US009028493B2

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

(10) **Patent No.: US 9,028,493 B2**
(45) **Date of Patent: *May 12, 2015**

(54) **IN VIVO ATTACHABLE AND DETACHABLE END EFFECTOR ASSEMBLY AND LAPAROSCOPIC SURGICAL INSTRUMENT AND METHODS THEREFOR**

(75) Inventors: **Patrick L. Dumbauld**, Lyons, CO (US); **Edward Cosgriff**, Denver, CO (US)

(73) Assignee: **Covidien LP**, Mansfield, MA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 578 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **13/415,639**

(22) Filed: **Mar. 8, 2012**

(65) **Prior Publication Data**

US 2012/0172925 A1 Jul. 5, 2012

Related U.S. Application Data

(63) Continuation of application No. 12/562,281, filed on Sep. 18, 2009, now Pat. No. 8,133,254.

(51) **Int. Cl.**

A61B 18/14	(2006.01)
A61B 17/00	(2006.01)
A61B 17/29	(2006.01)
A61B 18/00	(2006.01)

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

CPC ... ***A61B 18/1445*** (2013.01); *A61B 2017/00473* (2013.01); *A61B 2017/2931* (2013.01); *A61B 2017/2945* (2013.01); *A61B 2018/00601* (2013.01); *A61B 2018/0063* (2013.01); *A61B 2018/1412* (2013.01); *A61B 2018/1432* (2013.01); *A61B 2018/1455* (2013.01)

(58) **Field of Classification Search**

USPC 606/1, 51, 52, 205–208; 128/898; 600/104

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

371,664 A 10/1887 Brannan et al.
702,472 A 6/1902 Pignolet

(Continued)

FOREIGN PATENT DOCUMENTS

CA 2 104 423 2/1994
CA 2 520 413 3/2007

(Continued)

OTHER PUBLICATIONS

U.S. Appl. No. 08/926,869, filed Sep. 10, 1997, James G. Chandler.

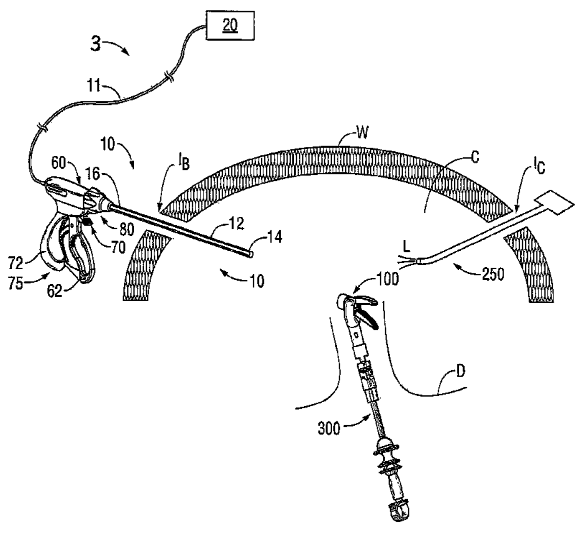
(Continued)

Primary Examiner — Michael Peffley

(57) **ABSTRACT**

A method of performing surgery includes the steps of providing a forceps having a housing including a shaft that extends therefrom and at least one handle moveable relative to the housing and providing an end effector assembly configured to selectively engage a distal end of the shaft. The method also includes the steps of inserting the forceps through a first opening formed in a body; inserting the end effector assembly through a second opening formed in the body; engaging the end effector assembly with the distal end of the shaft in vivo; and actuating the end effector assembly by moving the handle relative to the housing. The method may also include the steps of providing a coupling at the distal end of the shaft, and engaging, via the coupling, the distal end of the shaft with the end effector assembly.

18 Claims, 10 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

728,883	A	5/1903	Downes
1,586,645	A	6/1926	Bierman
1,813,902	A	7/1931	Bovie
1,822,330	A	9/1931	Ainslie
1,852,542	A	4/1932	Sovatkin
1,908,201	A	5/1933	Welch et al.
1,918,889	A	7/1933	Bacon
2,002,594	A	5/1935	Wappler et al.
2,011,169	A	8/1935	Wappler
2,031,682	A	2/1936	Wappler et al.
2,054,149	A	9/1936	Wappler
2,113,246	A	5/1937	Wappler
2,141,936	A	12/1938	Schmitt
2,176,479	A	10/1939	Willis
2,305,156	A	4/1941	Grubel
2,245,030	A	6/1941	Gottesfeld et al.
2,279,753	A	4/1942	Knopp
2,327,353	A	8/1943	Karle
2,632,661	A	8/1948	Cristofv
2,668,538	A	2/1954	Baker
2,796,065	A	6/1957	Kapp
2,824,915	A	2/1958	Buturuga
3,073,311	A	1/1963	Tibbs et al.
3,100,489	A	8/1963	Bagley
3,204,807	A	9/1965	Ramsing
3,372,288	A	3/1968	Wigington
3,459,187	A	8/1969	Pallotta
3,561,448	A	2/1971	Peternel
3,643,663	A	2/1972	Sutter
3,648,001	A	3/1972	Anderson et al.
3,651,811	A	3/1972	Hildebrandt et al.
3,678,229	A	7/1972	Osika
3,720,896	A	3/1973	Beierlein
3,763,726	A	10/1973	Hildebrand
3,779,918	A	12/1973	Ikeda et al.
3,798,688	A	3/1974	Wasson
3,801,766	A	4/1974	Morrison, Jr.
3,839,614	A	10/1974	Saganowski et al.
3,862,630	A	1/1975	Balamuth
3,863,339	A	2/1975	Reaney et al.
3,866,610	A	2/1975	Kletschka
3,875,945	A	4/1975	Friedman
3,897,786	A	8/1975	Garnett et al.
3,911,766	A	10/1975	Fridolph et al.
3,920,021	A	11/1975	Hiltebrandt
3,921,641	A	11/1975	Hulka
3,938,527	A	2/1976	Rioux et al.
3,952,749	A	4/1976	Fridolph et al.
3,970,088	A	7/1976	Morrison
3,987,795	A	10/1976	Morrison
4,005,714	A	2/1977	Hiltebrandt
4,016,881	A	4/1977	Rioux et al.
4,031,898	A	6/1977	Hiltebrandt et al.
4,041,952	A	8/1977	Morrison, Jr. et al.
4,043,342	A	8/1977	Morrison, Jr.
4,074,718	A	2/1978	Morrison, Jr.
4,076,028	A	2/1978	Simmons
4,080,820	A	3/1978	Allen
4,088,134	A	5/1978	Mazzariello
4,102,471	A	7/1978	Lore et al.
D249,549	S	9/1978	Pike
4,112,950	A	9/1978	Pike
4,127,222	A	11/1978	Adams
4,128,099	A	12/1978	Bauer
4,165,746	A	8/1979	Burgin
4,187,420	A	2/1980	Piber
4,200,104	A	4/1980	Harris
4,200,105	A	4/1980	Gonser
4,233,734	A	11/1980	Bies
4,236,470	A	12/1980	Stenson
4,274,413	A	6/1981	Hahn et al.
4,300,564	A	11/1981	Furihata
4,306,561	A	12/1981	De Medinaceli
4,311,145	A	1/1982	Esty et al.
D263,020	S	2/1982	Rau, III
4,315,510	A	2/1982	Kihn
4,363,944	A	12/1982	Poirier
4,370,980	A	2/1983	Lottick
4,375,218	A	3/1983	DiGeronimo
4,394,552	A	7/1983	Schlosser
4,416,276	A	11/1983	Newton et al.
4,418,692	A	12/1983	Guay
4,443,935	A	4/1984	Zamba et al.
4,452,246	A	6/1984	Bader et al.
4,470,786	A	9/1984	Sano et al.
4,492,231	A	1/1985	Auth
4,493,320	A	1/1985	Treat
4,503,855	A	3/1985	Maslanka
4,506,669	A	3/1985	Blake, III
4,509,518	A	4/1985	McGarry et al.
4,513,271	A	4/1985	Reisem
4,535,773	A	8/1985	Yoon
4,552,143	A	11/1985	Lottick
4,574,804	A	3/1986	Kurwa
4,597,379	A	7/1986	Kihn et al.
4,600,007	A	7/1986	Lahodny et al.
4,619,258	A	10/1986	Pool
4,624,254	A	11/1986	McGarry et al.
4,644,950	A	2/1987	Valli
4,655,215	A	4/1987	Pike
4,655,216	A	4/1987	Tischer
4,657,016	A	4/1987	Garito et al.
4,662,372	A	5/1987	Sharkany et al.
4,671,274	A	6/1987	Sorochenko
4,674,499	A	6/1987	Pao
4,685,459	A	8/1987	Xoch et al.
4,733,662	A	3/1988	DeSatnick et al.
D295,893	S	5/1988	Sharkany et al.
D295,894	S	5/1988	Sharkany et al.
4,753,235	A	6/1988	Hasson
4,754,892	A	7/1988	Retief
4,763,669	A	8/1988	Jaeger
D298,353	S	11/1988	Manno
4,781,175	A	11/1988	McGreevy et al.
D299,413	S	1/1989	DeCarolis
4,805,616	A	2/1989	Pao
4,827,927	A	5/1989	Newton
4,827,929	A	5/1989	Hodge
4,829,313	A	5/1989	Taggart
4,846,171	A	7/1989	Kauphusman et al.
4,887,612	A	12/1989	Esser et al.
4,890,610	A	1/1990	Kirwan, Sr. et al.
4,938,761	A	7/1990	Ensslin
4,947,009	A	8/1990	Osika et al.
4,973,801	A	11/1990	Frick et al.
4,985,030	A	1/1991	Melzer et al.
5,007,908	A	4/1991	Rydell
5,026,370	A	6/1991	Lottick
5,026,371	A	6/1991	Rydell et al.
5,035,695	A	7/1991	Weber, Jr. et al.
5,037,433	A	8/1991	Wilk et al.
5,042,707	A	8/1991	Taheri
5,047,046	A	9/1991	Bodoia
5,052,402	A	10/1991	Bencini et al.
5,078,716	A	1/1992	Doll
5,084,057	A	1/1992	Green et al.
5,085,659	A	2/1992	Rydell
5,099,840	A	3/1992	Goble et al.
5,100,430	A	3/1992	Avellanet et al.
5,108,392	A	4/1992	Spingler
5,112,343	A	5/1992	Thornton
5,116,332	A	5/1992	Lottick
5,122,139	A	6/1992	Sutter
5,144,323	A	9/1992	Yonkers
5,147,357	A	9/1992	Rose et al.
5,151,102	A	9/1992	Kamiyama et al.
5,151,978	A	9/1992	Bronikowski et al.
5,158,561	A	10/1992	Rydell et al.
5,169,396	A	12/1992	Dowlatshahi et al.
5,176,695	A	1/1993	Dulebohn
5,190,541	A	3/1993	Abele et al.
5,196,009	A	3/1993	Kirwan, Jr.
5,197,964	A	3/1993	Parins
5,209,747	A	5/1993	Knoepfler

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,211,655	A	5/1993	Hasson
5,215,101	A	6/1993	Jacobs et al.
5,217,457	A	6/1993	Delahuerga et al.
5,217,458	A	6/1993	Parins
5,217,460	A	6/1993	Knoepfler
5,219,354	A	6/1993	Choudhury et al.
5,244,462	A	9/1993	Delahuerga et al.
5,250,047	A	10/1993	Rydell
5,250,056	A	10/1993	Hasson
5,250,063	A	10/1993	Abidin et al.
5,254,129	A	10/1993	Alexander
5,258,001	A	11/1993	Corman
5,258,006	A	11/1993	Rydell et al.
5,261,918	A	11/1993	Phillips et al.
5,267,998	A	12/1993	Hagen
5,269,780	A	12/1993	Roos
5,269,804	A	12/1993	Bales et al.
D343,453	S	1/1994	Noda
5,275,615	A	1/1994	Rose
5,277,201	A	1/1994	Stern
5,281,220	A	1/1994	Blake, III
5,282,799	A	2/1994	Rydell
5,282,800	A	2/1994	Foshee et al.
5,282,826	A	2/1994	Quadri
5,290,286	A	3/1994	Parins
5,290,287	A	3/1994	Boebel et al.
5,300,082	A	4/1994	Sharpe et al.
5,304,203	A	4/1994	El-Mallawany et al.
5,308,353	A	5/1994	Beurrier
5,308,357	A	5/1994	Lichtman
5,312,433	A	5/1994	Boebel et al.
5,313,027	A	5/1994	Inoue et al.
5,314,445	A	5/1994	Degwitz et al.
5,314,463	A	5/1994	Camps et al.
5,318,589	A	6/1994	Lichtman
5,324,289	A	6/1994	Eggers
D348,930	S	7/1994	Olson
5,326,806	A	7/1994	Yokoshima et al.
5,330,471	A	7/1994	Eggers
5,330,502	A	7/1994	Hassler et al.
D349,341	S	8/1994	Lichtman et al.
5,334,166	A	8/1994	Palestrant
5,334,183	A	8/1994	Wuchinich
5,334,215	A	8/1994	Chen
5,336,220	A	8/1994	Ryan et al.
5,336,221	A	8/1994	Anderson
5,342,359	A	8/1994	Rydell
5,342,381	A	8/1994	Tidemand
5,342,393	A	8/1994	Stack
5,344,424	A	9/1994	Roberts et al.
5,350,391	A	9/1994	Iacovelli
5,352,222	A	10/1994	Rydell
5,354,271	A	10/1994	Voda
5,356,408	A	10/1994	Rydell
5,359,993	A	11/1994	Slater et al.
5,366,477	A	11/1994	LeMarie, III et al.
5,367,250	A	11/1994	Whisenand
5,368,600	A	11/1994	Failla et al.
5,374,277	A	12/1994	Hassler
5,376,089	A	12/1994	Smith
5,376,094	A	12/1994	Kline
D354,564	S	1/1995	Medema
5,383,875	A	1/1995	Bays et al.
5,383,880	A	1/1995	Hooven
5,383,897	A	1/1995	Wholey
5,389,098	A	2/1995	Tsuruta et al.
5,389,103	A	2/1995	Melzer et al.
5,389,104	A	2/1995	Hahnen et al.
5,391,166	A	2/1995	Eggers
5,391,183	A	2/1995	Janzen et al.
5,395,360	A	3/1995	Manoukian
5,396,900	A	3/1995	Slater et al.
5,397,325	A	3/1995	Della Badia et al.
5,403,312	A	4/1995	Yates et al.
5,403,342	A	4/1995	Tovey et al.
5,405,344	A	4/1995	Williamson et al.
5,409,763	A	4/1995	Serizawa et al.
D358,887	S	5/1995	Feinberg
5,411,519	A	5/1995	Tovey et al.
5,411,520	A	5/1995	Nash et al.
5,413,571	A	5/1995	Katsaros et al.
5,415,656	A	5/1995	Tihon et al.
5,415,657	A	5/1995	Taymor-Luria
5,417,709	A	5/1995	Slater
5,422,567	A	6/1995	Matsunaga
5,423,810	A	6/1995	Goble et al.
5,425,690	A	6/1995	Chang
5,425,739	A	6/1995	Jessen
5,429,616	A	7/1995	Schaffer
5,431,672	A	7/1995	Cote et al.
5,431,674	A	7/1995	Basile et al.
5,437,277	A	8/1995	Dumoulin et al.
5,437,292	A	8/1995	Kipshidze et al.
5,438,302	A	8/1995	Goble
5,439,478	A	8/1995	Palmer
5,441,059	A	8/1995	Dannan
5,441,517	A	8/1995	Kensey et al.
5,443,463	A	8/1995	Stern et al.
5,443,464	A	8/1995	Russell et al.
5,443,479	A	8/1995	Bressi, Jr.
5,443,480	A	8/1995	Jacobs et al.
5,445,638	A	8/1995	Rydell et al.
5,445,658	A	8/1995	Durrfeld et al.
5,449,480	A	9/1995	Kuriya et al.
5,451,224	A	9/1995	Goble et al.
5,454,809	A	10/1995	Janssen
5,454,823	A	10/1995	Richardson et al.
5,454,827	A	10/1995	Aust et al.
5,456,684	A	10/1995	Schmidt et al.
5,458,598	A	10/1995	Feinberg et al.
5,460,629	A	10/1995	Shlain et al.
5,461,765	A	10/1995	Linden et al.
5,462,546	A	10/1995	Rydell
5,472,442	A	12/1995	Klicek
5,472,443	A	12/1995	Cordis et al.
5,476,479	A	12/1995	Green et al.
5,478,351	A	12/1995	Meade et al.
5,480,406	A	1/1996	Nolan et al.
5,480,409	A	1/1996	Riza
5,482,054	A	1/1996	Slater et al.
5,484,436	A	1/1996	Eggers et al.
5,493,899	A	2/1996	Beck et al.
5,496,312	A	3/1996	Klicek
5,496,317	A	3/1996	Goble et al.
5,496,347	A	3/1996	Hashiguchi et al.
5,499,997	A	3/1996	Sharpe et al.
5,501,654	A	3/1996	Failla et al.
5,509,922	A	4/1996	Aranyi et al.
5,512,721	A	4/1996	Young et al.
5,514,134	A	5/1996	Rydell et al.
5,520,702	A	5/1996	Sauer et al.
5,527,313	A	6/1996	Scott et al.
5,528,833	A	6/1996	Sakuma
5,529,067	A	6/1996	Larsen et al.
5,531,744	A	7/1996	Nardella et al.
5,536,251	A	7/1996	Evard et al.
5,540,684	A	7/1996	Hassler, Jr.
5,540,685	A	7/1996	Parins et al.
5,540,706	A	7/1996	Aust et al.
5,540,715	A	7/1996	Katsaros et al.
5,542,945	A	8/1996	Fritzsch
5,549,604	A	8/1996	Sutcu et al.
5,554,172	A	9/1996	Horner et al.
5,558,671	A	9/1996	Yates
5,558,672	A	9/1996	Edwards et al.
5,562,619	A	10/1996	Mirarchi et al.
5,562,699	A	10/1996	Heimberger et al.
5,562,720	A	10/1996	Stern et al.
5,564,615	A	10/1996	Bishop et al.
5,568,859	A	10/1996	Levy et al.
5,569,241	A	10/1996	Edwardds
5,569,243	A	10/1996	Kortenbach et al.
5,571,100	A	11/1996	Goble et al.
5,573,424	A	11/1996	Poppe

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,573,534 A	11/1996	Stone	
5,573,535 A	11/1996	Viklund	
5,575,799 A	11/1996	Bolanos et al.	
5,575,805 A	11/1996	Li	
5,578,052 A	11/1996	Koros et al.	
5,579,781 A	12/1996	Cooke	
5,582,611 A	12/1996	Tsukagoshi et al.	
5,582,617 A	12/1996	Klieman et al.	
5,585,896 A	12/1996	Yamazaki et al.	
5,590,570 A	1/1997	LeMaire, III et al.	
5,591,181 A	1/1997	Stone et al.	
5,597,107 A	1/1997	Knodel et al.	
5,599,350 A	2/1997	Schulze et al.	
5,601,224 A	2/1997	Bishop et al.	
5,601,601 A	2/1997	Tal et al.	
5,601,641 A	2/1997	Stephens	
5,603,711 A	2/1997	Parins et al.	
5,603,723 A	2/1997	Aranyi et al.	
5,607,436 A	3/1997	Pratt et al.	
5,611,798 A	3/1997	Eggers	
5,611,808 A	3/1997	Hossain et al.	
5,611,813 A	3/1997	Lichtman	
5,618,294 A	4/1997	Aust et al.	
5,618,307 A	4/1997	Donlon et al.	
5,620,415 A	4/1997	Lucey et al.	
5,620,453 A	4/1997	Nallakrishnan	
5,620,459 A	4/1997	Lichtman	
5,624,452 A	4/1997	Yates	
5,626,578 A	5/1997	Tihon	
5,626,607 A	5/1997	Malecki et al.	
5,626,609 A	5/1997	Zvenyatsky et al.	
5,630,833 A	5/1997	Katsaros et al.	
5,637,110 A	6/1997	Pennybacker et al.	
5,637,111 A	6/1997	Sutcu et al.	
5,638,003 A	6/1997	Hall	
5,638,827 A	6/1997	Palmer et al.	
5,639,403 A	6/1997	Ida et al.	
5,643,294 A	7/1997	Tovey et al.	
5,647,869 A	7/1997	Goble et al.	
5,647,871 A	7/1997	Levine et al.	
5,649,959 A	7/1997	Hannam et al.	
5,655,650 A	8/1997	Naitou	
5,658,281 A	8/1997	Heard	
D384,413 S	9/1997	Zlock et al.	
5,662,667 A	9/1997	Knodel	
5,665,100 A	9/1997	Yoon	
5,667,526 A	9/1997	Levin	
5,673,841 A	10/1997	Schulze et al.	
5,674,220 A	10/1997	Fox et al.	
5,674,229 A	10/1997	Tovey et al.	
5,681,282 A	10/1997	Eggers et al.	
5,688,270 A	11/1997	Yates et al.	
5,690,652 A	11/1997	Wurster et al.	
5,690,653 A	11/1997	Richardson et al.	
5,693,051 A	12/1997	Schulze et al.	
5,693,920 A	12/1997	Maeda	
5,695,522 A	12/1997	LeMaire, III et al.	
5,700,261 A	12/1997	Brinkerhoff	
5,700,270 A	12/1997	Peyser et al.	
5,702,390 A	12/1997	Austin et al.	
5,707,369 A	1/1998	Vaitekunas et al.	
5,709,680 A	1/1998	Yates et al.	
5,713,895 A	2/1998	Lontine et al.	
5,716,366 A	2/1998	Yates	
5,720,742 A	2/1998	Zacharias	
5,720,744 A	2/1998	Eggleston et al.	
5,722,421 A	3/1998	Francese et al.	
5,725,536 A	3/1998	Oberlin et al.	
5,727,428 A	3/1998	LeMaire, III et al.	
5,735,848 A	4/1998	Yates et al.	
5,735,849 A	4/1998	Baden et al.	
5,743,906 A	4/1998	Parins et al.	
5,752,973 A	5/1998	Kieturakis	
5,755,717 A	5/1998	Yates et al.	
5,759,188 A	6/1998	Yoon	
5,762,255 A	6/1998	Chrisman et al.	
5,762,609 A	6/1998	Benaron et al.	
5,766,130 A	6/1998	Selmonosky	
5,766,166 A	6/1998	Hooven	
5,766,170 A	6/1998	Eggers	
5,766,196 A	6/1998	Griffiths	
5,769,849 A	6/1998	Eggers	
5,772,655 A	6/1998	Bauer et al.	
5,772,670 A	6/1998	Brosa	
5,776,128 A	7/1998	Eggers	
5,776,130 A	7/1998	Buysse et al.	
5,776,156 A	7/1998	Shikhman	
5,779,646 A	7/1998	Koblish et al.	
5,779,701 A	7/1998	McBrayer et al.	
5,779,727 A	7/1998	Orejola	
5,781,048 A	7/1998	Nakao et al.	
H1745 H	8/1998	Paraschac	
5,791,231 A	8/1998	Cohn et al.	
5,792,137 A	8/1998	Carr et al.	
5,792,165 A *	8/1998	Klieman et al.	606/170
5,792,177 A	8/1998	Kaseda	
5,797,537 A	8/1998	Oberlin et al.	
5,797,927 A	8/1998	Yoon	
5,797,938 A	8/1998	Paraschac et al.	
5,797,941 A	8/1998	Schulze et al.	
5,797,958 A	8/1998	Yoon	
5,797,959 A	8/1998	Castro et al.	
5,800,448 A	9/1998	Banko	
5,800,449 A	9/1998	Wales	
5,807,393 A	9/1998	Williamson, IV et al.	
5,810,764 A	9/1998	Eggers et al.	
5,810,805 A	9/1998	Sutcu et al.	
5,810,808 A	9/1998	Eggers	
5,810,811 A	9/1998	Yates et al.	
5,810,877 A	9/1998	Roth et al.	
5,814,043 A	9/1998	Shapeton	
5,814,054 A	9/1998	Kortenbach et al.	
5,817,083 A	10/1998	Shemesh et al.	
5,817,119 A	10/1998	Klieman et al.	
5,820,630 A	10/1998	Lind	
5,824,978 A	10/1998	Karasik et al.	
5,827,271 A	10/1998	Buysse et al.	
5,827,274 A	10/1998	Bonnet et al.	
5,827,279 A	10/1998	Hughett et al.	
5,827,281 A	10/1998	Levin	
5,827,323 A	10/1998	Klieman et al.	
5,827,548 A	10/1998	Lavallee et al.	
5,830,212 A	11/1998	Cartmell et al.	
5,833,690 A	11/1998	Yates et al.	
5,833,695 A	11/1998	Yoon	
5,836,072 A	11/1998	Sullivan et al.	
D402,028 S	12/1998	Grimm et al.	
5,843,080 A	12/1998	Fleenor et al.	
5,849,020 A	12/1998	Long et al.	
5,849,022 A	12/1998	Sakashita et al.	
5,851,214 A	12/1998	Larsen et al.	
5,853,412 A	12/1998	Mayenberger	
5,859,527 A	1/1999	Cook	
5,860,976 A	1/1999	Billings et al.	
5,865,361 A	2/1999	Milliman et al.	
5,876,401 A	3/1999	Schulze et al.	
5,876,410 A	3/1999	Petillo	
5,876,412 A	3/1999	Piraka	
5,882,567 A	3/1999	Cavallaro et al.	
D408,018 S	4/1999	McNaughton	
5,891,141 A	4/1999	Rydell	
5,891,142 A	4/1999	Eggers et al.	
5,893,848 A	4/1999	Negus et al.	
5,893,863 A	4/1999	Yoon	
5,893,875 A	4/1999	O'Connor et al.	
5,893,877 A	4/1999	Gampp, Jr. et al.	
5,897,563 A	4/1999	Yoon et al.	
5,902,301 A	5/1999	Olig	
5,906,630 A	5/1999	Anderhub et al.	
5,907,140 A	5/1999	Smith	
5,908,420 A	6/1999	Parins et al.	
5,908,432 A	6/1999	Pan	
5,911,719 A	6/1999	Eggers	
5,913,874 A	6/1999	Berns et al.	

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,921,916 A 7/1999 Aeikens et al.
5,921,984 A 7/1999 Sutcu et al.
5,925,043 A 7/1999 Kumar et al.
5,928,136 A 7/1999 Barry
5,935,126 A 8/1999 Riza
5,938,589 A 8/1999 Wako et al.
5,941,869 A 8/1999 Patterson et al.
5,944,718 A 8/1999 Dafforn et al.
5,951,545 A 9/1999 Schilling et al.
5,951,546 A 9/1999 Lorentzen
5,951,549 A 9/1999 Richardson et al.
5,954,720 A 9/1999 Wilson et al.
5,954,731 A 9/1999 Yoon
5,954,733 A 9/1999 Yoon
5,957,923 A 9/1999 Hahnen et al.
5,957,937 A 9/1999 Yoon
5,960,544 A 10/1999 Beyers
5,961,514 A 10/1999 Long et al.
5,964,758 A 10/1999 Dresden
5,967,997 A 10/1999 Turturro et al.
D416,089 S 11/1999 Barton et al.
5,976,132 A 11/1999 Morris
5,984,932 A 11/1999 Yoon
5,984,938 A 11/1999 Yoon
5,984,939 A 11/1999 Yoon
5,989,277 A 11/1999 LeMaire, III et al.
5,993,466 A 11/1999 Yoon
5,993,467 A 11/1999 Yoon
5,993,474 A 11/1999 Ouchi
5,997,565 A 12/1999 Inoue
6,003,517 A 12/1999 Sheffield et al.
6,004,332 A 12/1999 Yoon et al.
6,004,335 A 12/1999 Vaitekunas et al.
6,010,516 A 1/2000 Hulka et al.
6,010,519 A 1/2000 Mawhirt et al.
6,017,354 A 1/2000 Culp et al.
6,017,358 A 1/2000 Yoon et al.
6,021,693 A 2/2000 Feng-Sing
6,024,741 A 2/2000 Williamson et al.
6,024,743 A 2/2000 Edwards
6,024,744 A 2/2000 Kese et al.
6,027,522 A 2/2000 Palmer
6,030,384 A 2/2000 Nezhat
6,033,399 A 3/2000 Gines
6,039,733 A 3/2000 Buysse et al.
6,041,679 A 3/2000 Slater et al.
6,050,995 A 4/2000 Durgin
6,050,996 A 4/2000 Schmaltz et al.
6,053,914 A 4/2000 Eggers et al.
6,053,933 A 4/2000 Balazs et al.
D424,694 S 5/2000 Tetzlaff et al.
D425,201 S 5/2000 Tetzlaff et al.
6,059,782 A 5/2000 Novak et al.
6,063,103 A 5/2000 Hashiguchi
6,066,139 A 5/2000 Ryan et al.
6,071,283 A 6/2000 Nardella et al.
6,074,386 A 6/2000 Goble et al.
6,077,287 A 6/2000 Taylor et al.
6,080,180 A 6/2000 Yoon et al.
RE36,795 E 7/2000 Rydell
6,083,150 A 7/2000 Aznoian et al.
6,083,223 A 7/2000 Baker
6,086,586 A 7/2000 Hooven
6,086,601 A 7/2000 Yoon
6,090,107 A 7/2000 Borgmeier et al.
6,090,123 A 7/2000 Culp et al.
6,096,037 A 8/2000 Mulier et al.
6,099,537 A 8/2000 Sugai et al.
6,099,550 A 8/2000 Yoon
6,102,909 A 8/2000 Chen et al.
6,106,542 A 8/2000 Toybin et al.
6,110,171 A 8/2000 Rydell
6,113,596 A 9/2000 Hooven et al.
6,113,598 A 9/2000 Baker
6,117,158 A 9/2000 Measamer et al.
6,122,549 A 9/2000 Sharkey et al.
6,123,701 A 9/2000 Nezhat
H1904 H 10/2000 Yates et al.
6,126,658 A 10/2000 Baker
6,126,665 A 10/2000 Yoon
6,139,563 A 10/2000 Cosgrove, III et al.
6,143,005 A 11/2000 Yoon et al.
6,152,923 A 11/2000 Ryan
6,152,924 A 11/2000 Parins
6,159,217 A 12/2000 Robie et al.
6,162,220 A 12/2000 Nezhat
6,171,316 B1 1/2001 Kovac et al.
6,174,309 B1 1/2001 Wrublewski et al.
6,174,310 B1 1/2001 Kirwan, Jr.
6,178,628 B1 1/2001 Clemens et al.
6,179,834 B1 1/2001 Buysse et al.
6,179,837 B1 1/2001 Hooven
6,183,467 B1 2/2001 Shapeton et al.
6,187,003 B1 2/2001 Buysse et al.
6,190,386 B1 2/2001 Rydell
6,190,399 B1 2/2001 Palmer et al.
6,190,400 B1 2/2001 Vandemoer et al.
6,193,709 B1 2/2001 Miyawaki et al.
6,193,718 B1 2/2001 Kortenbach et al.
6,206,876 B1 3/2001 Levine et al.
6,206,877 B1 3/2001 Kese et al.
6,206,893 B1 3/2001 Klein et al.
6,214,028 B1 4/2001 Yoon et al.
6,217,602 B1 4/2001 Redmon
6,217,615 B1 4/2001 Sioshansi et al.
6,221,039 B1 4/2001 Durgin et al.
6,223,100 B1 4/2001 Green
6,224,593 B1 5/2001 Ryan et al.
6,224,614 B1 5/2001 Yoon
6,228,080 B1 5/2001 Gines
6,228,083 B1 5/2001 Lands et al.
6,248,124 B1 6/2001 Pedros et al.
6,248,944 B1 6/2001 Ito
6,261,307 B1 7/2001 Yoon et al.
6,267,758 B1 7/2001 Daw et al.
6,267,761 B1 7/2001 Ryan
6,270,497 B1 8/2001 Sekino et al.
6,270,508 B1 8/2001 Klieman et al.
6,273,887 B1 8/2001 Yamauchi et al.
6,277,117 B1 8/2001 Tetzlaff et al.
6,280,458 B1 8/2001 Boche et al.
6,283,961 B1 9/2001 Underwood et al.
D449,886 S 10/2001 Tetzlaff et al.
6,298,550 B1 10/2001 Kirwan
6,302,424 B1 10/2001 Gisinger et al.
6,309,404 B1 10/2001 Krzyzanowski
6,319,262 B1 11/2001 Bates et al.
6,319,451 B1 11/2001 Brune
6,322,561 B1 11/2001 Eggers et al.
6,322,580 B1 11/2001 Kanner
6,325,795 B1 12/2001 Lindemann et al.
6,329,778 B1 12/2001 Culp et al.
6,334,860 B1 1/2002 Dorn
6,334,861 B1 1/2002 Chandler et al.
D453,923 S 2/2002 Olson
6,345,532 B1 2/2002 Coudray et al.
6,350,264 B1 2/2002 Hooven
D454,951 S 3/2002 Bon
6,352,536 B1 3/2002 Buysse et al.
6,358,249 B1 3/2002 Chen et al.
6,358,259 B1 3/2002 Swain et al.
6,358,268 B1 3/2002 Hunt et al.
6,361,534 B1 3/2002 Chen et al.
6,364,876 B1 4/2002 Erb et al.
6,364,879 B1 4/2002 Chen et al.
D457,958 S 5/2002 Dycus et al.
D457,959 S 5/2002 Tetzlaff et al.
6,385,265 B1 5/2002 Duffy et al.
6,387,094 B1 5/2002 Eitenmuller
6,391,035 B1 5/2002 Appleby et al.
6,398,779 B1 6/2002 Buysse et al.
6,402,747 B1 6/2002 Lindemann et al.
6,409,728 B1 6/2002 Ehr et al.
H2037 H 7/2002 Yates et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,419,675	B1	7/2002	Gallo, Sr.	
6,425,896	B1	7/2002	Baltschun et al.	
6,432,112	B2	8/2002	Brock et al.	
6,440,130	B1	8/2002	Mulier et al.	
6,440,144	B1	8/2002	Bacher	
6,443,952	B1	9/2002	Mulier et al.	
6,443,970	B1	9/2002	Schulze et al.	
6,451,018	B1	9/2002	Lands et al.	
6,458,125	B1	10/2002	Cosmescu	
6,458,128	B1	10/2002	Schulze	
6,458,129	B2	10/2002	Scarfi	
6,458,130	B1	10/2002	Frazier et al.	
6,461,352	B2	10/2002	Morgan et al.	
6,461,368	B2	10/2002	Fogarty et al.	
6,464,701	B1	10/2002	Hooven et al.	
6,464,702	B2	10/2002	Schulze et al.	
6,464,704	B2	10/2002	Schmaltz et al.	
6,471,696	B1	10/2002	Berube et al.	
D465,281	S	11/2002	Lang	
D466,209	S	11/2002	Bon	
6,485,489	B2	11/2002	Teirstein et al.	
6,488,680	B1	12/2002	Francischelli et al.	
6,494,877	B2 *	12/2002	Odell et al.	606/1
6,494,888	B1	12/2002	Laufer et al.	
6,500,176	B1	12/2002	Truckai et al.	
6,506,196	B1	1/2003	Laufer	
6,508,815	B1	1/2003	Strul et al.	
6,511,480	B1	1/2003	Tetzlaff et al.	
6,514,215	B1	2/2003	Ouchi	
6,514,252	B2	2/2003	Nezhat et al.	
6,517,536	B2	2/2003	Hooven et al.	
6,517,539	B1	2/2003	Smith et al.	
6,527,771	B1	3/2003	Weadock et al.	
6,533,784	B2	3/2003	Truckai et al.	
6,537,272	B2	3/2003	Christopherson et al.	
6,540,745	B1	4/2003	Fairbourn et al.	
6,545,239	B2	4/2003	Spedale et al.	
6,554,844	B2	4/2003	Lee et al.	
6,558,385	B1	5/2003	McClurken et al.	
6,562,037	B2	5/2003	Paton et al.	
6,569,105	B1	5/2003	Kortenbach et al.	
6,582,450	B2	6/2003	Ouchi	
6,585,735	B1	7/2003	Frazier et al.	
6,602,252	B2	8/2003	Mollenauer	
6,605,790	B2	8/2003	Yoshida	
6,610,060	B2	8/2003	Mulier et al.	
6,613,048	B2	9/2003	Mulier et al.	
6,616,654	B2	9/2003	Mollenauer	
6,616,658	B2	9/2003	Ineson	
6,616,661	B2	9/2003	Wellman et al.	
6,620,161	B2	9/2003	Schulze et al.	
6,620,184	B2	9/2003	De Laforcade et al.	
6,623,482	B2	9/2003	Pendekanti et al.	
6,626,901	B1	9/2003	Treat et al.	
6,629,534	B1	10/2003	St. Goar et al.	
6,638,287	B2	10/2003	Danitz et al.	
6,641,595	B1	11/2003	Moran et al.	
6,652,514	B2	11/2003	Ellman et al.	
6,652,518	B2	11/2003	Pendekanti et al.	
6,652,521	B2	11/2003	Schulze	
6,656,173	B1	12/2003	Palermo	
6,656,175	B2	12/2003	Francischelli et al.	
6,656,177	B2	12/2003	Truckai et al.	
6,660,072	B2	12/2003	Chatterjee	
6,663,639	B1	12/2003	Laufer et al.	
6,663,641	B1	12/2003	Kovac et al.	
6,666,854	B1	12/2003	Lange	
6,669,696	B2	12/2003	Bacher et al.	
6,673,092	B1	1/2004	Bacher	
6,676,660	B2	1/2004	Wampler et al.	
6,676,676	B2	1/2004	Danitz et al.	
6,679,882	B1	1/2004	Kornerup	
6,682,527	B2	1/2004	Strul	
6,682,528	B2	1/2004	Frazier et al.	
6,685,704	B2	2/2004	Greep	
6,685,724	B1	2/2004	Haluck	
6,689,131	B2	2/2004	McClurken	
6,692,445	B2	2/2004	Roberts et al.	
6,693,246	B1	2/2004	Rudolph et al.	
6,695,840	B2	2/2004	Schulze	
6,702,810	B2	3/2004	McClurken et al.	
6,723,092	B2	4/2004	Brown et al.	
6,726,068	B2	4/2004	Miller	
6,726,686	B2	4/2004	Buysse et al.	
6,726,694	B2	4/2004	Blatter et al.	
6,733,498	B2	5/2004	Paton et al.	
6,733,501	B2	5/2004	Levine	
6,736,813	B2	5/2004	Yamauchi et al.	
6,743,229	B2	6/2004	Buysse et al.	
6,743,230	B2	6/2004	Lutze et al.	
6,743,239	B1	6/2004	Kuehn et al.	
6,743,240	B2	6/2004	Smith et al.	
6,755,338	B2	6/2004	Hahnen et al.	
6,755,824	B2	6/2004	Jain et al.	
6,755,843	B2	6/2004	Chung et al.	
6,756,553	B1	6/2004	Yamaguchi et al.	
6,757,977	B2	7/2004	Dambal et al.	
D493,888	S	8/2004	Reschke	
6,770,072	B1	8/2004	Truckai et al.	
6,773,409	B2	8/2004	Truckai et al.	
6,773,432	B1	8/2004	Clayman et al.	
6,773,434	B2	8/2004	Ciarrocca	
6,773,435	B2	8/2004	Schulze et al.	
6,773,441	B1	8/2004	Laufer et al.	
6,775,575	B2	8/2004	Bommannan et al.	
6,776,780	B2	8/2004	Mulier et al.	
6,784,405	B2	8/2004	Flugstad et al.	
6,786,905	B2	9/2004	Swanson et al.	
6,790,217	B2	9/2004	Schulze et al.	
6,796,981	B2	9/2004	Wham et al.	
D496,997	S	10/2004	Dycus et al.	
6,800,825	B1	10/2004	Sasaki et al.	
6,802,843	B2	10/2004	Truckai et al.	
6,808,525	B2	10/2004	Latterell et al.	
D499,181	S	11/2004	Dycus et al.	
6,818,000	B2	11/2004	Muller et al.	
6,818,007	B1	11/2004	Dampney et al.	
6,821,273	B2	11/2004	Mollenauer	
6,821,285	B2	11/2004	Laufer et al.	
6,824,547	B2	11/2004	Wilson, Jr. et al.	
6,830,174	B2	12/2004	Hillstead et al.	
6,835,200	B2	12/2004	Laufer et al.	
6,843,789	B2	1/2005	Goble	
6,857,357	B2	2/2005	Fujii	
6,858,028	B2	2/2005	Mulier et al.	
D502,994	S	3/2005	Blake, III	
6,860,880	B2	3/2005	Treat et al.	
6,878,147	B2	4/2005	Prakash et al.	
6,887,240	B1	5/2005	Lands et al.	
6,889,116	B2	5/2005	Jinno	
6,905,497	B2	6/2005	Truckai et al.	
6,908,463	B2	6/2005	Treat et al.	
6,914,201	B2	7/2005	Van Vooren et al.	
6,916,314	B2 *	7/2005	Schneider et al.	606/1
6,926,716	B2	8/2005	Baker et al.	
6,929,644	B2	8/2005	Truckai et al.	
6,932,810	B2	8/2005	Ryan	
6,932,816	B2	8/2005	Phan	
6,934,134	B2	8/2005	Mori et al.	
6,936,061	B2	8/2005	Sasaki	
D509,297	S	9/2005	Wells	
6,942,662	B2	9/2005	Goble et al.	
6,943,311	B2	9/2005	Miyako	
6,951,559	B1	10/2005	Greep	
6,953,430	B2	10/2005	Kodooka	
6,953,461	B2	10/2005	McClurken et al.	
6,958,070	B2	10/2005	Witt et al.	
6,960,210	B2	11/2005	Lands et al.	
6,964,662	B2	11/2005	Kidooka	
6,966,907	B2	11/2005	Goble	
6,972,017	B2	12/2005	Smith et al.	
6,974,452	B1	12/2005	Gille et al.	
6,976,492	B2	12/2005	Ingle et al.	
6,977,495	B2	12/2005	Donofrio	

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,979,786	B2	12/2005	Aukland et al.
6,981,628	B2	1/2006	Wales
6,987,244	B2	1/2006	Bauer
6,989,017	B2	1/2006	Howell et al.
6,994,707	B2	2/2006	Ellman et al.
6,994,709	B2	2/2006	Iida
6,997,931	B2	2/2006	Sauer et al.
7,001,381	B2	2/2006	Harano et al.
7,001,408	B2	2/2006	Knodel et al.
7,011,657	B2	3/2006	Truckai et al.
7,025,763	B2	4/2006	Karasawa et al.
7,033,354	B2	4/2006	Keppel
7,033,356	B2	4/2006	Latterell et al.
7,041,102	B2	5/2006	Truckai et al.
7,044,948	B2	5/2006	Keppel
7,052,489	B2	5/2006	Griego et al.
7,052,496	B2	5/2006	Yamauchi
7,063,699	B2	6/2006	Hess et al.
7,063,715	B2	6/2006	Onuki et al.
D525,361	S	7/2006	Hushka
7,070,597	B2	7/2006	Truckai et al.
7,083,618	B2	8/2006	Couture et al.
7,083,619	B2	8/2006	Truckai et al.
7,083,620	B2	8/2006	Jahns et al.
7,087,051	B2	8/2006	Bourne et al.
7,087,054	B2	8/2006	Truckai et al.
7,090,673	B2	8/2006	Dycus et al.
7,090,689	B2	8/2006	Nagase et al.
7,101,371	B2	9/2006	Dycus et al.
7,101,372	B2	9/2006	Dycus et al.
7,101,373	B2	9/2006	Dycus et al.
7,103,947	B2	9/2006	Sartor et al.
7,107,124	B2	9/2006	Green
7,108,694	B2	9/2006	Miura et al.
7,112,199	B2	9/2006	Cosmescu
7,112,201	B2	9/2006	Truckai et al.
D531,311	S	10/2006	Guerra et al.
7,115,123	B2	10/2006	Knowlton et al.
7,115,139	B2	10/2006	McClurken et al.
7,118,570	B2	10/2006	Tetzlaff et al.
7,118,587	B2	10/2006	Dycus et al.
7,131,860	B2	11/2006	Sartor et al.
7,131,970	B2	11/2006	Moses et al.
7,131,971	B2	11/2006	Dycus et al.
7,135,018	B2	11/2006	Ryan et al.
7,135,020	B2	11/2006	Lawes et al.
7,137,980	B2	11/2006	Buysse et al.
D533,274	S	12/2006	Visconti et al.
D533,942	S	12/2006	Kerr et al.
7,145,757	B2	12/2006	Shea et al.
7,147,632	B2	12/2006	Prakash et al.
7,147,638	B2	12/2006	Chapman et al.
7,150,097	B2	12/2006	Sremcich et al.
7,150,749	B2	12/2006	Dycus et al.
7,153,314	B2	12/2006	Laufer et al.
D535,027	S	1/2007	James et al.
7,156,842	B2	1/2007	Sartor et al.
7,156,846	B2	1/2007	Dycus et al.
7,160,298	B2	1/2007	Lawes et al.
7,160,299	B2	1/2007	Baily
7,166,106	B2	1/2007	Bartel et al.
7,169,145	B2	1/2007	Isaacson et al.
7,169,146	B2	1/2007	Truckai et al.
7,179,255	B2	2/2007	Lettice et al.
7,179,258	B2	2/2007	Buysse et al.
7,184,820	B2	2/2007	Jersey-Willuhn et al.
D538,932	S	3/2007	Malik
7,189,233	B2	3/2007	Truckai et al.
7,195,631	B2	3/2007	Dumbauld
D541,418	S	4/2007	Schechter et al.
7,204,835	B2	4/2007	Latterell et al.
7,207,990	B2	4/2007	Lands et al.
7,208,005	B2	4/2007	Frecker et al.
D541,611	S	5/2007	Aglassinge
D541,938	S	5/2007	Kerr et al
7,211,084	B2	5/2007	Goble et al.
7,223,264	B2	5/2007	Daniel et al.
7,223,265	B2	5/2007	Keppel
D545,432	S	6/2007	Watanabe
7,232,440	B2	6/2007	Dumbauld et al.
D547,154	S	7/2007	Lee
7,238,184	B2	7/2007	Megerman et al.
7,241,288	B2	7/2007	Braun
7,241,296	B2	7/2007	Buysse et al.
7,244,257	B2	7/2007	Podjahsky et al.
7,246,734	B2	7/2007	Shelto, IV
7,248,944	B2	7/2007	Green
7,252,667	B2	8/2007	Moses et al.
7,254,433	B2	8/2007	Diab et al.
7,255,697	B2	8/2007	Dycus et al.
7,267,677	B2	9/2007	Johnson et al.
7,270,660	B2	9/2007	Ryan
7,270,664	B2	9/2007	Johnson et al.
7,276,068	B2	10/2007	Johnson et al.
7,288,103	B2	10/2007	Suzuki
7,291,161	B2	11/2007	Hooven
7,300,435	B2	11/2007	Wham et al.
7,303,557	B2	12/2007	Wham et al.
7,311,709	B2	12/2007	Truckai et al.
7,314,471	B2	1/2008	Holman
7,318,823	B2	1/2008	Sharps et al.
7,326,202	B2	2/2008	McGaffigan
7,329,256	B2	2/2008	Johnson et al.
7,329,257	B2	2/2008	Kanehira et al.
D564,662	S	3/2008	Moses et al.
7,338,526	B2	3/2008	Steinberg
7,342,754	B2	3/2008	Fitzgerald et al.
7,344,268	B2	3/2008	Jhigamian
7,347,864	B2	3/2008	Vargas
D567,943	S	4/2008	Moses et al.
7,354,440	B2	4/2008	Truckal et al.
7,367,976	B2	5/2008	Lawes et al.
7,377,920	B2	5/2008	Buysse et al.
7,384,420	B2	6/2008	Dycus et al.
7,384,421	B2	6/2008	Hushka
7,396,265	B2	7/2008	Darley et al.
7,396,336	B2	7/2008	Orszulak et al.
7,396,356	B2	7/2008	Mollenauer
D575,395	S	8/2008	Hushka
D575,401	S	8/2008	Hixson et al.
7,422,592	B2	9/2008	Morley et al.
7,425,835	B2	9/2008	Eisele
7,431,721	B2	10/2008	Paton et al.
7,435,249	B2	10/2008	Buysse et al.
7,438,714	B2	10/2008	Phan
7,442,193	B2	10/2008	Shields et al.
7,442,194	B2	10/2008	Dumbauld et al.
7,445,621	B2	11/2008	Dumbauld et al.
D582,038	S	12/2008	Swoyer et al.
7,458,972	B2	12/2008	Keppel
7,473,253	B2	1/2009	Dycus et al.
7,481,810	B2	1/2009	Dumbauld et al.
7,487,780	B2	2/2009	Hooven
7,491,201	B2	2/2009	Shields et al.
7,491,202	B2	2/2009	Odom et al.
7,500,975	B2	3/2009	Cunningham et al.
7,503,474	B2	3/2009	Hillstead et al.
7,510,556	B2	3/2009	Nguyen et al.
7,513,898	B2	4/2009	Johnson et al.
7,517,351	B2	4/2009	Culp et al.
7,540,872	B2	6/2009	Schechter et al.
7,549,995	B2	6/2009	Schultz
7,553,312	B2	6/2009	Tetzlaff et al.
7,553,686	B2	6/2009	George et al.
7,569,626	B2	8/2009	Truckai
7,582,087	B2	9/2009	Tetzlaff et al.
7,588,565	B2	9/2009	Marchitto et al.
7,594,313	B2	9/2009	Prakash et al.
7,594,916	B2	9/2009	Weinberg
7,597,693	B2	10/2009	Garrison
7,621,910	B2	11/2009	Sugi
7,624,186	B2	11/2009	Tanida
7,625,370	B2	12/2009	Hart et al.
7,628,791	B2	12/2009	Garrison et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,628,792 B2 12/2009 Guerra
7,637,409 B2 12/2009 Marczyk
7,641,653 B2 1/2010 Dalla Betta et al.
7,651,493 B2 1/2010 Arts et al.
7,651,494 B2 1/2010 McClurken et al.
7,655,004 B2 2/2010 Long
7,655,007 B2 2/2010 Baily
7,668,597 B2 2/2010 Engmark et al.
7,678,111 B2 3/2010 Mulier et al.
7,686,804 B2 3/2010 Johnson et al.
7,686,827 B2 3/2010 Hushka
7,708,735 B2 5/2010 Chapman et al.
7,717,115 B2 5/2010 Barrett et al.
7,717,904 B2 5/2010 Suzuki et al.
7,717,914 B2 5/2010 Kimura
7,717,915 B2 5/2010 Miyazawa
7,722,607 B2 5/2010 Dumbauld et al.
D617,900 S 6/2010 Kingsley et al.
D617,901 S 6/2010 Unger et al.
D617,902 S 6/2010 Twomey et al.
D617,903 S 6/2010 Unger et al.
D618,798 S 6/2010 Olson et al.
7,727,231 B2 6/2010 Swanson
7,731,717 B2 6/2010 Odom et al.
7,736,374 B2 6/2010 Vaughan et al.
7,744,615 B2 6/2010 Couture
7,749,217 B2 7/2010 Podhajsky
7,753,908 B2 7/2010 Swanson
7,753,909 B2 7/2010 Chapman et al.
D621,503 S 8/2010 Otten et al.
7,766,910 B2 8/2010 Hixson et al.
7,771,425 B2 8/2010 Dycus et al.
7,776,036 B2 8/2010 Schechter et al.
7,776,037 B2 8/2010 Odom
7,780,662 B2 8/2010 Bahney
7,780,663 B2 8/2010 Yates et al.
7,789,878 B2 9/2010 Dumbauld et al.
7,799,026 B2 9/2010 Schechter et al.
7,799,028 B2 9/2010 Schechter et al.
7,811,283 B2 10/2010 Moses et al.
7,819,872 B2 10/2010 Johnson et al.
D627,462 S 11/2010 Kingsley
D628,289 S 11/2010 Romero
D628,290 S 11/2010 Romero
7,828,798 B2 11/2010 Buysse et al.
7,832,408 B2 11/2010 Shelton, IV et al.
7,837,685 B2 11/2010 Weinberg et al.
7,839,674 B2 11/2010 Lowrey et al.
7,842,033 B2 11/2010 Isaacson et al.
7,846,158 B2 12/2010 Podhajsky
7,846,161 B2 12/2010 Dumbauld et al.
7,857,812 B2 12/2010 Dycus et al.
D630,324 S 1/2011 Reschke
7,877,852 B2 2/2011 Unger et al.
7,877,853 B2 2/2011 Unger et al.
7,879,035 B2 2/2011 Garrison et al.
7,887,535 B2 2/2011 Lands et al.
7,887,536 B2 2/2011 Johnson et al.
7,896,878 B2 3/2011 Johnson et al.
7,898,288 B2 3/2011 Wong
7,900,805 B2 3/2011 Shelton, IV et al.
7,901,398 B2* 3/2011 Stanczak et al. 606/1
7,901,400 B2 3/2011 Wham et al.
7,905,380 B2 3/2011 Shelton, IV et al.
7,905,881 B2 3/2011 Masuda et al.
7,909,820 B2 3/2011 Lipson et al.
7,909,823 B2 3/2011 Moses et al.
7,909,824 B2 3/2011 Masuda et al.
7,918,848 B2 4/2011 Lau et al.
7,922,718 B2 4/2011 Moses et al.
7,922,742 B2 4/2011 Hillstead et al.
7,922,953 B2 4/2011 Guerra
7,931,649 B2 4/2011 Couture et al.
7,935,052 B2 5/2011 Dumbauld
7,945,332 B2 5/2011 Schecheter
7,947,041 B2 5/2011 Tetzlaff et al.
7,949,407 B2 5/2011 Kaplan et al.
7,951,149 B2 5/2011 Carlton
7,951,150 B2 5/2011 Johnson et al.
7,955,326 B2 6/2011 Paul et al.
7,955,327 B2 6/2011 Sartor et al.
7,955,331 B2 6/2011 Truckai et al.
7,955,332 B2 6/2011 Arts et al.
7,963,965 B2 6/2011 Buysse et al.
7,967,839 B2 6/2011 Flock et al.
7,972,328 B2 7/2011 Wham et al.
7,972,331 B2 7/2011 Hafner
7,976,544 B2 7/2011 McClurken et al.
7,981,113 B2 7/2011 Truckai et al.
7,988,507 B2 8/2011 Darley et al.
7,998,095 B2 8/2011 Mcauley
8,012,150 B2 9/2011 Wham et al.
8,016,827 B2 9/2011 Chojin
8,034,049 B2 10/2011 Odom et al.
D649,249 S 11/2011 Guerra
D649,643 S 11/2011 Allen, IV et al.
8,048,074 B2 11/2011 Masuda
8,070,746 B2 12/2011 Orton et al.
8,070,748 B2 12/2011 Hixson et al.
8,075,580 B2 12/2011 Makower
8,089,417 B2 1/2012 Popovic et al.
8,092,451 B2 1/2012 Schechter et al.
8,104,956 B2 1/2012 Blaha
8,112,871 B2 2/2012 Brandt et al.
8,114,122 B2 2/2012 Nau, Jr.
8,123,743 B2 2/2012 Arts et al.
8,128,624 B2 3/2012 Couture et al.
8,128,625 B2 3/2012 Odom
8,133,224 B2 3/2012 Geiselhart
8,133,254 B2 3/2012 Dumbauld et al.
8,147,489 B2 4/2012 Moses et al.
2002/0107517 A1 8/2002 Witt et al.
2002/0111624 A1 8/2002 Witt et al.
2002/0165469 A1 11/2002 Murakami
2003/0014052 A1 1/2003 Buysse et al.
2003/0014053 A1 1/2003 Nguyen et al.
2003/0018332 A1 1/2003 Schmaltz et al.
2003/0069570 A1 4/2003 Witzel et al.
2003/0109875 A1 6/2003 Tetzlaff et al.
2003/0114851 A1 6/2003 Truckai et al.
2003/0130653 A1 7/2003 Sixto, Jr. et al.
2003/0139741 A1 7/2003 Goble et al.
2003/0158548 A1 8/2003 Phan et al.
2003/0171747 A1 9/2003 Kanehira et al.
2003/0181910 A1 9/2003 Dyc et al.
2003/0191396 A1 10/2003 Sanghvi et al.
2003/0216732 A1 11/2003 Truckai et al.
2003/0229344 A1 12/2003 Dyc et al.
2003/0236325 A1 12/2003 Bonora
2004/0030330 A1 2/2004 Brassell et al.
2004/0064151 A1 4/2004 Mollenauer
2004/0073238 A1 4/2004 Makower
2004/0073256 A1 4/2004 Marchitto et al.
2004/0115296 A1 6/2004 Duffin
2004/0176779 A1 9/2004 Casutt et al.
2004/0199181 A1 10/2004 Knodel et al.
2004/0224590 A1 11/2004 Rawa et al.
2004/0236326 A1 11/2004 Schulze et al.
2004/0249374 A1 12/2004 Tetzlaff et al.
2004/0260281 A1 12/2004 Baxter, III et al.
2005/0004564 A1 1/2005 Wham et al.
2005/0004569 A1 1/2005 Witt et al.
2005/0033278 A1 2/2005 McClurken et al.
2005/0059858 A1 3/2005 Frith et al.
2005/0059934 A1 3/2005 Wenchell et al.
2005/0090817 A1 4/2005 Phan
2005/0096645 A1 5/2005 Wellman et al.
2005/0149017 A1 7/2005 Dycus
2005/0254081 A1 11/2005 Ryu et al.
2005/0283148 A1 12/2005 Janssen et al.
2006/0052779 A1 3/2006 Hammill
2006/0064086 A1 3/2006 Odom
2006/0079933 A1 4/2006 Hhka et al.
2006/0084973 A1 4/2006 Hhka

(56) **References Cited**

U.S. PATENT DOCUMENTS

2006/0111711	A1	5/2006	Goble
2006/0173452	A1	8/2006	Buysse et al.
2006/0190035	A1	8/2006	Hhka et al.
2006/0217709	A1	9/2006	Couture et al.
2006/0224053	A1	10/2006	Black et al.
2006/0253126	A1	11/2006	Bjerken et al.
2006/0259036	A1	11/2006	Tetzlaff et al.
2006/0264922	A1	11/2006	Sartor et al.
2006/0271030	A1	11/2006	Francis et al.
2006/0283093	A1	12/2006	Petrovic et al.
2006/0287641	A1	12/2006	Perlin
2007/0027447	A1	2/2007	Theroux et al.
2007/0043337	A1	2/2007	McAuley
2007/0043353	A1	2/2007	Dyc et al.
2007/0062017	A1	3/2007	Dyc et al.
2007/0118115	A1	5/2007	Artale et al.
2007/0173811	A1	7/2007	Couture et al.
2007/0173813	A1	7/2007	Odom
2007/0198011	A1	8/2007	Sugita
2007/0225695	A1	9/2007	Mayer et al.
2007/0255279	A1	11/2007	Buysse et al.
2007/0260238	A1	11/2007	Guerra
2007/0260242	A1	11/2007	Dyc et al.
2007/0265616	A1	11/2007	Couture et al.
2007/0265620	A1	11/2007	Kraas et al.
2008/0004616	A1	1/2008	Patrick
2008/0004656	A1*	1/2008	Livneh 606/205
2008/0015575	A1	1/2008	Odom et al.
2008/0033428	A1	2/2008	Artale et al.
2008/0039831	A1	2/2008	Odom et al.
2008/0039835	A1	2/2008	Johnson et al.
2008/0045947	A1	2/2008	Johnson et al.
2008/0046122	A1	2/2008	Manzo et al.
2008/0058802	A1	3/2008	Couture et al.
2008/0082100	A1	4/2008	Orton et al.
2008/0125767	A1	5/2008	Blaha
2008/0125797	A1	5/2008	Kelleher
2008/0171938	A1	7/2008	Masuda et al.
2008/0172051	A1	7/2008	Masuda et al.
2008/0208289	A1	8/2008	Darley et al.
2008/0215050	A1	9/2008	Bakos
2008/0234701	A1	9/2008	Morales et al.
2008/0243106	A1	10/2008	Coe et al.
2008/0243120	A1	10/2008	Lawes et al.
2008/0243158	A1	10/2008	Morgan
2008/0249523	A1	10/2008	McPherson et al.
2008/0249527	A1	10/2008	Couture
2008/0271360	A1	11/2008	Barfield
2008/0281311	A1	11/2008	Dunning et al.
2008/0300580	A1	12/2008	Shelton, IV et al.
2008/0312653	A1	12/2008	Arts et al.
2008/0319292	A1	12/2008	Say et al.
2008/0319442	A1	12/2008	Unger et al.
2009/0012520	A1	1/2009	Hixson et al.
2009/0012556	A1	1/2009	Boudreaux et al.
2009/0015832	A1	1/2009	Popovic et al.
2009/0024126	A1	1/2009	Artale et al.
2009/0036881	A1	2/2009	Artale et al.
2009/0036899	A1	2/2009	Carlton et al.
2009/0043304	A1	2/2009	Tetzlaff et al.
2009/0048596	A1	2/2009	Shields et al.
2009/0054894	A1	2/2009	Yachi
2009/0062794	A1	3/2009	Buysse et al.
2009/0065565	A1	3/2009	Cao
2009/0076506	A1	3/2009	Baker
2009/0076534	A1	3/2009	Shelton, IV et al.
2009/0082766	A1	3/2009	Unger et al.
2009/0088738	A1	4/2009	Guerra et al.
2009/0088739	A1	4/2009	Hhka et al.
2009/0088740	A1	4/2009	Guerra et al.
2009/0088741	A1	4/2009	Hhka et al.
2009/0088744	A1	4/2009	Townsend
2009/0088745	A1	4/2009	Hhka et al.
2009/0088746	A1	4/2009	Hhka et al.
2009/0088747	A1	4/2009	Hhka et al.
2009/0088748	A1	4/2009	Guerra et al.
2009/0088749	A1	4/2009	Hhka et al.
2009/0088750	A1	4/2009	Hhka et al.
2009/0105750	A1	4/2009	Price et al.
2009/0112200	A1	4/2009	Eggers
2009/0112206	A1	4/2009	Dumbauld et al.
2009/0112229	A1	4/2009	Omori et al.
2009/0131934	A1	5/2009	Odom et al.
2009/0138006	A1	5/2009	Bales et al.
2009/0149853	A1	6/2009	Shields et al.
2009/0149854	A1	6/2009	Cunningham et al.
2009/0157071	A1	6/2009	Wham et al.
2009/0157072	A1	6/2009	Wham et al.
2009/0157075	A1	6/2009	Wham et al.
2009/0171350	A1	7/2009	Dyc et al.
2009/0171354	A1	7/2009	Deville et al.
2009/0177094	A1	7/2009	Brown et al.
2009/0182327	A1	7/2009	Unger
2009/0182329	A1	7/2009	Dyc
2009/0187188	A1	7/2009	Guerra et al.
2009/0198233	A1	8/2009	Chojin
2009/0204114	A1	8/2009	Odom
2009/0204137	A1	8/2009	Maxwell
2009/0206126	A1	8/2009	Huitema et al.
2009/0209957	A1	8/2009	Schmaltz et al.
2009/0209960	A1	8/2009	Chojin
2009/0234354	A1	9/2009	Johnson et al.
2009/0248007	A1	10/2009	Falkenstein et al.
2009/0248013	A1	10/2009	Falkenstein et al.
2009/0248019	A1	10/2009	Falkenstein et al.
2009/0248020	A1	10/2009	Falkenstein et al.
2009/0248021	A1	10/2009	McKenna
2009/0248022	A1	10/2009	Falkenstein et al.
2009/0248050	A1	10/2009	Hirai
2009/0248051	A1	10/2009	Masuda
2009/0254080	A1	10/2009	Honda
2009/0254081	A1	10/2009	Allison et al.
2009/0261804	A1	10/2009	McKenna et al.
2009/0270771	A1	10/2009	Takahashi
2009/0292282	A9	11/2009	Dyc
2009/0318912	A1	12/2009	Mayer et al.
2010/0016857	A1	1/2010	McKenna et al.
2010/0023009	A1	1/2010	Moses et al.
2010/0030028	A1	2/2010	Cabrera et al.
2010/0036375	A1	2/2010	Regadas
2010/0042140	A1	2/2010	Cunningham
2010/0042142	A1	2/2010	Cunningham
2010/0042143	A1	2/2010	Cunningham
2010/0049187	A1	2/2010	Carlton et al.
2010/0049194	A1	2/2010	Hart et al.
2010/0057078	A1	3/2010	Arts et al.
2010/0057081	A1	3/2010	Hanna
2010/0057082	A1	3/2010	Hanna
2010/0057083	A1	3/2010	Hanna
2010/0057084	A1	3/2010	Hanna
2010/0063500	A1	3/2010	Mzala
2010/0069903	A1	3/2010	Allen, IV et al.
2010/0069904	A1	3/2010	Cunningham
2010/0069953	A1	3/2010	Cunningham et al.
2010/0076427	A1	3/2010	Heard
2010/0076430	A1	3/2010	Romero
2010/0076431	A1	3/2010	Allen, IV
2010/0076432	A1	3/2010	Horner
2010/0087816	A1	4/2010	Roy
2010/0087818	A1	4/2010	Cunningham
2010/0094271	A1	4/2010	Ward et al.
2010/0094286	A1	4/2010	Chojin
2010/0094287	A1	4/2010	Cunningham et al.
2010/0094289	A1	4/2010	Taylor et al.
2010/0100122	A1	4/2010	Hinton
2010/0130971	A1	5/2010	Baily
2010/0130977	A1	5/2010	Garrison et al.
2010/0145334	A1	6/2010	Olson et al.
2010/0179539	A1	7/2010	Nau, Jr.
2010/0179543	A1	7/2010	Johnson et al.
2010/0179545	A1	7/2010	Twomey et al.
2010/0179546	A1	7/2010	Cunningham
2010/0179547	A1	7/2010	Cunningham et al.
2010/0198215	A1	8/2010	Julian et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2010/0198218	A1	8/2010	Manzo
2010/0198248	A1	8/2010	Vakharia
2010/0204697	A1	8/2010	Dumbauld et al.
2010/0204698	A1	8/2010	Chapman et al.
2010/0217258	A1	8/2010	Floume et al.
2010/0217264	A1	8/2010	Odom et al.
2010/0228249	A1	9/2010	Mohr et al.
2010/0228250	A1	9/2010	Brogna
2010/0249769	A1	9/2010	Nau, Jr. et al.
2010/0249776	A1	9/2010	Kerr
2010/0256635	A1	10/2010	McKenna et al.
2010/0274160	A1	10/2010	Yachi et al.
2010/0274244	A1	10/2010	Heard
2010/0274265	A1	10/2010	Wingardner et al.
2010/0280511	A1	11/2010	Rachlin et al.
2010/0280515	A1	11/2010	Hixson et al.
2010/0286691	A1	11/2010	Kerr et al.
2010/0292691	A1	11/2010	Brogna
2010/0307934	A1	12/2010	Chowaniec et al.
2010/0312235	A1	12/2010	Bahney
2010/0312238	A1	12/2010	Schechter et al.
2010/0312242	A1	12/2010	Odom
2010/0331742	A1	12/2010	Masuda
2010/0331839	A1	12/2010	Schechter et al.
2011/0004209	A1	1/2011	Lawes et al.
2011/0004210	A1	1/2011	Johnson et al.
2011/0009864	A1	1/2011	Bucciaglia et al.
2011/0015632	A1	1/2011	Artale
2011/0018164	A1	1/2011	Sartor et al.
2011/0034918	A1	2/2011	Reschke
2011/0036183	A1	2/2011	Artale et al.
2011/0046623	A1	2/2011	Reschke
2011/0054467	A1	3/2011	Mueller et al.
2011/0054468	A1	3/2011	Dyc
2011/0054469	A1	3/2011	Kapp et al.
2011/0054471	A1	3/2011	Gerhardt et al.
2011/0054472	A1	3/2011	Romero
2011/0060333	A1	3/2011	Mueller
2011/0060334	A1	3/2011	Brandt et al.
2011/0060335	A1	3/2011	Harper et al.
2011/0060356	A1	3/2011	Reschke et al.
2011/0066174	A1	3/2011	Gilbert
2011/0071522	A1	3/2011	Dumbauld et al.
2011/0071523	A1	3/2011	Dickhans
2011/0071525	A1	3/2011	Dumbauld et al.
2011/0072638	A1	3/2011	Brandt et al.
2011/0073246	A1	3/2011	Brandt et al.
2011/0073594	A1	3/2011	Bonn
2011/0077648	A1	3/2011	Lee et al.
2011/0077649	A1	3/2011	Kingsley
2011/0082457	A1	4/2011	Kerr et al.
2011/0082494	A1	4/2011	Kerr et al.
2011/0087221	A1	4/2011	Siebrecht et al.
2011/0098689	A1	4/2011	Nau, Jr. et al.
2011/0106079	A1	5/2011	Garrison et al.
2011/0118736	A1	5/2011	Harper et al.
2011/0162796	A1	7/2011	Guerra
2011/0178519	A1	7/2011	Couture et al.
2011/0184405	A1	7/2011	Mueller
2011/0190653	A1	8/2011	Harper et al.
2011/0190765	A1	8/2011	Chojin
2011/0193608	A1	8/2011	Krapohl
2011/0218530	A1	9/2011	Reschke
2011/0230880	A1	9/2011	Chojin et al.
2011/0238066	A1	9/2011	Olson
2011/0238067	A1	9/2011	Moses et al.
2011/0251605	A1	10/2011	Hoarau et al.
2011/0251606	A1	10/2011	Kerr
2011/0251611	A1	10/2011	Horner et al.
2011/0270245	A1	11/2011	Horner et al.
2011/0270250	A1	11/2011	Horner et al.
2011/0270251	A1	11/2011	Horner et al.
2011/0270252	A1	11/2011	Horner et al.
2011/0276048	A1	11/2011	Kerr et al.
2011/0276049	A1	11/2011	Gerhardt
2011/0295251	A1	12/2011	Garrison
2011/0295313	A1	12/2011	Kerr
2011/0301592	A1	12/2011	Kerr et al.
2011/0301599	A1	12/2011	Roy et al.
2011/0301600	A1	12/2011	Garrison et al.
2011/0301601	A1	12/2011	Garrison et al.
2011/0301602	A1	12/2011	Roy et al.
2011/0301603	A1	12/2011	Kerr et al.
2011/0301604	A1	12/2011	Horner et al.
2011/0301605	A1	12/2011	Horner
2011/0301606	A1	12/2011	Kerr
2011/0301637	A1	12/2011	Kerr et al.
2011/0319886	A1	12/2011	Chojin et al.
2011/0319888	A1	12/2011	Mueller et al.
2012/0004658	A1	1/2012	Chojin
2012/0010614	A1	1/2012	Couture
2012/0022532	A1	1/2012	Garrison
2012/0029515	A1	2/2012	Couture
2012/0041438	A1	2/2012	Nau, Jr. et al.
2012/0046659	A1	2/2012	Mueller
2012/0046660	A1	2/2012	Nau, Jr.
2012/0046662	A1	2/2012	Gilbert
2012/0059371	A1	3/2012	Anderson et al.
2012/0059372	A1	3/2012	Johnson
2012/0059374	A1	3/2012	Johnson et al.
2012/0059375	A1	3/2012	Couture et al.
2012/0059408	A1	3/2012	Mueller
2012/0059409	A1	3/2012	Reschke et al.
2012/0078250	A1	3/2012	Orton et al.
2012/0083785	A1	4/2012	Roy et al.
2012/0083786	A1	4/2012	Artale et al.
2012/0083827	A1	4/2012	Artale et al.
2012/0095456	A1	4/2012	Schechter et al.
2012/0095460	A1	4/2012	Rooks et al.

FOREIGN PATENT DOCUMENTS

CA	2 590 520	11/2007
CN	201299462	9/2009
DE	2415263	10/1975
DE	2514501	10/1976
DE	2627679	1/1977
DE	3423356	1/1986
DE	3612646	4/1987
DE	8712328	3/1988
DE	4303882	8/1994
DE	4403252	8/1995
DE	19515914	7/1996
DE	19506363	8/1996
DE	29616210	1/1997
DE	19608716	4/1997
DE	19751106	5/1998
DE	19751108	5/1999
DE	19946527	12/2001
DE	10045375	4/2002
DE	10 2004 026179	12/2005
DE	20 2007 009165	10/2007
DE	20 2007 009317	10/2007
DE	20 2007 016233	3/2008
DE	19738457	1/2009
DE	10 2008 018406	7/2009
EP	0364216	4/1990
EP	0467501	1/1992
EP	0509670	10/1992
EP	0518230	12/1992
EP	0541930	5/1993
EP	0306123	8/1993
EP	0572131	12/1993
EP	0584787	3/1994
EP	0589453	3/1994
EP	0589555	3/1994
EP	0623316	11/1994
EP	0624348	11/1994
EP	0640317	3/1995
EP	0648475	4/1995
EP	0650701	5/1995
EP	0694290	3/1996
EP	0717966	6/1996
EP	0754437	3/1997

(56) **References Cited**

FOREIGN PATENT DOCUMENTS

EP	0517243		9/1997
EP	0853922		7/1998
EP	0875209		11/1998
EP	0878169		11/1998
EP	0887046		1/1999
EP	0888747		1/1999
EP	0913126		5/1999
EP	0923907		6/1999
EP	0950378		10/1999
EP	0986990		3/2000
EP	1034747		9/2000
EP	1034748		9/2000
EP	1025807		10/2000
EP	1034746		10/2000
EP	1050278		11/2000
EP	1053719		11/2000
EP	1053720		11/2000
EP	1055399		11/2000
EP	1055400		11/2000
EP	1080694		3/2001
EP	1082944		3/2001
EP	1159926		12/2001
EP	1177771		2/2002
EP	1278007		1/2003
EP	1301135		4/2003
EP	1330991		7/2003
EP	1486177		6/2004
EP	1472984		11/2004
EP	0774232		1/2005
EP	1527747		5/2005
EP	1530952		5/2005
EP	1532932		5/2005
EP	1535581		6/2005
EP	1609430		12/2005
EP	1201192		2/2006
EP	1632192		3/2006
EP	1186274		4/2006
EP	1642543		4/2006
EP	1645238		4/2006
EP	1645240		4/2006
EP	1649821		4/2006
EP	1707143		10/2006
EP	1545360		3/2007
EP	1767163		3/2007
EP	1769765		4/2007
EP	1769766		4/2007
EP	1772109		4/2007
EP	1785097		5/2007
EP	1785098		5/2007
EP	1785101		5/2007
EP	1787597		5/2007
EP	1810625		7/2007
EP	1810628		7/2007
EP	1842500		10/2007
EP	1878400		1/2008
EP	1894535		3/2008
EP	1929970		6/2008
EP	1946715		7/2008
EP	1958583		8/2008
EP	1990019		11/2008
EP	1683496		12/2008
EP	1997438		12/2008
EP	1997439		12/2008
EP	1527744		2/2009
EP	2103268		9/2009
EP	2105104		9/2009
EP	2147649		1/2010
EP	2153791		2/2010
EP	2206474		7/2010
EP	1920725		10/2010
EP	2243439		10/2010
EP	2294998		3/2011
EP	2301467		3/2011
EP	1628586		7/2011
GB	623316		5/1949
GB	1490585		11/1977
GB	2214430	A	6/1989
GB	2213416	A	8/1989
JP	61-501068		9/1984
JP	6-502328		3/1992
JP	5-5106		1/1993
JP	5-40112		2/1993
JP	6-030945		2/1994
JP	6-121797		5/1994
JP	6-285078		10/1994
JP	6-343644		12/1994
JP	6-511401		12/1994
JP	7-265328		10/1995
JP	8-56955		3/1996
JP	8-317936		3/1996
JP	8-289895		5/1996
JP	8-252263		10/1996
JP	8-317934		12/1996
JP	9-10223		1/1997
JP	9-122138		5/1997
JP	10-24051		1/1998
JP	11-070124		5/1998
JP	10-155798		6/1998
JP	2000-102545		9/1998
JP	11-47150		2/1999
JP	11-169381		6/1999
JP	11-192238		7/1999
JP	11-244298		9/1999
JP	2000-342599		12/2000
JP	2000-350732		12/2000
JP	2001-8944		1/2001
JP	2001-29356		2/2001
JP	2001-128990		5/2001
JP	2001-190564		7/2001
JP	2001-3400		11/2001
JP	2002-528166		3/2002
JP	2003-245285		9/2003
JP	2004-517668		6/2004
JP	2004-528869		9/2004
JP	2011-125195		6/2011
SU	401367		11/1974
WO	WO 89/00757		1/1989
WO	WO 92/04873		4/1992
WO	WO 92/06642		4/1992
WO	WO 93/19681		10/1993
WO	WO 93/21845		11/1993
WO	WO 94/00059		1/1994
WO	WO 94/08524		4/1994
WO	WO 94/20025		9/1994
WO	WO 95/02369		1/1995
WO	WO 95/07662		3/1995
WO	WO 95/15124		6/1995
WO	WO 95/20360		8/1995
WO	WO 95/20921		8/1995
WO	WO 96/05776		2/1996
WO	WO 96/11635		4/1996
WO	WO 96/22056		7/1996
WO	WO 96/13218		9/1996
WO	WO 97/00646		1/1997
WO	WO 97/00647		1/1997
WO	WO 97/10764		3/1997
WO	WO 97/18768		5/1997
WO	WO 97/24073		7/1997
WO	WO 97/24993		7/1997
WO	WO 98/14124		4/1998
WO	WO 98/27880		7/1998
WO	WO 98/31290		7/1998
WO	WO 98/43264		10/1998
WO	WO 99/03407		1/1999
WO	WO 99/03408		1/1999
WO	WO 99/03409		1/1999
WO	WO 99/03414		1/1999
WO	WO 99/12488		3/1999
WO	WO 99/23933		5/1999
WO	WO 99/23959		5/1999
WO	WO 99/25261		5/1999
WO	WO 99/40857		8/1999
WO	WO 99/40861		8/1999
WO	WO 99/51158		10/1999

(56) **References Cited**

FOREIGN PATENT DOCUMENTS

WO	WO 99/66850	12/1999
WO	WO 00/24322	5/2000
WO	WO 00/24330	5/2000
WO	WO 00/24331	5/2000
WO	WO 00/33753	6/2000
WO	WO 00/36986	6/2000
WO	WO 00/41638	7/2000
WO	WO 00/47124	8/2000
WO	WO 00/53112	9/2000
WO	WO 00/59392	10/2000
WO	WO 01/01847	1/2001
WO	WO 01/15614	3/2001
WO	WO 01/17448	3/2001
WO	WO 01/54604	8/2001
WO	WO 01/66025	9/2001
WO	WO 02/07627	1/2002
WO	WO 02/058544	8/2002
WO	WO 02/067798	9/2002
WO	WO 02/080783	10/2002
WO	WO 02/080784	10/2002
WO	WO 02/080785	10/2002
WO	WO 02/080786	10/2002
WO	WO 02/080793	10/2002
WO	WO 02/080794	10/2002
WO	WO 02/080795	10/2002
WO	WO 02/080796	10/2002
WO	WO 02/080797	10/2002
WO	WO 02/080798	10/2002
WO	WO 02/080799	10/2002
WO	WO 02/081170	10/2002
WO	WO 02/085218	10/2002
WO	WO 03/061500	7/2003
WO	WO 03/068046	8/2003
WO	WO 03/090630	11/2003
WO	WO 03/096880	11/2003
WO	WO 03/101311	12/2003
WO	WO 2004/028585	4/2004
WO	WO 2004/032776	4/2004
WO	WO 2004/032777	4/2004
WO	WO 2004/052221	6/2004
WO	WO 2004/073488	9/2004
WO	WO 2004/073490	9/2004
WO	WO 2004/073753	9/2004
WO	WO 2004/082495	9/2004
WO	WO 2004/098383	11/2004
WO	WO 2004/103156	12/2004
WO	WO 2005/004734	1/2005
WO	WO 2005/004735	1/2005
WO	WO 2005/009255	2/2005
WO	WO 2005/011049	2/2005
WO	WO 2005/030071	4/2005
WO	WO 2005/048809	6/2005
WO	WO 2005/050151	6/2005
WO	WO 2005/110264	11/2005
WO	WO 2006/021269	3/2006
WO	WO 2008/008457	1/2008
WO	WO 2008/040483	4/2008
WO	WO 2008/045348	4/2008
WO	WO 2008/045350	4/2008
WO	WO 2008/0112147	9/2008
WO	WO 2009/0005850	1/2009
WO	WO 2009/032623	3/2009
WO	WO 2009/0039179	3/2009
WO	WO 2009/0039510	3/2009
WO	WO 2009/124097	10/2009
WO	WO 2010/104753	9/2010

OTHER PUBLICATIONS

U.S. Appl. No. 09/177,950, filed Oct. 23, 1998, Randel A. Frazier.
U.S. Appl. No. 09/387,883, filed Sep. 1, 1999, Dale F. Schmaltz.
U.S. Appl. No. 09/591,328, filed Jun. 20, 2000, Thomas P. Ryan.
U.S. Appl. No. 12/336,970, filed Dec. 17, 2008, Paul R. Sremeich.
U.S. Appl. No. 12/915,809, filed Oct. 29, 2010, Thomas J. Gerhardt, Jr.
U.S. Appl. No. 12/947,352, filed Nov. 16, 2010, Jason L. Craig.
U.S. Appl. No. 12/947,420, filed Nov. 16, 2010, Jason L. Craig.
U.S. Appl. No. 12/948,081, filed Nov. 17, 2010, Boris Chernov.
U.S. Appl. No. 12/948,144, filed Nov. 17, 2010, Boris Chernov.
U.S. Appl. No. 12/950,505, filed Nov. 19, 2010, David M. Garrison.
U.S. Appl. No. 12/955,010, filed Nov. 29, 2010, Paul R. Romero.
U.S. Appl. No. 12/955,042, filed Nov. 29, 2010, Steven C. Rupp.
U.S. Appl. No. 12/981,771, filed Dec. 30, 2010, James D. Allen, IV.
U.S. Appl. No. 12/981,787, filed Dec. 30, 2010, John R. Twomey.
U.S. Appl. No. 13/006,538, filed Jan. 14, 2011, John W. Twomey.
U.S. Appl. No. 13/028,810, filed Feb. 16, 2011, Robert M. Sharp.
U.S. Appl. No. 13/030,231, filed Feb. 18, 2011, Jeffrey M. Roy.
U.S. Appl. No. 13/050,182, filed Mar. 17, 2011, Glenn A. Horner.
U.S. Appl. No. 13/072,945, filed Mar. 28, 2011, Patrick L. Dumbauld.
U.S. Appl. No. 13/080,383, filed Apr. 5, 2011, David M. Garrison.
U.S. Appl. No. 13/085,144, filed Apr. 12, 2011, Keir Hart.
U.S. Appl. No. 13/089,779, filed Apr. 19, 2011, Yevgeniy Fedotov.
U.S. Appl. No. 13/091,331, filed Apr. 21, 2011, Jeffrey R. Townsend.
U.S. Appl. No. 13/102,573, filed May 6, 2011, John R. Twomey.
U.S. Appl. No. 13/102,604, filed May 6, 2011, Paul E. Ourada.
U.S. Appl. No. 13/108,093, filed May 16, 2011, Boris Chernov.
U.S. Appl. No. 13/108,129, filed May 16, 2011, Boris Chernov.
U.S. Appl. No. 13/108,152, filed May 16, 2011, Boris Chernov.
U.S. Appl. No. 13/108,177, filed May 16, 2011, Boris Chernov.
U.S. Appl. No. 13/108,196, filed May 16, 2011, Boris Chernov.
U.S. Appl. No. 13/108,441, filed May 16, 2011, Boris Chernov.
U.S. Appl. No. 13/108,468, filed May 16, 2011, Boris Chernov.
U.S. Appl. No. 13/111,642, filed May 19, 2011, John R. Twomey.
U.S. Appl. No. 13/111,678, filed May 19, 2011, Nikolay Kharin.
U.S. Appl. No. 13/113,231, filed May 23, 2011, David M. Garrison.
U.S. Appl. No. 13/157,047, filed Jun. 9, 2011, John R. Twomey.
U.S. Appl. No. 13/162,814, filed Jun. 17, 2011, Barbara R. Tyrrell.
U.S. Appl. No. 13/166,477, filed Jun. 22, 2011, Daniel A. Joseph.
U.S. Appl. No. 13/166,497, filed Jun. 22, 2011, Daniel A. Joseph.
U.S. Appl. No. 13/179,919, filed Jul. 11, 2011, Russell D. Hempstead.
U.S. Appl. No. 13/179,960, filed Jul. 11, 2011, Boris Chernov.
U.S. Appl. No. 13/179,975, filed Jul. 11, 2011, Grant T. Sims.
U.S. Appl. No. 13/180,018, filed Jul. 11, 2011, Chase Collings.
U.S. Appl. No. 13/183,856, filed Jul. 15, 2011, John R. Twomey.
U.S. Appl. No. 13/185,593, filed Jul. 19, 2011, James D. Allen, IV.
U.S. Appl. No. 13/204,841, filed Aug. 8, 2011, Edward J. Chojin.
U.S. Appl. No. 13/205,999, filed Aug. 9, 2011, Jeffrey R. Unger.
U.S. Appl. No. 13/212,297, filed Aug. 18, 2011, Allan J. Evans.
U.S. Appl. No. 13/212,308, filed Aug. 18, 2011, Allan J. Evans.
U.S. Appl. No. 13/212,329, filed Aug. 18, 2011, Allan J. Evans.
U.S. Appl. No. 13/212,343, filed Aug. 18, 2011, Duane E. Kerr.
U.S. Appl. No. 13/223,521, filed Sep. 1, 2011, John R. Twomey.
U.S. Appl. No. 13/227,220, filed Sep. 7, 2011, James D. Allen, IV.
U.S. Appl. No. 13/228,742, filed Sep. 9, 2011, Duane E. Kerr.
U.S. Appl. No. 13/231,643, filed Sep. 13, 2011, Keir Hart.
U.S. Appl. No. 13/234,357, filed Sep. 16, 2011, James D. Allen, IV.
U.S. Appl. No. 13/236,168, filed Sep. 19, 2011, James D. Allen, IV.
U.S. Appl. No. 13/236,271, filed Sep. 19, 2011, Monte S. Fry.
U.S. Appl. No. 13/243,628, filed Sep. 23, 2011, William Ross Whitney.
U.S. Appl. No. 13/247,778, filed Sep. 28, 2011, John R. Twomey.
U.S. Appl. No. 13/247,795, filed Sep. 28, 2011, John R. Twomey.
U.S. Appl. No. 13/248,976, filed Sep. 29, 2011, James D. Allen, IV.
U.S. Appl. No. 13/249,013, filed Sep. 29, 2011, Jeffrey R. Unger.
U.S. Appl. No. 13/249,024, filed Sep. 29, 2011, John R. Twomey.
U.S. Appl. No. 13/251,380, filed Oct. 3, 2011, Duane E. Kerr.
U.S. Appl. No. 13/277,373, filed Oct. 20, 2011, Glenn A. Horner.
U.S. Appl. No. 13/277,926, filed Oct. 20, 2011, David M. Garrison.
U.S. Appl. No. 13/277,962, filed Oct. 20, 2011, David M. Garrison.
U.S. Appl. No. 13/293,754, filed Nov. 10, 2011, Jeffrey M. Roy.
U.S. Appl. No. 13/306,523, filed Nov. 29, 2011, David M. Garrison.
U.S. Appl. No. 13/306,553, filed Nov. 29, 2011, Duane E. Kerr.
U.S. Appl. No. 13/308,104, filed Nov. 30, 2011, John R. Twomey.
U.S. Appl. No. 13/312,172, filed Dec. 6, 2011, Robert J. Behnke, II.
U.S. Appl. No. 13/324,863, filed Dec. 13, 2011, William H. Nau, Jr.
U.S. Appl. No. 13/344,729, filed Jan. 6, 2012, James D. Allen, IV.

(56) **References Cited**

OTHER PUBLICATIONS

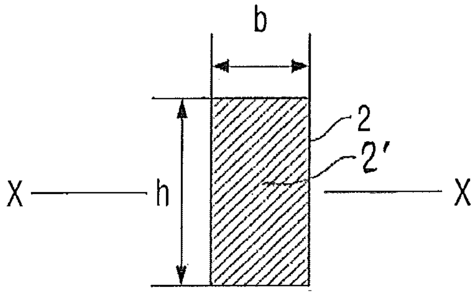
U.S. Appl. No. 13/355,829, filed Jan. 23, 2012, John R.Twomey.
U.S. Appl. No. 13/357,979, filed Jan. 25, 2012, David M. Garrison.
U.S. Appl. No. 13/358,136, filed Jan. 25, 2012, James D. Allen, IV.
U.S. Appl. No. 13/358,657, filed Jan. 26, 2012, Kim V. Brandt.
U.S. Appl. No. 13/360,925, filed Jan. 30, 2012, James H. Orszulak.
U.S. Appl. No. 13/369,152, filed Feb. 8, 2012, William H. Nau, Jr.
U.S. Appl. No. 13/400,290, filed Feb. 20, 2012, Eric R. Larson.
U.S. Appl. No. 13/401,964, filed Feb. 22, 2012, John R. Twomey.
U.S. Appl. No. 13/404,435, filed Feb. 24, 2012, Kim V. Brandt.
U.S. Appl. No. 13/404,476, filed Feb. 24, 2012, Kim V. Brandt.
Michael Choti, "Abdominoperineal Resection with the LigaSure Vessel Sealing System and LigaSure Atlas 20 cm Open Instrument" ; Innovations That Work, Jun. 2003.
Chung et al., "Clinical Experience of Sutureless Closed Hemorrhoidectomy with LigaSure" Diseases of the Colon & Rectum vol. 46, No. 1 Jan. 2003.
Tinkcler L.F., "Combined Diathermy and Suction Forceps", Feb. 6, 1967, British Medical Journal Feb. 6, 1976, vol. 1, nr. 5431 p. 361, ISSN: 0007-1447.
Carbonell et al., "Comparison of the Gyrus PlasmaKinetic Sealer and the Valleylab LigaSure Device in the Hemostasis of Small, Medium, and Large-Sized Arteries" Carolinas Laparoscopic and Advanced Surgery Program, Carolinas Medical Center, Charlotte, NC; Date: Aug. 2003.
Peterson et al. "Comparison of Healing Process Following Ligation with Sutures and Bipolar Vessel Sealing" Surgical Technology International (2001).
"Electrosurgery: A Historical Overview" Innovations in Electrosurgery; Sales/Product Literature; Dec. 31, 2000.
Johnson et al. "Evaluation of a Bipolar Electrothermal Vessel Sealing Device in Hemorrhoidectomy" Sales/Product Literature; Jan. 2004.
E. David Crawford "Evaluation of a New Vessel Sealing Device in Urologic Cancer Surgery" Sales/Product Literature 2000.
Johnson et al. "Evaluation of the LigaSure Vessel Sealing System in Hemorrhoidectormy" American College of Surgeons (ACS) Clinicla Congress Poster (2000).
Muller et al., "Extended Left Hemicolectomy Using the LigaSure Vessel Sealing System" Innovations That Work, Sep. 1999.
Kennedy et al. "High-burst-strength, feedback-controlled bipolar vessel sealing" Surgical Endoscopy (1998) 12: 876-878.
Burdette et al. "In Vivo Probe Measurement Technique for Determining Dielectric Properties At VHF Through Microwave Frequencies", IEEE Transactions on Microwave Theory and Techniques, vol. MTT-28, No. 4, Apr. 1980 pp. 414-427.
Carus et al., "Initial Experience With the LigaSure Vessel Sealing System in Abdominal Surgery", Innovations That Work, Jun. 2002.
Heniford et al. "Initial Research and Clinical Results with an Electrothermal Bipolar Vessel Sealer" Oct. 1999.
Heniford et al. "Initial Results with an Electrothermal Bipolar Vessel Sealer" Surgical Endoscopy (2000) 15:799-801.
Herman et al., "Laparoscopic Intestinal Resection With the LigaSure Vessel Sealing System: A Case Report"; Innovations That Work, Feb. 2002.
Koyle et al., "Laparoscopic Palomo Varicocele Ligation in Children and Adolescents" Pediatric Endosurgery & Innovative Techniques, vol. 6, No. 1, 2002.
W. Scott Helton, "LigaSure Vessel Sealing System: Revolutionary Hemostasis Product for General Surgery"; Sales/Product Literature 1999.
LigaSure Vessel Sealing System, the Seal of Confidence in General, Gynecologic, Urologic, and Laparaoscopic Surgery; Sales/Product Literature; Apr. 2002.
Joseph Ortenberg "LigaSure System Used in Laparoscopic 1st and 2nd Stage Orchiopexy" Innovations That Work, Nov. 2002.
Sigel et al. "The Mechanism of Blood Vessel Closure by High Frequency Electrocoagulation" Surgery Gynecology & Obstetrics, Oct. 1965 pp. 823-831.
Sampayan et al, "Multilayer Ultra-High Gradient Insulator Technology" Discharges and Electrical Insulation in Vacuum, 1998. Netherlands Aug. 17-21, 1998; vol. 2, pp. 740-743.
Paul G. Horgan, "A Novel Technique for Parenchymal Division During Hepatectomy" The American Journal of Surgery, vol. 181, No. 3, Apr. 2001 pp. 236-237.
Benaron et al., "Optical Time-Of-Flight and Absorbance Imaging of Biologic Media", Science, American Association for the Advancement of Science, Washington, DC, vol. 259, Mar. 5, 1993, pp. 1463-1466.
Olsson et al. "Radical Cystectomy in Females" Current Surgical Techniques in Urology, vol. 14, Issue 3, 2001.
Palazzo et al. "Randomized clinical trial of Ligasure versus open haemorrhoidectomy" British Journal of Surgery 2002, 89, 154-157.
Levy et al. "Randomized Trial of Suture Versus Electrosurgical Bipolar Vessel Sealing in Vaginal Hysterectomy" Obstetrics & Gynecology, vol. 102, No. 1, Jul. 2003.
"Reducing Needlestick Injuries in the Operating Room" Sales/Product Literature 2001.
Bergdahl et al. "Studies on Coagulation and the Development of an Automatic Computerized Bipolar Coagulator" J.Neurosurg, vol. 75, Jul. 1991, pp. 148-151.
Strasberg et al. "A Phase I Study of the LigaSure Vessel Sealing System in Hepatic Surgery" Section of HBP Surger, Washington University School of Medicine, St. Louis MO, Presented at AHPBA, Feb. 2001.
Sayfan et al. "Sutureless Closed Hemorrhoidectomy: A New Technique" Annals of Surgery vol. 234 No. 1 Jul. 2001; pp. 21-24.
Levy et al., "Update on Hysterectomy—New Technologies and Techniques" OBG Management, Feb. 2003.
Dulemba et al. "Use of a Bipolar Electrothermal Vessel Sealer in Laparoscopically Assisted Vaginal Hysterectomy" Sales/Product Literature; Jan. 2004.
Strasberg et al., "Use of a Bipolar Vessel-Sealing Device for Parenchymal Transection During Liver Surgery" Journal of Gastrointestinal Surgery, vol. 6, No. 4, Jul./Aug. 2002 pp. 569-574.
Sengupta et al., "Use of a Computer-Controlled Bipolar Diathermy System in Radical Prostatectomies and Other Open Urological Surgery" ANZ Journal of Surgery (2001) 71.9 pp. 538-540.
Rothenberg et al. "Use of the LigaSure Vessel Sealing System in Minimally Invasive Surgery in Children" Int'l Pediatric Endosurgery Group (IPEG) 2000.
Crawford et al. "Use of the LigaSure Vessel Sealing System in Urologic Cancer Surgery" Grand Rounds in Urology 1999 vol. 1 Issue 4 pp. 10-17.
Craig Johnson, "Use of the LigaSure Vessel Sealing System in Bloodless Hemorrhoidectomy" Innovations That Work, Mar. 2000.
Levy et al. "Use of a New Energy-based Vessel Ligation Device During Vaginal Hysterectomy" Int'l Federation of Gynecology and Obstetrics (FIGO) World Congress 1999.
Barbara Levy, "Use of a New Vessel Ligation Device During Vaginal Hysterectomy" FIGO 2000, Washington, D.C.
E. David Crawford "Use of a Novel Vessel Sealing Technology in Management of the Dorsal Veinous Complex" Sales/Product Literature 2000.
Jarrett et al., "Use of the LigaSure Vessel Sealing System for Peri-Hilar Vessels in Laparoscopic Nephrectomy" Sales/Product Literature 2000.
Crouch et al. "A Velocity-Dependent Model for Needle Insertion in Soft Tissue" MICCAI 2005; LNCS 3750 pp. 624-632, Dated: 2005.
McLellan et al. "Vessel Sealing for Hemostasis During Pelvic Surgery" Int'l Federation of Gynecology and Obstetrics FIGO World Congress 2000, Washington, D.C.
McLellan et al. "Vessel Sealing for Hemostasis During Gynecologic Surgery" Sales/Product Literature 1999.
Int'l Search Report EP 98944778.4 dated Oct. 31, 2000.
Int'l Search Report EP 98957771 dated Aug. 9, 2001.
Int'l Search Report EP 98957773 dated Aug. 1, 2001.
Int'l Search Report EP 98958575.7 dated Sep. 20, 2002.
Int'l Search Report EP 04013772.1 dated Apr. 1, 2005.
Int'l Search Report EP 04027314.6 dated Mar. 10, 2005.
Int'l Search Report EP 04027479.7 dated Mar. 8, 2005.
Int'l Search Report EP 04027705.5 dated Feb. 3, 2005.

(56) **References Cited**

OTHER PUBLICATIONS

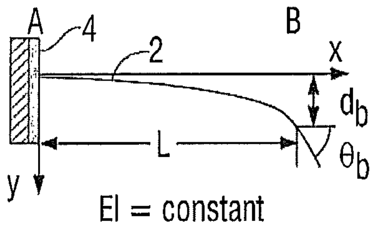
Int'l Search Report EP 04709033.7 dated Dec. 8, 2010.
Int'l Search Report EP 04752343.6 dated Jul. 20, 2007.
Int'l Search Report EP 05002671.5 dated Dec. 22, 2008.
Int'l Search Report EP 05002674.9 dated Jan. 16, 2009.
Int'l Search Report EP 05013463.4 dated Oct. 7, 2005.
Int'l Search Report EP 05013894 dated Feb. 3, 2006.
Int'l Search Report EP 05013895.7 dated Oct. 21, 2005.
Int'l Search Report EP 05016399.7 dated Jan. 13, 2006.
Int'l Search Report EP 05017281.6 dated Nov. 24, 2005.
Int'l Search Report EP 05019130.3 dated Oct. 27, 2005.
Int'l Search Report EP 05019429.9 dated May 6, 2008.
Int'l Search Report EP 05020532 dated Jan. 10, 2006.
Int'l Search Report EP 05020665.5 dated Feb. 27, 2006.
Int'l Search Report EP 05020666.3 dated Feb. 27, 2006.
Int'l Search Report EP 05021197.8 dated Feb. 20, 2006.
Int'l Search Report EP 05021779.3 dated Feb. 2, 2006.
Int'l Search Report EP 05021780.1 dated Feb. 23, 2006.
Int'l Search Report EP 05021937.7 dated Jan. 23, 2006.
Int'l Search Report—extended—EP 05021937.7 dated Mar. 15, 2006.
Int'l Search Report EP 05023017.6 dated Feb. 24, 2006.
Int'l Search Report EP 06002279.5 dated Mar. 30, 2006.
Int'l Search Report EP 06005185.1 dated May 10, 2006.
Int'l Search Report EP 06006716.2 dated Aug. 4, 2006.
Int'l Search Report EP 06008515.6 dated Jan. 8, 2009.
Int'l Search Report EP 06008779.8 dated Jul. 13, 2006.
Int'l Search Report EP 06014461.5 dated Oct. 31, 2006.
Int'l Search Report EP 06020574.7 dated Oct. 2, 2007.
Int'l Search Report EP 06020583.8 dated Feb. 7, 2007.
Int'l Search Report EP 06020584.6 dated Feb. 1, 2007.
Int'l Search Report EP 06020756.0 dated Feb. 16, 2007.
Int'l Search Report EP 06 024122.1 dated Apr. 16, 2007.
Int'l Search Report EP 06024123.9 dated Mar. 6, 2007.
Int'l Search Report EP 07 001480.8 dated Apr. 19, 2007.
Int'l Search Report EP 07 001488.1 dated Jun. 5, 2007.
Int'l Search Report EP 07 004429.2 dated Nov. 2, 2010.
Int'l Search Report EP 07 009026.1 dated Oct. 8, 2007.
Int'l Search Report Extended—EP 07 009029.5 dated Jul. 20, 2007.
Int'l Search Report EP 07 009321.6 dated Aug. 28, 2007.
Int'l Search Report EP 07 010672.9 dated Oct. 16, 2007.
Int'l Search Report EP 07 013779.9 dated Oct. 26, 2007.
Int'l Search Report EP 07 014016 dated Jan. 28, 2008.
Int'l Search Report EP 07 015191.5 dated Jan. 23, 2008.
Int'l Search Report EP 07 015601.3 dated Jan. 4, 2008.
Int'l Search Report EP 07 016911 dated May 28, 2010.
Int'l Search Report EP 07 016911.5 extended dated Mar. 2, 2011.
Int'l Search Report EP 07 020283.3 dated Feb. 5, 2008.
Int'l Search Report EP 07 021646.0 dated Mar. 20, 2008.
Int'l Search Report EP 07 021646.0 dated Jul. 9, 2008.
Int'l Search Report EP 07 021647.8 dated May 2, 2008.
Int'l Search Report EP 08 002692.5 dated Dec. 12, 2008.
Int'l Search Report EP 08 004655.0 dated Jun. 24, 2008.
Int'l Search Report EP 08 006732.5 dated Jul. 29, 2008.
Int'l Search Report EP 08 006917.2 dated Jul. 3, 2008.
Int'l Search Report EP 08 016539.2 dated Jan. 8, 2009.
Int'l Search Report EP 08 020807.7 dated Apr. 24, 2009.
Int'l Search Report EP 09 003677.3 dated May 4, 2009.
Int'l Search Report EP 09 003813.4 dated Aug. 3, 2009.
Int'l Search Report EP 09 004491.8 dated Sep. 9, 2009.
Int'l Search Report EP 09 005051.9 dated Jul. 6, 2009.
Int'l Search Report EP 09 005575.7 dated Sep. 9, 2009.
Int'l Search Report EP 09 010521.4 dated Dec. 16, 2009.
Int'l Search Report EP 09 011745.8 dated Jan. 5, 2010.
Int'l Search Report EP 09 012629.3 dated Dec. 8, 2009.
Int'l Search Report EP 09 012687.1 dated Dec. 23, 2009.
Int'l Search Report EP 09 012688.9 dated Dec. 28, 2009.
Int'l Search Report EP 09 152267.2 dated Jun. 15, 2009.
Int'l Search Report EP 09 152898.4 dated Jun. 10, 2009.
Int'l Search Report EP 09 154850.3 dated Jul. 20, 2009.
Int'l Search Report EP 09 160476.9 dated Aug. 4, 2009.
Int'l Search Report EP 09 164903.8 dated Aug. 21, 2009.
Int'l Search Report EP 09 165753.6 dated Nov. 11, 2009.
Int'l Search Report EP 09 168153.6 dated Jan. 14, 2010.
Int'l Search Report EP 09 168810.1 dated Feb. 2, 2010.
Int'l Search Report EP 09 172749.5 dated Dec. 4, 2009.
Int'l Search Report EP 10 000259.1 dated Jun. 30, 2010.
Int'l Search Report EP 10 011750.6 dated Feb. 1, 2011.
Int'l Search Report EP 10 157500.9 dated Jul. 30, 2010.
Int'l Search Report EP 10 159205.3 dated Jul. 7, 2010.
Int'l Search Report EP 10 160870.1 dated Aug. 9, 2010.
Int'l Search Report EP 10 161596.1 dated Jul. 28, 2010.
Int'l Search Report EP 10 167655.9 dated Aug. 31, 2011.
Int'l Search Report EP 10 168705.1 dated Oct. 4, 2010.
Int'l Search Report EP 10 169647.4 dated Oct. 29, 2010.
Int'l Search Report EP 10 172005.0 dated Sep. 30, 2010.
Int'l Search Report EP 10 175956.1 dated Nov. 12, 2010.
Int'l Search Report EP 10 181034.9 dated Jan. 26, 2011.
Int'l Search Report EP 10 181575.1 dated Apr. 5, 2011.
Int'l Search Report EP 10 181969.6 dated Feb. 4, 2011.
Int'l Search Report EP 10 182019 dated Aug. 4, 2011.
Int'l Search Report EP 10 182022.3 dated Mar. 11, 2011.
Int'l Search Report EP 10 185386.9 dated Jan. 10, 2011.
Int'l Search Report EP 10 185405.7 dated Jan. 5, 2011.
Int'l Search Report EP 10 186527.7 dated Jun. 17, 2011.
Int'l Search Report EP 10 189206.5 dated Mar. 17, 2011.
Int'l Search Report EP 10 191320.0 dated Feb. 15, 2011.
Int'l Search Report EP 11 151509.4 dated Jun. 6, 2011.
Int'l Search Report EP 11 152220.7 dated May 19, 2011.
Int'l Search Report EP 11 152360.1 dated Jun. 6, 2011.
Int'l Search Report EP 11 159771.2 dated May 28, 2010.
Int'l Search Report EP 11 161117.4 dated Jun. 30, 2011.
Int'l Search Report EP 11 161118.2 dated Oct. 12, 2011.
Int'l Search Report EP 11 164274.0 dated Aug. 3, 2011.
Int'l Search Report EP 11 164275.7 dated Aug. 25, 2011.
Int'l Search Report EP 11 167437.0 dated Aug. 8, 2011.
Int'l Search Report EP 11 168458.5 dated Jul. 29, 2011.
Int'l Search Report EP 11 173008.1 dated Nov. 4, 2011.
Int'l Search Report EP 11 179514 dated Nov. 4, 2011.
Int'l Search Report EP 11 180182.5 dated Nov. 15, 2011.
Int'l Search Report PCT/US98/18640 dated Jan. 29, 1999.
Int'l Search Report PCT/US98/23950 dated Jan. 14, 1999.
Int'l Search Report PCT/US98/24281 dated Feb. 22, 1999.
Int'l Search Report PCT/US99/24869 dated Feb. 3, 2000.
Int'l Search Report PCT/US01/11218 dated Aug. 14, 2001.
Int'l Search Report PCT/US01/11224 dated Nov. 13, 2001.
Int'l Search Report PCT/US01/11340 dated Aug. 16, 2001.
Int'l Search Report PCT/US01/11420 dated Oct. 16, 2001.
Int'l Search Report PCT/US02/01890 dated Jul. 25, 2002.
Int'l Search Report PCT/US02/11100 dated Jul. 16, 2002.
Int'l Search Report PCT/US03/08146 dated Aug. 8, 2003.
Int'l Search Report PCT/US03/18674 dated Sep. 18, 2003.
Int'l Search Report PCT/US03/18676 dated Sep. 19, 2003.
Int'l Search Report PCT/US03/28534 dated Dec. 19, 2003.
Int'l Search Report PCT/US03/28539 dated Jan. 6, 2004.
Int'l Search Report PCT/US04/03436 dated Mar. 3, 2005.
Int'l Search Report PCT/US04/13273 dated Dec. 15, 2004.
Int'l Search Report PCT/US04/15311dated Jan. 12, 2005.
Int'l Search Report PCT/US07/021438 dated Apr. 1, 2008.
Int'l Search Report PCT/US07/021440 dated Apr. 8, 2008.
Int'l Search Report PCT/US08/52460 dated Apr. 24, 2008.
Int'l Search Report PCT/US08/61498 dated Sep. 22, 2008.
Int'l Search Report PCT/US09/032690 dated Jun. 16, 2009.

* cited by examiner



$$I_X = \frac{b \cdot h^3}{12}$$

FIG. 1A



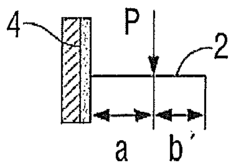
v = deflection in y direction

v′ = dv/dx = slope of deflection curve

d_b = v(L) = deflection at right end of beam

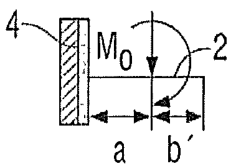
θ_b = v′(L) = angle at right end of beam

FIG. 1B



$0 < X < A$	$A < X < L$	
$v = \frac{Px^2}{6EI}(3a - x)$	$v = \frac{Pa^2}{6EI}(3x - a)$	$\delta_b = \frac{Pa^2}{6EI}(3L - a)$
$v' = \frac{Px}{2EI}(2a - x)$	$v' = \frac{Pa^2}{6EI}$	$\theta_b = \frac{Pa^2}{2EI}$

FIG. 1C



$v = \frac{M_0 x^2}{2EI}$	$v = \frac{M_0 a}{2EI}(2x - a)$	$\delta_b = \frac{M_0 a}{6EI}(2L - a)$
$v' = \frac{M_0 x}{EI}$	$v' = \frac{M_0 a}{EI}$	$\theta_b = \frac{M_0 a}{EI}$

FIG. 1D

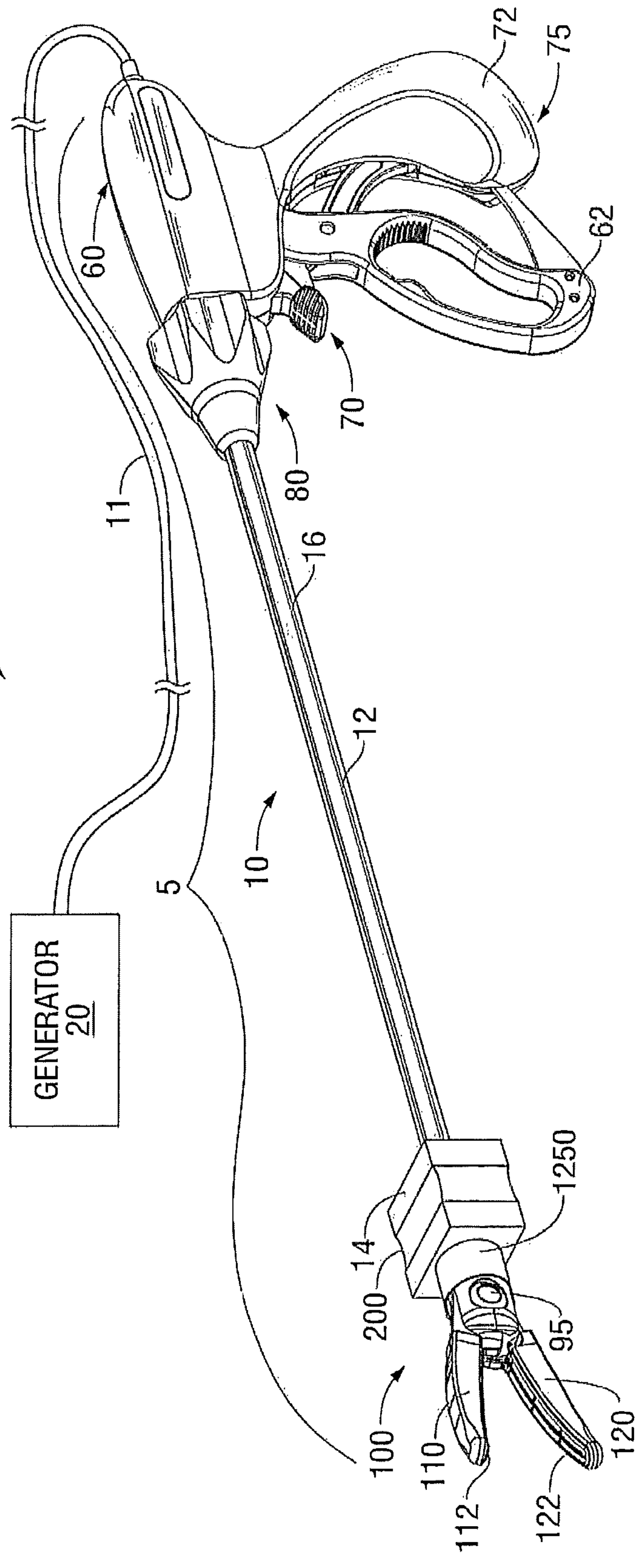

GENERATOR
20
3
5
10
11
12
14
16
60
62
70
72
75
80
95
100
110
112
120
122
200
1250

FIG. 2

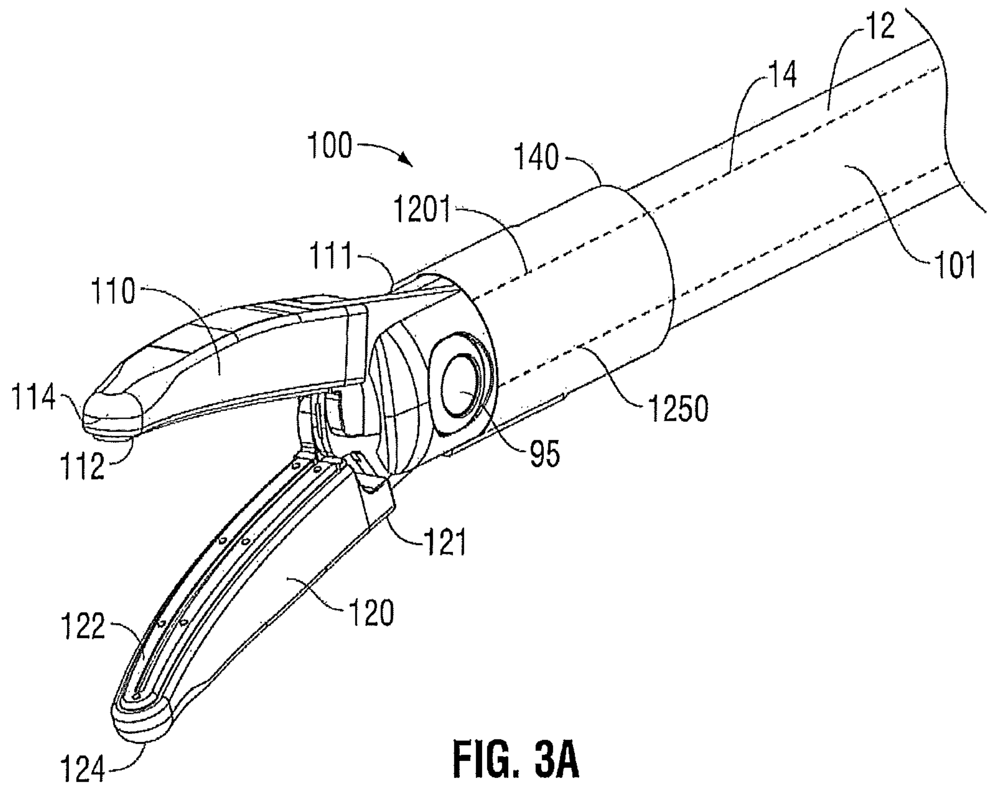

12
14
100
140
1201
111
110
101
114
1250
112
95
121
122
120
124

FIG. 3A

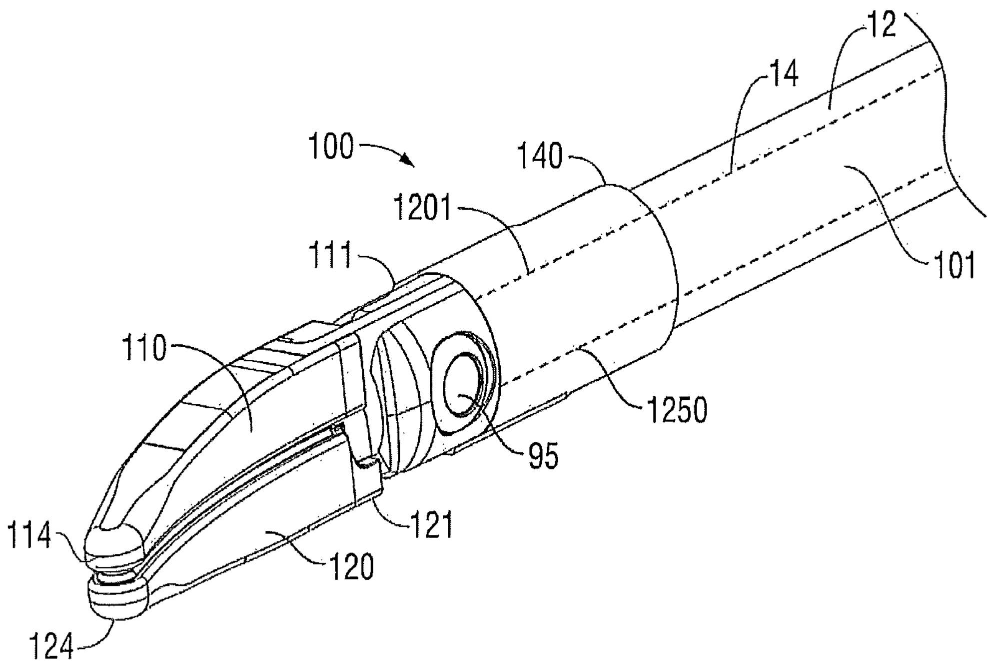

12
14
100
140
1201
101
111
110
1250
95
114
121
120
124

FIG. 3B

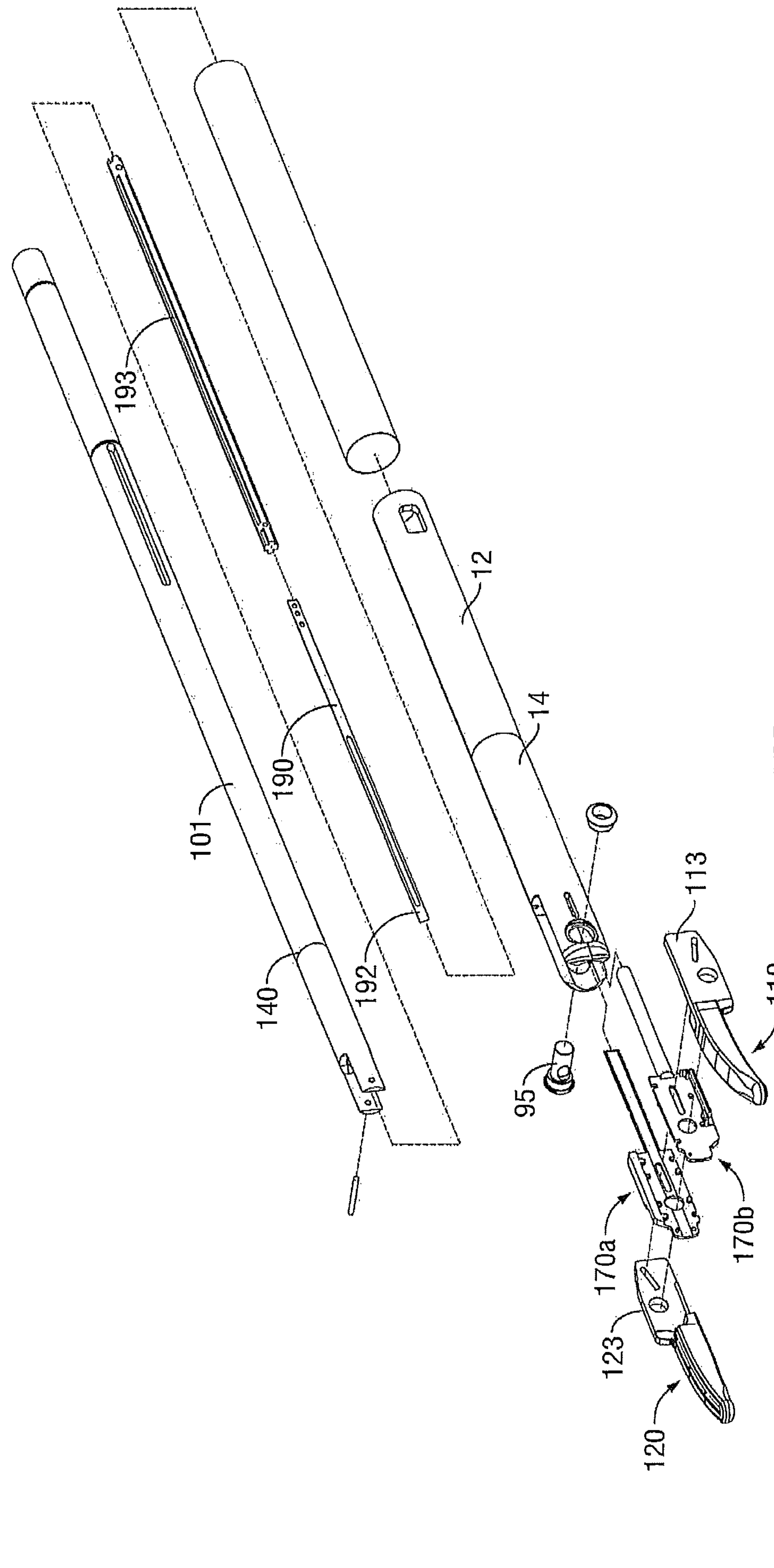
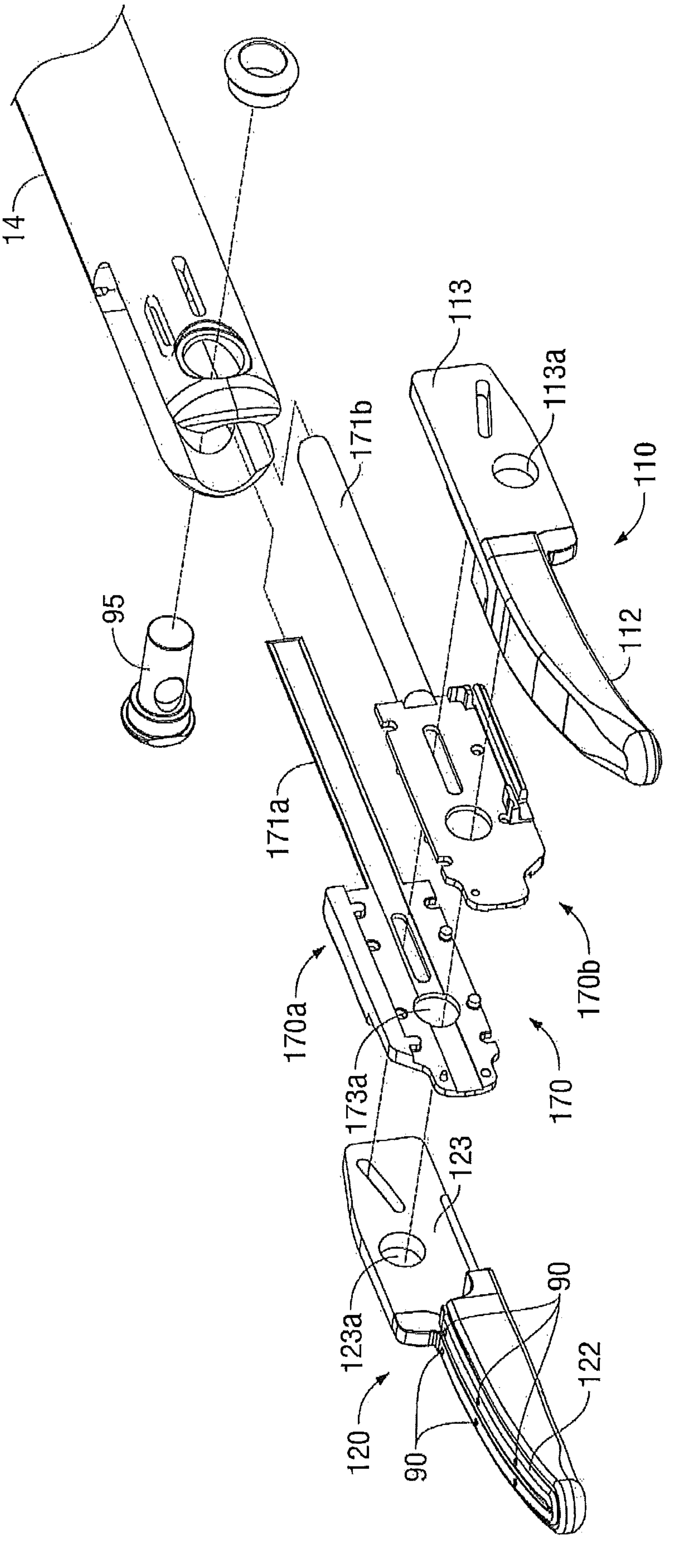
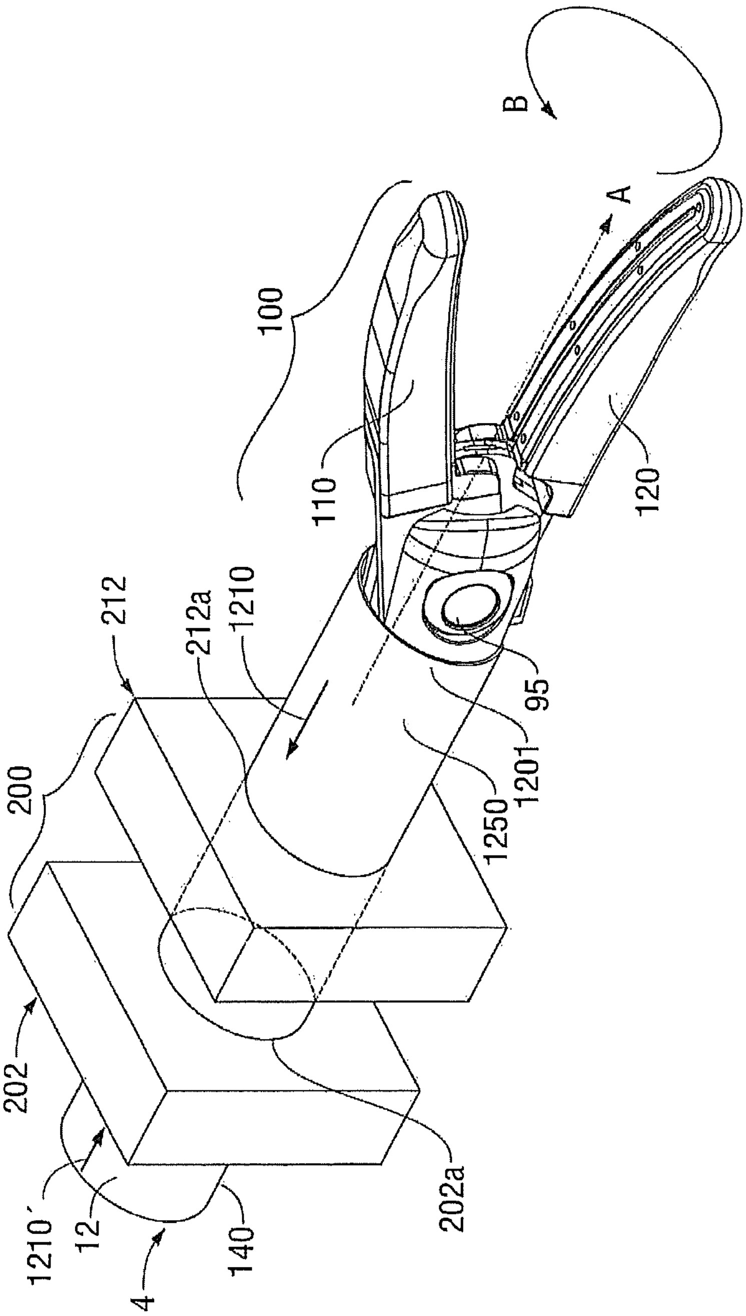


FIG. 4



14
95
113
113a
171b
110
112
171a
170a
170b
173a
170
123
123a
90
122
120

FIG. 5



100
110
120
A
B
212
212a
1210
95
1201
1250
200
202
202a
1210′
12
14
140

FIG. 6

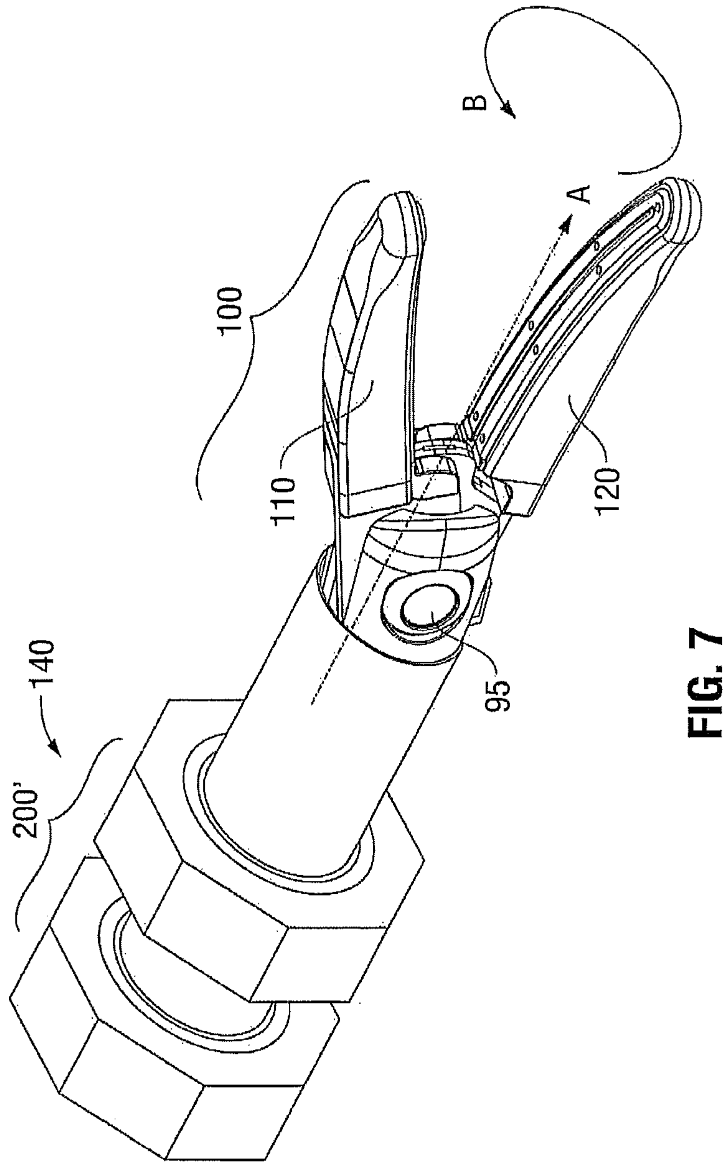


FIG. 7

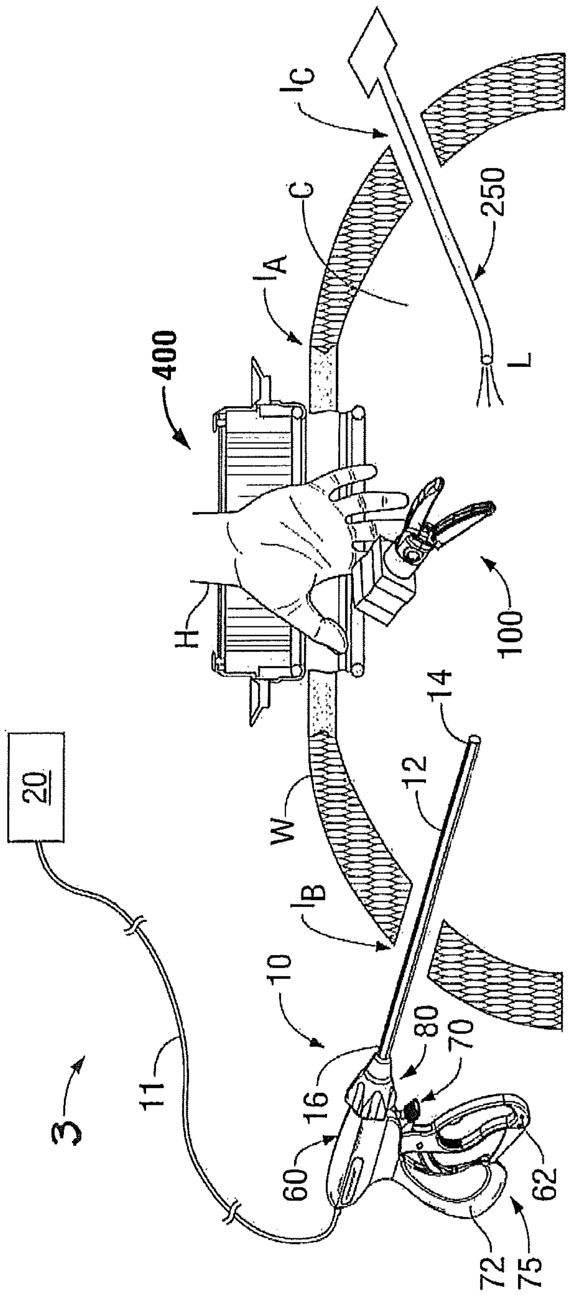


FIG. 8

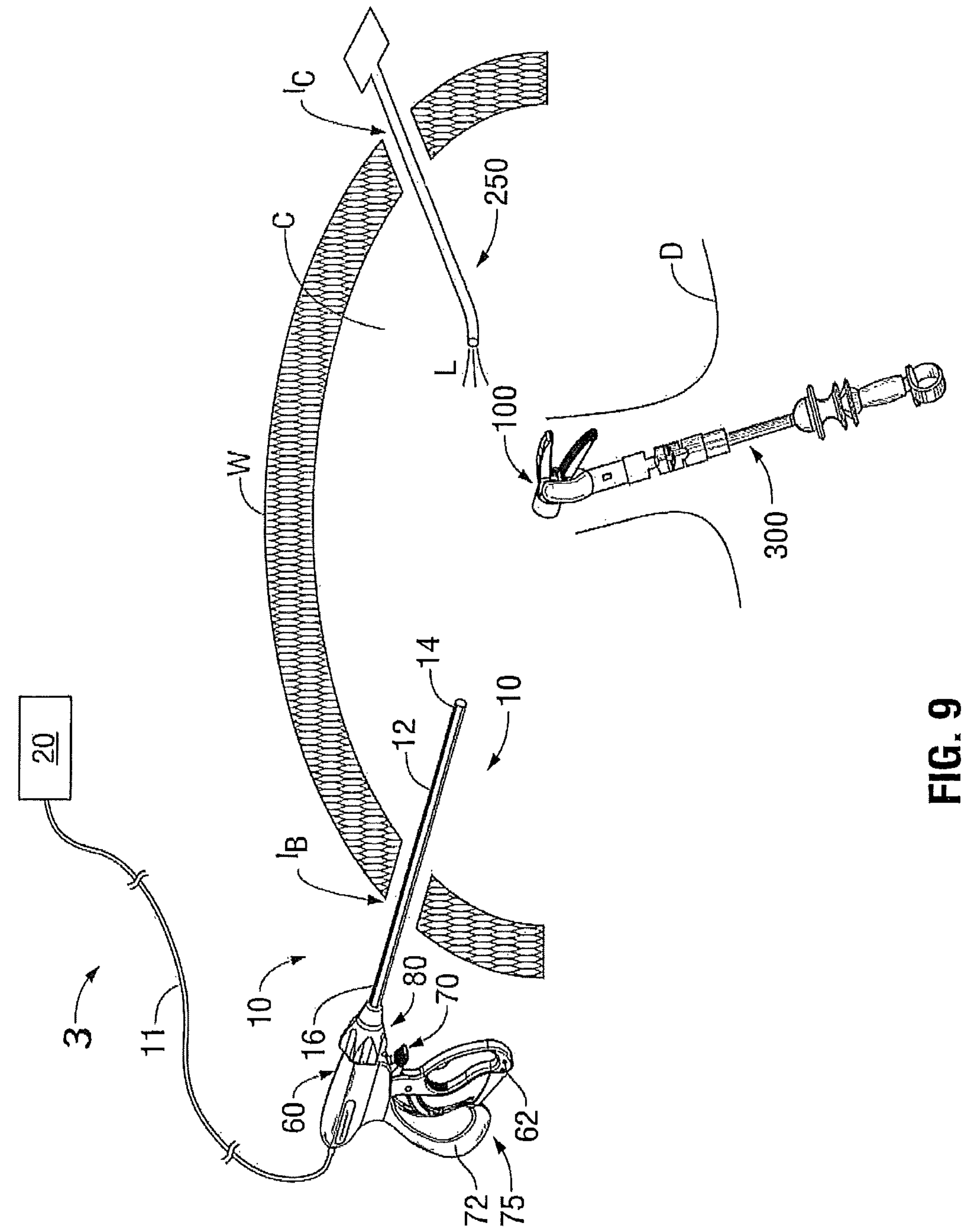


FIG. 9

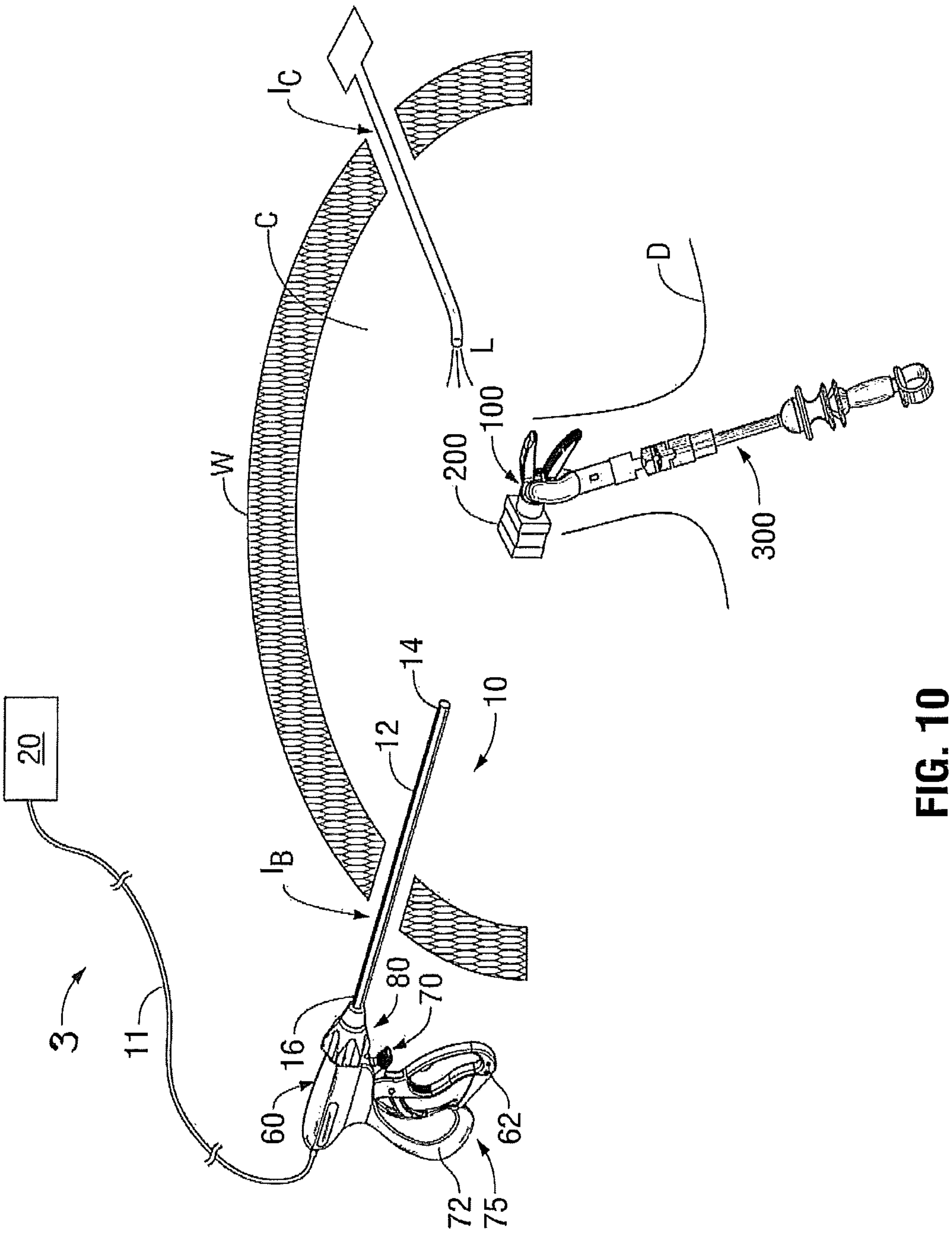


FIG. 10

IN VIVO ATTACHABLE AND DETACHABLE END EFFECTOR ASSEMBLY AND LAPAROSCOPIC SURGICAL INSTRUMENT AND METHODS THEREFOR

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 12/562,281 by Dumbauld et al., "IN VIVO ATTACHABLE AND DETACHABLE END EFFECTOR ASSEMBLY AND LAPAROSCOPIC SURGICAL INSTRUMENT AND METHODS THEREFOR", filed on Sep. 18, 2009, and published as U.S. Patent Application Publication US 2011/0071522 A1 "IN VIVO ATTACHABLE AND DETACHABLE END EFFECTOR ASSEMBLY AND LAPAROSCOPIC SURGICAL INSTRUMENT AND METHODS THEREFOR", now U.S. Pat. No. 8,133,254 issued on Mar. 13, 2012, the entire contents of each of which is incorporated by reference herein.

BACKGROUND

1. Technical Field

The present disclosure relates to endoscopic or laparoscopic surgery and more particularly to end effector assemblies for surgical instruments used therein.

2. Description of the Related Art

The trend in surgical procedures is to reduce the invasiveness of the procedure by reducing the size of the surgical incision. More and more frequently, the surgical incision is performed in the navel of the patient. For a laparoscopic surgical instrument, the outer shaft diameter is determined by the inner diameter of the ports (cannulae) with which the instrument will be used. As port size decreases to accommodate the reduced size of the surgical incision, the diameter/cross-sectional area of the end effectors of the surgical instrument must be reduced while the length of the end effectors must also be reduced to provide greater rigidity to reduce the susceptibility of the end effectors to deflection.

The resulting rigidity of the end effectors of the instrument thereby necessitates tight dimensional tolerances and a corresponding increase in material and manufacturing costs to provide the necessary rigidity.

SUMMARY

To advance the state of the art of surgery, the present disclosure relates to a method of performing surgery that includes the steps of providing a forceps having a housing including a shaft that extends therefrom and at least one handle moveable relative to the housing and providing an end effector assembly configured to selectively engage a distal end of the shaft. The method also includes the steps of inserting the forceps through a first opening formed in a body; inserting the end effector assembly through a second opening formed in the body; engaging the end effector assembly with the distal end of the shaft in vivo; and actuating the end effector assembly by moving the handle relative to the housing.

The method may include the step of providing a coupling at the distal end of the shaft, and may further include the step of engaging, via the coupling, the distal end of the shaft with the end effector assembly.

BRIEF DESCRIPTION OF THE DRAWINGS

Various embodiments of the present disclosure are described herein with reference to the drawings wherein:

FIG. **1**A illustrates a beam having a rectangular cross-section and the corresponding equation and dimensions to calculate the moment of inertia of the beam around a particular axis;

FIG. **1**B illustrates a cantilevered beam and the corresponding mathematical factors related to calculating the deflection of the beam along the length of the beam with respect to the anchor point;

FIG. **1**C illustrates the cantilevered beam of FIG. **1**B and the equations to calculate the deflection of the beam under a load as a function of the distance along the length of the beam with respect to the anchor point;

FIG. **1**D illustrates the cantilevered beam of FIG. **1**B and the equations to calculate the deflection of the beam under a bending moment as a function of the distance along the length of the beam with respect to the anchor point;

FIG. **2** is a left, perspective view of an endoscopic bipolar forceps showing a housing, a shaft and an in vivo detachable end effector assembly according to one embodiment of the present disclosure;

FIG. **3**A is an enlarged, left, perspective view of the end effector assembly and shaft of FIG. **1** in which the in vivo detachable end effector assembly is in an open position;

FIG. **3**B is a an enlarged, left, perspective view of the end effector assembly and shaft of FIG. **1** in which the in vivo detachable end effector assembly is in a closed position;

FIG. **4** is a left, perspective, exploded view of the shaft and push rod of the in vivo detachable end effector assembly;

FIG. **5** is a detailed, left, perspective, exploded view of the jaw members of the in vivo detachable end effector assembly;

FIG. **6** is a right, perspective view of the in vivo detachable end effector assembly and the shaft generally joined by a coupling according to one embodiment of the present disclosure;

FIG. **7** is a right, perspective view of the in vivo detachable end effector assembly and the shaft joined by a compression coupling according to one embodiment of the present disclosure;

FIG. **8** is a simplified view of an abdominal cavity in a subject illustrating an in vivo method of attaching a detachable end effector assembly to an endoscopic surgical instrument during a laparoscopic procedure according to one embodiment of the present disclosure;

FIG. **9** is a simplified view of an abdominal cavity in a subject illustrating an in vivo method of attaching, via a grasping device, a detachable end effector assembly to an endoscopic surgical instrument during a laparoscopic procedure according to another embodiment of the present disclosure; and

FIG. **10** is a simplified view of an abdominal cavity in a subject illustrating an in vivo method of attaching a detachable end effector assembly to an endoscopic surgical instrument during a laparoscopic procedure via a coupling that is configured to interface with the end effector assembly and the endoscopic surgical instrument according to still another embodiment of the present disclosure.

DETAILED DESCRIPTION

Various embodiments of the present disclosure are described hereinbelow with reference to the accompanying drawings. Well-known functions or constructions are not described in detail to avoid obscuring the present disclosure in unnecessary detail.

The present disclosure relates to a laparoscopic surgical instrument having a mating joint to enable attachment and detachment of a detachable end effector. The detachable end effector may be introduced into the abdominal cavity through a surgical incision such as at the navel while the laparoscopic surgical instrument is introduced, without the detachable end effector, into the abdominal cavity through another surgical incision. Alternatively, the detachable end effector may be introduced through a natural orifice such as the anal canal, while the laparoscopic surgical instrument is introduced, without the detachable end effector, through a surgical incision in the abdominal cavity.

The detachable end effector may be introduced by a second instrument, such as a grasper, which is used to attach or connect the detachable end effector to the mating joint of the instrument.

As compared to conventional laparoscopic surgical instruments, since the detachable end effector is introduced through a natural orifice of the patient, the length and the diameter of the detachable end effector of the laparoscopic surgical instrument according to the embodiments of the present disclosure may be increased.

Removal of the diameter and length constraints of the end effectors of the prior art generally allows for looser tolerances and more cost effective end effector fabrication processes. As the diameter is a significant factor in determining the necessary rigidity of the end effector assembly, a larger-diameter end effector assembly can be a longer end effector assembly because the end effector assembly will be less susceptible to deflection and thus provide a more uniform distribution of sealing pressure to the tissue.

As is well-known in the art, deflection of a cantilevered beam, which can approximate the deflection of the end effector assembly with respect to the shaft of the endoscopic instrument, is directly proportional to the distance of the applied load from an anchor point, in this case, the joint between the end effector assembly and the shaft, and inversely proportional to Young's modulus of elasticity E and the moment of inertia I of the end effector assembly, as illustrated in FIGS. **1A-1D**. For an assumed rectangular cross-section **2'** of the beam **2** as illustrated in FIG. **1A**, since the moment of inertia I_x around the x-axis is proportional to the width b times the cube of the height h, i.e., h^3, it can be seen that an increase in height h, while b remains constant, significantly increases the moment of inertia I_x. As can then be seen from FIGS. **1B-1C**, if the beam **2** is assumed to be a cantilevered beam anchored at anchor point **4**, representing the distal end of a shaft of an endoscopic instrument, the deflection v in the y-direction is directly proportional to the applied load P and the cube of the distance a from the anchor point **4**, i.e., a^3. Since the load P and the cube of the distance a are independent of the moment of inertia I_x, it can then be understood that any increase in moment of inertia I_x (while the other factors remain the same) will reduce the deflection v. FIG. **1D** simply illustrates the same effect if one assumes a bending moment M_0 around anchor point **4** instead of load P.

Following completion of the surgical procedure, the detachable end effector having an enlarged moment of inertia and rigidity is detached from the mating joint via the second instrument, which may again be introduced through the natural orifice and used to withdraw the detachable end effector from the abdominal cavity while the laparoscopic surgical instrument is withdrawn through the surgical incision.

In the drawings and in the descriptions which follow, the term "proximal", as is traditional, will refer to the end of the forceps **10** which is closer to the user, while the term "distal" will refer to the end which is further from the user. It should be noted that with respect to the end effector assembly **100**, reference to proximal end and distal end will be with respect to configuration of the end effector assembly **100** following attachment to the distal end **14** of the shaft **12** and corresponding actual use via the endoscopic bipolar forceps **10** during the surgical procedure, as opposed to the position of the end effector assembly **100** during the attachment process.

Referring now to FIG. **2**, a tissue sealing system **3** having a combination forceps and in vivo detachable end effector assembly **5** according to the present disclosure is shown. The combination forceps and in vivo detachable end effector assembly **5** includes a forceps **10** coupled to a generator **20**. Upon attachment and engagement of end effector assembly **100**, as described in more detail below, the combination forceps and in vivo detachable end effector assembly **5** is adapted to seal tissue using electrosurgical energy. The generator **20** may be configured to output various types of electrosurgical energy (e.g., from about 300 MHz to about 10,000 MHz).

The forceps **10** is coupled to the generator **20** via a cable **11** adapted to transmit energy and control signals therebetween. Various embodiments of the forceps **10** utilizing the aforementioned types of energy are discussed in more detail below.

As indicated, the forceps **10** is configured to support an in vivo detachable end effector assembly **100**. Forceps **10** typically includes various conventional features (e.g., a housing **60**, a handle assembly **75**, a rotating assembly **80**, a trigger assembly **70**) which enable forceps **10** and detachable end effector assembly **100** to mutually cooperate to grasp, seal and, if warranted, divide tissue. Forceps **10** generally includes housing **60** and handle assembly **75**, which includes moveable handle **62** and handle **72** that is integral with housing **60**. Handle **62** is moveable relative to handle **72** to actuate detachable end effector assembly **100** to grasp and treat tissue. Forceps **10** also includes a shaft **12** that has distal end **14** that mechanically engages detachable end effector assembly **100** and proximal end **16** that mechanically engages housing **60** proximate rotating assembly **80** disposed at the distal end of housing **60**. Rotating assembly **80** is mechanically associated with shaft **12**. Movement of rotating assembly **80** imparts similar rotational movement to shaft **12** which, in turn, rotates detachable end effector assembly **100**.

Referring also to FIGS. **3A-3B**, detachable end effector assembly **100** includes a proximal end **1250** comprising a shaft **1201** at proximal end **1250** that is configured to engage distal end **14** of the shaft **12** of the forceps **10** at interface joint **140**. The engagement between the shaft **12** and the shaft **1201** at interface joint **140** enables the attachment and detachment of the end effector assembly **100** with the forceps **10**.

Detachable end effector assembly **100** also includes two jaw members **110** and **120** having proximal ends **111**, **121** and distal ends **114**, **124**. Jaw members **110** and **120** are pivotable about a post or pivot pin **95** and are movable from a first position wherein jaw members **110** and **120** are spaced relative to another, to a second position wherein jaw members **110** and **120** are closed and cooperate to grasp tissue therebetween. As discussed in more detail below, the detachable end effector assembly **100** may be adapted for use with various energy sources.

In the illustrated embodiment, the shaft **12** houses a pushrod **101** that is operatively coupled to the movable handle **62** such that when the handle **62** is moved relative to the handle **72** the pushrod **101** moves longitudinally, either proximally or distally within the shaft **12**. The pushrod **101** may include one or more pins disposed at the distal end **16** of shaft **12**. Each of the jaw members **110** and **120** includes a corresponding slot disposed at the proximal ends thereof that mechanically cooperates with the push pins in a cam-follower mechanical arrangement. Motion of the pushrod **101** causes the pins to slide within respective slots **105** to actuate the jaw members. Other ways of opening/closing the jaws **110** and **120** are contemplated such as any known combinations of mechanical or electro-mechanical arrangement of gears, cams, pulleys, springs and sleeves.

The forceps **10** may also include a trigger assembly **70** that advances a knife **190** disposed within the detachable end effector assembly **100**. Once a tissue seal is formed, the user activates the trigger assembly **70** to separate the tissue along the tissue seal.

Each jaw member **110** and **120** also includes a sealing surface **112** and **122**, respectively, disposed on an inner-facing surface thereof. Sealing surfaces **112** and **122** cooperate to seal tissue held therebetween upon the application of energy. Sealing surfaces **112** and **122** are connected to generator **20** that communicates energy through the tissue held therebetween.

As best seen in FIG. **2**, forceps **10** also includes an electrosurgical cable **11** which connects the forceps **10** to generator **20**. Cable **11** is internally divided into cable leads (not shown) which each transmit electrosurgical energy through their respective feed paths through the forceps **10** to the detachable end effector assembly **100**.

As mentioned above, detachable end effector assembly **100** is attached at the distal end **14** of shaft **12** and includes a pair of opposing jaw members **110** and **120**. As described above, movable handles **62** and **72** mechanically cooperate to impart movement of the jaw members **110** and **120** from an open position, wherein the jaw members **110** and **120** are disposed in spaced relation relative to one another, to a clamping or closed position wherein the jaw members **110** and **120** cooperate to grasp tissue therebetween.

As shown best in FIGS. **3A-3B**, **4** and **5**, the detachable end effector assembly **100** is designed as a bilateral assembly, i.e., both jaw members **110** and **120** pivot relative to one another about a pivot pin **95** disposed therethrough. The jaw members **110** and **120** are curved to facilitate manipulation of tissue and to provide better "line of sight" for accessing organs and large tissue structures. In other embodiments, the jaw members **110** and **120** may have a straight configuration.

Push rod **101**, which ultimately connects to a drive assembly (not shown), is dimensioned to slidingly receive knife drive rod **193**, knife **190** and posts **171*a*** and **171*b*** of halves **170*a*** and **170*b*** of knife guide **170**. Push rod **101**, in turn, is received within shaft **12**. Upon actuation of the drive assembly, the push rod **101** reciprocates which, in turn, causes the pins to ride within slots to open and close the jaw members **110** and **120** as desired. The jaw members **110** and **120**, in turn, pivot about pivot pin **95** disposed through respective pivot holes **113*a*** and **123*a*** disposed within flanges **113** and **123**.

Jaw members **110** and **120** are electrically isolated from one another such that electrosurgical energy can be effectively transferred through the tissue to form a tissue seal. Jaw members **110** and **120** are engaged to the end of rotating shaft **12** by pivot pin **95** such that rotation of the rotating assembly **80** correspondingly rotates shaft **12** (along with push rod **101** and knife **190**) which, in turn, rotates detachable end effector assembly **100** (See FIG. **2**).

FIG. **6** illustrates the in vivo detachable end effector assembly **100** and the distal end **14** of shaft **12** of the endoscopic surgical instrument or forceps **10** that is generally joined by a coupling **200** according to one embodiment of the present disclosure. The coupling **200** has an orifice **202*a*** at proximal end **202** and an orifice **212*a*** at distal end **212**. The orifice **202*a*** at proximal end **202** is configured to receive the distal end **14** of shaft **12** of the endoscopic surgical instrument or forceps **10** while the orifice **212*a*** at distal end **212** is configured to receive proximal end **1250** of the shaft **1201** of the detachable end effector assembly **100**. As previously described above with respect to FIGS. **3**A and **3**B, detachable end effector assembly **100** includes proximal end **1250** comprising shaft **1201** at proximal end **1250** that is configured to engage distal end **14** of the shaft **12** of the forceps **10** at interface joint **140**. The engagement between the shaft **12** and the shaft **1201** enables the attachment and detachment of the end effector assembly **100** with the forceps **10** during an in vivo surgical procedure. The installation of the coupling **200** during the in vivo surgical procedure thereby secures the joint **140** and enables the attachment of the end effector assembly **100** to the shaft **12** of the forceps **10**. Conversely, release of the coupling **200** upon completion of activities required using the forceps **10** during the in vivo surgical procedure enables the detachment of the end effector assembly **100** from the shaft **12** of the forceps **10**. To assist in the installation of the coupling **200**, one or more alignment indicators, e.g., an arrow **1210** formed at an appropriate location on the shaft **1201** of the end effector assembly **100** and a corresponding arrow **1210'** formed on the shaft **12** of the forceps **10**, facilitate engagement of the end effector assembly **100** with the forceps **10** during an in vivo surgical procedure.

FIG. **7** illustrates the in vivo detachable end effector assembly **100** and the shaft **12** of forceps **10** joined at interface joint **140** by an example coupling, e.g., a compression coupling **200'** that may have a compression fitting at one or both ends or a compression fitting at one end and another type of fitting such as a screw threaded fitting at the other end, according to one embodiment of the present disclosure. Numerous other suitable couplings may be employed to perform the joining of the end effector assembly **100** and the shaft **12**, including, but not limited to, Luer lock fittings, snap-fit coupling, ball and socket fittings and the like.

The shaft **12** and the end effector assembly **100** are configured such that engagement of the end effector assembly **100** with the distal end **14** of the shaft **12** establishes electrical communication between the forceps **10** and the tissue sealing surface **112** and/or **122** of the end effector assembly **100**.

As also described above previously, the distal end **14** of the shaft **12** is configured to interface with coupling **200**. The coupling **200** is configured to interface with the end effector assembly **100**. The end effector assembly **100** is configured to detachably engage and disengage from the distal end **14** of the shaft **12** via engagement of the end effector assembly **100** with the coupling **200**.

The shaft **12** and the end effector assembly **100** are configured such that engagement of the end effector assembly **100** with the distal end **14** of the shaft **12** via the coupling **200** establishes electrical communication between the forceps **10** and the end effector assembly **100**.

To accomplish the intended purpose of the combination forceps and in vivo detachable end effector assembly **5** (see FIG. **2**), the end effector assembly **100** may be configured to vary the ratio between the moment of inertia of the cross-section of the end effector assembly and the moment of inertia of the cross-section of the shaft **12** depending on any particular surgical purpose.

In addition, coupling **200** may be configured to selectively engage a first end effector assembly having a cross-sectional moment of inertia value and a second end effector assembly having a cross-sectional moment of inertia value that differs from the cross-sectional moment of inertia value of the first end effector assembly. That is, the coupling may be a universal type coupling configured to selectively engage end effector assemblies of different or various sizes.

FIGS. **8-10** illustrate simplified views of portions of the in vivo method of attaching the detachable end effector assembly **100** to the forceps **10** to form the combination forceps and end effector assembly **5** (see FIG. **2**) for use during the surgical procedure to seal and cut tissue.

More particularly, FIG. **8** is a simplified view of an abdominal cavity C in a subject illustrating the in vivo method of attaching detachable end effector assembly **100** to forceps **10** during a laparoscopic procedure according to one embodiment of the present disclosure. A surgical hand access apparatus **400** is shown installed within an opening or surgical incision I_A in abdominal wall W located at a position such as at the navel of the subject as shown. Such a surgical hand access apparatus and the method of installation are described in commonly-owned U.S. Patent Application Publication US 2006/0229501 A1, by Jensen et al., entitled "SURGICAL HAND ACCESS APPARATUS", now U.S. Pat. No. 7,766,824 issued on Aug. 3, 2010. The hand H of a surgeon is illustrated grasping the in vivo detachable end effector assembly **100** and inserting or positioning the end effector assembly **100** through the incision I_A and into the abdominal cavity C. The end effector assembly **100** is grasped and oriented in a position to facilitate attachment and engagement of the end effector assembly **100** with the forceps **10**.

The forceps **10** is provided and inserted, minus the detachable end effector assembly **100**, through another opening or incision I_B in the body that allows the surgeon to position the distal end **14** of the shaft **12** such that upon attachment and engagement of the end effector assembly **100** to the shaft **12**, the resulting combination forceps and end effector assembly **5** (see FIG. **2**) is advantageously positioned to perform the desired surgical procedure.

Although not shown, the method further includes the step of engaging the end effector assembly **100** with the distal end **14** of the shaft **12**. The step of engaging the end effector assembly **100** with the distal end **14** of the shaft **12** enables establishment of electrical communication between the forceps **10** and the tissue sealing surface **112** and/or **122** of jaw members **110** and/or **120** of the end effector assembly **100**.

When at least one jaw member, e.g., lower jaw member **120**, of the end effector assembly **100** further includes a mechanical cutting element, e.g., knife blade **190**, the step of engaging the end effector assembly **100** with the distal end **14** of the shaft **12** also enables establishment of mechanical communication between the forceps **10** and the mechanical cutting element of the jaw member **120** to enable mechanical cutting of tissue.

As described above to assist in the installation of the coupling **200**, the method may include providing one or more alignment indicators, e.g., arrow **1210** formed at an appropriate location on the shaft **1201** of the end effector assembly **100** and/or corresponding arrow **1210'** formed on the shaft **12** of the forceps **10**, to facilitate engagement of the end effector assembly **100** with the forceps **10** during an in vivo surgical procedure. The step of aligning the end effector assembly **100** with the forceps **10** may include rotating the end effector assembly **100**, in the direction indicated by arrow B around longitudinal axis A of the end effector assembly **100**, and also translating the end effector assembly **100** in the direction of the longitudinal axis A, as illustrated in FIGS. **6** and **7**.

To further assist the surgeon in implementing the attachment and engagement of the end effector assembly **100** to the shaft **12** and in implementing the surgical procedure, an endoscopic camera **250** may be positioned and inserted through the abdominal wall W into the abdominal cavity C through another opening or incision I_C in the body at an opposite side of the abdominal wall W to facilitate transmission of light L towards the end effector assembly **100** and the distal end **14** of the shaft **12** and to facilitate reception of cinematic images.

FIG. **9** is a simplified view of the abdominal cavity C in a subject illustrating an in vivo method of attaching, via a grasping device, the detachable end effector assembly **100** to the forceps **10** during a laparoscopic procedure according to another embodiment of the present disclosure. A grasping device **300**, such as the endoscopic surgical device having an articulating handle assembly that is disclosed in commonly-owned U.S. patent application Ser. No. 12/193,864 by De Santis et al., filed on Aug. 19, 2008, entitled "ENDOSCOPIC SURGICAL DEVICE", published on Feb. 26, 2009 as U.S. Patent Application Publication No. US 2009/0054734 A1, the entire contents of which are hereby incorporated by reference herein, is positioned and inserted through an opening in the body such as a natural orifice D, Again, the end effector assembly **100** is grasped and oriented in a position to facilitate attachment and engagement of the end effector assembly **100** with the forceps **10**.

In a similar manner as described above with respect to FIG. **8**, the forceps **10** is provided and inserted, minus the detachable end effector assembly **100**, through opening or incision I_B in the body that allows the surgeon to position the distal end **14** of the shaft **12** such that upon attachment and engagement of the end effector assembly **100** to the shaft **12**, the resulting combination forceps and end effector assembly **5** (see FIG. **2**) is advantageously positioned to perform the desired surgical procedure.

Again, although not shown, the method may further include the step of engaging the end effector assembly **100** with the distal end **14** of the shaft **12**. The step of engaging the end effector assembly **100** with the distal end **14** of the shaft **12** enables establishment of electrical communication between the forceps **10** and the end effector assembly **100**.

In a similar manner, when at least one jaw member, e.g., lower jaw member **120**, of the end effector assembly **100** further includes a mechanical cutting element, e.g., knife blade **190**, the step of engaging the end effector assembly **100** with the distal end **14** of the shaft **12** also enables establishment of mechanical communication between the forceps **10** and the mechanical cutting element (knife blade **190**) of the jaw member **120** to enable mechanical cutting of tissue.

FIG. **10** is a simplified view of the adominal cavity C in a subject illustrating an alternative in viva method of attaching the detachable end effector assembly **100** to forceps **10** during a laparoscopic procedure, as compared to the in vivo method described above with respect to FIG. **9**, via the coupling **200** that is configured to interface with the end effector assembly **100** and the forceps **10**, according to still another embodiment of the present disclosure.

As described previously above with respect to FIGS. **6** and **7**, the end effector assembly **100** and the distal end **14** of the shaft **12** of the forceps **10** are configured to interface with the coupling **200**. As can be appreciated, the previous steps of implementing the method of engaging the forceps **10** with the end effector assembly **100** described above with respect to FIG. **9** are each implemented by interfacing the coupling **200** with the end effector assembly **100** and with the distal end **14** of the shaft **12**.

The methods described above with respect to FIGS. **8-10** may be implemented wherein forceps **10** includes trigger assembly **70** (that includes a trigger—see FIG. **2**) operably coupled to the housing **60** and the end effector assembly **100** includes a knife **192** (see FIG. **4**) and the method includes the step of actuating the trigger **70** to advance the knife **192** to separate tissue disposed in the end effector assembly **100**.

Additionally, the method may be implemented by providing coupling **200** configured to selectively engage a first end effector assembly having a cross-sectional moment of inertia value and a second end effector assembly having a cross-sectional moment of inertia value that differs from the cross-sectional moment of inertia value of the first end effector assembly depending on a surgical need. That is, as described previously, the coupling **200** may be a universal type coupling configured to selectively engage end effector assemblies of different or various sizes depending on the requirements for a particular surgical procedure or need.

Actuation of the handles **62** and **72** closes the jaw members **110** and **120** about tissue with a pre-determinable and consistent closure pressure to effect a tissue seal. Closure pressures for sealing large tissue structures fall within the range of about 3 kg/cm^2 to about 16 kg/cm^2.

Stop members **90** which extend from the sealing surface **122** provide a consistent and accurate gap distance "G" (not shown) between the electrically conductive sealing surfaces **112** and in the range from about 0.001 inches (about 0.0254 millimeters) to about 0.006 inches (about 0.1524 millimeters) which is also effective for sealing tissue.

After the tissue is grasped between jaw members **110** and **120**, the forceps **10** is ready for selective application of electrosurgical energy and subsequent separation of the tissue. By controlling the intensity, frequency and duration of the electrosurgical energy and pressure applied to the tissue, the user can effectively seal tissue.

Referring to FIG. **2**, it can be appreciated from the foregoing that the embodiments of the present disclosure may include a kit for an in vivo surgical procedure that includes forceps **10** having housing **60** including shaft **12** that extends therefrom and at least one handle **62** that is movable relative to the housing **60**. The kit also includes the selectively engageable end effector assembly **100** that is configured to selectively engage the distal end **14** of the shaft **12**. The kit may further include coupling **200** that is configured to facilitate engagement of the end effector assembly **100** to the forceps **10**.

The state of the art of endoscopic surgery is advanced by the embodiments of the present disclosure, since the embodiments of the present disclosure enable removing the diameter and length constraints of the end effectors of the prior art to generally allow for looser tolerances and more cost effective end effector fabrication processes. As described above, the diameter is a significant factor in determining the necessary rigidity of the end effector assembly, so that a larger-diameter end effector assembly can be a longer end effector assembly because the end effector assembly will be less susceptible to deflection and thus will provide a more uniform distribution of sealing pressure to the tissue.

While several embodiments of the disclosure have been shown in the drawings and/or discussed herein, it is not intended that the disclosure be limited thereto, as it is intended that the disclosure be as broad in scope as the art will allow and that the specification be read likewise. Therefore, the above description should not be construed as limiting, but merely as exemplifications of particular embodiments. Those skilled in the art will envision other modifications within the scope and spirit of the claims appended hereto.

What is claimed is:

1. A method of performing surgery, comprising the steps of:

providing an instrument having a housing including a shaft that extends therefrom;

providing a treatment member configured to selectively engage a distal end of the shaft;

inserting the instrument through a first opening formed in a body;

inserting the treatment member through a second opening formed in the body;

engaging the instrument with the distal end of the shaft in vivo; and

engaging the treatment member to treat tissue.

2. A method of performing surgery according to claim **1**, wherein the step of engaging the treatment member with the shaft establishes an electro-mechanical connection for electrosurgically treating tissue.

3. A method of performing surgery according to claim **1**, wherein the treatment member is adapted to connect to an electrosurgical energy source and the method further includes the step of activating the treatment member, via the electrosurgical energy source, to treat tissue.

4. A method of performing surgery according to claim **1**, wherein the step of inserting the instrument through a first opening formed in a body is performed by inserting the instrument through a natural body orifice.

5. A method of performing surgery according to claim **1**, wherein the step of inserting the treatment member through a second opening formed in the body is performed by inserting the treatment member through a natural body orifice.

6. A method of performing surgery according to claim **1**, wherein the method includes the step of inserting a camera through a third opening in the body.

7. A method of performing surgery according to claim **6**, further comprising the step of visualizing, via the camera, engagement of the treatment member with the distal end of the shaft.

8. A method of performing surgery according to claim **1**, further comprising the step of inserting a grasping device through a third opening in the body.

9. A method of performing surgery according to claim **8**, wherein the step of inserting the grasping device through a third opening in the body is performed by grasping the treatment member via the grasping device and inserting the treatment member through a third opening in the body.

10. A method of performing surgery according to claim **9**, further comprising the step of engaging the treatment member with the distal end of the shaft.

11. A method of performing surgery according to claim **1**, further comprising the step of providing a coupling at the distal end of the shaft.

12. A method of performing surgery according to claim **11**, further comprising the step of engaging, via the coupling, the distal end of the shaft with the treatment member.

13. A method of performing surgery according to claim **11**, wherein the step of providing a coupling at the distal end of the shaft is performed by providing at least one of a Luer-lock coupling, a threaded coupling, a compression coupling, a snap-fit coupling, a slide-fit coupling and a magnetic coupling.

14. A method of performing surgery according to claim **1**, wherein the instrument includes a trigger operably coupled to the housing and the treatment member includes a knife and the method includes the step of actuating the trigger to advance the knife to separate tissue disposed in the treatment member.

15. A method of performing surgery according to claim **1**, further comprising the step of providing an alignment indicator to at least one of the instrument and the treatment member to facilitate engagement between the instrument and the treatment member.

16. A method of performing surgery according to claim **15**, further comprising the step of aligning the instrument and the treatment member.

17. A method of performing surgery according to claim **16**, further comprising the step of engaging the instrument and the treatment member.

18. A method of performing surgery according to claim **11**, wherein the step of providing a coupling at the distal end of the shaft is performed by providing a coupling configured to selectively engage a first treatment member having a cross-sectional moment of inertia and a second treatment member having a cross-sectional moment of inertia that differs from the cross-sectional moment of inertia of the first treatment member.

* * * * *

专利名称(译)	体内可附接和可拆卸的末端执行器组件和腹腔镜手术器械及其方法		
公开(公告)号	US9028493	公开(公告)日	2015-05-12
申请号	US13/415639	申请日	2012-03-08
[标]申请(专利权)人(译)	柯惠有限合伙公司		
申请(专利权)人(译)	泰科医疗集团LP		
当前申请(专利权)人(译)	COVIDIEN LP		
[标]发明人	DUMBAULD PATRICK L COSGRIFF EDWARD		
发明人	DUMBAULD, PATRICK L. COSGRIFF, EDWARD		
IPC分类号	A61B18/14 A61B17/00 A61B17/29 A61B18/00		
CPC分类号	A61B18/1445 A61B2017/00473 A61B2017/2931 A61B2017/2945 A61B2018/00601 A61B2018/0063 A61B2018/1412 A61B2018/1432 A61B2018/1455 A61B17/2812 A61B18/1482 A61B2017/2946 A61B2017/2947		
优先权	12/562281 2012-03-13 US		
其他公开文献	US20120172925A1		
外部链接	Espacenet USPTO		

摘要(译)

一种执行手术的方法包括以下步骤：提供具有壳体的钳子，所述壳体包括从其延伸的轴和至少一个可相对于壳体移动的手柄，并提供端部执行器组件，所述端部执行器组件构造成选择性地接合轴的远端。该方法还包括将镊子穿过形成在主体中的第一开口的步骤;将末端执行器组件插入穿过主体中形成的第二开口;使末端执行器组件与轴的远端在体内接合;通过相对于壳体移动手柄来致动末端执行器组件。该方法还可包括以下步骤：在轴的远端处提供联接，以及经由联接器将轴的远端与端部执行器组件接合。