Mar. 12, 2013, now Pat. No. 9,168,074, which is a continuation of application No. 12/918,105, filed as application No. PCT/FR2009/051658 on Sep. 2, 2009, now Pat. No. 8,414,583.

(51) **Int. Cl.**

A61B 17/72	(2006.01)
A61B 17/86	(2006.01)
A61B 17/88	(2006.01)
A61F 2/42	(2006.01)
A61B 17/00	(2006.01)
A61F 2/30	(2006.01)

(52) **U.S. Cl.**

CPC ***A61B 17/7233*** (2013.01); ***A61B 17/88*** (2013.01); ***A61F 2/4225*** (2013.01); ***A61F 2/4241*** (2013.01); *A61B 2017/00862* (2013.01); *A61B 2017/681* (2013.01); *A61B 17/7208* (2013.01); *A61B 17/7225* (2013.01); *A61B 17/7266* (2013.01); *A61B 17/7283* (2013.01); *A61B 2017/8655* (2013.01); *A61F 2002/30062* (2013.01); *A61F 2002/30563* (2013.01); *A61F 2002/30622* (2013.01); *A61F 2002/3085* (2013.01); *A61F 2002/30878* (2013.01); *A61F 2210/0004* (2013.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

1,517,334	A	12/1924	Young
1,893,864	A	1/1933	Kocher
2,128,005	A	8/1938	Lombard
2,208,848	A	7/1940	Jorgensen
2,531,911	A	11/1950	Johnson
2,580,821	A	1/1952	Nicola
2,984,248	A	5/1961	Sidelman
3,338,689	A	8/1967	Hetzel et al.
3,462,765	A	8/1969	Swanson
3,466,669	A	9/1969	Flatt
3,593,342	A	7/1971	Niebauer et al.
3,646,654	A	3/1972	Cervenka et al.
3,681,786	A	8/1972	Lynch
3,739,403	A	6/1973	Nicolle
3,805,302	A	4/1974	Mathys
3,824,631	A	7/1974	Burstein et al.
3,875,594	A	4/1975	Swanson
D243,716	S	3/1977	Treace et al.
4,091,806	A	5/1978	Aginsky
4,158,893	A	6/1979	Swanson
4,204,284	A	5/1980	Koeneman
4,237,875	A	12/1980	Termanini
4,276,660	A	7/1981	Laure
4,364,382	A	12/1982	Mennen
4,367,562	A	1/1983	Gauthier et al.
4,485,816	A	12/1984	Krumme
D277,509	S	2/1985	Lawrence et al.
D277,784	S	2/1985	Sgarlato et al.
4,522,200	A	6/1985	Stednitz
D284,099	S	6/1986	Laporta et al.
4,634,382	A	1/1987	Kusano et al.
D291,731	S	9/1987	Aikins
4,759,768	A	7/1988	Hermann et al.
4,871,367	A	10/1989	Christensen et al.
4,905,679	A	3/1990	Morgan
4,955,916	A	9/1990	Carignan et al.
4,969,909	A	11/1990	Barouk
5,011,497	A	4/1991	Persson et al.
5,047,059	A	9/1991	Saffar
5,062,851	A	11/1991	Branemark
5,074,865	A	12/1991	Fahmy
5,092,896	A	3/1992	Meuli et al.
5,108,443	A	4/1992	Branemark
5,133,761	A	7/1992	Krouskop
5,179,915	A	1/1993	Cohen et al.
5,190,546	A	3/1993	Jervis
5,207,712	A	5/1993	Cohen
5,326,364	A	7/1994	Clift, Jr. et al.
5,360,450	A	11/1994	Giannini
5,382,251	A	1/1995	Hood et al.
5,405,400	A	4/1995	Linscheid et al.
5,405,401	A	4/1995	Lippincott, III et al.
5,417,692	A	5/1995	Goble et al.
5,425,776	A	6/1995	Cohen
5,425,777	A	6/1995	Sarkisian et al.
5,454,814	A	10/1995	Comte
5,464,427	A	11/1995	Curtis et al.
5,474,557	A	12/1995	Mai
D366,114	S	1/1996	Ohata
5,480,447	A	1/1996	Skiba
5,484,443	A	1/1996	Pascarella et al.
D369,412	S	4/1996	Morgan
5,507,822	A	4/1996	Bouchon et al.
5,522,903	A	6/1996	Sokolow et al.
5,554,157	A	9/1996	Errico et al.
5,578,036	A	11/1996	Stone et al.
5,634,925	A	6/1997	Urbanski
5,674,297	A	10/1997	Lane et al.
5,690,631	A	11/1997	Duncan et al.
5,702,472	A	12/1997	Huebner
D388,877	S	1/1998	Morgan
5,725,585	A	3/1998	Zobel
5,779,707	A	7/1998	Bertholet et al.
5,782,927	A	7/1998	Klawitter et al.
5,824,095	A	10/1998	Di Maio, Jr. et al.
5,876,434	A	3/1999	Flomenblit et al.
5,881,443	A	3/1999	Roberts et al.
5,882,444	A	3/1999	Flomenblit et al.
5,919,193	A	7/1999	Slavitt
5,951,288	A	9/1999	Sawa
5,958,159	A	9/1999	Prandi
5,984,970	A	11/1999	Bramlet
5,984,971	A	11/1999	Faccioli et al.
6,011,497	A	1/2000	Tsang et al.
6,017,366	A	1/2000	Berman
6,093,188	A	7/2000	Murray
6,123,709	A	9/2000	Jones
6,146,387	A	11/2000	Trott et al.
6,162,234	A	12/2000	Freedland et al.
6,187,008	B1	2/2001	Hamman
6,193,757	B1	2/2001	Foley et al.
6,197,037	B1	3/2001	Hair
6,200,330	B1	3/2001	Benderev et al.
6,248,109	B1	6/2001	Stoffella
6,261,289	B1	7/2001	Levy
6,319,284	B1	11/2001	Rushdy et al.
6,325,805	B1	12/2001	Ogilvie et al.
6,342,076	B1	1/2002	Lundborg
6,348,052	B1	2/2002	Sammarco
6,352,560	B1	3/2002	Poeschmann et al.
6,383,223	B1	5/2002	Baehler et al.
6,386,877	B1	5/2002	Sutter
6,395,031	B1	5/2002	Foley et al.
6,413,260	B1	7/2002	Berrevoets et al.
6,423,097	B2	7/2002	Rauscher
6,428,634	B1	8/2002	Besselink et al.
6,454,808	B1	9/2002	Masada
6,458,134	B1	10/2002	Songer et al.
6,475,242	B1	11/2002	Bramlet
6,517,543	B1	2/2003	Berrevoets et al.
6,554,833	B2	4/2003	Levy et al.
6,689,169	B2	2/2004	Harris
6,692,499	B2	2/2004	Tormala et al.
6,699,247	B2	3/2004	Zucherman et al.
6,699,292	B2	3/2004	Ogilvie et al.
6,706,045	B2	3/2004	Lin et al.
6,736,818	B2	5/2004	Perren et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,773,437	B2	8/2004	Ogilvie et al.
6,811,568	B2	11/2004	Minamikawa
6,827,741	B2	12/2004	Reeder
6,833,006	B2	12/2004	Foley et al.
6,869,449	B2	3/2005	Ball et al.
6,896,177	B2	5/2005	Carter
6,981,974	B2	1/2006	Berger
7,025,789	B2	4/2006	Chow et al.
7,037,342	B2	5/2006	Nilsson et al.
7,041,106	B1	5/2006	Carver et al.
7,044,953	B2	5/2006	Capanni
7,052,498	B2	5/2006	Levy et al.
7,182,787	B2	2/2007	Hassler et al.
7,240,677	B2	7/2007	Fox
7,291,175	B1	11/2007	Gordon
7,537,664	B2	5/2009	O'Neill et al.
7,588,603	B2	9/2009	Leonard
7,600,956	B2	10/2009	McDuff et al.
7,601,152	B2	10/2009	Levy et al.
7,655,042	B2	2/2010	Foley et al.
7,670,339	B2	3/2010	Levy et al.
7,674,426	B2	3/2010	Grohowski, Jr.
7,780,737	B2	8/2010	Bonnard et al.
7,794,483	B2	9/2010	Capanni
7,837,738	B2	11/2010	Reigstad et al.
7,842,091	B2	11/2010	Johnstone et al.
7,909,880	B1	3/2011	Grant
7,918,879	B2	4/2011	Yeung et al.
7,922,765	B2	4/2011	Reiley
7,955,388	B2	6/2011	Jensen et al.
7,976,580	B2	7/2011	Berger
7,993,403	B2	8/2011	Foley et al.
8,048,173	B2	11/2011	Ochoa
8,100,983	B2	1/2012	Schulte
8,162,942	B2	4/2012	Coati et al.
8,202,305	B2	6/2012	Reiley
8,262,712	B2	9/2012	Coilard-Lavirotte et al.
8,308,779	B2	11/2012	Reiley
8,388,667	B2	3/2013	Reiley et al.
8,394,097	B2	3/2013	Peyrot et al.
8,414,583	B2	4/2013	Prandi et al.
8,414,648	B2	4/2013	Reiley
8,425,570	B2	4/2013	Reiley
8,444,693	B2	5/2013	Reiley
8,470,004	B2	6/2013	Reiley
8,475,456	B2	7/2013	Augoyard et al.
8,529,611	B2	9/2013	Champagne et al.
8,597,337	B2	12/2013	Champagne
8,608,785	B2	12/2013	Reed et al.
8,685,024	B2	4/2014	Roman
8,715,325	B2	5/2014	Weiner et al.
8,728,387	B2	5/2014	Jones et al.
8,734,462	B2	5/2014	Reiley et al.
8,734,491	B2	5/2014	Seavey
8,834,483	B2	9/2014	Cheney et al.
8,834,572	B2	9/2014	Averous et al.
8,840,623	B2	9/2014	Reiley
8,840,651	B2	9/2014	Reiley
8,858,601	B2	10/2014	Reiley
8,864,804	B2	10/2014	Champagne et al.
8,920,477	B2	12/2014	Reiley
8,986,348	B2	3/2015	Reiley
8,992,703	B2	3/2015	O'Neill et al.
8,998,999	B2	4/2015	Lewis et al.
9,011,504	B2	4/2015	Reed
9,039,743	B2	5/2015	Reiley
9,044,287	B2	6/2015	Reed et al.
9,056,014	B2	6/2015	McCormick et al.
9,072,562	B2	7/2015	Weiner et al.
9,072,564	B2	7/2015	Reed et al.
9,089,427	B2	7/2015	Grohowski, Jr.
9,089,431	B2	7/2015	Grohowski, Jr.
D738,504	S	9/2015	Weiner et al.
9,125,698	B2	9/2015	Miller
9,125,704	B2	9/2015	Reed et al.
9,135,374	B2	9/2015	Jones et al.
9,161,789	B2	10/2015	Peyrot et al.
9,168,074	B2	10/2015	Prandi et al.
9,180,010	B2	11/2015	Dong et al.
9,282,977	B2	3/2016	Penzimer et al.
9,283,007	B2	3/2016	Augoyard et al.
9,403,213	B2	8/2016	Lapszynski
9,452,002	B2	9/2016	Roman et al.
9,492,215	B2	11/2016	Augoyard et al.
9,498,266	B2	11/2016	McCormick et al.
9,498,273	B2	11/2016	Thoren et al.
9,554,914	B2	1/2017	Taylor et al.
9,724,140	B2	8/2017	McCormick
9,757,168	B2	9/2017	Seavey et al.
9,775,630	B2	10/2017	Leavitt et al.
10,022,167	B2	7/2018	Augoyard et al.
10,111,690	B2	10/2018	Anderson et al.
2001/0025199	A1	9/2001	Rauscher
2001/0049529	A1	12/2001	Cachia et al.
2002/0019636	A1	2/2002	Ogilvie et al.
2002/0055785	A1	5/2002	Harris
2002/0065561	A1	5/2002	Ogilvie et al.
2002/0068939	A1	6/2002	Levy et al.
2002/0082705	A1	6/2002	Bouman et al.
2002/0099395	A1	7/2002	Acampora et al.
2002/0133156	A1	9/2002	Cole
2002/0169066	A1	11/2002	Cassidy et al.
2002/0189622	A1	12/2002	Cauthen et al.
2003/0040805	A1	2/2003	Minamikawa
2003/0069645	A1	4/2003	Ball et al.
2003/0120277	A1	6/2003	Berger
2003/0130660	A1	7/2003	Levy et al.
2004/0002759	A1	1/2004	Ferree
2004/0093081	A1	5/2004	Nilsson et al.
2004/0102853	A1	5/2004	Boumann et al.
2004/0138756	A1	7/2004	Reeder
2004/0172031	A1	9/2004	Rubecamp et al.
2004/0220574	A1	11/2004	Pelo et al.
2004/0220678	A1	11/2004	Chow et al.
2004/0230193	A1	11/2004	Cheung et al.
2005/0065589	A1	3/2005	Schneider et al.
2005/0119757	A1	6/2005	Hassler et al.
2005/0124990	A1	6/2005	Teague et al.
2005/0216015	A1	9/2005	Kreidler
2005/0251265	A1	11/2005	Calandruccio et al.
2005/0261768	A1	11/2005	Trieu
2005/0283159	A1	12/2005	Amara
2006/0015181	A1	1/2006	Elberg
2006/0036322	A1	2/2006	Reiley
2006/0052725	A1	3/2006	Santilli
2006/0052878	A1	3/2006	Schmieding
2006/0074492	A1	4/2006	Frey
2006/0084998	A1	4/2006	Levy et al.
2006/0085075	A1	4/2006	McLeer
2006/0147332	A1	7/2006	Jones et al.
2006/0247787	A1	11/2006	Rydell et al.
2007/0038303	A1	2/2007	Myerson et al.
2007/0123993	A1	5/2007	Hassler et al.
2007/0142920	A1	6/2007	Niemi
2007/0156241	A1	7/2007	Reiley et al.
2007/0162018	A1	7/2007	Jensen et al.
2007/0166122	A1	7/2007	McDuff et al.
2007/0185584	A1	8/2007	Kaufmann et al.
2007/0198088	A1	8/2007	Biedermann et al.
2007/0213831	A1	9/2007	de Cubber
2007/0233110	A1	10/2007	Muhanna et al.
2007/0239158	A1	10/2007	Trieu et al.
2008/0039949	A1	2/2008	Meesenburg et al.
2008/0132894	A1	6/2008	Coilard-Lavirotte et al.
2008/0154385	A1	6/2008	Trail et al.
2008/0177262	A1*	7/2008	Augoyard A61B 17/7208 606/280
2008/0177291	A1*	7/2008	Jensen A61B 17/68 606/301
2008/0195219	A1	8/2008	Wiley et al.
2008/0221697	A1	9/2008	Graser
2008/0221698	A1	9/2008	Berger
2008/0234763	A1	9/2008	Patterson et al.
2008/0269908	A1	10/2008	Warburton

(56) **References Cited**

U.S. PATENT DOCUMENTS

2009/0005821 A1	1/2009	Chirico et al.	
2009/0012564 A1	1/2009	Chirico et al.	
2009/0018556 A1	1/2009	Prandi	
2009/0138096 A1	5/2009	Myerson et al.	
2009/0254189 A1	10/2009	Scheker	
2009/0254190 A1	10/2009	Gannoe et al.	
2010/0010637 A1	1/2010	Pequignot	
2010/0016905 A1	1/2010	Greenhalgh et al.	
2010/0016982 A1	1/2010	Solomons	
2010/0057214 A1	3/2010	Graham et al.	
2010/0121390 A1	5/2010	Kleinman	
2010/0131014 A1	5/2010	Peyrot	
2010/0131072 A1	5/2010	Schulte	
2010/0161068 A1	6/2010	Lindner et al.	
2010/0185295 A1	7/2010	Emmanuel	
2010/0228301 A1	9/2010	Greenhalgh et al.	
2010/0249942 A1	9/2010	Goswami et al.	
2010/0256731 A1	10/2010	Mangiardi	
2010/0256770 A1	10/2010	Hakansson et al.	
2010/0262254 A1	10/2010	Lawrence et al.	
2011/0004317 A1	1/2011	Hacking et al.	
2011/0093084 A1	4/2011	Morton	
2011/0093085 A1	4/2011	Morton	
2011/0118739 A1*	5/2011	Tyber	A61B 17/7233 606/62
2011/0144644 A1	6/2011	Prandi et al.	
2011/0208304 A1	8/2011	Justin et al.	
2011/0301652 A1	12/2011	Reed et al.	
2011/0301653 A1	12/2011	Reed et al.	
2012/0029579 A1	2/2012	Bottlang et al.	
2012/0065692 A1	3/2012	Champagne et al.	
2012/0083791 A1	4/2012	Cheney et al.	
2012/0089197 A1	4/2012	Anderson	
2012/0197311 A1	8/2012	Kirschman	
2012/0259419 A1	10/2012	Brown et al.	
2013/0053975 A1	2/2013	Reed et al.	
2013/0060295 A1	3/2013	Reed et al.	
2013/0066435 A1	3/2013	Averous et al.	
2013/0123862 A1	5/2013	Anderson et al.	
2013/0131822 A1	5/2013	Lewis et al.	
2013/0150965 A1	6/2013	Taylor et al.	
2013/0190761 A1	7/2013	Prandi et al.	
2013/0190831 A1	7/2013	Ek et al.	
2013/0231744 A1	9/2013	Taylor et al.	
2013/0317559 A1	11/2013	Leavitt et al.	
2013/0325077 A1	12/2013	Champagne et al.	
2014/0005219 A1	1/2014	Foster et al.	
2014/0039630 A1	2/2014	Peyrot et al.	
2014/0058462 A1	2/2014	Reed et al.	
2014/0107712 A1	4/2014	Fallin et al.	
2014/0142715 A1	5/2014	McCormick	
2014/0180428 A1	6/2014	McCormick	
2014/0188239 A1	7/2014	Cummings	
2014/0257509 A1	9/2014	Dacosta et al.	
2014/0276827 A1	9/2014	Roman et al.	
2014/0277554 A1	9/2014	Roman et al.	
2014/0309747 A1	10/2014	Taylor et al.	
2014/0316474 A1	10/2014	Graham	
2014/0343615 A1	11/2014	Cheney et al.	
2015/0011998 A1	1/2015	McCormick et al.	
2015/0066097 A1	3/2015	Biedermann	
2015/0073413 A1	3/2015	Palmer et al.	
2015/0094778 A1	4/2015	McCormick et al.	
2015/0112341 A1	4/2015	Penzimer et al.	
2015/0112342 A1	4/2015	Penzimer et al.	
2015/0112446 A1	4/2015	Melamed et al.	
2015/0150607 A1	6/2015	Chen et al.	
2015/0164563 A1	6/2015	Lewis et al.	
2015/0223848 A1	8/2015	McCormick	
2015/0223849 A1	8/2015	McCormick et al.	
2015/0223850 A1	8/2015	Reed	
2015/0223853 A1	8/2015	Appenzeller et al.	
2015/0342655 A1	12/2015	Reed et al.	
2016/0058484 A1	3/2016	McCombs-Stearnes et al.	
2016/0338751 A1	11/2016	Kellar et al.	
2017/0065310 A1	3/2017	Girod et al.	
2017/0239059 A1	8/2017	Boublil et al.	
2017/0252084 A1	9/2017	Anderson et al.	
2017/0333081 A1	11/2017	Cordier et al.	
2018/0021145 A1	1/2018	Seavey et al.	
2018/0161170 A1	6/2018	Petranto	

FOREIGN PATENT DOCUMENTS

CA	2836654	A1	6/2014
CA	2837497	A1	6/2014
EP	0042808	A1	12/1981
EP	0340159	A1	11/1989
EP	0420794	A1	4/1991
EP	0454645	A1	10/1991
EP	1300122	A2	4/2003
EP	1356794	A3	11/2003
EP	1582159	A1	10/2005
EP	1923012	A1	5/2008
EP	2228015	A3	3/2011
EP	2471477	A1	7/2012
EP	2471478	A1	7/2012
EP	2544633	A1	1/2013
EP	2749236	A3	10/2014
FR	2663838	A1	1/1992
FR	2725126	A1	4/1996
FR	2783702	A1	3/2000
FR	2787313	A1	6/2000
FR	2794019	A1	12/2000
FR	2801189	A1	5/2001
FR	2846545	A1	5/2004
FR	2856269	A1	12/2004
FR	2884406		10/2006
FR	2927529	A1	8/2009
FR	2935601	A1	3/2010
FR	2957244	A1	9/2011
GB	2119655	A	11/1983
GB	2430625	B	4/2007
JP	S60145133	A	7/1985
JP	03001854	A	8/1991
JP	H7303662	A	11/1995
JP	2004535249	A	11/2004
JP	3648687	B2	5/2005
JP	2007530194	A	11/2007
JP	2008188411	A	8/2008
JP	2008537696	A	9/2008
JP	4695511	B2	6/2011
JP	5631597	B2	11/2014
JP	5645826	B2	12/2014
KR	20070004513	A	1/2007
KR	20070022256	A	2/2007
KR	101004561	B1	1/2011
KR	101235983	B1	2/2013
WO	9116014	A1	10/1991
WO	9625129	A1	8/1996
WO	9641596	A1	12/1996
WO	9726846	A1	7/1997
WO	9733537	A1	9/1997
WO	0117445	A1	3/2001
WO	03084416	A1	10/2003
WO	2005020830	A1	3/2005
WO	2005020831	A2	3/2005
WO	2005063149	A1	7/2005
WO	2005104961	A1	11/2005
WO	2006109004	A1	10/2006
WO	2007135322	A1	11/2007
WO	2008057404	A2	5/2008
WO	2008112308	A1	9/2008
WO	2008129214	A2	10/2008
WO	2009055952	A1	5/2009
WO	2009103085	A1	8/2009
WO	2010029246	A1	3/2010
WO	2011082343	A1	7/2011
WO	2011110784	A1	9/2011
WO	2011116078	A1	9/2011
WO	2011130229	A1	10/2011
WO	2012089330	A1	7/2012
WO	2012089331	A1	7/2012
WO	2013164819	A1	11/2013

(56) **References Cited**

FOREIGN PATENT DOCUMENTS

WO	2014031947 A1	2/2014
WO	2014165123 A1	10/2014
WO	2015136212 A1	9/2015

OTHER PUBLICATIONS

Cross section, <https://byjus.com/maths/cross-section/> (last visited Jan. 26, 2022). 4 pgs. [Exhibit No. 1009 to Petition for Inter Partes Review of U.S. Pat. No. 9,168,074].
Declaration of Michael Sherman (Jan. 28, 2022). 119 pgs. [Exhibit No. 1002 to Petition for Inter Partes Review of U.S. Pat. No. 9,168,074].
EP Notification for Application No. 09741356.1 dated Feb. 12, 2015, 4 pages.
Excerpt from Tool.com—File and Rasp Tools, (Copyright 2022), 6 pages. [Exhibit No. 2002 to Patent Owner's Preliminary Response, IPR2022-00486 of U.S. Pat. No. 9,168,074 filed May 16, 2022].
HammerFix IP Fusion System, Hammertoe Deformity Surgical Technique, designed by Extremity Medical, published Mar. 31, 2014 (8 pages).
International Search Report for PCT/FR2008/050453 dated Nov. 4, 2008, 4 pages.
International Search Report, PCT/FR2006/050345, dated Aug. 30, 2006, 3 pages.
Intraosseous Fixation System, Hammertoe Surgical Technique, designed by OrthoHelix, published Aug. 23, 2012 (16 pages).
Japanese Office Action for Application No. 2011-526540 dated Aug. 13, 2013, 3 pages.
Jung, H. J. et al., JJ., Decision Denying Institution of Inter Partes Review, IPR2022-00486 of U.S. Pat. No. 9,168,074 , *OsteoMed LLC* v. *Stryker European Operations Holdings LLC*. (Aug. 12, 2022). 42 pages.
Patent Owner's Preliminary Response and Exhibits List, IPR2022-00486 of U.S. Pat. No. 9,168,074 , *OsteoMed LLC* v. *Stryker European Operations Holdings LLC*. (Filed May 16, 2022), 77 pages. [Including Appendices at Exhibits 2003 and 2004].
Petition for Inter Partes Review of U.S. Pat. No. 9,168,074 , *OsteoMed LLC* v. *Stryker European Operations Holdings LLC*. (Jan. 28, 2022). 98 pgs.
Pietrzak WS, et al., "A bioabsorbable fixation implant for use in proximal interphalangeal joint (hammer toe) arthrodesis: Biomechanical testing in a synthetic bone substrate". J Foot Ankle Surg. Sep.-Oct. 2006;45(5):288-94. doi: 10.1053/j.jfas.2006.05.004. PMID: 16949524. 7 pgs. [Exhibit No. 1007 to Petition for Inter Partes Review of U.S. Pat. No. 9,168,074].
The American Heritage College Dictionary, Fourth Edition, Houghton Mifflin Company (Apr. 2007). 3 pgs. [Exhibit No. 1008 to Petition for Inter Partes Review of U.S. Pat. No. 9,168,074].

* cited by examiner

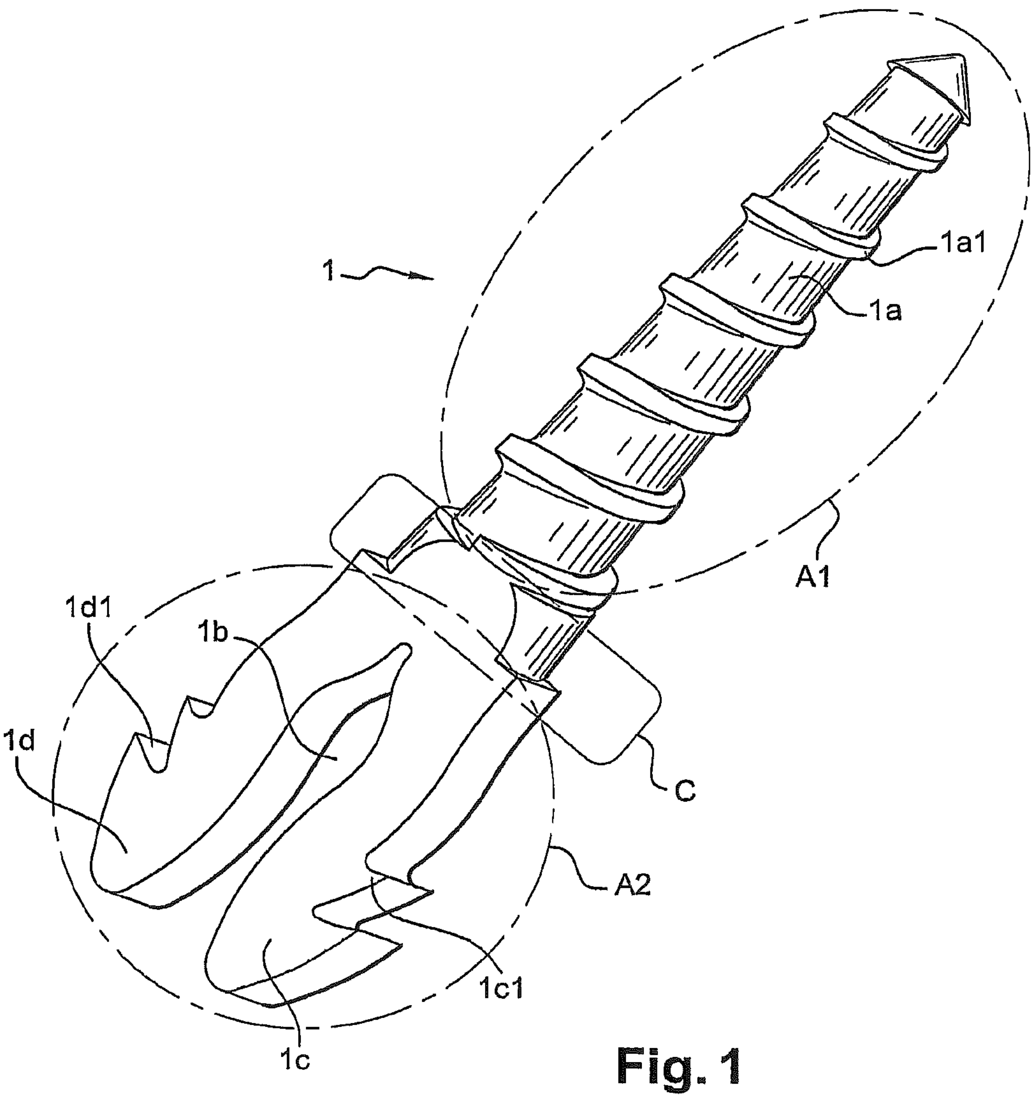
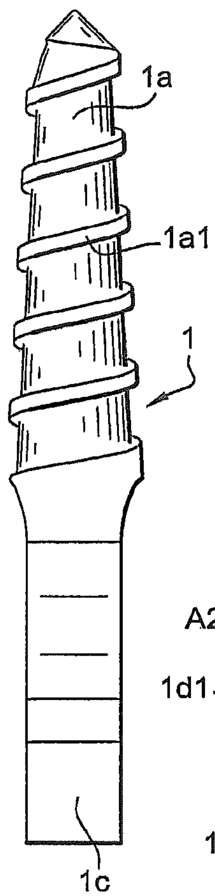
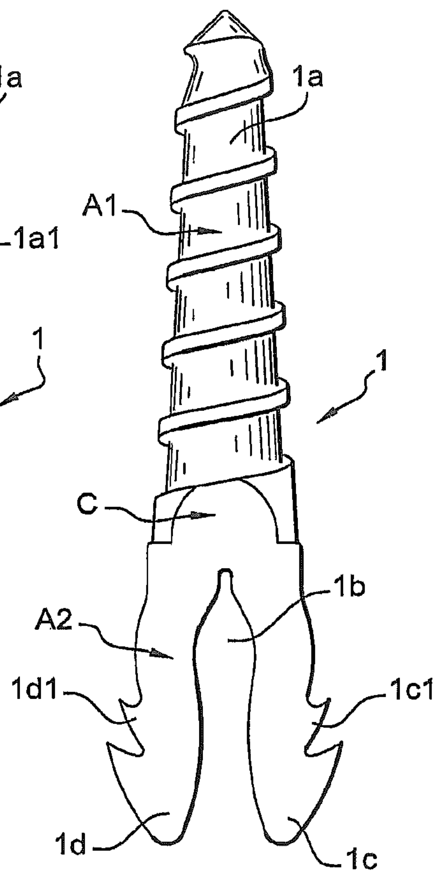


Fig. 1





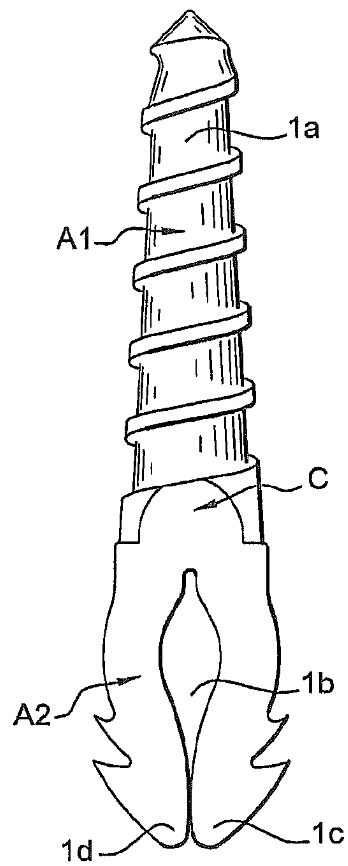


Fig. 3 Fig. 2 Fig. 4

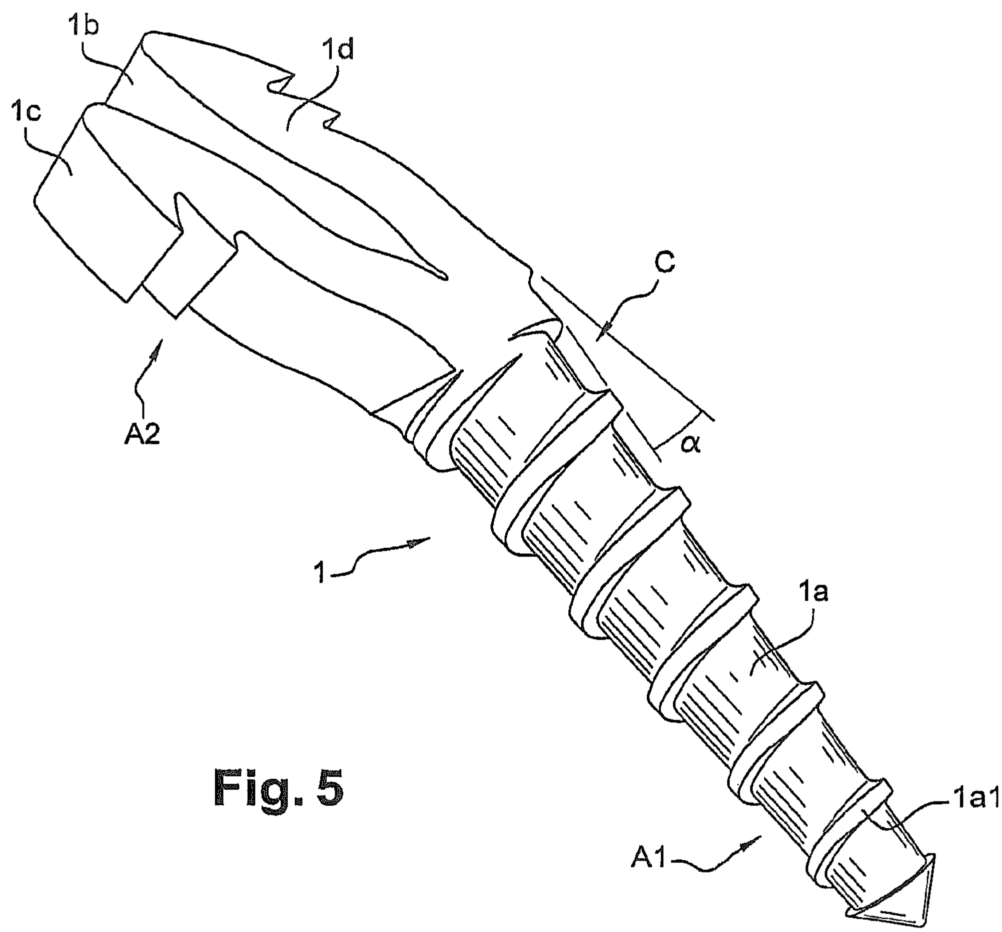


Fig. 5

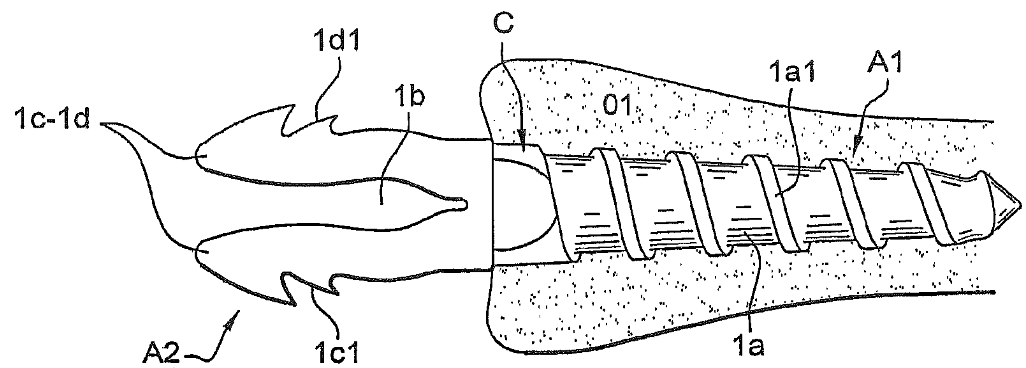


Fig. 6

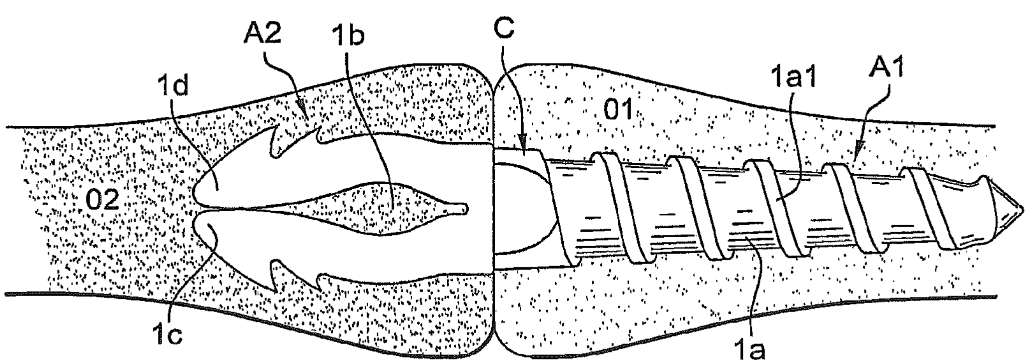


Fig. 7

RESORPTIVE INTRAMEDULLARY IMPLANT BETWEEN TWO BONES OR TWO BONE FRAGMENTS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 18/770,767, filed on Jul. 12, 2024, which is a continuation of U.S. patent application Ser. No. 16/506,353, filed on Jul. 9, 2019, now U.S. Pat. No. 12,059,186, which is a continuation of U.S. patent application Ser. No. 14/858,855, filed Sep. 18, 2015, now U.S. Pat. No. 10,383,671, which is a divisional of U.S. patent application Ser. No. 13/795,946, filed Mar. 12, 2013, now U.S. Pat. No. 9,168,074, which is a continuation of U.S. patent application Ser. No. 12/918,105, filed Oct. 29, 2010, now U.S. Pat. No. 8,414,583, which application is a U.S. national phase entry under 35 U.S.C. § 371 of International Application No. PCT/FR2009/051658, filed Sep. 2, 2009, published as WO 2010/029246, which claims priority from French Patent Application No. 0856035, filed Sep. 9, 2008, whose entire disclosures are herewith incorporated by reference.

FIELD OF THE INVENTION

The invention relates to the technical field of orthopedic implants, particularly for arthrodesis and osteosynthesis.

More particularly, the invention relates to an intramedullary implant for arthrodesis between two bone parts or osteosynthesis between two bone fragments, particularly in the case of the hand or foot.

BACKGROUND OF THE INVENTION

Different solutions have been proposed to achieve these functions.

For example, a solution comes from the teaching of patent application FR 2,884,406 [US 2008/0177262], of which the applicant of the present application is also the applicant. This patent describes an intramedullary osteosynthesis device constituted of an elongated body whose ends constitute anchor zones cooperating with the bone parts to be immobilized. The anchor zones are shaped and made of a material selected to enable insertion into the bone parts, then to ensure an anchor in the bone parts by preventing any rotational movement by resisting traction and by maintaining a compression force.

Another solution also comes from patent application FR 07.02003 [US 2010/0131014], also from the same applicant. This document describes an implant in the form of two anchor zones connected by a central zone and whose general shape is substantially inscribed in a very elongated rectangle of X-shape, so as to form in the anchor zones two legs adapted to move apart by elastic or shape-memory effect.

From this design, different criteria have been established to make the implant easy to place and efficient in order to create a primary and secondary stability for the osteosynthesis or arthrodesis site.

However, these solutions are not adapted for the case of an implant made of resorptive material.

BRIEF SUMMARY OF THE INVENTION

From this state of the art, the object that the invention proposes to attain is further improving the anchor and the

stability of the implant as well as its adaptation to the morphology of the implantation site when the implant is made of resorptive material.

To solve such a problem, a resorptive intramedullary implant between two bones or two bone fragments has been designed and developed; it is constituted, in a known manner, of a single-piece body having a general elongated shape with, at each end, zones for anchoring to the bone parts being considered. According to the invention, one of the zones has a cylindrical shape, whereas the other zone is flat.

Advantageously, the implant is made of a resorptive material whose mechanical properties are determined to last the time necessary for the consolidation, so that the implant is resorbed after six months. For example, the implant is composed of lactic acid polymer or copolymer (PLA, PGA . . .).

Considering the specific mechanical characteristics of resorptive materials, and to solve the given problem of improving anchor and stability, the cylindrical cross-section is threaded and tapers in the direction of its free end.

To solve the given problem of enabling a deformation by elasticity, thus causing an expansion adapted to the geometry of the site and to the properties of the material, the flat cross-section zone has, substantially in its median portion, an opening adapted to enable elastic deformation of the zone. The opening defines at least two anchor arms.

It therefore appears that the combination of a cylindrical and threaded anchor zone and a flat-sectioned anchor zone is particularly advantageous considering the problem to be solved.

To solve the given problem of resisting the shear and flexion forces susceptible of occurring in the area of the bone site, between the two anchor zones, the body has a central zone of transition adapted to resist the shear and flexion forces occurring in the area of the bone site and adapted to serve as an abutment.

From this basic design of the implant, the anchor zones are either coaxial or angularly offset by between about 1° and 30° and, advantageously, by 10°. The bend between the anchor zones is located so as to substantially correspond to an arthrodesis line of the bones being considered.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is explained in more detail hereinafter with reference to the attached drawings, in which:

FIG. **1** is a perspective view of the implant;

FIG. **2** is a front view of the implant before insertion into the bone part in question;

FIG. **3** is a side view corresponding to FIG. **2**;

FIG. **4** is a view like FIG. **2** showing the position of the anchor arms of the flat section after insertion;

FIG. **5** is a perspective view of another advantageous embodiment of the implant;

FIGS. **6** and **7** show the installation of the implant into two bone parts.

DETAILED DESCRIPTION

The implant according to the invention has a one-piece body **1** of elongated shape and having a first proximal zone A**1** and a second distal zone A**2**. The entire implant body is made of a resorptive material whose mechanical properties are determined for the implant to be resorbed in no less than about 6 months. In one embodiment, the implant is composed of lactic acid polymer or copolymer (PLA, PGA . . .).

As will be described later in the description, the zones A**1** and A**2** have anchor formations for the respective bone parts. Taking into account the specific characteristics of the resorptive material and to attain the given object of anchor and stability, the zone A**1** is of a cylindrical shape section whereas the other zone A**2** is flat.

The zone A**1** has a generally cylindrical outer surface **1***a* with a limited taper toward its free end. The surface **1***a* has a helical rib forming a screwthread **1***a***1**.

The zone A**2** is flat and has substantially in its center, an opening **1***b* adapted to enable elastic deformation of the zone A**2**. More particularly, the opening **1***b* defines at least two anchor arms **1***c* and **1***d*, each having at least one outwardly projecting tooth **1***c***1**, **1***d***1**.

Advantageously, between the two zones A**1** and A**2** the body **1** has a central zone C for transition adapted to resist shear and flexion forces that can occur at the end of a bone. By way of nonlimiting example, this median zone C can have a length of about 3.5 mm and a thickness of about 2 mm, for an overall implant length comprised between about 15 and 25 mm and a diameter of about 2 or 3 mm at the zone A**1**.

In the embodiment shown in FIG. **1**, the two zones A**1** and A**2** are coaxial.

To solve the problem of adaptation to the shape of the implantation site, the anchor zones A**1** and A**2** can be offset at an angle α adapted to the geometry of the bone site. This angle α is comprised between about 1° and 30° and, advantageously, on the order of 10° when the implant is for foot arthrodesis (FIG. **5**).

In this embodiment in which the two anchor zones are angularly offset, the bend is located so as to correspond substantially to the arthrodesis line of the bone parts being fused.

FIGS. **6** and **7** schematically show the positioning of the implant according to the invention between two bone parts O**1** and O**2**. After suitable holes have been made in the bone by a rasp-type tool, the operator screws the thread **1***a* into the bone part O**1** substantially up to the median zone C that serves as abutment preventing the implant from sinking too deeply into the bone (FIG. **6**). The operator then fits the second bone part O**2** back onto the anchor arms **1***d* and **1***c* of the zone A**2**, the anchor arms then spread and tighten by elasticity (FIG. **7**).

The operative technique can be the following:

Drilling of the two holes with a conventional drill;

Preparation of the holes with a rasp for the flat side and a bone tap to form the inner screw thread on the cylindrical side;

Use of a screwdriver with a gripper end;

Screwing in the cylindrical side P**1** [A**1**] for an arthrodesis IPP of the foot;

Fitting of the bone back onto the flat side [A**2**] of the implant.

The advantages are readily apparent from the description; in particular, it is to be emphasized and understood that the combination of the two anchor zones A**1** and A**2** of cylindrical and a flat shape, respectively, significantly enhances anchor and stability of the implant adapted to the geometry of the bone site and to the material properties, namely, a resorptive material.

The invention claimed is:

1. A method for fixing first and second bone parts, the method comprising the steps of:

drilling a first hole in a first bone part;

drilling a second hole in a second bone part;

tapping the first hole;

threading a first end of a monolithic implant into the first hole until a step abuts the first bone part;

moving first and second anchor arms of a second end of the implant towards one another, the first anchor arm including first and second teeth extending in a first direction and the second anchor arm including third and fourth teeth extending in a second direction different from the first direction; and

fitting the second end into the second bone part.

2. The method of claim **1**, wherein during the fitting step, the first and second anchor arms move away from one another.

3. The method of claim **1**, further comprising the step of preparing the second bone part with a rasp prior to fitting the second end of the implant into the second bone part.

4. The method of claim **1**, wherein the second end has an opening in a median portion thereof adapted to enable elastic deformation of the first and second anchor arms, and wherein the first and second anchor arms are in a compressed state while the second end is being fitted into the second bone part, the first and second anchor arms move away from each other once fitted within the second bone part.

5. The method of claim **1**, wherein the intramedullary implant includes a longitudinal axis and the step defines a plane substantially perpendicular to the longitudinal axis.

6. The method of claim **1**, wherein the fitting step includes fitting a first flat portion of the first tooth, a second flat portion of the second tooth, a third flat portion of the third tooth and a fourth flat portion of the fourth tooth within the second bone part.

7. The method of claim **6**, wherein the first, second, third and fourth flat portions are coplanar.

8. The method of claim **1**, wherein the first end tapers in a direction away from the second end.

9. The method of claim **1**, wherein an opening is formed between the first and second anchor arms to permit the first and second anchor arms to move with respect to each other.

10. The method of claim **1**, wherein the moving step includes elastically deforming the first and second anchor arms.

11. The method of claim **1**, wherein the first and second ends are offset from each other.

12. A method for fixing first and second bone parts, the method comprising the steps of:

drilling a first hole in a first bone part;

drilling a second hole in a second bone part;

tapping the first hole;

rasping the second hole;

rotating a first end of a monolithic implant to thread the first end into the first hole until a step abuts the first bone part;

elastically deforming first and second anchor arms of a second end of the implant towards one another, the first anchor arm including first and second teeth extending in a first direction and the second anchor arm including third and fourth teeth extending in a second direction different from the first direction; and

fitting the second end into the second bone part.

13. The method of claim **12**, wherein during the fitting step, the first and second anchor arms move away from one another.

14. The method of claim **12**, wherein the second end has an opening in a median portion thereof adapted to enable elastic deformation of the first and second anchor arms, and wherein the first and second anchor arms are in a compressed state while the second end is being fitted into the second bone part, the first and second anchor arms move away from each other once fitted within the second bone part.

15. The method of claim **12**, wherein the intramedullary implant includes a longitudinal axis and the step defines a plane substantially perpendicular to the longitudinal axis.

16. The method of claim **12**, wherein the first tooth includes a first flat portion, the second tooth includes a second flat portion, the third tooth includes a third flat portion and the fourth tooth includes a fourth flat portion.

17. The method of claim **16**, wherein the first, second, third and fourth flat portions are coplanar.

18. The method of claim **12**, wherein the first end tapers in a direction away from the second end.

19. The method of claim **12**, wherein the elastically deforming step includes moving the first and second anchor arms with respect to each other about an opening formed therebetween.

20. The method of claim **12**, wherein the first and second ends are offset from each other.

* * * * *