



US007467740B2

(12) **United States Patent**  
**Shelton, IV et al.**

(10) **Patent No.:** **US 7,467,740 B2**  
(45) **Date of Patent:** **Dec. 23, 2008**

(54) **SURGICAL STAPLING INSTRUMENTS  
HAVING FLEXIBLE CHANNEL AND ANVIL  
FEATURES FOR ADJUSTABLE STAPLE  
HEIGHTS**

(58) **Field of Classification Search** ..... 227/178.1,  
227/19, 175.1; 606/8, 153, 144; 411/21,  
411/24

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,037,727 A 4/1936 Chapelle  
3,269,630 A 8/1966 Fleischer

(Continued)

FOREIGN PATENT DOCUMENTS

CA 2512960 A1 1/2006

(Continued)

OTHER PUBLICATIONS

Disclosed Anonymously, "Motor-Driven Surgical Stapler Improvements," Research Disclosure Database No. 526041, Published: Feb. 2008.

(Continued)

*Primary Examiner*—Brian D Nash

(75) Inventors: **Frederick E. Shelton, IV**, New Vienna,  
OH (US); **Jerome R. Morgan**,  
Cincinnati, OH (US); **Michael A.  
Murray**, Bellevue, KY (US); **Richard  
W. Timm**, Cincinnati, OH (US); **James  
T. Spivey**, Loveland, OH (US); **James  
W. Voegelé**, Cincinnati, OH (US); **Leslie  
M Fugikawa**, Cincinnati, OH (US);  
**Eugene L. Timperman**, Cincinnati, OH  
(US)

(73) Assignee: **Ethicon Endo-Surgery, Inc.**, Cincinnati,  
OH (US)

(\*) Notice: Subject to any disclaimer, the term of this  
patent is extended or adjusted under 35  
U.S.C. 154(b) by 96 days.

(21) Appl. No.: **11/540,735**

(22) Filed: **Sep. 29, 2006**

(65) **Prior Publication Data**

US 2007/0083234 A1 Apr. 12, 2007

**Related U.S. Application Data**

(63) Continuation-in-part of application No. 11/231,456,  
filed on Sep. 21, 2005.

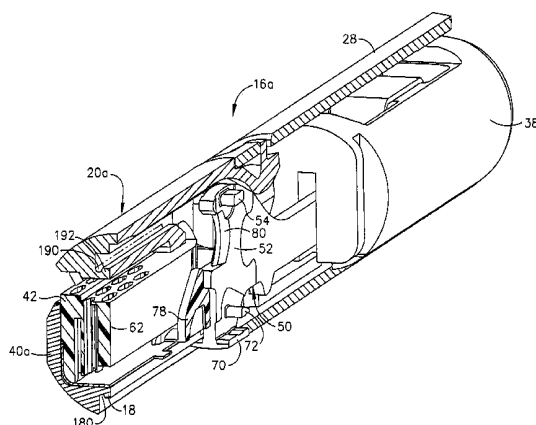
(51) **Int. Cl.**  
**A61B 17/04** (2006.01)

(52) **U.S. Cl.** ..... **227/178.1; 227/19; 227/179.1**

(57) **ABSTRACT**

A surgical instrument for being endoscopically or laparoscopically inserted into a surgical site for simultaneous stapling and severing of tissue includes force adjusted spacing between an upper jaw (anvil) and a lower jaw (staple cartridge engaged to an elongate staple channel) so that the height of staple formation corresponds to the thickness of the tissue, yet does not exceed the height range that may be accommodated by the length of the staples. In particular, resilient structures may be formed into one or more of the elongate channel that supports the staple cartridge, the anvil that is pivotally attached to the elongate channel, and/or a firing member that includes a cutting surface (knife) that severs tissue between a top pin that engages the anvil and a lower foot that engage the elongate channel. The resilience responds to the force exerted by clamped tissue to vary the spacing between the anvil and the staple cartridge supported within the elongate channel.

**25 Claims, 34 Drawing Sheets**



U.S. PATENT DOCUMENTS					
3,551,987 A	1/1971	Wilkinson	RE34,519 E	1/1994	Fox et al.
3,643,851 A	2/1972	Green et al.	5,275,323 A	1/1994	Schulze et al.
3,662,939 A	5/1972	Bryan	5,282,806 A	2/1994	Haber et al.
3,717,294 A	2/1973	Green	5,282,829 A	2/1994	Hermes
3,734,207 A	5/1973	Fishbein	5,307,976 A	5/1994	Olson et al.
3,819,100 A	6/1974	Noiles et al.	5,309,927 A	5/1994	Welch
3,894,174 A	7/1975	Cartun	5,318,221 A	6/1994	Green et al.
3,940,844 A	3/1976	Colby et al.	5,332,142 A	7/1994	Robinson et al.
4,317,451 A	3/1982	Cerwin et al.	5,342,395 A	8/1994	Jarrett et al.
4,331,277 A	5/1982	Green	5,342,396 A	8/1994	Cook
4,379,457 A	4/1983	Gravener et al.	5,344,060 A	9/1994	Gravener et al.
4,383,634 A	5/1983	Green	5,350,400 A	9/1994	Esposito et al.
4,402,445 A	9/1983	Green	5,366,134 A	11/1994	Green et al.
4,415,112 A	11/1983	Green	5,366,479 A	11/1994	McGarry et al.
4,428,376 A	1/1984	Mericle	5,379,933 A	1/1995	Green et al.
4,475,679 A	10/1984	Fleury, Jr.	5,383,880 A	1/1995	Hooven
4,485,816 A	12/1984	Krumme	5,389,098 A	2/1995	Tsuruta et al.
4,500,024 A	2/1985	DiGiovanni et al.	5,395,033 A	3/1995	Byrne et al.
4,520,817 A	6/1985	Green	5,397,046 A	3/1995	Savage et al.
4,522,327 A	6/1985	Korthoff et al.	5,403,312 A	4/1995	Yates et al.
4,526,174 A	7/1985	Froehlich	5,413,267 A	5/1995	Solyntjes et al.
4,530,453 A	7/1985	Green	5,413,268 A	5/1995	Green et al.
4,548,202 A	10/1985	Duncan	5,415,335 A	5/1995	Knodell, Jr.
4,566,620 A	1/1986	Green et al.	5,425,745 A	6/1995	Green et al.
4,573,622 A	3/1986	Green et al.	5,431,322 A	7/1995	Green et al.
4,580,712 A	4/1986	Green	5,433,721 A	7/1995	Hooven et al.
4,589,416 A	5/1986	Green	5,441,193 A	8/1995	Gravener
4,605,001 A	8/1986	Rothfuss et al.	5,445,304 A	8/1995	Plyley et al.
4,606,343 A	8/1986	Conta et al.	5,456,401 A	10/1995	Green et al.
4,608,981 A	9/1986	Rothfuss et al.	5,462,215 A	10/1995	Viola et al.
4,610,383 A	9/1986	Rothfuss et al.	5,465,895 A	11/1995	Knodel et al.
4,629,107 A	12/1986	Fedotov et al.	5,465,896 A	11/1995	Allen et al.
4,633,874 A	1/1987	Chow et al.	5,470,006 A	11/1995	Rodak
4,671,445 A	6/1987	Barker et al.	5,472,132 A	12/1995	Savage et al.
4,709,120 A	11/1987	Pearson	5,474,566 A	12/1995	Alesi et al.
4,715,520 A	12/1987	Roehr, Jr. et al.	5,480,089 A	1/1996	Blewett
4,728,020 A	3/1988	Green et al.	5,482,197 A	1/1996	Green et al.
4,741,336 A	5/1988	Failla et al.	5,484,095 A	1/1996	Green et al.
4,754,909 A	7/1988	Barker et al.	5,484,451 A	1/1996	Akopov et al.
4,767,044 A	8/1988	Green	5,485,947 A	1/1996	Olson et al.
4,805,617 A	2/1989	Bedi et al.	5,485,952 A	1/1996	Fontayne
4,869,414 A	9/1989	Green et al.	5,487,499 A	1/1996	Sorrentino et al.
4,869,415 A	9/1989	Fox	5,487,500 A	1/1996	Knodel et al.
4,892,244 A	1/1990	Fox et al.	5,489,058 A	2/1996	Plyley et al.
4,915,100 A	4/1990	Green	5,497,933 A	3/1996	DeFonzo et al.
4,941,623 A	7/1990	Pruitt	5,503,320 A	4/1996	Webster et al.
4,944,443 A	7/1990	Odds et al.	5,503,635 A	4/1996	Sauer et al.
4,955,959 A	9/1990	Tompkins et al.	5,503,638 A	4/1996	Cooper et al.
4,978,049 A	12/1990	Green	5,509,596 A	4/1996	Green et al.
5,009,661 A	4/1991	Michelson	5,518,163 A	5/1996	Hooven
5,027,834 A	7/1991	Pruitt	5,518,164 A	5/1996	Hooven
5,031,814 A	7/1991	Tompkins et al.	5,522,817 A	6/1996	Sander et al.
5,040,715 A	8/1991	Green et al.	5,529,235 A	6/1996	Boiarski et al.
5,065,929 A	11/1991	Schulze et al.	5,535,934 A	7/1996	Boiarski et al.
5,071,430 A	12/1991	de Salis et al.	5,535,935 A	7/1996	Vidal et al.
5,080,556 A	1/1992	Carreno	5,535,937 A	7/1996	Boiarski et al.
5,104,025 A	4/1992	Main et al.	5,540,375 A	7/1996	Bolanos et al.
5,106,008 A	4/1992	Tompkins et al.	5,547,117 A	8/1996	Hamblin et al.
5,111,987 A	5/1992	Moeinzadeh et al.	5,549,628 A	8/1996	Cooper et al.
5,129,570 A	7/1992	Schulze et al.	5,553,675 A	9/1996	Pitzen et al.
5,137,198 A	8/1992	Nobis et al.	5,554,169 A	9/1996	Green et al.
5,156,315 A	10/1992	Green et al.	5,560,532 A	10/1996	DeFonzo et al.
5,200,280 A	4/1993	Karasa	5,562,239 A	10/1996	Boiarski et al.
5,207,697 A	5/1993	Carusillo et al.	5,562,241 A	10/1996	Knodel et al.
5,211,649 A	5/1993	Kohler et al.	5,562,682 A	10/1996	Oberlin et al.
5,219,111 A	6/1993	Bilotti et al.	5,564,615 A	10/1996	Bishop et al.
5,242,457 A	9/1993	Akopov et al.	5,571,090 A	11/1996	Sherts
5,246,156 A	9/1993	Rothfuss et al.	5,573,543 A	11/1996	Akopov et al.
5,253,793 A	10/1993	Green et al.	5,574,431 A	11/1996	McKeown et al.
5,258,009 A	11/1993	Connors	5,575,799 A	11/1996	Bolanos et al.
5,271,544 A	12/1993	Fox et al.	5,575,803 A	11/1996	Cooper et al.
			5,577,654 A	11/1996	Bishop
			5,580,067 A	12/1996	Hamblin et al.

# US 7,467,740 B2

Page 3

5,582,611 A	12/1996	Tsuruta et al.	5,796,188 A	8/1998	Bays
5,584,425 A	12/1996	Savage et al.	5,797,536 A	8/1998	Smith et al.
5,586,711 A	12/1996	Plyley et al.	5,797,537 A	8/1998	Oberlin et al.
5,588,579 A	12/1996	Schnut et al.	5,797,538 A	8/1998	Heaton et al.
5,588,580 A	12/1996	Paul et al.	5,807,393 A	9/1998	Williamson, IV et al.
5,588,581 A	12/1996	Conlon et al.	5,817,093 A	10/1998	Williamson, IV et al.
5,597,107 A	1/1997	Knodel et al.	5,820,009 A	10/1998	Melling et al.
5,601,224 A	2/1997	Bishop et al.	5,823,066 A	10/1998	Huitema et al.
5,603,443 A	2/1997	Clark et al.	5,826,776 A	10/1998	Schulze et al.
5,605,272 A	2/1997	Witt et al.	5,829,662 A	11/1998	Allen et al.
5,605,273 A	2/1997	Hamblin et al.	5,833,690 A	11/1998	Yates et al.
5,607,094 A	3/1997	Clark et al.	5,836,503 A	11/1998	Ehrenfels et al.
5,607,095 A	3/1997	Smith et al.	5,839,639 A	11/1998	Sauer et al.
5,624,452 A	4/1997	Yates	5,843,132 A	12/1998	Ilvento
5,628,446 A	5/1997	Geiste et al.	5,855,311 A	1/1999	Hamblin et al.
5,630,539 A	5/1997	Plyley et al.	5,865,361 A	2/1999	Milliman et al.
5,630,540 A	5/1997	Blewett	5,871,135 A	2/1999	Williamson, IV et al.
5,632,432 A	5/1997	Schulze et al.	5,878,937 A	3/1999	Green et al.
5,634,584 A	6/1997	Okorocha et al.	5,878,938 A	3/1999	Bittner et al.
5,636,779 A	6/1997	Palmer	5,893,506 A	4/1999	Powell
5,636,780 A	6/1997	Green et al.	5,894,979 A	4/1999	Powell
5,639,008 A	6/1997	Gallagher et al.	5,897,562 A	4/1999	Bolanos et al.
5,645,209 A	7/1997	Green et al.	5,901,895 A	5/1999	Heaton et al.
5,647,526 A	7/1997	Green et al.	5,911,353 A	6/1999	Bolanos et al.
5,651,491 A	7/1997	Heaton et al.	5,915,616 A	6/1999	Viola et al.
5,653,374 A	8/1997	Young et al.	5,918,791 A	7/1999	Sorrentino et al.
5,653,721 A	8/1997	Knodel et al.	5,941,442 A	8/1999	Geiste et al.
5,657,921 A	8/1997	Young et al.	5,954,259 A	9/1999	Viola et al.
5,658,300 A	8/1997	Bito et al.	5,988,479 A	11/1999	Palmer
5,662,258 A	9/1997	Knodel et al.	6,010,054 A	1/2000	Johnson et al.
5,662,662 A	9/1997	Bishop et al.	6,017,356 A	1/2000	Frederick et al.
5,667,517 A	9/1997	Hooven	6,022,352 A	2/2000	Vandewalle
5,667,527 A	9/1997	Cook	6,024,741 A	2/2000	Williamson, IV et al.
5,669,544 A	9/1997	Schulze et al.	6,024,748 A	2/2000	Manzo et al.
5,673,840 A	10/1997	Schulze et al.	6,032,849 A	3/2000	Mastri et al.
5,673,841 A	10/1997	Schulze et al.	6,079,606 A	6/2000	Milliman et al.
5,673,842 A	10/1997	Bittner et al.	6,083,234 A	7/2000	Nicholas et al.
5,678,748 A	10/1997	Plyley et al.	6,086,600 A	7/2000	Kortenbach
5,680,981 A	10/1997	Mililli et al.	6,102,271 A	8/2000	Longo et al.
5,680,982 A	10/1997	Schulze et al.	6,109,500 A	8/2000	Alli et al.
5,680,983 A	10/1997	Plyley et al.	H1904 H	10/2000	Yates et al.
5,688,270 A	11/1997	Yates et al.	6,126,670 A	10/2000	Walker et al.
5,690,269 A	11/1997	Bolanos et al.	6,131,789 A	10/2000	Schulze et al.
5,692,668 A	12/1997	Schulze et al.	6,155,473 A	12/2000	Tompkins et al.
5,693,042 A	12/1997	Boiarski et al.	6,156,056 A	12/2000	Kearns et al.
5,697,543 A	12/1997	Burdorff	6,171,316 B1	1/2001	Kovac et al.
5,697,943 A	12/1997	Sauer et al.	6,171,330 B1	1/2001	Benchetrit
5,702,408 A	12/1997	Wales et al.	6,202,914 B1	3/2001	Geiste et al.
5,704,534 A	1/1998	Huitema et al.	6,223,835 B1	5/2001	Habedank et al.
5,706,997 A	1/1998	Green et al.	6,241,139 B1	6/2001	Milliman et al.
5,706,998 A	1/1998	Plyley et al.	6,250,532 B1	6/2001	Green et al.
5,709,680 A	1/1998	Yates et al.	6,264,086 B1	7/2001	McGuckin, Jr.
5,711,472 A	1/1998	Bryan	6,264,087 B1	7/2001	Whitman
5,713,505 A	2/1998	Huitema	6,273,897 B1	8/2001	Dallessandro et al.
5,715,988 A	2/1998	Palmer	6,315,184 B1	11/2001	Whitman
5,716,366 A	2/1998	Yates	6,320,123 B1	11/2001	Reimers
5,718,359 A	2/1998	Palmer et al.	6,325,810 B1	12/2001	Hamilton et al.
5,725,536 A	3/1998	Oberlin et al.	6,330,965 B1	12/2001	Milliman et al.
5,732,871 A	3/1998	Clark et al.	6,358,224 B1	3/2002	Tims et al.
5,735,445 A	4/1998	Vidal et al.	6,387,113 B1	5/2002	Hawkins et al.
5,738,474 A	4/1998	Blewett	6,398,797 B2	6/2002	Bombard et al.
5,743,456 A	4/1998	Jones et al.	6,416,486 B1	7/2002	Wampler
5,747,953 A	5/1998	Philipp	RE37,814 E	8/2002	Allgeyer
5,752,644 A	5/1998	Bolanos et al.	6,440,146 B2	8/2002	Nicholas et al.
5,752,965 A	5/1998	Francis et al.	6,443,973 B1	9/2002	Whitman
5,758,814 A	6/1998	Gallagher et al.	6,488,197 B1	12/2002	Whitman
5,762,255 A	6/1998	Chrisman et al.	6,491,201 B1	12/2002	Whitman
5,762,256 A	6/1998	Mastri et al.	6,503,257 B2	1/2003	Grant et al.
5,779,130 A	7/1998	Alesi et al.	6,505,768 B2	1/2003	Whitman
5,782,396 A	7/1998	Mastri et al.	6,522,101 B2	2/2003	Malackowski
5,782,397 A	7/1998	Koukline	6,592,597 B2	7/2003	Grant et al.
5,785,232 A	7/1998	Vidal et al.	6,602,252 B2	8/2003	Mollenauer
5,794,834 A	8/1998	Hamblin et al.	6,616,686 B2	9/2003	Coleman et al.

# US 7,467,740 B2

Page 4

6,619,529 B2	9/2003	Green et al.	7,225,964 B2	6/2007	Mastri et al.
6,620,166 B1	9/2003	Wenstrom, Jr. et al.	7,246,734 B2	7/2007	Shelton, IV
6,629,988 B2	10/2003	Weadock	2002/0117534 A1	8/2002	Green et al.
6,644,532 B2	11/2003	Green et al.	2002/0165541 A1	11/2002	Whitman
6,656,193 B2	12/2003	Grant et al.	2003/0105478 A1	6/2003	Whitman et al.
6,669,073 B2	12/2003	Milliman et al.	2003/0130677 A1	7/2003	Whitman et al.
6,681,978 B2	1/2004	Geiste et al.	2003/0216778 A1	11/2003	Weadock
6,681,979 B2	1/2004	Whitman	2003/0220660 A1	11/2003	Kortenbach et al.
6,695,199 B2	2/2004	Whitman	2004/0002726 A1	1/2004	Nunez et al.
6,698,643 B2	3/2004	Whitman	2004/0028502 A1	2/2004	Cummins
6,716,233 B1	4/2004	Whitman	2004/0034357 A1	2/2004	Beane et al.
6,755,338 B2	6/2004	Hahnen et al.	2004/0044364 A1	3/2004	DeVries et al.
6,767,356 B2	7/2004	Kanner et al.	2004/0094597 A1	5/2004	Whitman et al.
6,773,438 B1	8/2004	Knodel et al.	2004/0097987 A1	5/2004	Pugsley et al.
6,786,382 B1	9/2004	Hoffman	2004/0101822 A1	5/2004	Weisner et al.
6,793,652 B1	9/2004	Whitman et al.	2004/0108357 A1	6/2004	Milliman et al.
6,805,273 B2	10/2004	Bilotti et al.	2004/0111081 A1	6/2004	Whitman et al.
6,806,808 B1	10/2004	Watters et al.	2004/0122471 A1	6/2004	Toby et al.
6,814,741 B2	11/2004	Bowman et al.	2004/0164123 A1	8/2004	Racenet et al.
6,817,509 B2	11/2004	Geiste et al.	2004/0167572 A1	8/2004	Roth et al.
6,821,273 B2	11/2004	Mollenauer	2004/0173659 A1	9/2004	Green et al.
6,828,902 B2	12/2004	Casden	2004/0222268 A1	11/2004	Bilotti et al.
6,830,174 B2	12/2004	Hillstead et al.	2004/0232199 A1	11/2004	Shelton, IV et al.
6,835,199 B2	12/2004	McGuckin, Jr. et al.	2004/0232201 A1	11/2004	Wenchell et al.
6,843,403 B2	1/2005	Whitman	2004/0243151 A1	12/2004	Demmy et al.
6,846,307 B2	1/2005	Whitman et al.	2004/0243176 A1	12/2004	Hahnen et al.
6,846,308 B2	1/2005	Whitman et al.	2005/0006434 A1	1/2005	Wales et al.
6,846,309 B2	1/2005	Whitman et al.	2005/0021026 A1	1/2005	Baily
6,849,071 B2	2/2005	Whitman et al.	2005/0023324 A1	2/2005	Doll et al.
RE38,708 E	3/2005	Bolanos et al.	2005/0070958 A1	3/2005	Swayze et al.
6,877,647 B2	4/2005	Green et al.	2005/0072827 A1	4/2005	Mollenauer
6,905,057 B2	6/2005	Swayze et al.	2005/0080454 A1	4/2005	Drews et al.
6,939,358 B2	9/2005	Palacios et al.	2005/0103819 A1	5/2005	Racenet et al.
6,945,444 B2	9/2005	Gresham et al.	2005/0107824 A1	5/2005	Hillstead et al.
6,953,138 B1	10/2005	Dworak et al.	2005/0119669 A1	6/2005	Demmy
6,953,139 B2	10/2005	Milliman et al.	2005/0125009 A1	6/2005	Perry et al.
6,959,852 B2	11/2005	Shelton, IV et al.	2005/0131390 A1	6/2005	Heinrich et al.
6,964,363 B2	11/2005	Wales et al.	2005/0143759 A1	6/2005	Kelly
6,978,921 B2	12/2005	Shelton, IV et al.	2005/0145671 A1	7/2005	Viola
6,981,628 B2	1/2006	Wales	2005/0165415 A1	7/2005	Wales
6,981,941 B2	1/2006	Whitman et al.	2005/0169974 A1	8/2005	Tenerz et al.
6,986,451 B1	1/2006	Mastri et al.	2005/0173490 A1	8/2005	Shelton, IV
6,988,649 B2	1/2006	Shelton, IV et al.	2005/0184121 A1	8/2005	Heinrich
7,000,818 B2	2/2006	Shelton, IV et al.	2005/0187576 A1	8/2005	Whitman et al.
7,000,819 B2	2/2006	Swayze et al.	2005/0189397 A1	9/2005	Jankowski
7,032,798 B2	4/2006	Whitman et al.	2005/0203550 A1	9/2005	Laufer et al.
7,044,352 B2	5/2006	Shelton, IV et al.	2005/0216055 A1	9/2005	Scirica et al.
7,044,353 B2	5/2006	Mastri et al.	2005/0230453 A1	10/2005	Viola
7,048,687 B1	5/2006	Reuss et al.	2005/0263562 A1	12/2005	Shelton, IV et al.
7,055,730 B2	6/2006	Ehrenfels et al.	2005/0263563 A1	12/2005	Racenet et al.
7,055,731 B2	6/2006	Shelton, IV et al.	2005/0274768 A1	12/2005	Cummins et al.
7,059,508 B2	6/2006	Shelton, IV et al.	2006/0011699 A1	1/2006	Olson et al.
7,063,712 B2	6/2006	Vargas et al.	2006/0025813 A1	2/2006	Shelton et al.
7,066,944 B2	6/2006	Laufer et al.	2006/0025816 A1	2/2006	Shelton
7,077,856 B2	7/2006	Whitman	2006/0047307 A1	3/2006	Ortiz et al.
7,083,075 B2	8/2006	Swayze et al.	2006/0047308 A1	3/2006	Ortiz et al.
7,090,673 B2	8/2006	Dycus et al.	2006/0049229 A1	3/2006	Milliman et al.
7,090,684 B2	8/2006	McGuckin, Jr. et al.	2006/0052825 A1	3/2006	Ransick et al.
7,097,089 B2	8/2006	Marczyk	2006/0060630 A1	3/2006	Shelton, IV et al.
7,098,794 B2	8/2006	Lindsay et al.	2006/0085033 A1	4/2006	Criscuolo et al.
7,111,769 B2	9/2006	Wales et al.	2006/0087442 A1	4/2006	Smith et al.
7,114,642 B2	10/2006	Whitman	2006/0097026 A1	5/2006	Shelton, IV
7,118,582 B1	10/2006	Wang et al.	2006/0100643 A1	5/2006	Laufer et al.
7,128,253 B2	10/2006	Mastri et al.	2006/0122636 A1	6/2006	Bailley et al.
7,128,254 B2	10/2006	Shelton, IV et al.	2006/0142772 A1	6/2006	Ralph et al.
7,140,527 B2	11/2006	Ehrenfels et al.	2006/0151567 A1	7/2006	Roy
7,143,924 B2	12/2006	Scirica et al.	2006/0173470 A1	8/2006	Oray et al.
7,143,925 B2	12/2006	Shelton, IV et al.	2006/0183246 A1	8/2006	Wiesner et al.
7,143,926 B2	12/2006	Shelton, IV et al.	2006/0190028 A1	8/2006	Wales et al.
7,159,750 B2	1/2007	Racenet et al.	2006/0226196 A1	10/2006	Hueil et al.
7,168,604 B2	1/2007	Milliman et al.	2006/0245971 A1	11/2006	Burns et al.
7,188,758 B2	3/2007	Viola et al.	2006/0278680 A1	12/2006	Viola et al.
7,210,609 B2	5/2007	Leiboff et al.	2006/0278681 A1	12/2006	Viola et al.

2006/0289602 A1	12/2006	Wales et al.	EP	0702937 A1	3/1996
2006/0291981 A1	12/2006	Viola et al.	EP	0705571 A1	4/1996
2007/0034666 A1	2/2007	Holsten et al.	EP	0484677 B2	6/1996
2007/0034668 A1	2/2007	Holsten et al.	EP	0541987 B1	7/1996
2007/0045379 A1	3/2007	Shelton, IV	EP	0667119 B1	7/1996
2007/0073340 A1	3/2007	Shelton, IV et al.	EP	0770355 A1	5/1997
2007/0075114 A1	4/2007	Shelton, IV et al.	EP	0503662 B1	6/1997
2007/0084897 A1	4/2007	Shelton, IV et al.	EP	0625335 B1	11/1997
2007/0102452 A1	5/2007	Shelton, IV et al.	EP	0552423 B1	1/1998
2007/0102453 A1	5/2007	Morgan et al.	EP	0592244 B1	1/1998
2007/0102472 A1	5/2007	Shelton, IV	EP	0648476 B1	1/1998
2007/0102473 A1	5/2007	Shelton, IV et al.	EP	0603472 B1	11/1998
2007/0102474 A1	5/2007	Shelton, IV et al.	EP	0878169 A1	11/1998
2007/0102475 A1	5/2007	Ortiz et al.	EP	0760230 B1	2/1999
2007/0102476 A1	5/2007	Shelton, IV et al.	EP	0537572 B1	6/1999
2007/0106317 A1	5/2007	Shelton, IV et al.	EP	0552050 B1	5/2000
2007/0158385 A1	7/2007	Hueil et al.	EP	1090592 A1	4/2001
2007/0170225 A1	7/2007	Shelton, IV et al.	EP	1256318 B1	5/2001
2007/0175949 A1	8/2007	Shelton, IV et al.	EP	0908152 B1	1/2002
2007/0175950 A1	8/2007	Shelton, IV et al.	EP	0872213 B1	5/2002
2007/0175951 A1	8/2007	Shelton, IV et al.	EP	1238634 A2	9/2002
2007/0175952 A1	8/2007	Shelton, IV et al.	EP	0656188 B1	1/2003
2007/0175953 A1	8/2007	Shelton, IV et al.	EP	0829235 B1	6/2003
2007/0175955 A1	8/2007	Shelton, IV et al.	EP	0813843 B1	10/2003
2007/0175956 A1	8/2007	Swayze et al.	EP	0705570 B1	4/2004
2007/0175957 A1	8/2007	Shelton, IV et al.	EP	1086713 B1	5/2004
2007/0175958 A1	8/2007	Shelton, IV et al.	EP	1426012 A1	6/2004
2007/0175959 A1	8/2007	Shelton, IV et al.	EP	0888749 B1	9/2004
2007/0175960 A1	8/2007	Shelton, IV et al.	EP	1477119 A1	11/2004
2007/0175961 A1	8/2007	Shelton, IV et al.	EP	1479345 A1	11/2004
2007/0175962 A1	8/2007	Shelton, IV et al.	EP	1479347 A1	11/2004
2007/0175964 A1	8/2007	Shelton, IV et al.	EP	1479348 A1	11/2004
2007/0179476 A1	8/2007	Shelton, IV et al.	EP	1520523 A1	4/2005
2007/0194079 A1	8/2007	Hueil et al.	EP	1520525 A1	4/2005
2007/0194080 A1	8/2007	Swayze et al.	EP	1522264 A1	4/2005
2007/0194081 A1	8/2007	Hueil et al.	EP	1550408 A1	7/2005
2007/0194082 A1	8/2007	Morgan et al.	EP	1557129 A1	7/2005
2007/0213750 A1	9/2007	Weadock	EP	1064883 B1	8/2005
2007/0233053 A1	10/2007	Shelton, IV et al.	EP	1621141 A2	2/2006
2007/0262116 A1	11/2007	Hueil et al.	EP	1652481 A2	5/2006
2007/0295780 A1	12/2007	Shelton et al.	EP	1382303 B1	6/2006
2008/0029570 A1	2/2008	Shelton et al.	EP	1045672 B1	8/2006
2008/0029571 A1	2/2008	Shelton et al.	EP	1617768 B1	8/2006
2008/0029572 A1	2/2008	Shelton et al.	EP	1702567 A2	9/2006
2008/0029573 A1	2/2008	Shelton et al.	EP	1129665 B1	11/2006
2008/0029574 A1	2/2008	Shelton et al.	EP	1256317 B1	12/2006
2008/0029575 A1	2/2008	Shelton et al.	EP	1728473 A1	12/2006
2008/0029576 A1	2/2008	Shelton et al.	EP	1728475 A2	12/2006
2008/0029577 A1	2/2008	Shelton et al.	EP	1484024 B1	1/2007

## FOREIGN PATENT DOCUMENTS

CA	2514274 A1	1/2006	EP	11479346 B1	1/2007
DE	273689 C	5/1914	EP	1300117 B1	8/2007
DE	9412228 U	9/1994	FR	1112936 A	3/1956
DE	69328576 T2	1/2001	GB	939929 A	10/1963
DE	20112837 U1	10/2001	GB	2336214 A	10/1999
DE	20121753 U1	4/2003	JP	6007357 A	1/1994
DE	10314072 A1	10/2004	JP	7051273 A	2/1995
EP	0122046 A1	10/1984	JP	8033641 A	2/1996
EP	0033548 B1	5/1986	JP	8229050 A	9/1996
EP	0639349 A2	2/1994	JP	2001286477 A	10/2001
EP	0593920 A1	4/1994	JP	2002369820 A	12/2002
EP	0600182 A2	6/1994	JP	2005103293 A	4/2005
EP	0630612 A1	12/1994	RU	2187249 C2	8/2002
EP	0634144 A1	1/1995	RU	2225170 C2	3/2004
EP	0646356 A2	4/1995	SU	1377053 A1	2/1988
EP	0646357 A2	4/1995	SU	1561964 A1	5/1990
EP	0669104 A1	8/1995	SU	1722476 A1	3/1992
EP	0679367 A2	11/1995	WO	WO 93/08755 A1	5/1993
EP	0392547 B1	12/1995	WO	WO 95/18572 A1	7/1995
EP	0685204 A1	12/1995	WO	WO 95/29639 A1	11/1995
EP	0699418 A1	3/1996	WO	WO 96/35464 A1	11/1996
			WO	WO 98/30153 A1	7/1998
			WO	WO 99/12483 A1	3/1999
			WO	WO 99/15086 A1	4/1999

# US 7,467,740 B2

Page 6

WO	WO 99/34744 A1	7/1999
WO	WO 00/57796 A1	10/2000
WO	WO 00/72762 A1	12/2000
WO	WO 00/72765 A1	12/2000
WO	WO 01/05702 A1	1/2001
WO	WO 01/10482 A1	2/2001
WO	WO 01/62158 A2	8/2001
WO	WO 01/62162 A1	8/2001
WO	WO 01/62164 A2	8/2001
WO	WO 01/91646 A1	12/2001
WO	WO 02/17799 A1	3/2002
WO	WO 02/30297 A2	4/2002
WO	WO 02/43571 A2	6/2002
WO	WO 02/067785 A2	9/2002
WO	WO 03/000138 A2	1/2003
WO	WO 03/001329 A2	1/2003
WO	WO 03/079909 A3	3/2003
WO	WO 03/030743 A2	4/2003
WO	WO 03/037193 A1	5/2003
WO	WO 03/047436 A3	6/2003
WO	WO 03/057048 A1	7/2003
WO	WO 03/057058 A1	7/2003
WO	WO 03/063694 A1	8/2003
WO	WO 03/077769 A1	9/2003
WO	WO 03/082126 A1	10/2003
WO	WO 03/088845 A2	10/2003
WO	WO 03/090630 A2	11/2003
WO	WO 03/094743 A1	11/2003
WO	WO 03/094745 A1	11/2003
WO	WO 03/094746 A1	11/2003
WO	WO 03/094747 A1	11/2003
WO	WO 03/101313 A1	12/2003
WO	WO 03/105702 A2	12/2003
WO	WO 2004/006980 A2	1/2004
WO	WO 2004/032754 A2	4/2004
WO	WO 2004/032760 A2	4/2004
WO	WO 2004/032762 A1	4/2004
WO	WO 2004/032763 A2	4/2004
WO	WO 2004/047653 A2	6/2004
WO	WO 2004/049956 A2	6/2004
WO	WO 2004/086987 A1	10/2004

WO	WO 2004/096057 A2	11/2004
WO	WO 2004/112618 A2	12/2004
WO	WO 2005/027983 A2	3/2005
WO	WO 2005/096954 A2	10/2005
WO	WO 2006/044490 A2	4/2006
WO	WO 2006/044581 A2	4/2006
WO	WO 2006/083748 A1	8/2006
WO	WO 2006/132992 A1	12/2006
WO	WO 2007/016290 A2	2/2007

## OTHER PUBLICATIONS

U.S. Appl. No. 11/824,251, filed Jun. 29, 2007.  
U.S. Appl. No. 12/038,939, filed Feb. 28, 2008.  
U.S. Appl. No. 11/652,165, filed Jan. 11, 2007.  
U.S. Appl. No. 11/824,299, filed Jun. 29, 2007.  
U.S. Appl. No. 11/824,446, filed Jun. 29, 2007.  
U.S. Appl. No. 11/824,136, filed Jun. 29, 2007.  
U.S. Appl. No. 11/824,363, filed Jun. 29, 2007.  
U.S. Appl. No. 11/824,389, filed Jun. 29, 2007.  
U.S. Appl. No. 11/824,415, filed Jun. 29, 2007.  
U.S. Appl. No. 11/824,274, filed Jun. 29, 2007.  
U.S. Appl. No. 11/824,275, filed Jun. 29, 2007.  
U.S. Appl. No. 11/823,988, filed Jun. 29, 2007.  
U.S. Appl. No. 11/824,079, filed Jun. 29, 2007.  
U.S. Appl. No. 11/824,524, filed Jun. 29, 2007.  
U.S. Appl. No. 11/824,298, filed Jun. 29, 2007.  
U.S. Appl. No. 11/824,252, filed Jun. 29, 2007.  
U.S. Appl. No. 11/475,412, filed Jun. 27, 2006.  
U.S. Appl. No. 11/497,898, filed Aug. 2, 2006.  
U.S. Appl. No. 11/541,164, filed Sep. 29, 2006.  
U.S. Appl. No. 11/529,879, filed Sep. 29, 2006.  
U.S. Appl. No. 11/541,050, filed Sep. 29, 2006.  
U.S. Appl. No. 11/541,151, filed Sep. 29, 2006.  
U.S. Appl. No. 11/529,904, filed Sep. 29, 2006.  
U.S. Appl. No. 11/529,935, filed Sep. 29, 2006.  
U.S. Appl. No. 11/541,123, filed Sep. 29, 2006.  
U.S. Appl. No. 11/541,182, filed Sep. 29, 2006.  
U.S. Appl. No. 11/541,098, filed Sep. 29, 2006.  
U.S. Appl. No. 11/541,374, filed Sep. 29, 2006.  
International Search Report, Application No. PCT/US2007/011275, dated Feb. 6, 2008 (7 pages).

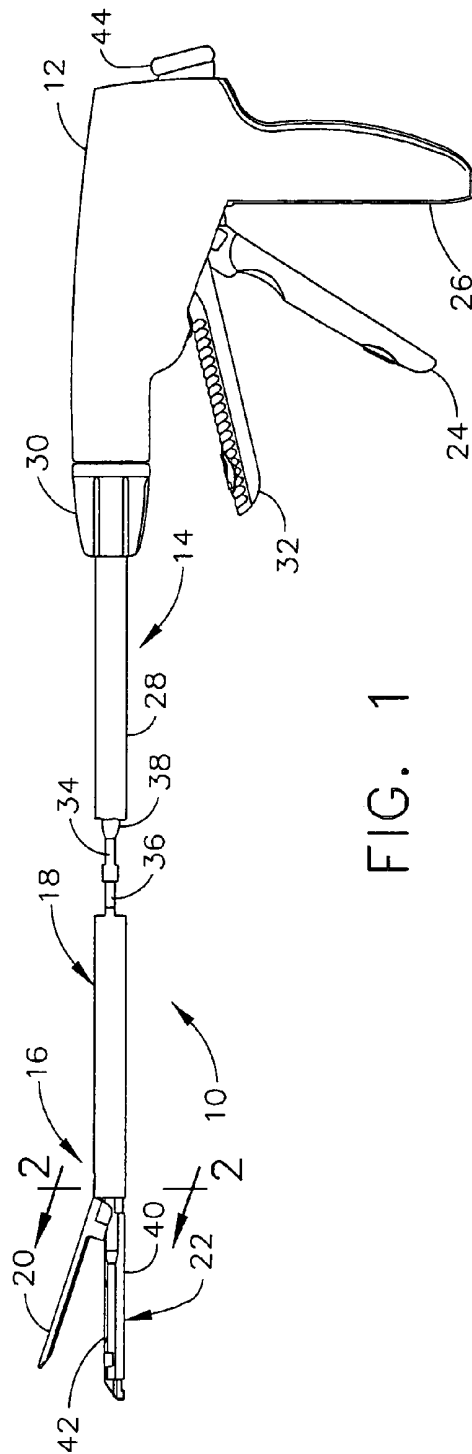


FIG. 1

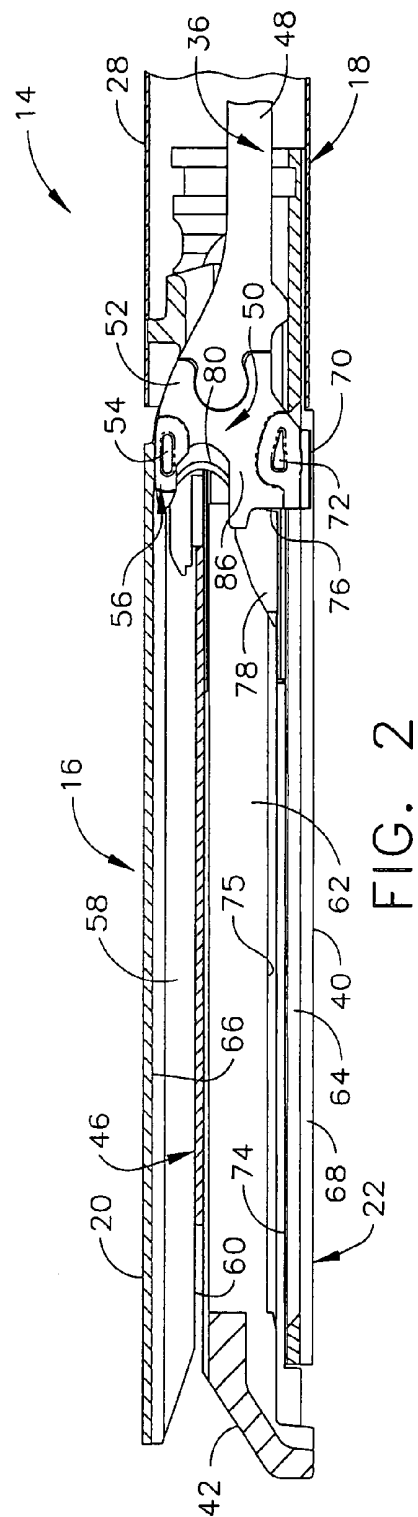


FIG. 2

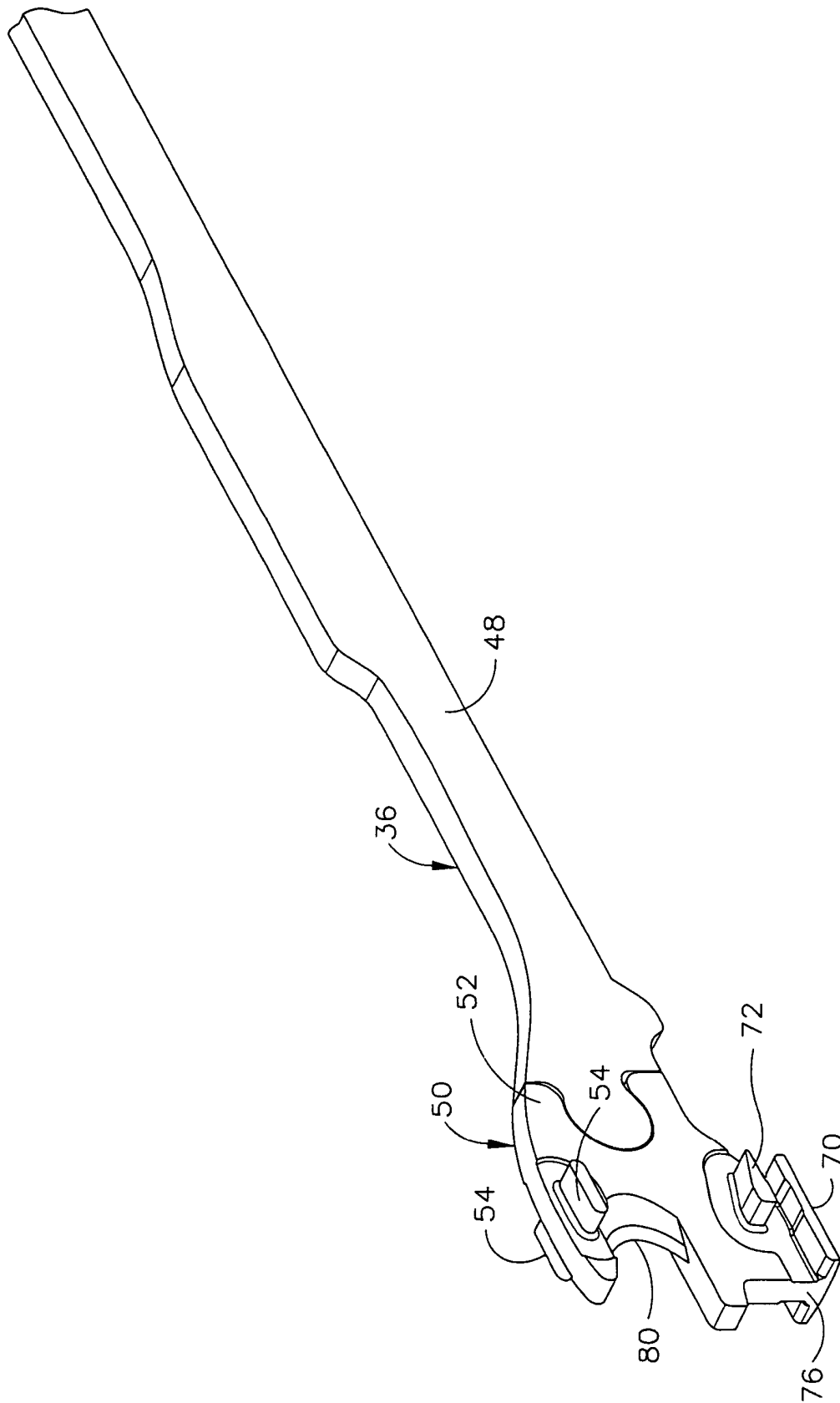
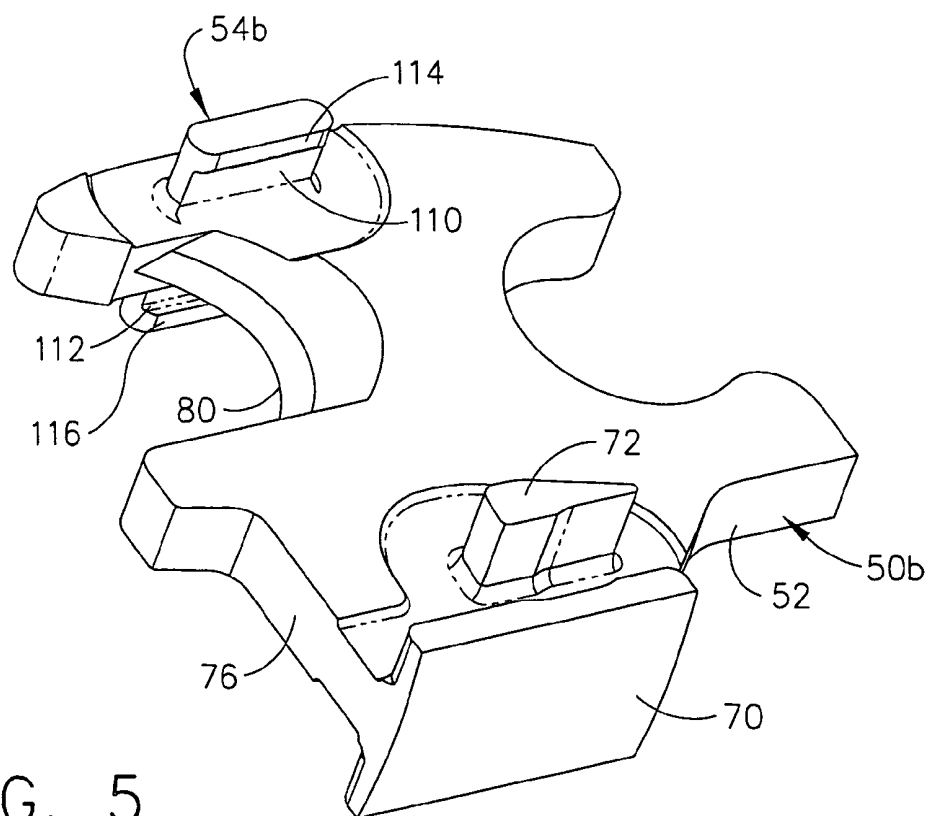
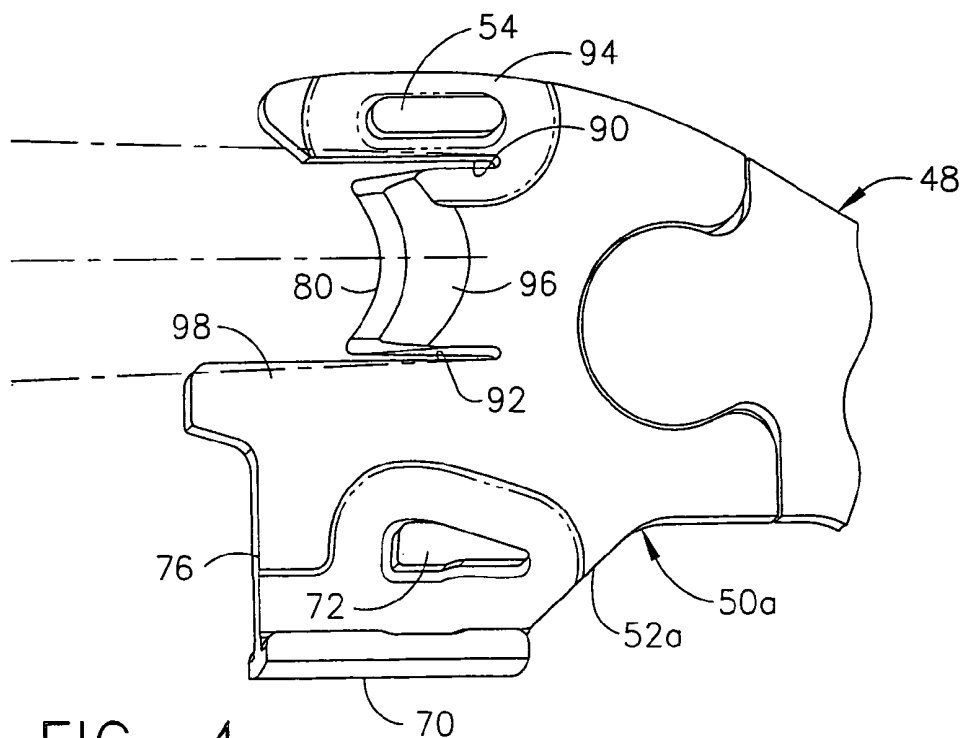


FIG. 3





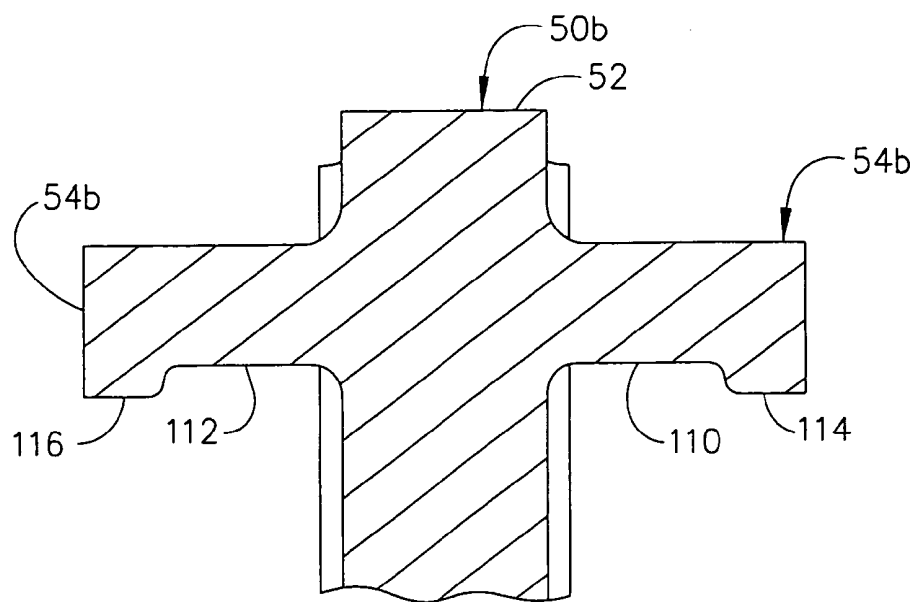


FIG. 6

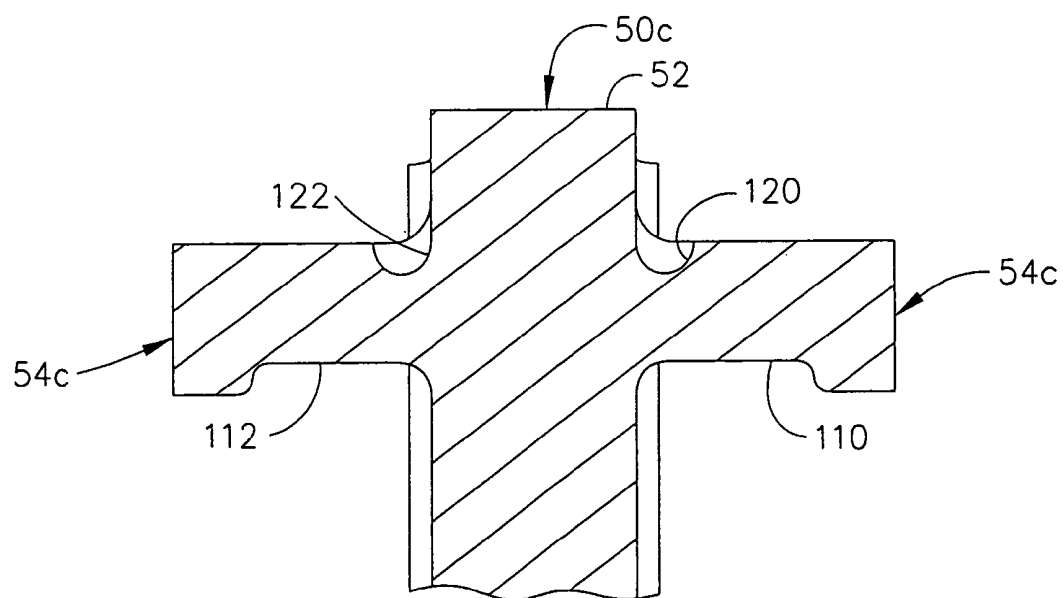


FIG. 7

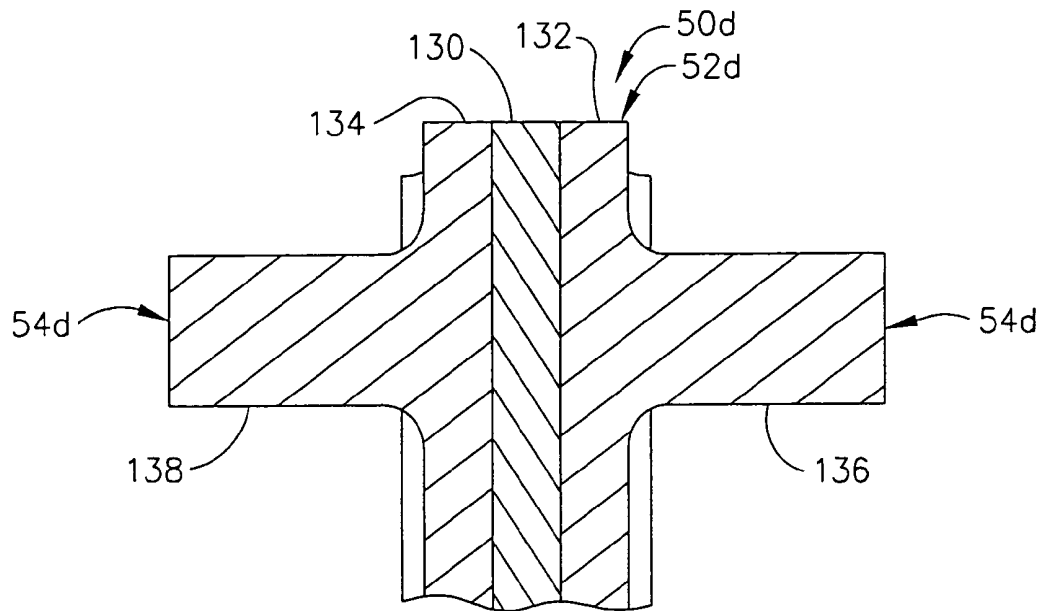


FIG. 8

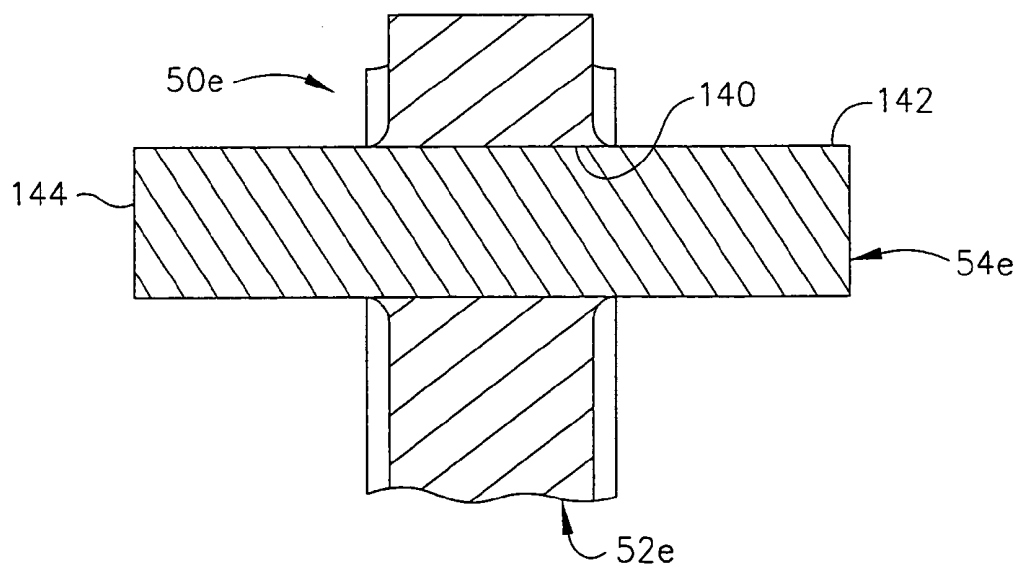


FIG. 9

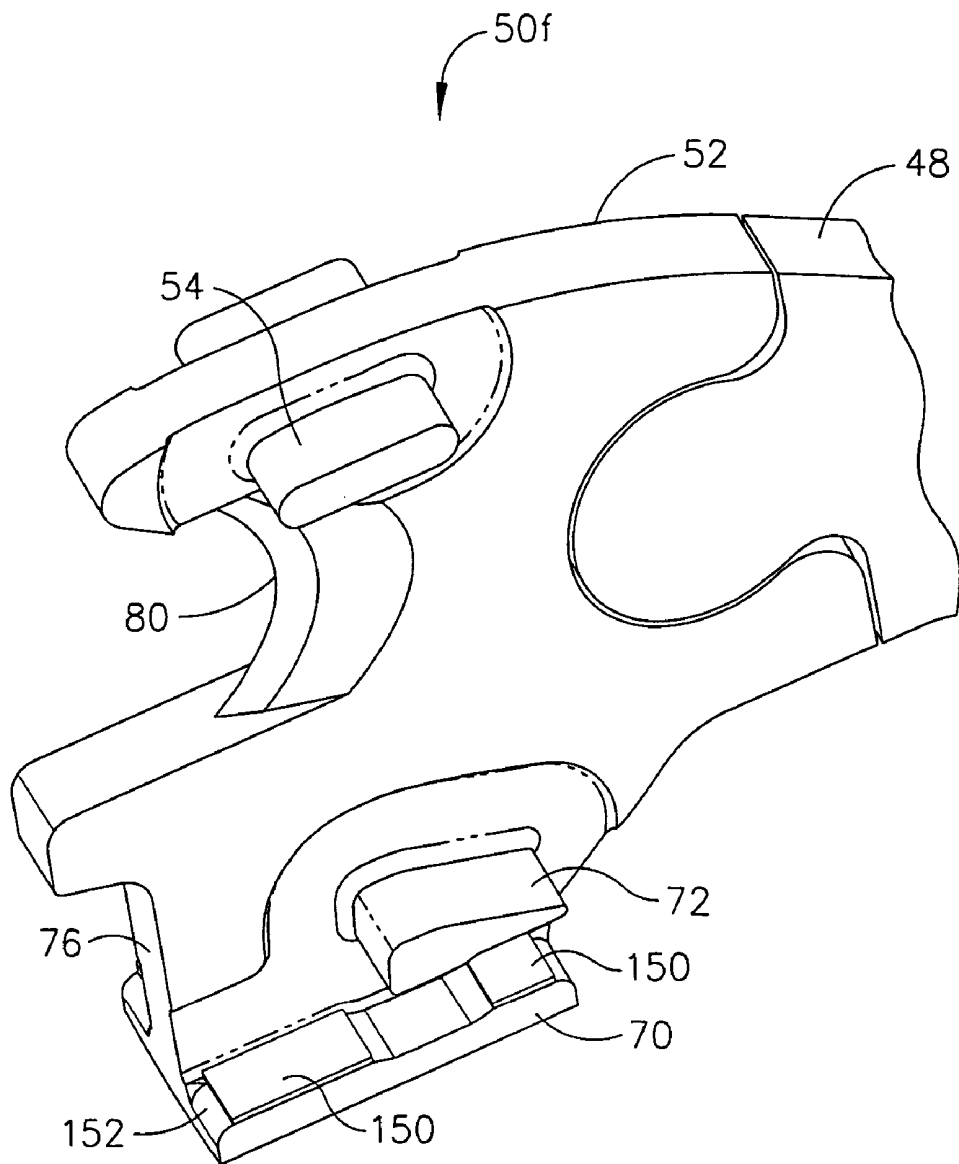


FIG. 10

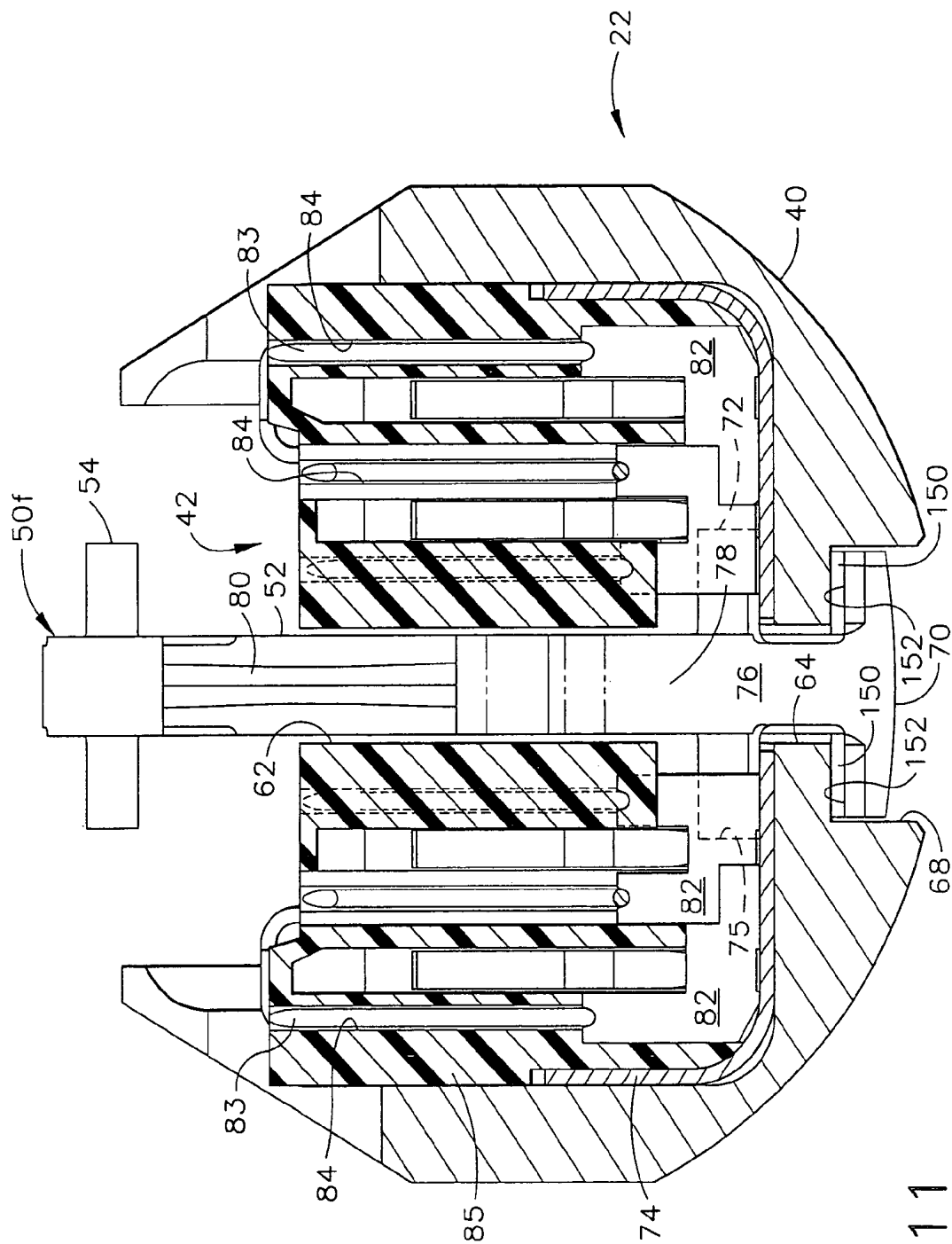


FIG. 11

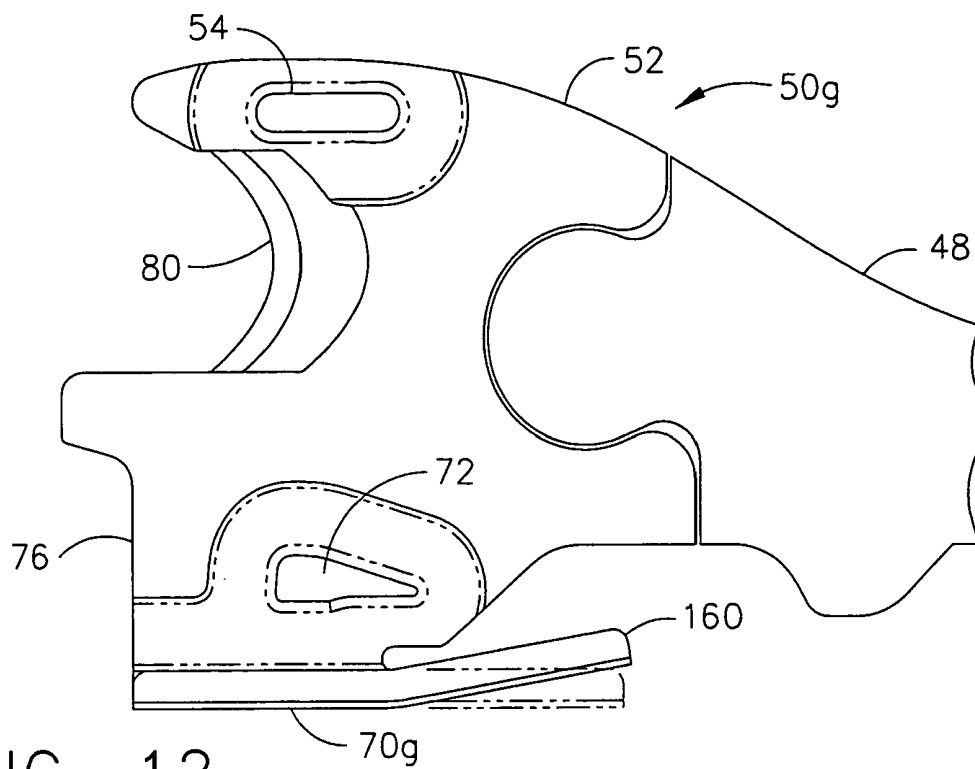


FIG. 12

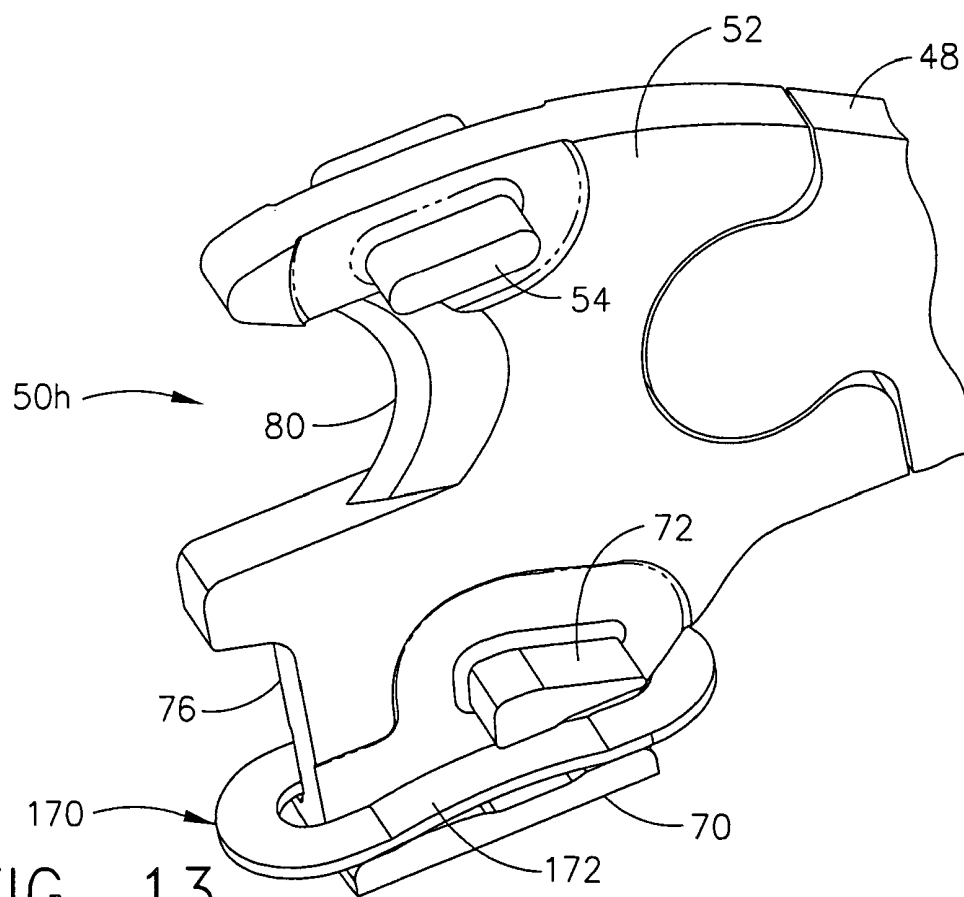


FIG. 13

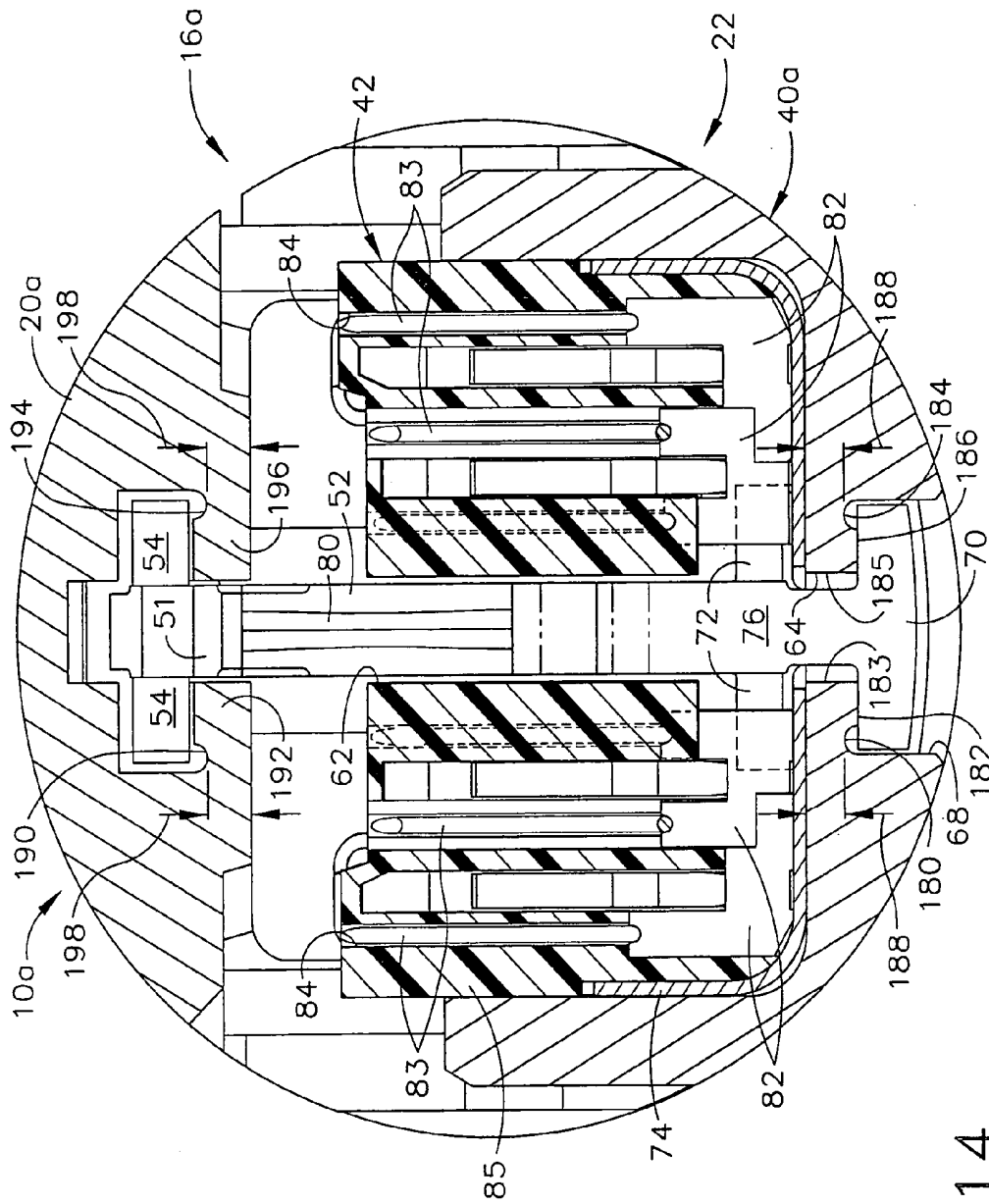


FIG. 14

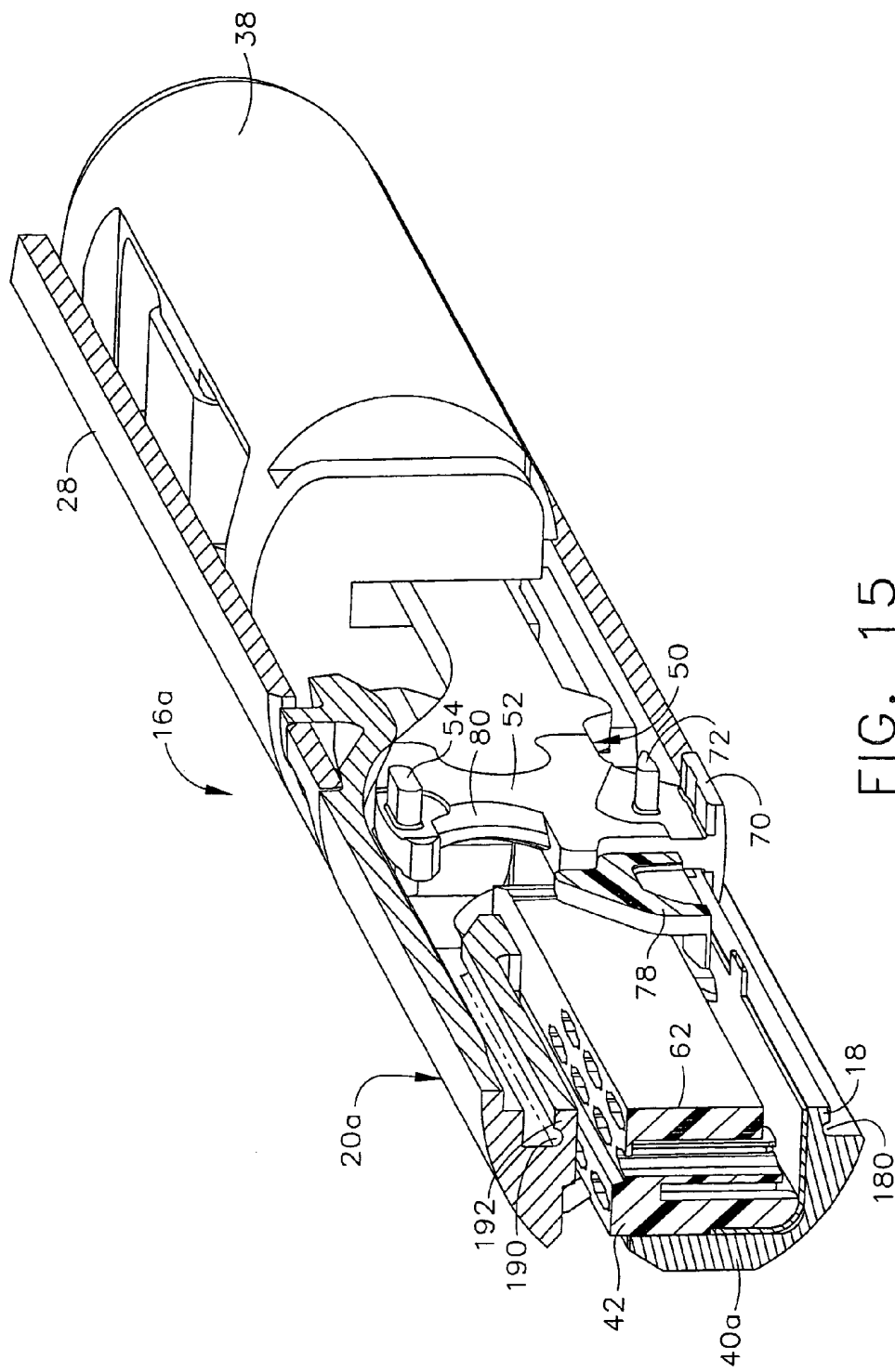


FIG. 15



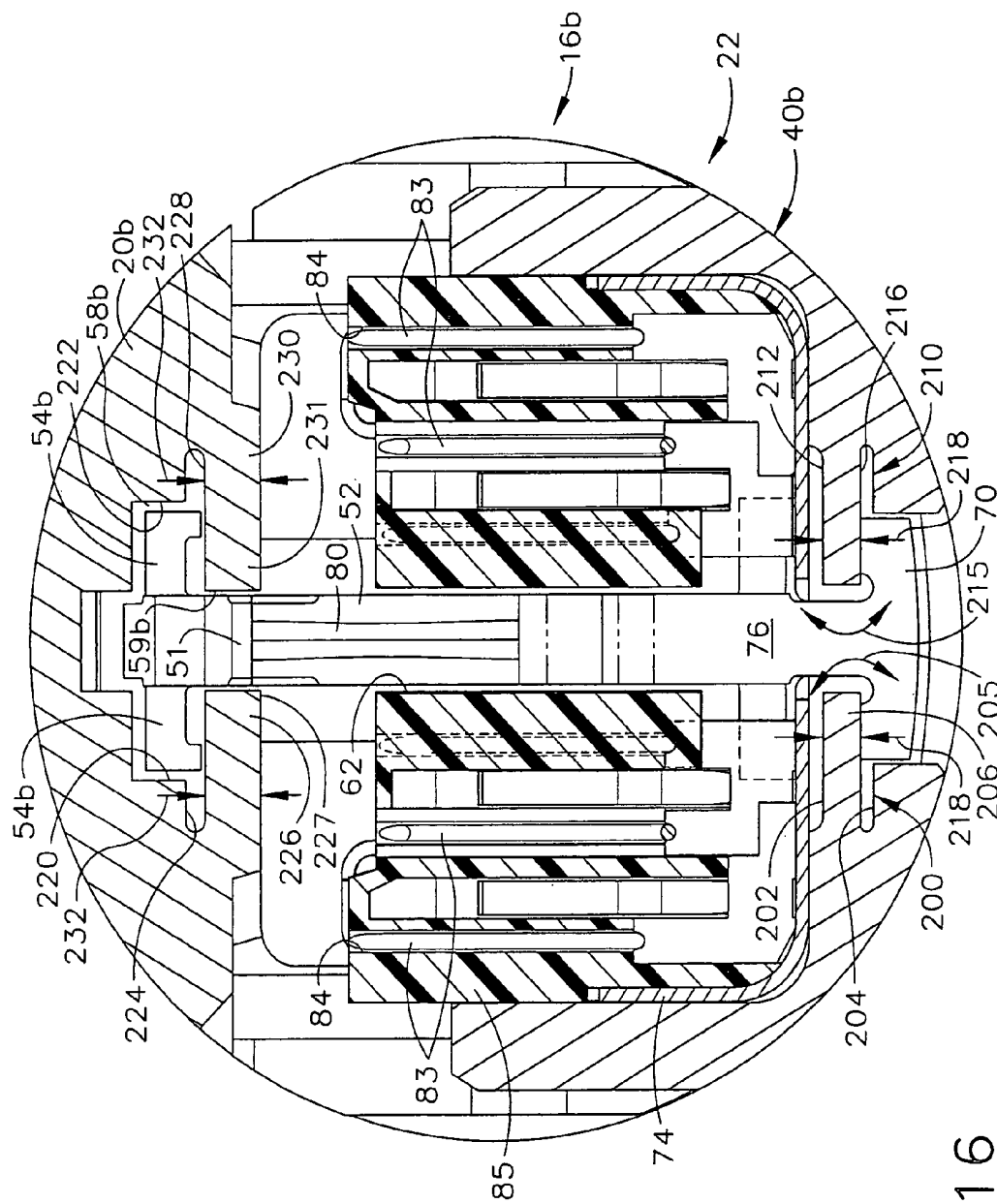


FIG. 16

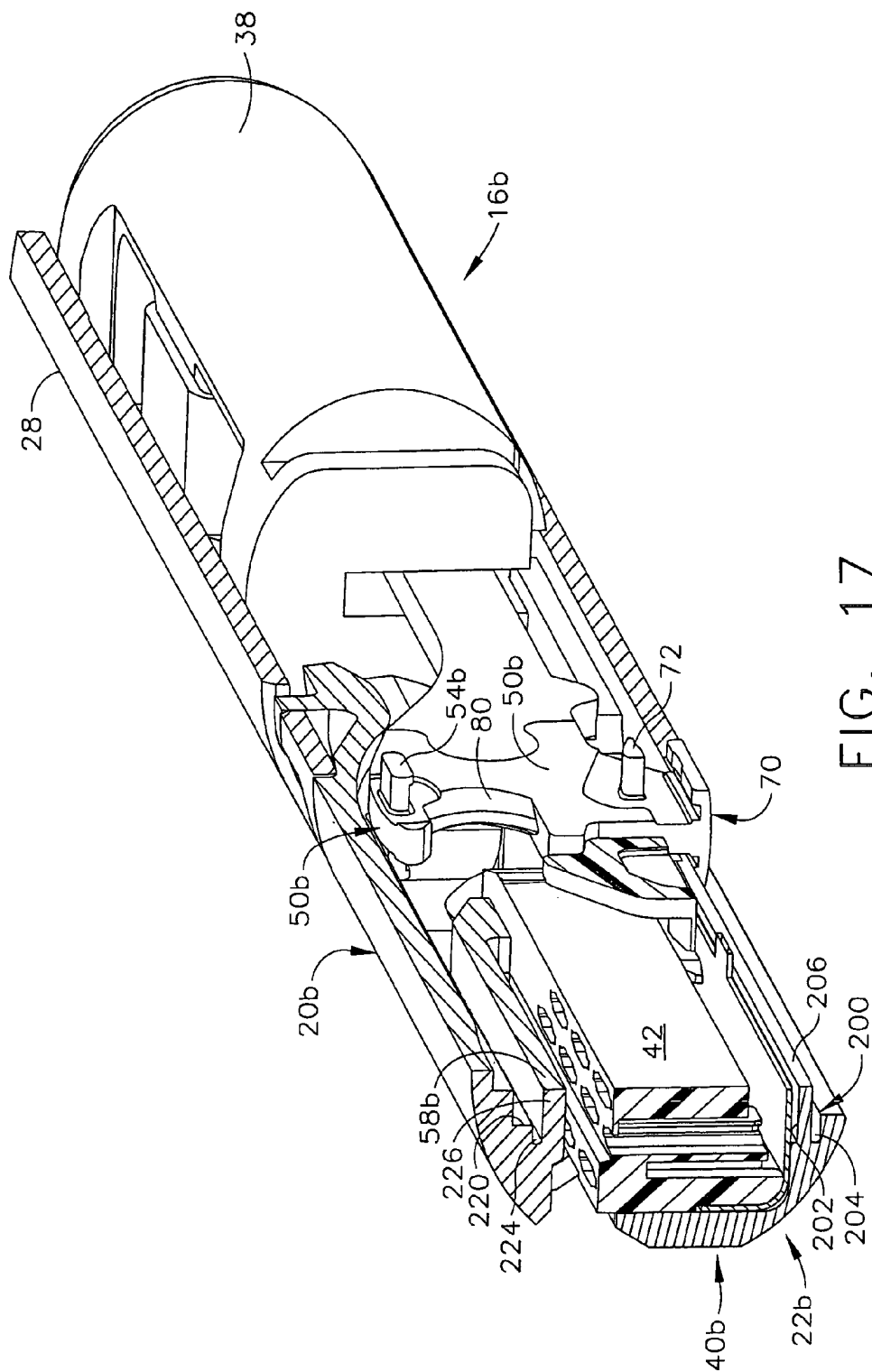


FIG. 17

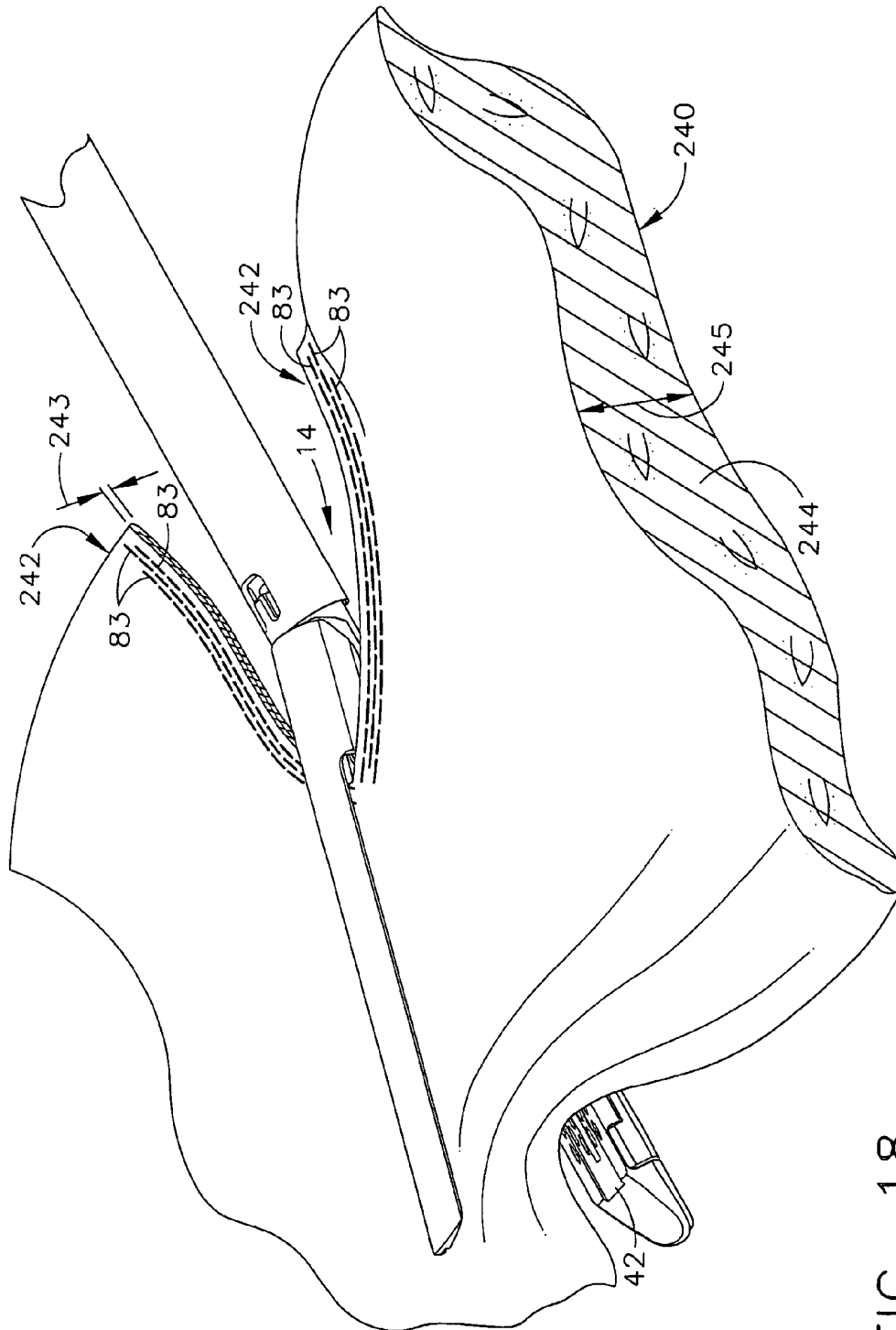


FIG. 18

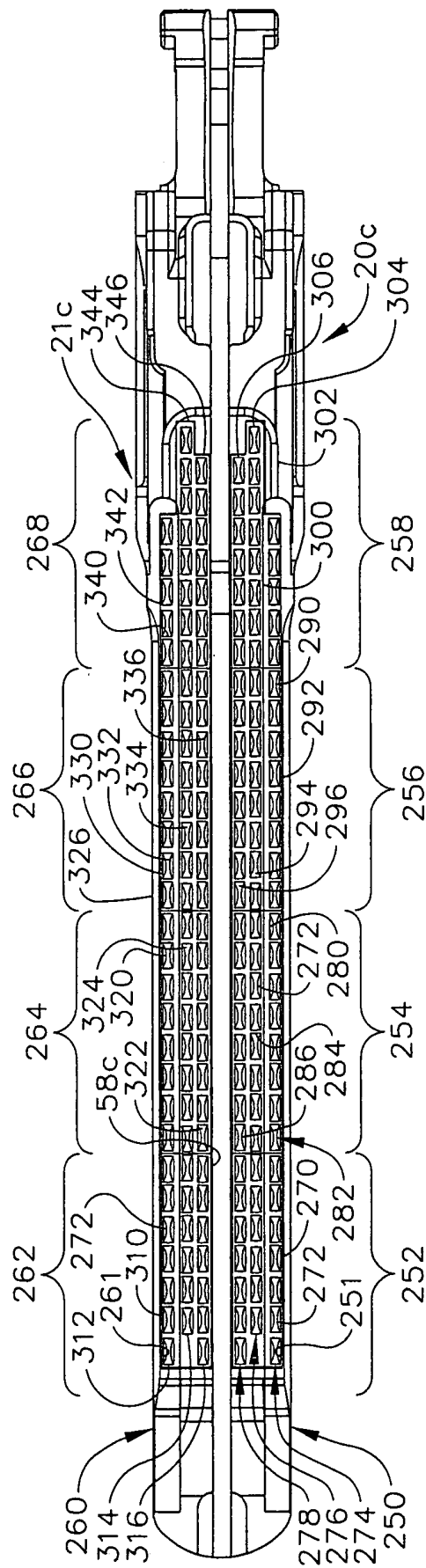


FIG. 19

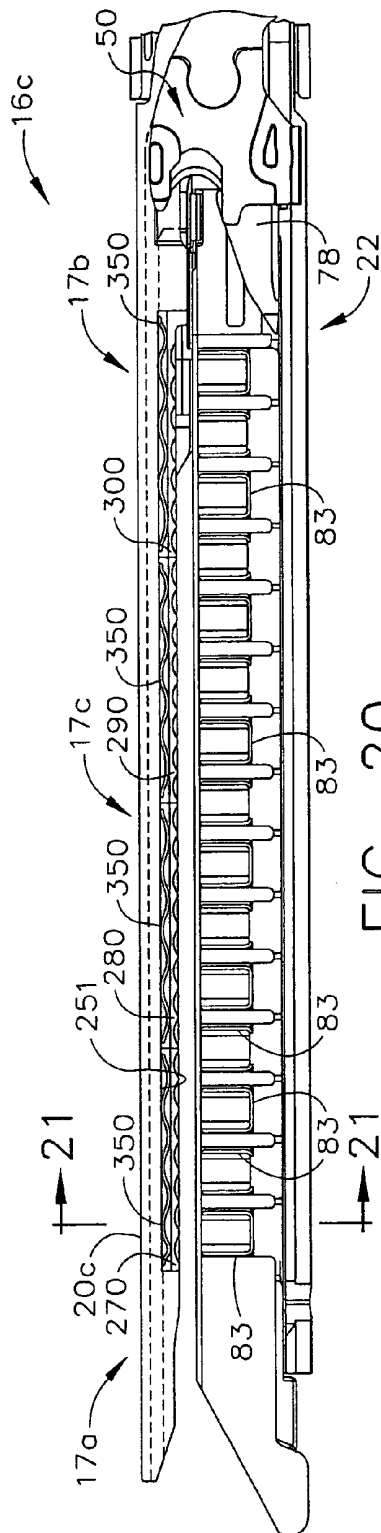


FIG. 20

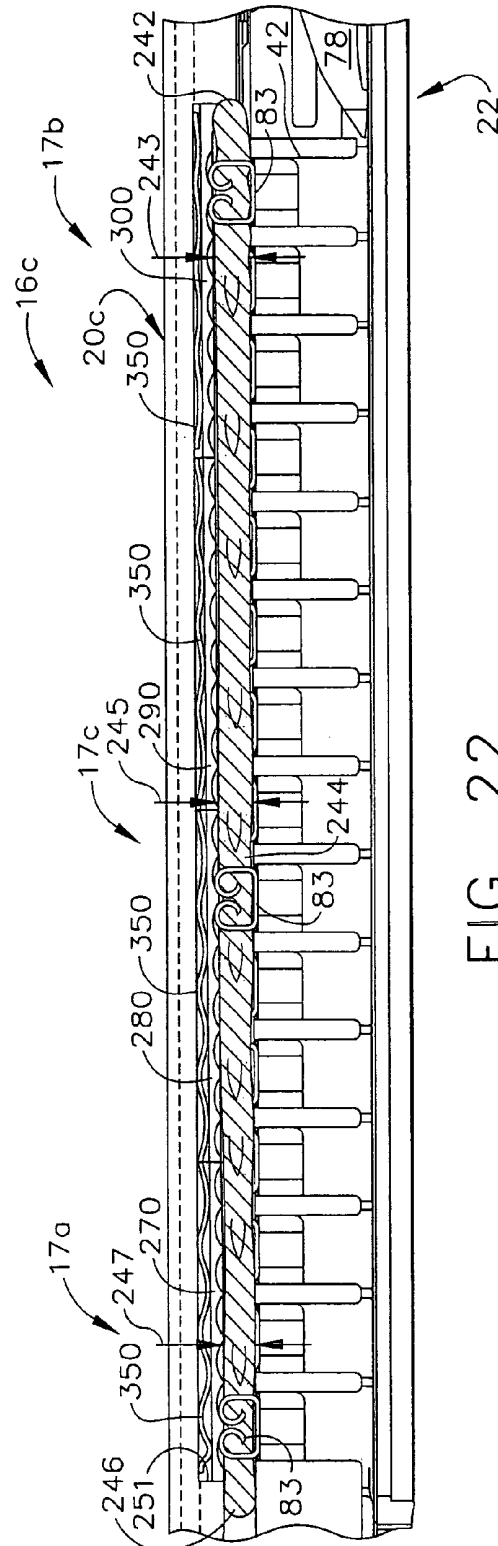


FIG. 22

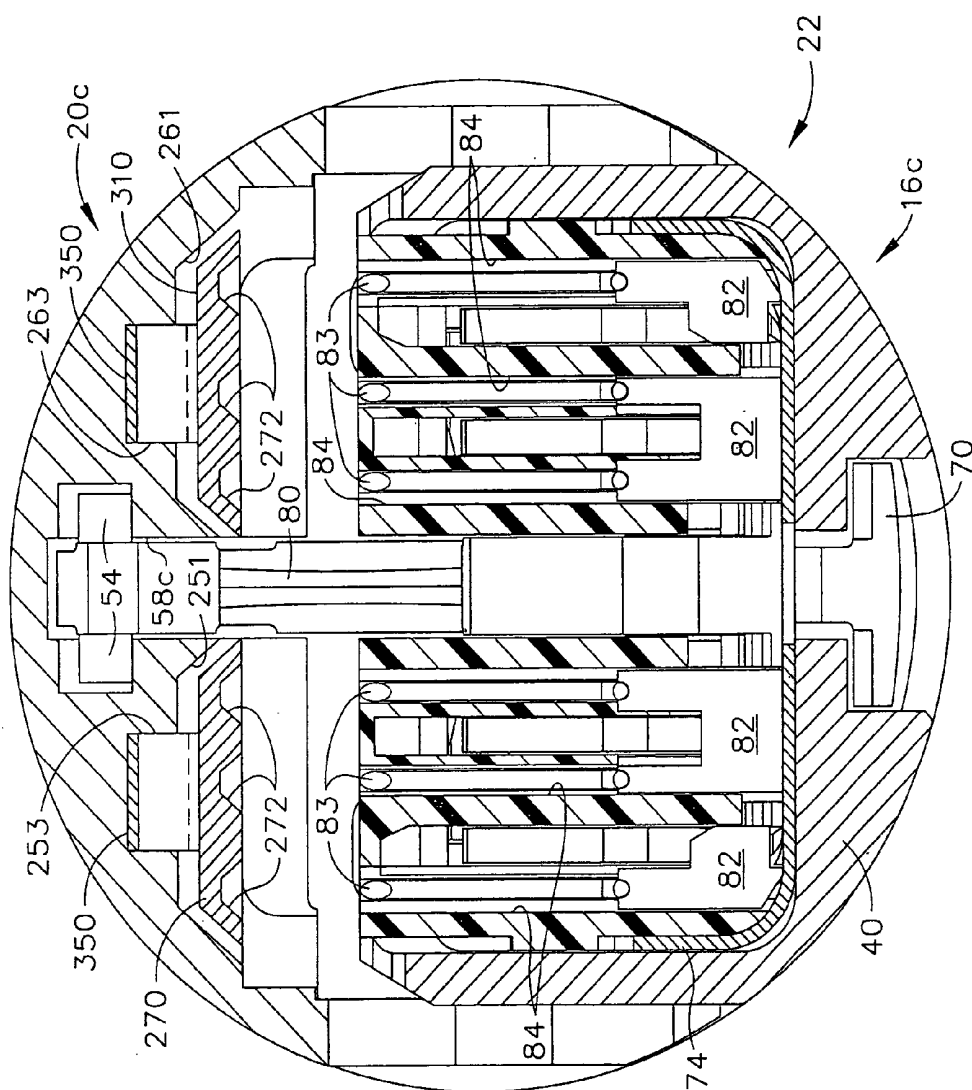


FIG. 21

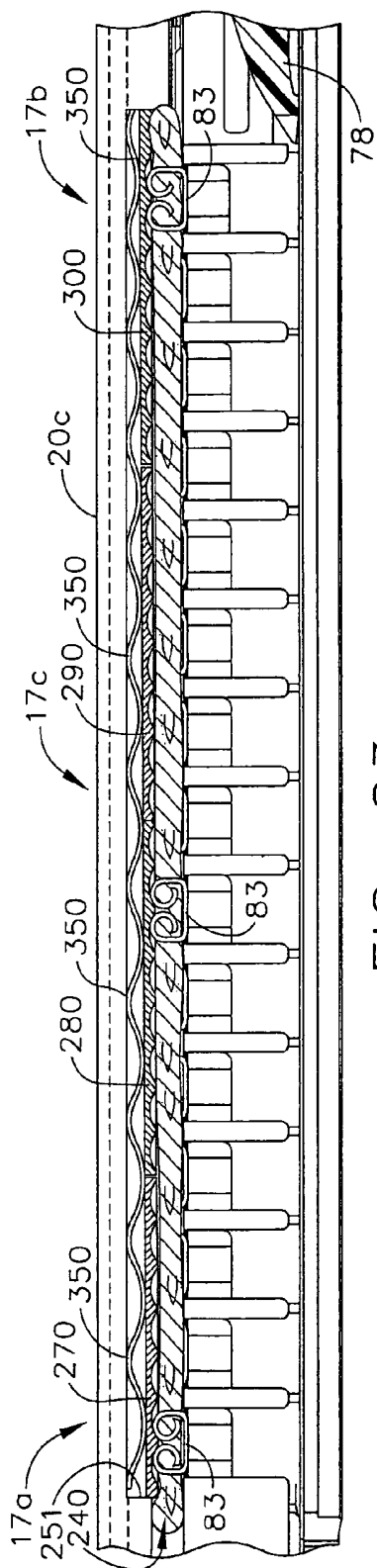


FIG. 23

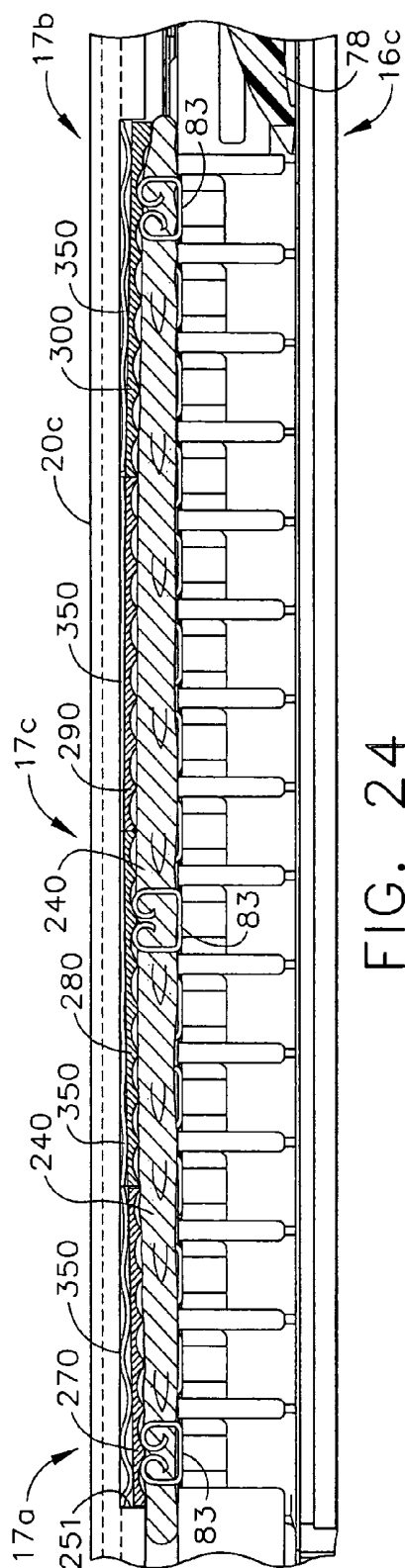


FIG. 24

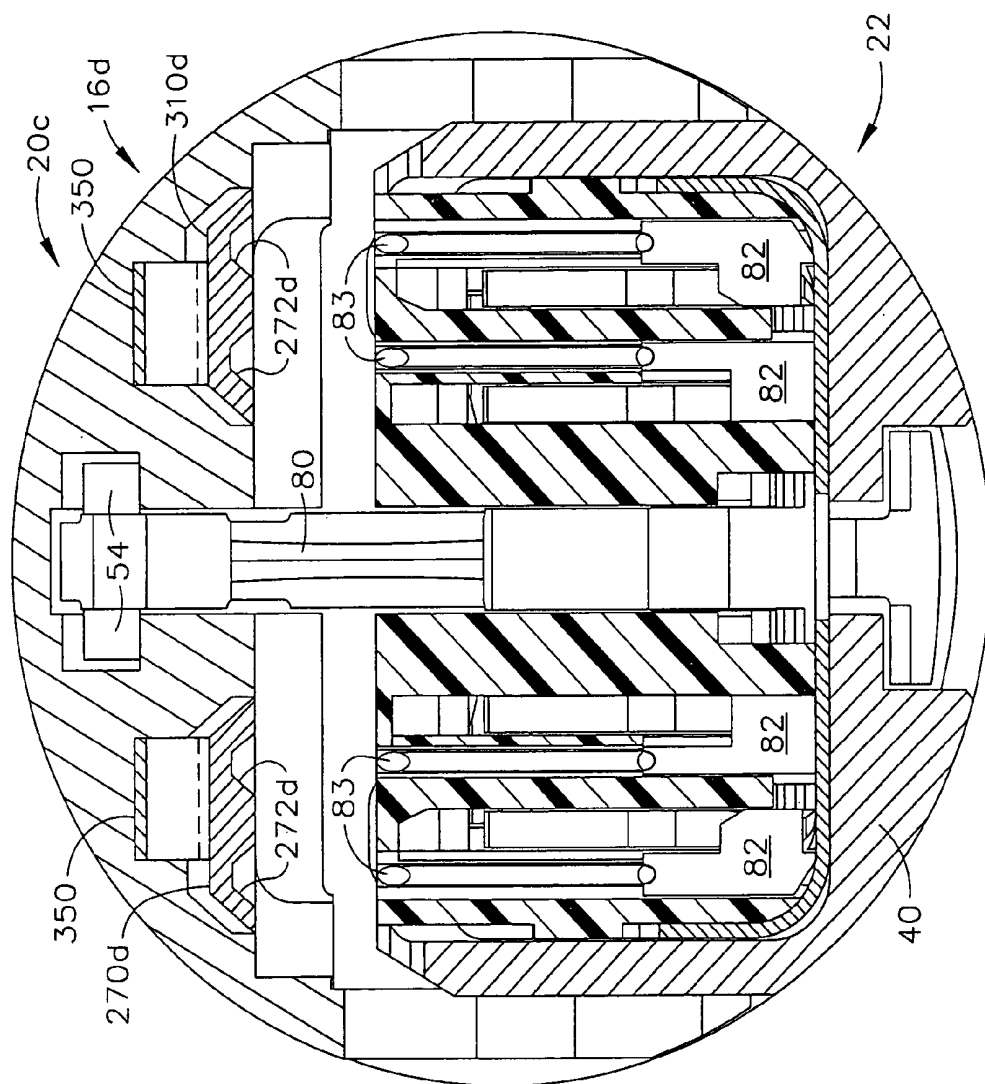


FIG. 25



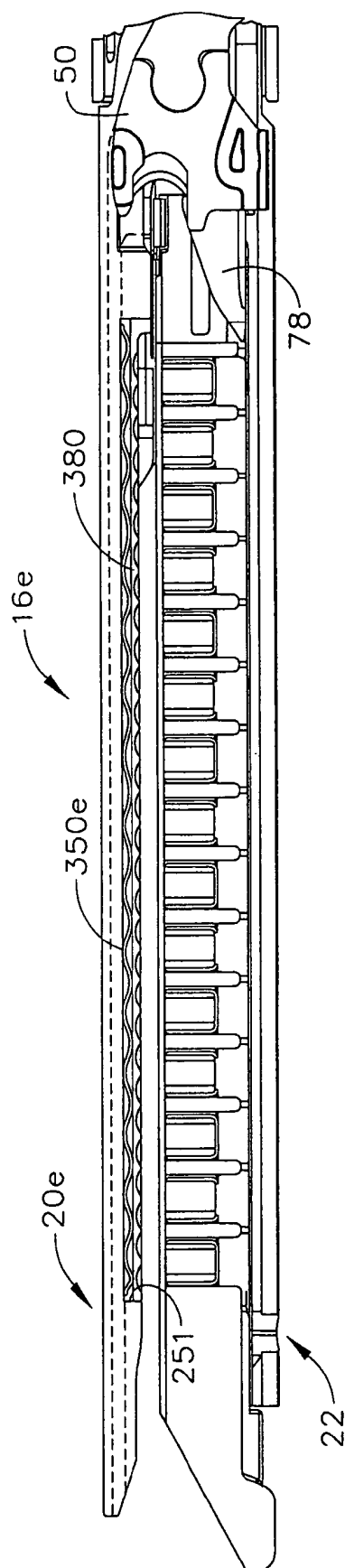


FIG. 26

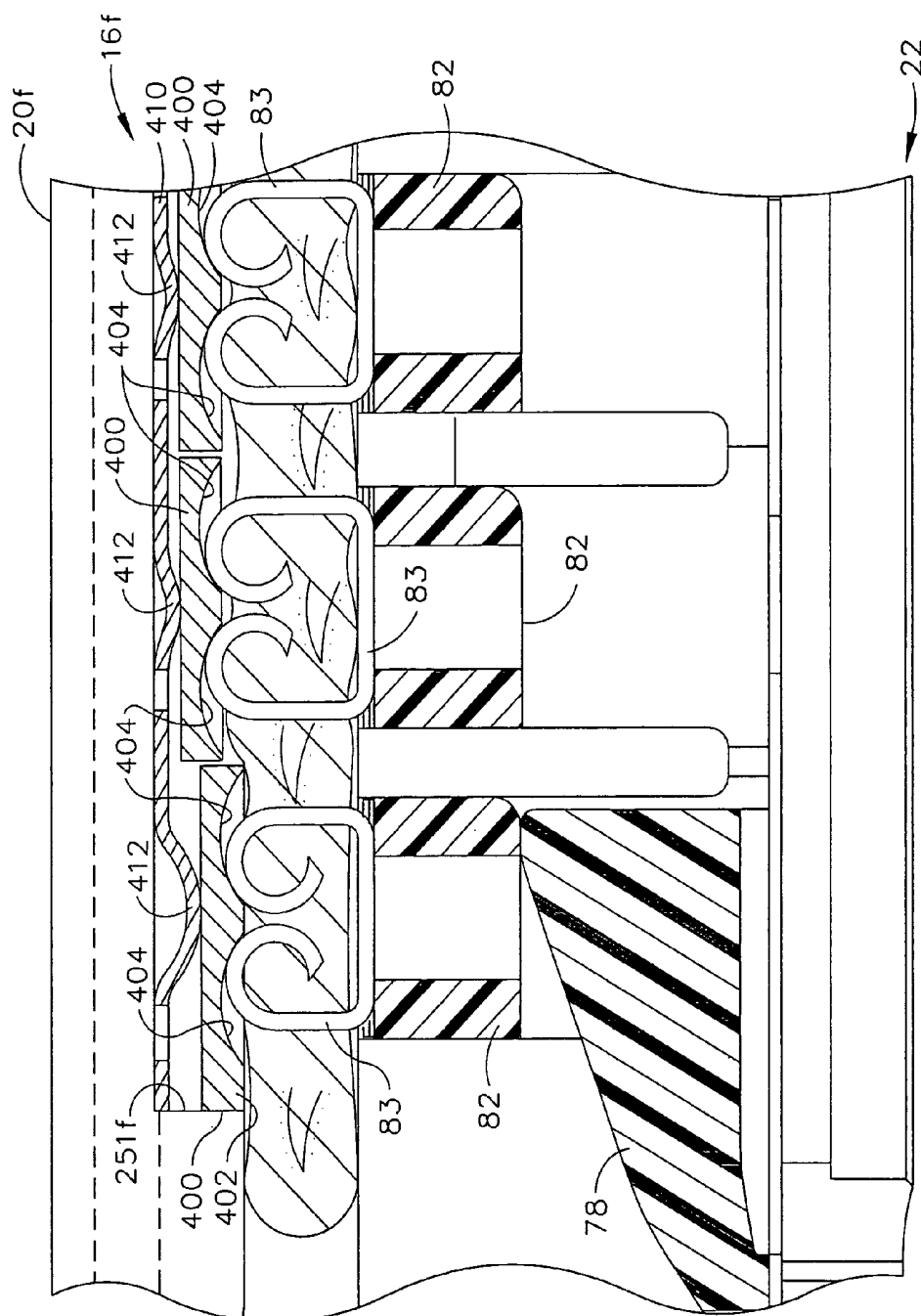


FIG. 27

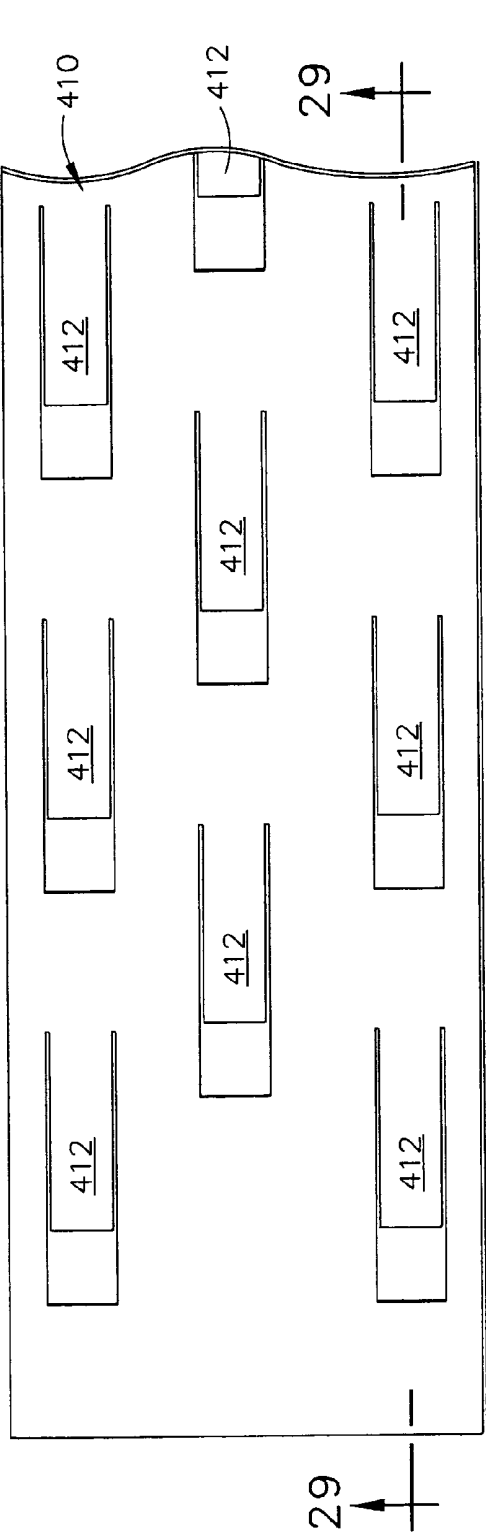


FIG. 28



FIG. 29

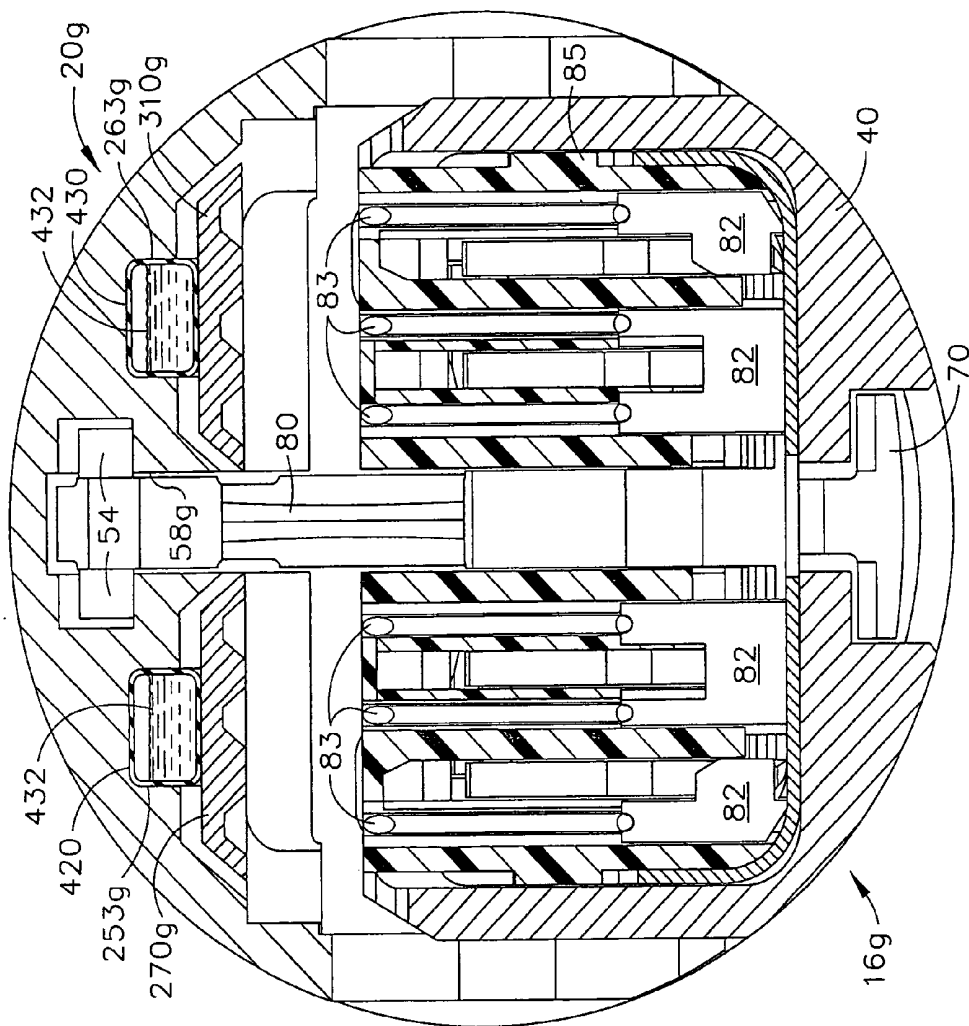


FIG. 30

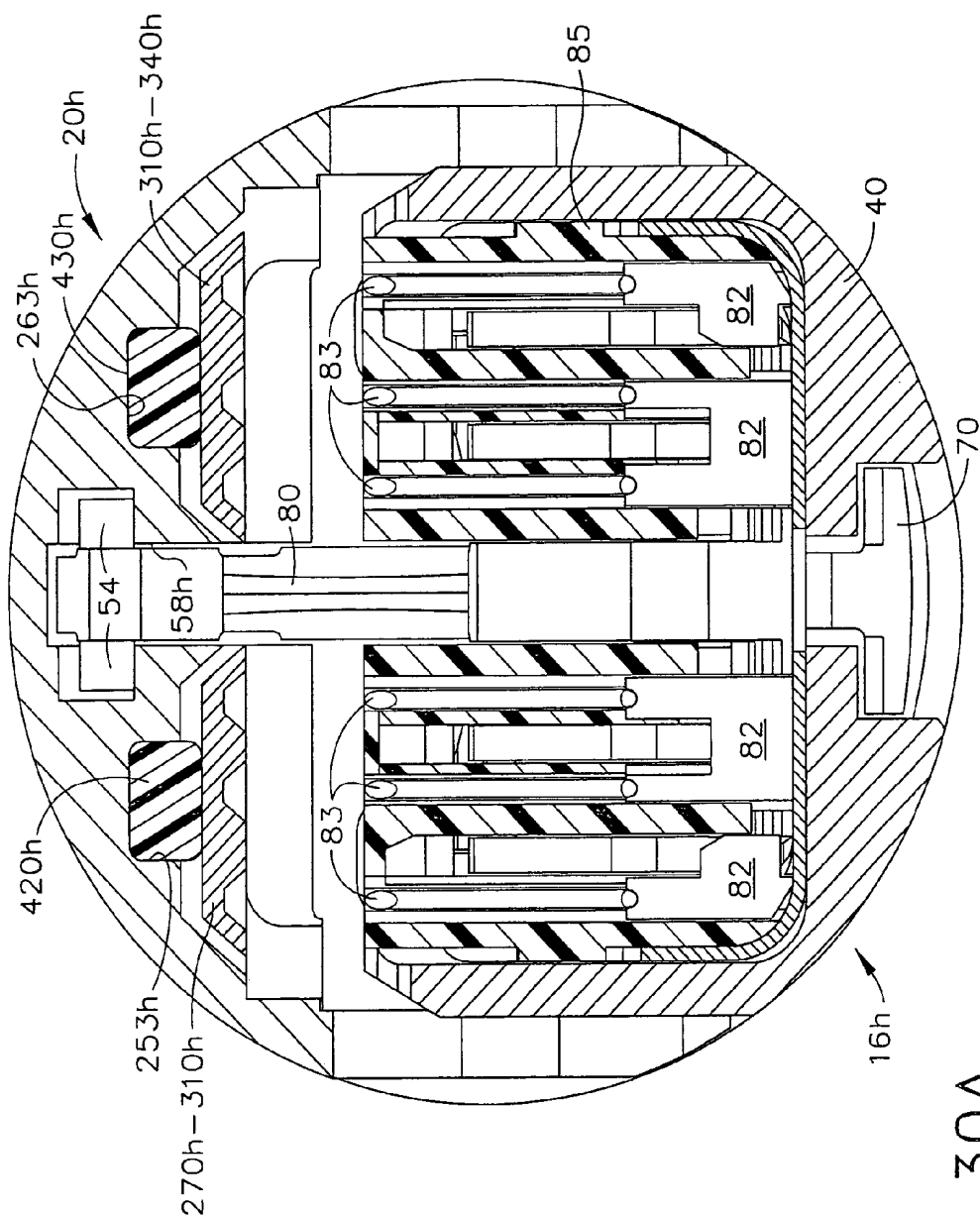
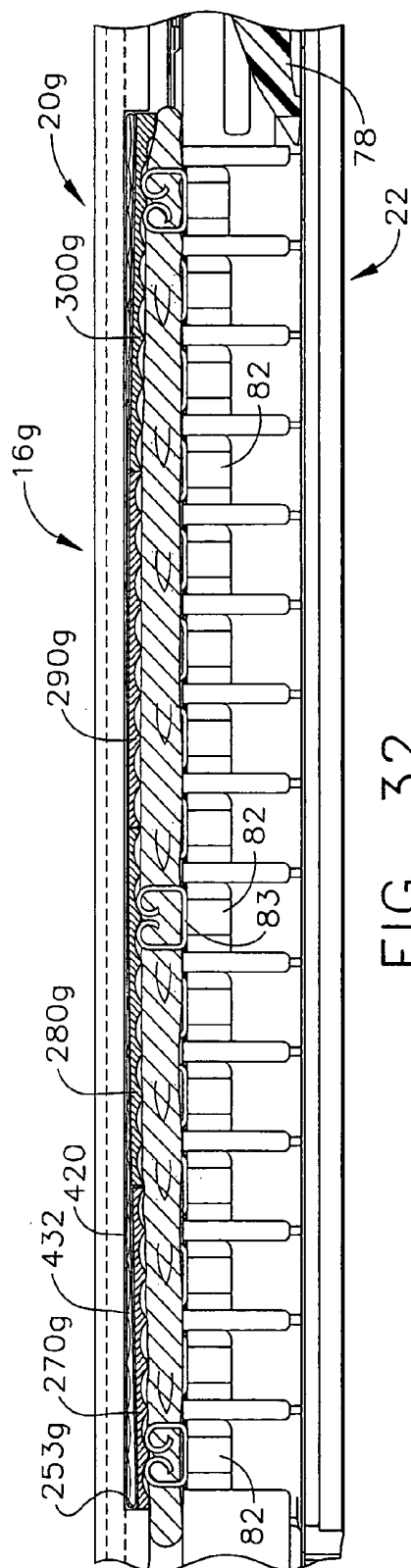
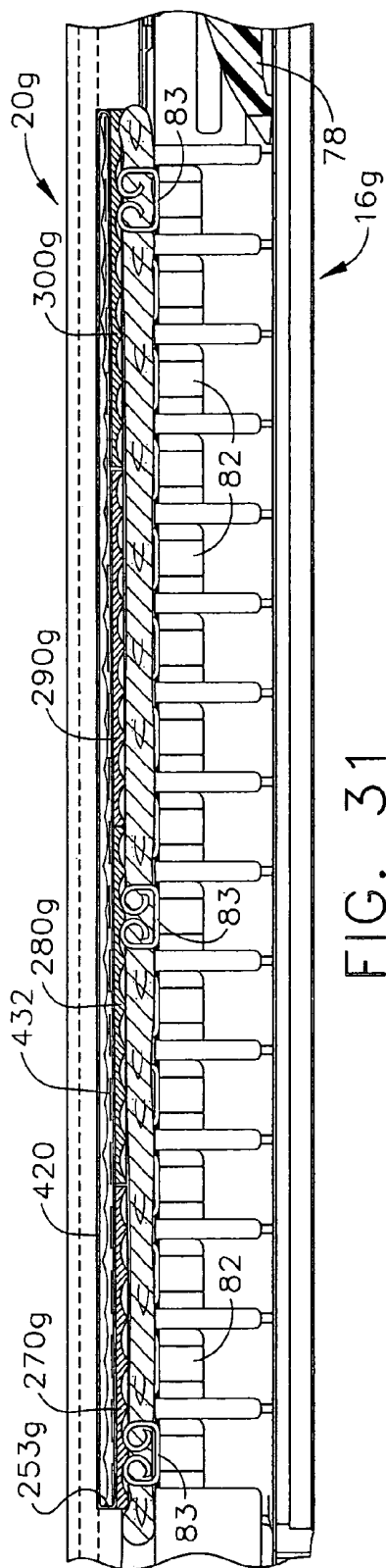


FIG. 30A



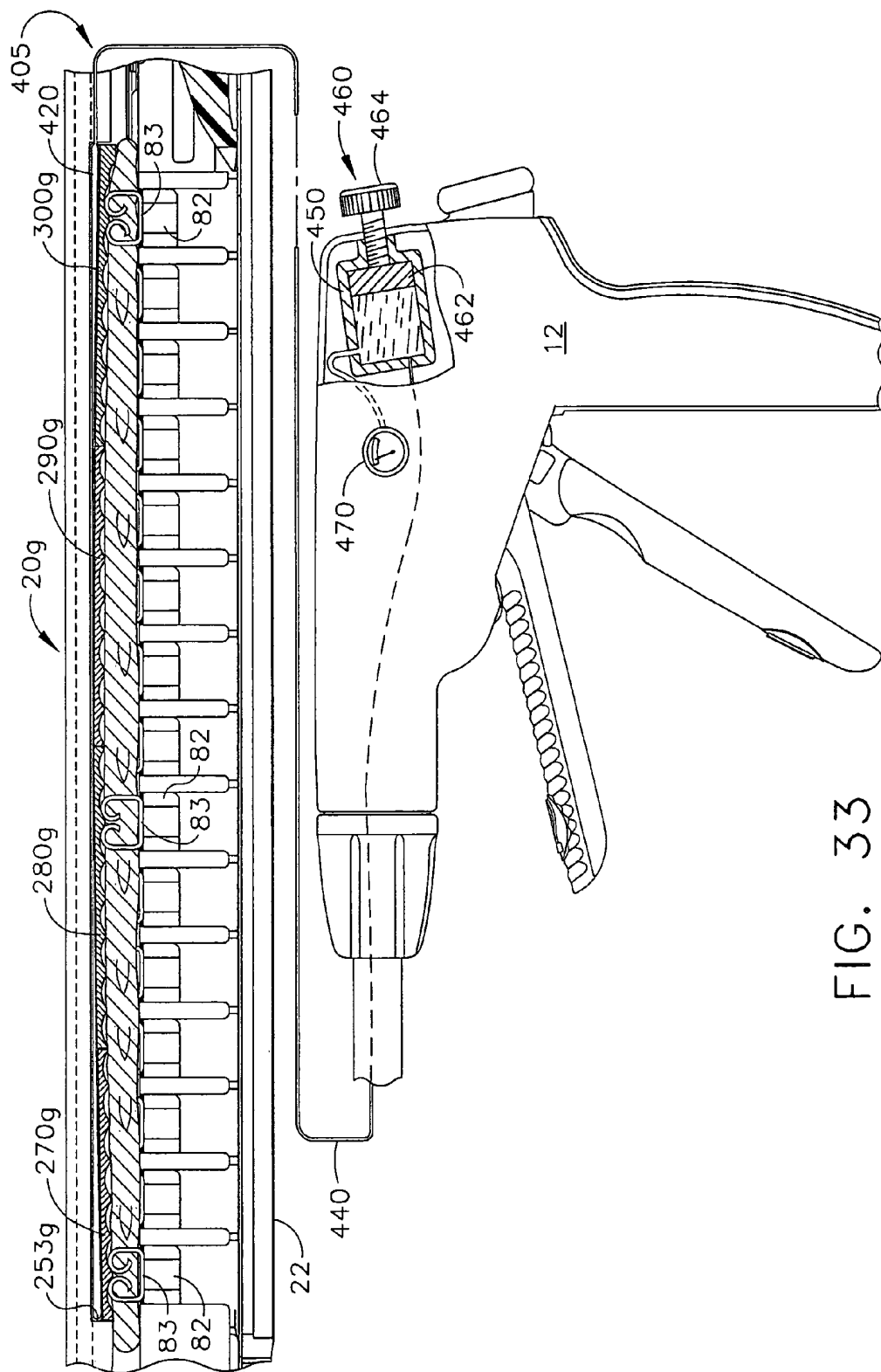
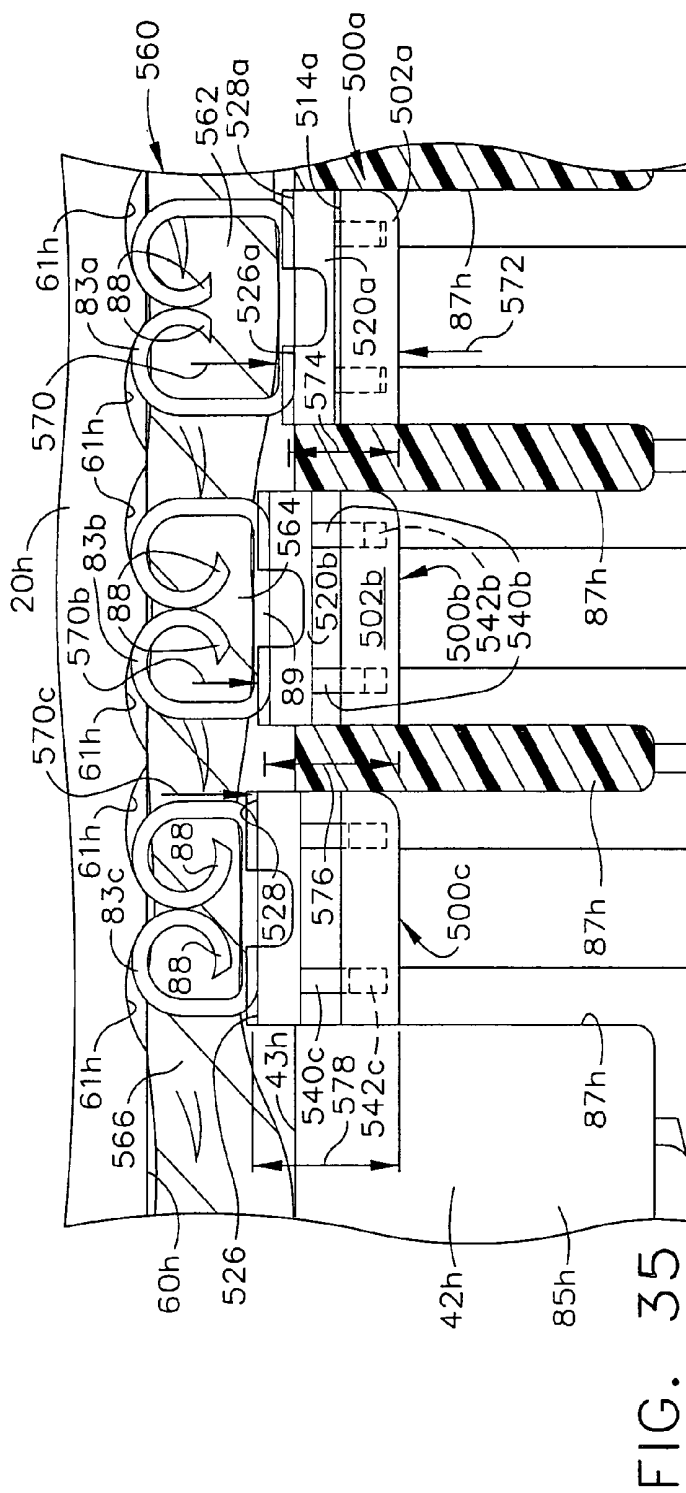
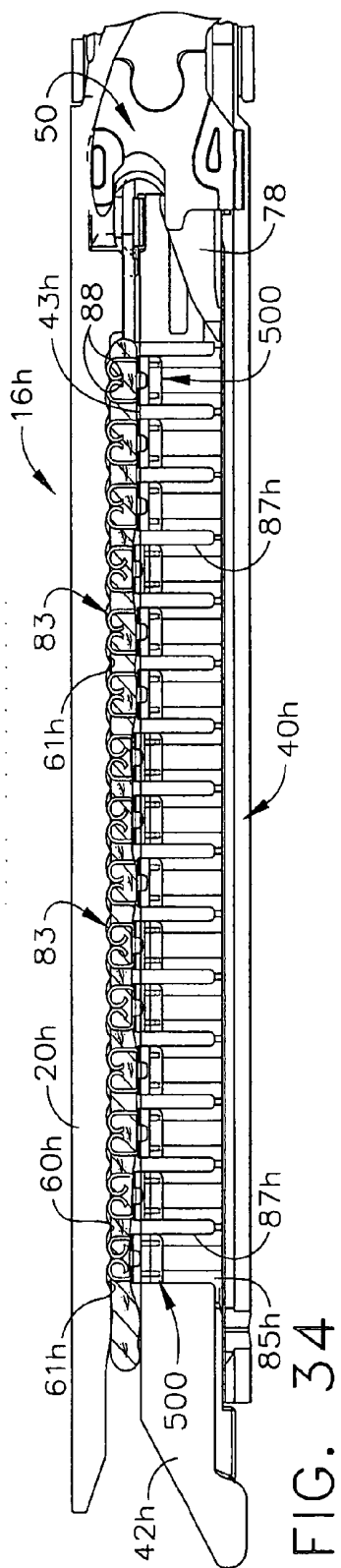
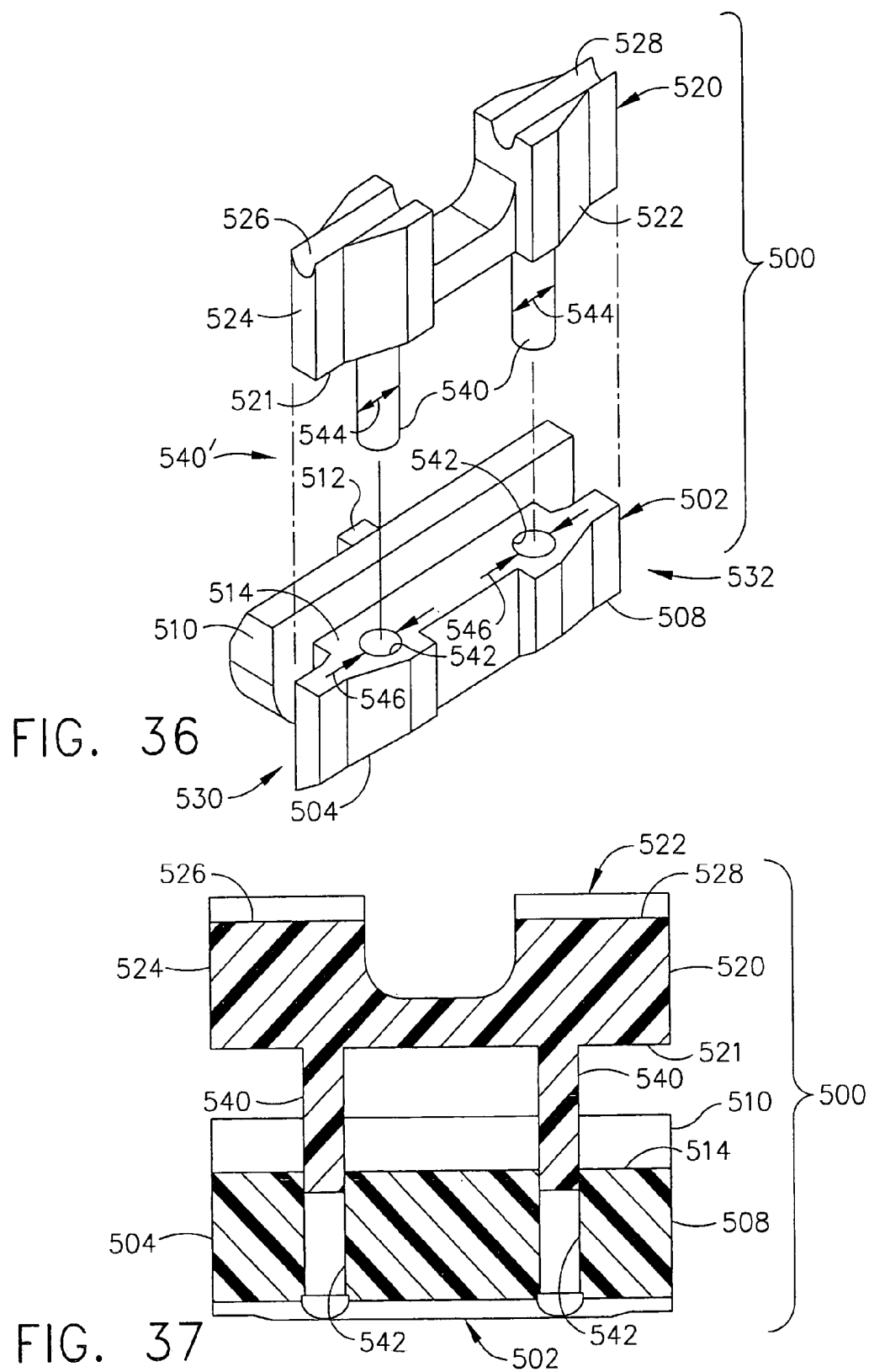


FIG. 33







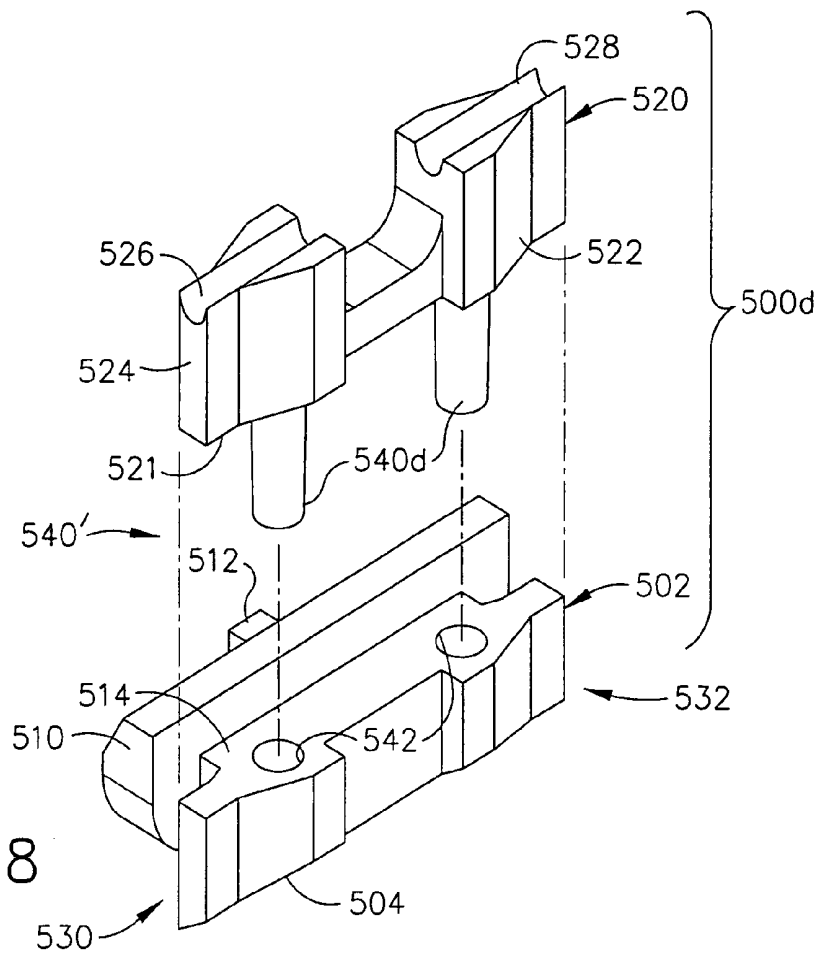


FIG. 38

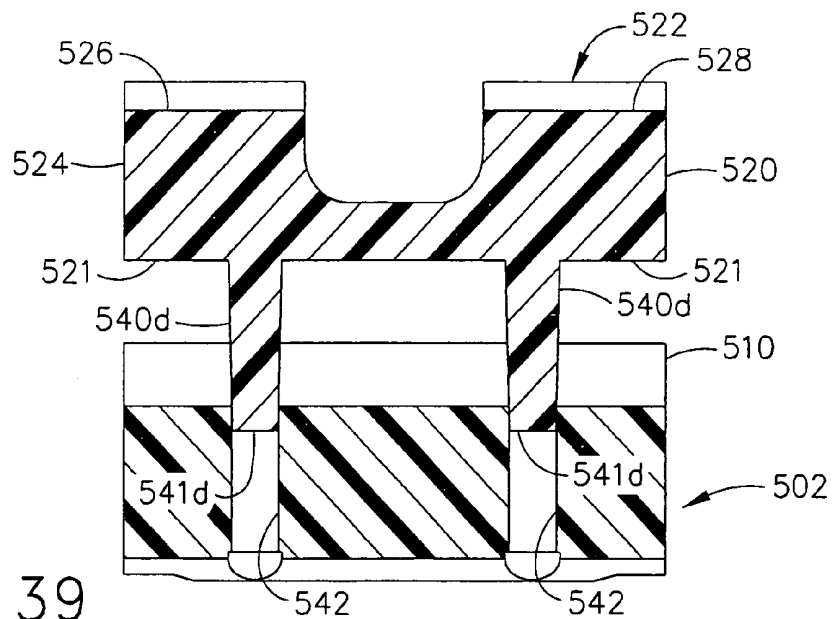
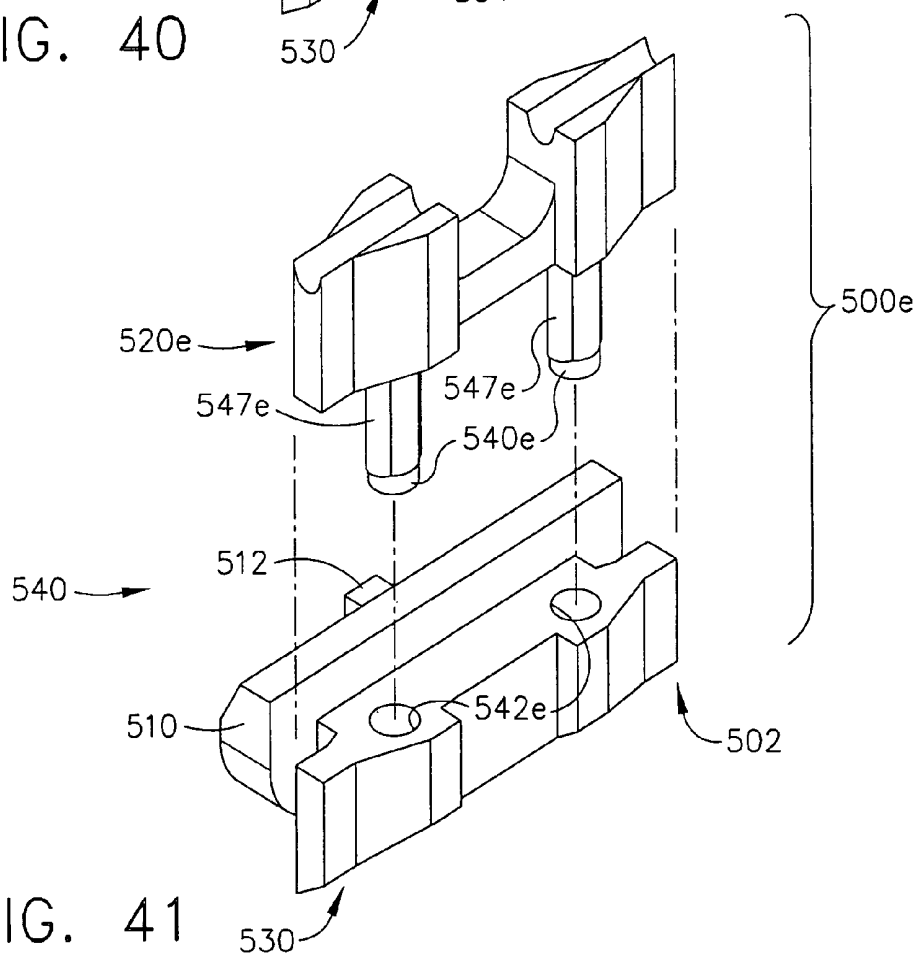
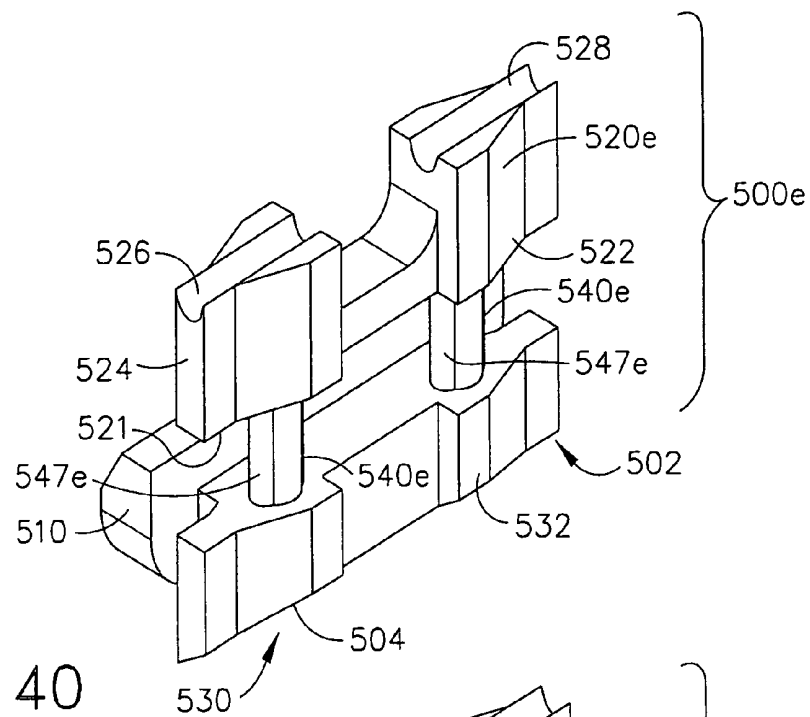


FIG. 39



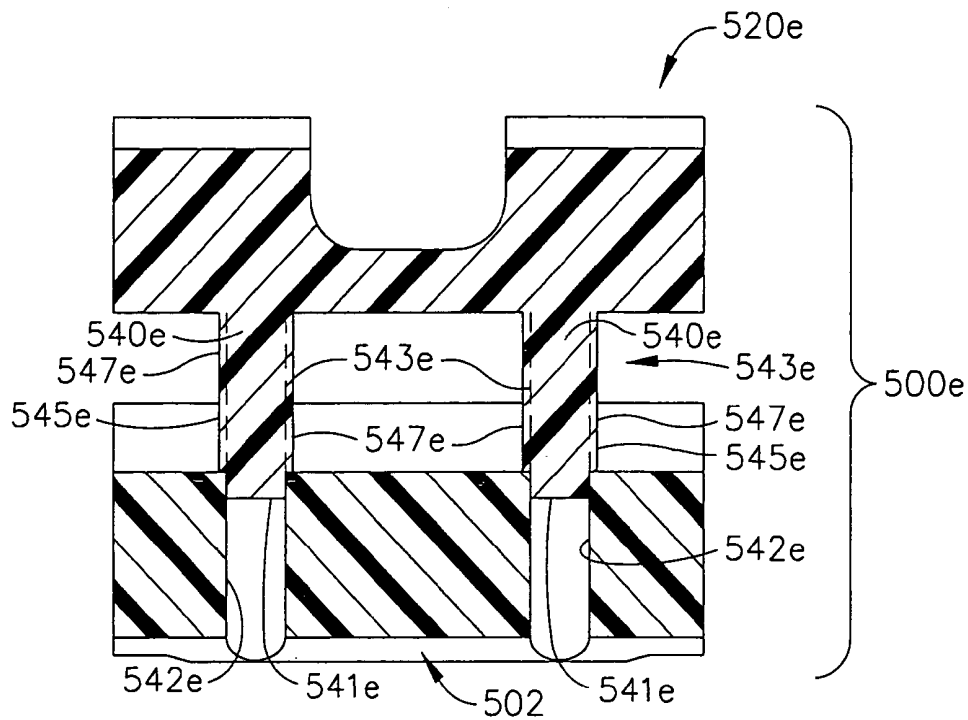


FIG. 42

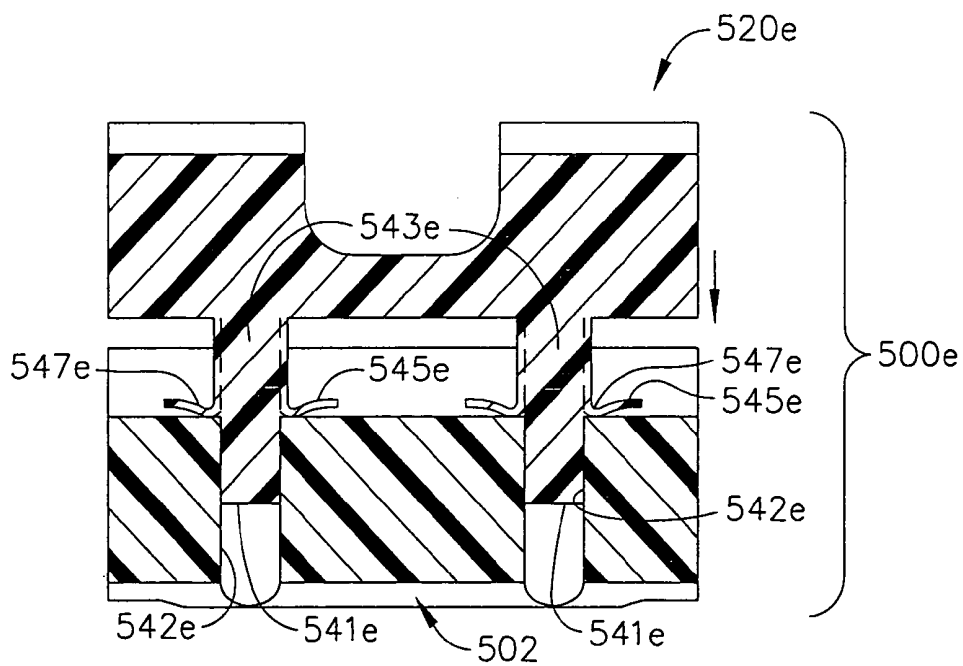


FIG. 43

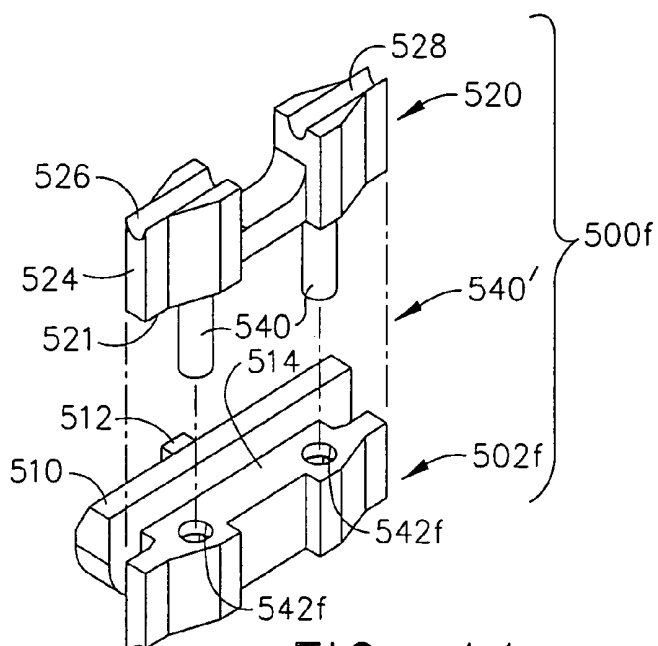


FIG. 44

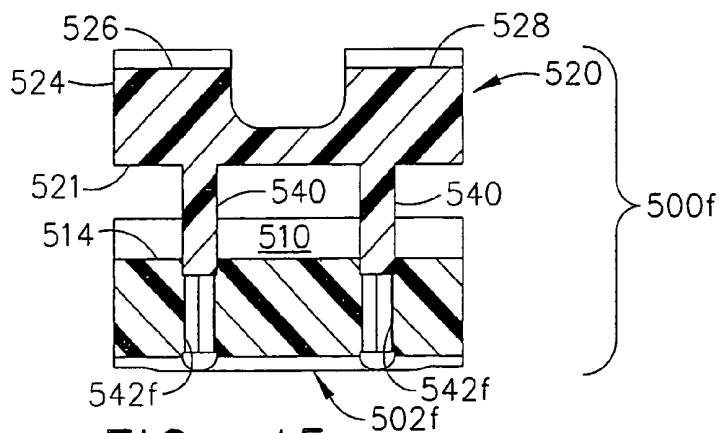


FIG. 45

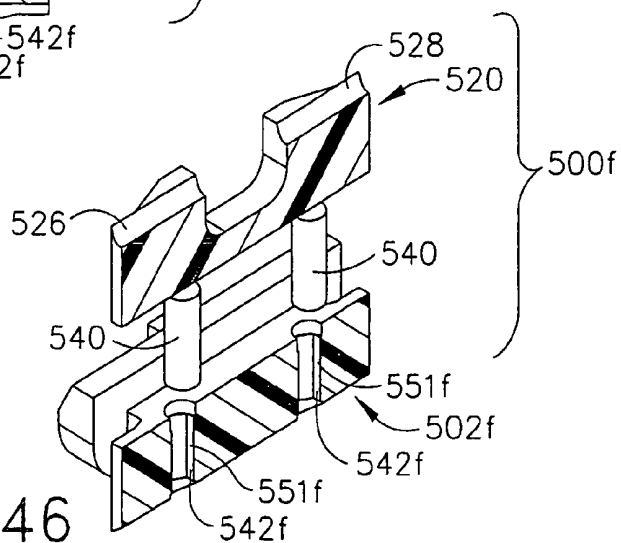


FIG. 46

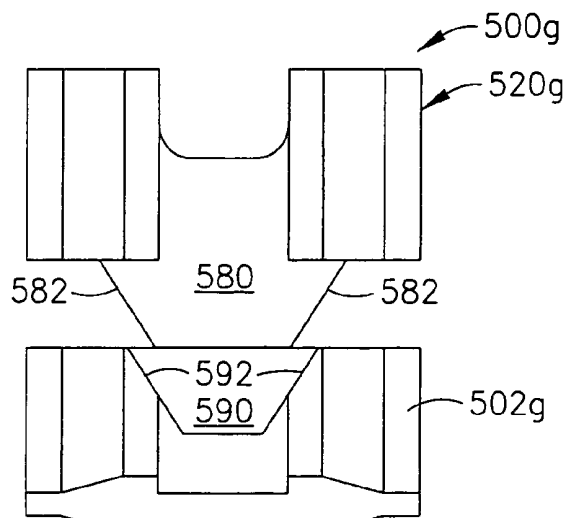


FIG. 47

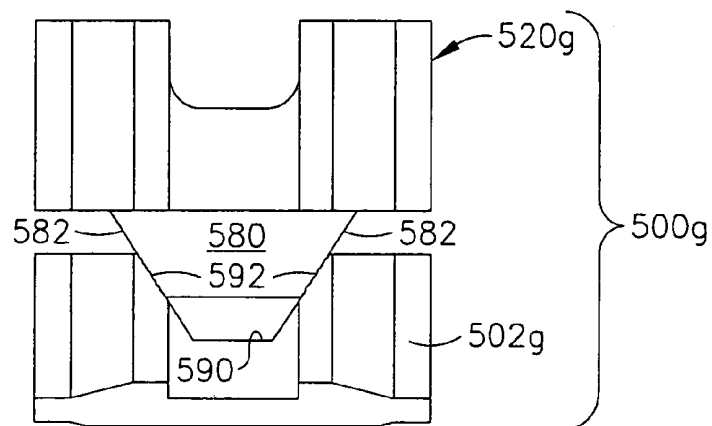


FIG. 48

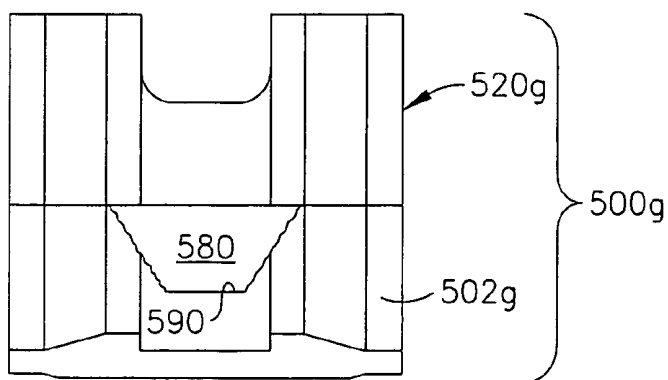
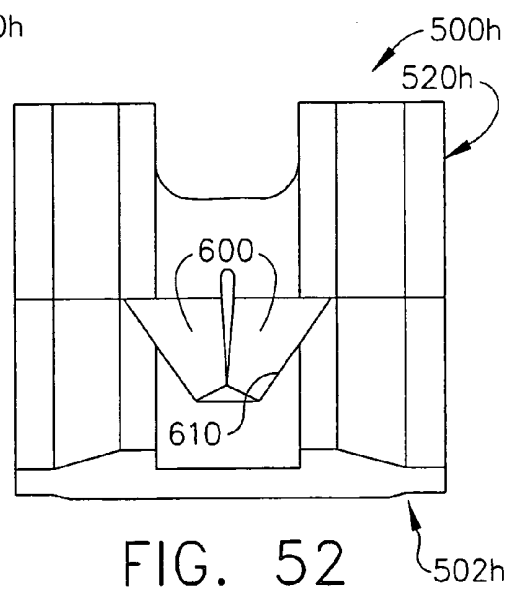
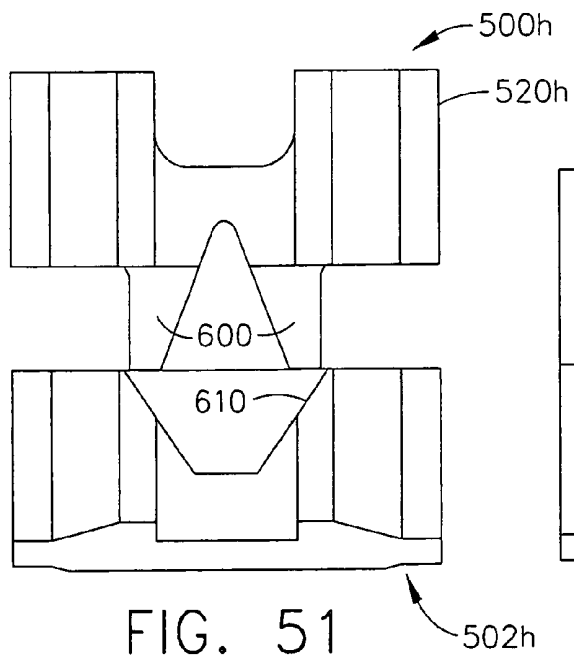
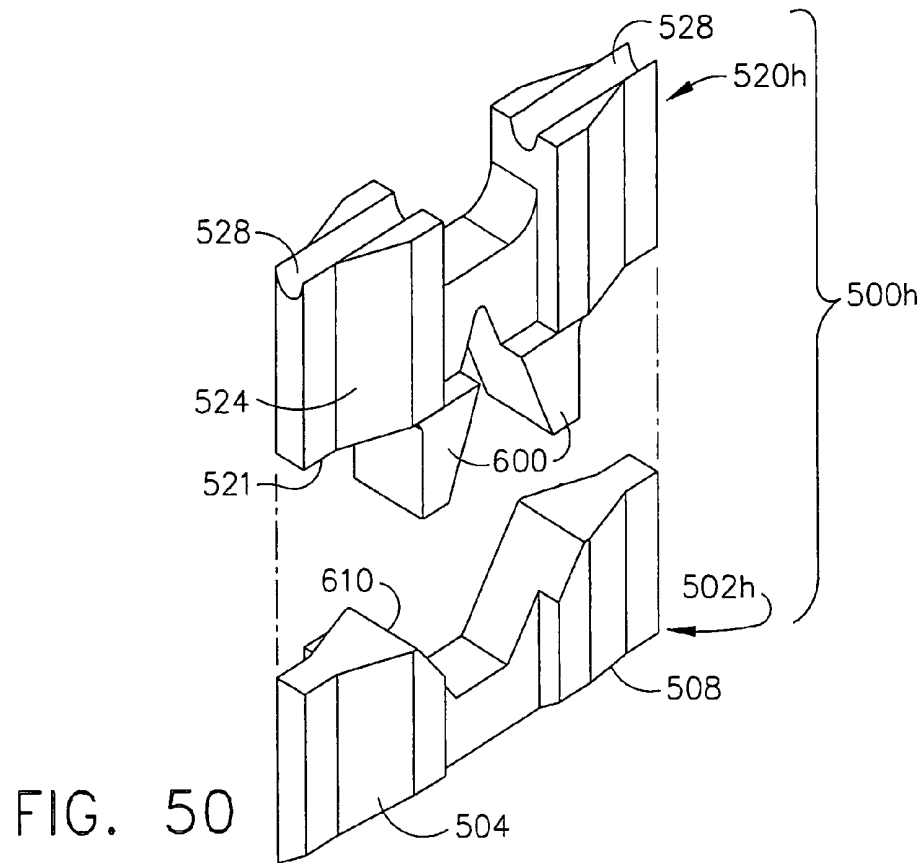
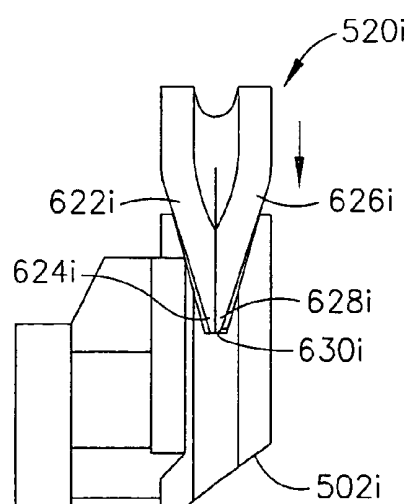
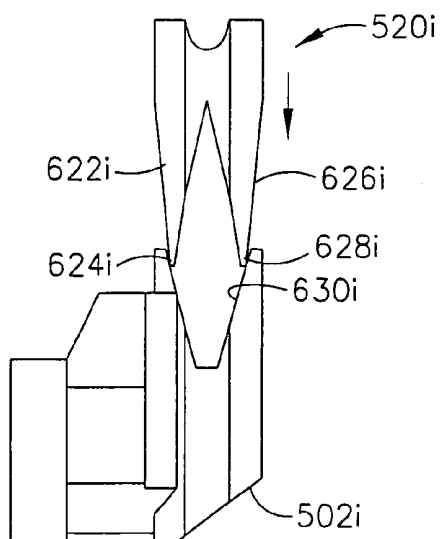
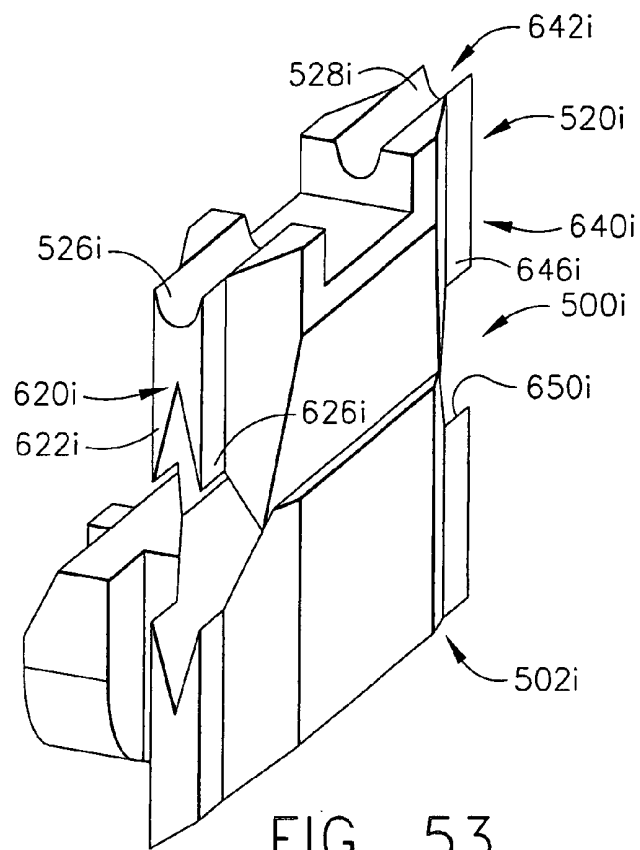


FIG. 49







# **SURGICAL STAPLING INSTRUMENTS HAVING FLEXIBLE CHANNEL AND ANVIL FEATURES FOR ADJUSTABLE STAPLE HEIGHTS**

## **CROSS REFERENCE TO RELATED APPLICATIONS**

The subject application is a continuation-in-part application of U.S. patent application Ser. No. 11/231,456, filed Sep. 21, 2005 and entitled "Surgical Stapling Instrument Having Force Controlled Spacing End Effector", the disclosure of which is herein incorporated by reference in its entirety. This application is also related to the following U.S. patent application which is being concurrently filed herewith and which is herein incorporated by reference: Surgical Stapling Instruments With Collapsible Features For Controlling Staple Height, Inventors: Frederick E. Shelton, IV, Jeffery S. Swayze, Leslie M. Fugikawa, and Eugene L. Timperman, U.S. patent application Ser. No. 11/540,734, filed Sep. 29, 2006.

## **FIELD OF THE INVENTION**

The present invention relates in general to surgical stapler instruments that are capable of applying lines of staples to tissue while cutting the tissue between those staple lines and, more particularly, to improvements relating to stapler instruments and improvements in processes for forming various components of such stapler instruments including adding bolstering material to the severed and stapled tissue.

## **BACKGROUND**

Endoscopic and laparoscopic surgical instruments are often preferred over traditional open surgical devices since a smaller incision tends to reduce the post-operative recovery time and complications. The use of laparoscopic and endoscopic surgical procedures has been relatively popular and has provided additional incentive to develop the procedures further. In laparoscopic procedures, surgery is performed in the interior of the abdomen through a small incision. Similarly, in endoscopic procedures, surgery is performed in any hollow viscus of the body through narrow endoscopic tubes inserted through small entrance wounds in the skin.

Laparoscopic and endoscopic procedures generally require that the surgical region be insufflated. Accordingly, any instrumentation inserted into the body must be sealed to ensure that gases do not enter or exit the body through the incision. Moreover, laparoscopic and endoscopic procedures often require the surgeon to act on organs, tissues and/or vessels far removed from the incision. Thus, instruments used in such procedures are typically long and narrow while being functionally controllable from a proximal end of the instrument.

Significant development has gone into a range of endoscopic surgical instruments that are suitable for precise placement of a distal end effector at a desired surgical site through a cannula of a trocar. These distal end effectors engage the tissue in a number of ways to achieve a diagnostic or therapeutic effect (e.g., endocutter, grasper, cutter, staplers, clip applier, access device, drug/gene therapy delivery device, and energy device using ultrasound, RF, laser, etc.).

Known surgical staplers include an end effector that simultaneously makes a longitudinal incision in tissue and applies lines of staples on opposing sides of the incision. The end effector includes a pair of cooperating jaw members that, if

the instrument is intended for endoscopic or laparoscopic applications, are capable of passing through a cannula passageway. One of the jaw members receives a staple cartridge having at least two laterally spaced rows of staples. The other jaw member defines an anvil having staple-forming pockets aligned with the rows of staples in the cartridge. The instrument includes a plurality of reciprocating wedges which, when driven distally, pass through openings in the staple cartridge and engage drivers supporting the staples to effect the firing of the staples toward the anvil.

Recently, an improved "E-beam" firing bar was described for a surgical stapling and severing instrument that advantageously included a top pin that slides within an internal slot formed in the upper jaw (anvil) and has a middle pin and bottom foot that slides on opposite sides of a lower jaw of an end effector, or more particularly a staple applying assembly. Distal to the middle pin, a contacting surface actuates a staple cartridge held within an elongate staple channel that forms the lower jaw. Between the contacting surface and the top pin, a cutting surface, or knife, severs tissue clamped between the anvil and the staple cartridge of the lower jaw. Since both jaws are thus engaged by the E-beam, the E-beam maintains a desired spacing between the jaws to ensure proper staple formation. Thus, if a lesser amount of tissue is clamped, the E-beam holds up the anvil to ensure sufficient spacing for the staples to properly form against an undersurface of the anvil. In addition, if a greater amount of tissue is clamped, the E-beam draws down the anvil to ensure that the spacing does not exceed the length of the staple such that ends of each staple are not sufficiently bent to achieve a desired degree of retention. Such an E-beam firing bar is described in U.S. patent application Ser. No. 10/443,617, entitled "Surgical Stapling Instrument Incorporating an E-Beam Firing Mechanism", filed on May 20, 2003, now U.S. Pat. No. 6,978,921, issued Dec. 27, 2005, the disclosure of which is hereby incorporated by reference in its entirety.

While an E-beam firing bar has many advantages for a surgical stapling and severing instrument, often it is desirable to sever and staple tissue of various thicknesses. A thin layer of tissue may result in staples that only form loosely, perhaps requiring the need for bolstering material. A thick layer of tissue may result in formed staples that exert a strong compressive force on the captured tissue, perhaps resulting in necrosis, bleeding or poor staple formation/retention. Rather than limiting the range of tissue thicknesses that are appropriate for a given surgical stapling and severing instrument, it would be desirable to accommodate a wider range of tissue thickness with the same surgical stapling and severing instrument.

Consequently, a significant need exists for an improved surgical stapling and severing instrument that incorporates a staple applying assembly (end effector) that adjusts to the amount of tissue that is clamped.

In addition, the staple drivers that are commonly employed in existing staple applying assemblies are traditionally made as stiff as possible to assure proper "B" form staple height. Because of this stiff construction, these drivers do not provide any flexibility for adjusting the formed height of the staple to a particular thickness of tissue clamped within the assembly.

Thus, another significant need exists for staple drivers that are able to facilitate the adjustment of the formed height of the staples in response to variations in tissue thickness.

## **BRIEF SUMMARY**

The invention overcomes the above-noted and other deficiencies of the prior art by providing a surgical instrument

that incorporates a firing bar that translates through a staple applying assembly having a lower jaw and a pivotally attached upper jaw, engaging each to assist in maintaining the desired spacing between inner surfaces that compress tissue in between. Advantageously, the distance between the two jaws is allowed to flex apart slightly to allow for a larger thickness of compressed tissue, yet the firing bar prevents excessive flexure that would exceed the limits on the device to form staples through the compressed tissue. Thereby, enhanced clinical flexibility is achieved with the same surgical instrument being suitable for a larger range of surgical procedures or to accommodate variations in the patient population.

In one aspect of the invention, a surgical instrument has a lower jaw that includes an elongate staple channel having a longitudinal channel slot formed therein that receives a staple cartridge. Staples in the staple cartridge have a staple length sized for forming a closed staple between a range of tissue thicknesses. A firing bar has a vertical portion passing through a longitudinal anvil slot in an anvil pivotally attached to the elongate staple channel and passes through the longitudinal channel slot formed in the elongate staple channel. An upper lateral surface extending from the vertical portion exerts an inward compressive force on the anvil during firing translation and a lower lateral surface extending from the vertical portion exerts an inward compressive force on the elongate staple channel during firing translation. The firing bar advantageously accommodates the range of effective staple formation by including a resilient portion that varies in height between a staple forming undersurface of an anvil and an upper surface of the staple cartridge.

In another aspect of the invention, a surgical instrument has an anvil that is pivotally coupled to the elongate staple channel and includes an anvil channel that is internally formed. In particular, a vertical slot inwardly opens along a longitudinal axis of the anvil and has left and right rectangular prism-shaped recesses communicating with, bisected by, and transverse to the vertical slot, wherein said left and right rectangular prism-shaped recesses extend substantially along the longitudinal length of the vertical slot. A firing device that includes a distally presented cutting edge for severing tissue is longitudinally received between the elongate staple channel and the vertical slot of the anvil channel of the anvil. An upper member of the firing device has left and right lateral upper pins sized to slidably engage upper and lower inner surfaces of the left and right rectangular-shaped recesses of the anvil channel. A lower member of the firing device engages the channel slot in the elongate staple cartridge. A middle member of the firing device actuates the staple cartridge by distally translating a wedge member of the staple cartridge. The firing device positively engages both the elongate staple channel and the anvil during longitudinal firing travel to provide spacing in between for staple formation. Engagement of the firing device during firing maintains vertical spacing between the elongate staple channel and the anvil resisting both pinching due to an inadequate clamped tissue and partial opening due to an excessive amount of clamped tissue. This affirmative spacing is advantageously varied within an effective range of the staple length of the staple cartridge by incorporating a resilient portion in the firing device to allow some flexure to accommodate an increased compression load due to a thicker layer of clamped tissue.

In yet another aspect of the invention, the surgical instrument advantageously operates through an elongate shaft with

a closed end effector of upper and lower jaws suitably sized for insertion through a cannula of a trocar to an insufflated body cavity or body lumen.

In another aspect of the invention there is disclosed a surgical instrument that comprises an elongate channel that is configured to operably support a staple cartridge therein. An anvil is pivotally coupled to the elongate channel and is selectively pivotable between an open position and a closed position wherein a staple forming undersurface thereof is in confronting relationship to an upper surface of a staple cartridge supported within the elongate channel in response to a closing motion applied to the anvil and from a closed position to the open position in response to an opening motion applied to the anvil. A firing member is operably supported relative to the elongate channel and is selectively longitudinally translatable from an unfired position through the elongate channel in a staple firing motion in response to a firing force applied to the firing member and to retract to the unfired position in response to a retraction force applied to the firing member. In various embodiments, at least one of the elongate channel and the anvil has a resilient structure configured to flexibly interact with the firing member during the staple firing motion to allow a distance between the staple forming undersurface of the anvil and the upper surface of the staple cartridge to vary in relation to a thickness of tissue clamped between the staple forming undersurface of the anvil and the upper surface of the staple cartridge.

In another general aspect of the present invention there is disclosed a surgical instrument that comprises an elongate staple channel that has a first flexible portion and a second flexible portion that is spaced from the first flexible portion to define a longitudinal channel slot therebetween. A staple cartridge is operably supported within the elongate staple channel and an elongate shaft is operably coupled to the elongate staple channel. An anvil is pivotally attached to the elongate staple channel and is selectively pivotable between a closed position wherein a staple forming undersurface thereof is in confronting relationship to an upper surface of the staple cartridge and an open position wherein a distal end of the anvil is spaced from the upper surface of the staple cartridge. The anvil further has a longitudinal anvil slot therein. A control handle assembly is proximally operably coupled through the elongate shaft to selectively apply opening and closing motions to the anvil. A firing member is operably coupled to the control handle assembly through the elongate shaft for selective longitudinal reciprocating motion in the elongate staple channel such that one portion of the firing member extends through the longitudinal anvil slot and another portion of the firing member extends through the longitudinal channel slot between the first and second flexible portions.

In yet another general aspect of the present invention there is disclosed a surgical instrument that comprises an elongate staple channel that has a longitudinal channel slot. A staple cartridge is operably supported within the elongate staple channel. An elongate shaft is operably coupled to the elongate staple channel. An anvil is pivotally attached to the elongate staple channel and is selectively pivotable between a closed position wherein a staple forming undersurface thereof is in confronting relationship to an upper surface of the staple cartridge and an open position wherein a distal end of the anvil is spaced from the upper surface of the staple cartridge. The anvil further has a first resilient anvil portion and a second resilient anvil portion that is spaced from the first resilient anvil portion to define a portion of an elongate anvil slot therebetween. A control handle assembly is proximally operably coupled through the elongate shaft to selectively apply

opening and closing motions to the anvil. A firing member is operably coupled to the control handle assembly through the elongate shaft for selective longitudinal reciprocating motion in the elongate staple channel such that one portion of the firing member extends through the anvil slot between the first and second resilient anvil portions and another portion of the firing member extends through the longitudinal channel slot.

These and other objects and advantages of the present invention shall be made apparent from the accompanying drawings and the description thereof.

#### BRIEF DESCRIPTION OF THE FIGURES

The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the invention, and, together with the general description of the invention given above, and the detailed description of the embodiments given below, serve to explain the principles of the present invention.

FIG. 1 is a left side view in elevation of a surgical stapling and severing instrument with an open end effector (staple applying assembly) with a shaft partially cut away to expose a firing member of a proximal firing rod and distal firing bar guided by a frame ground and encompassed by a closure sleeve.

FIG. 2 is a left side view of a closed end effector (staple applying assembly) with a retracted force adjusted height firing bar consistent with the present invention of the surgical stapling and severing instrument of FIG. 1 taken in longitudinal vertical cross section along lines 2-2.

FIG. 3 is a left isometric view of the force adjusted (compliant) height firing bar of FIG. 2.

FIG. 4 is a left side view of a distal portion ("E-beam") of a first version of the force adjusted height firing bar of FIG. 2 having horizontal slits formed respectively between the top pin and cutting surface and between the middle pin and the cutting surface to enhance vertical flexure.

FIG. 5 is a lower left isometric view of a distal portion ("E-beam") of a second version of the force adjusted firing bar of FIG. 2 having a relieved lower area of an upper pin to enhance vertical flexure.

FIG. 6 is a front view in elevation of an upper portion of the E-beam of FIG. 5 taken in vertical and transverse cross section through the upper pin along lines 6-6.

FIG. 7 is a front view of an upper portion of a third version of the E-beam of FIG. 5 taken in vertical and transverse cross section along lines 6-6 but further including relieved upper root attachments of the top pin for enhanced vertical flexure.

FIG. 8 is a front view of an upper portion of a fourth version of the E-beam of FIG. 5 taken in vertical and transverse cross section along lines 6-6 but including a resilient inner vertical laminate layer instead of a relieved undersurface of the top pin for enhanced vertical flexure.

FIG. 9 is a front view of an upper portion of a fifth version of the E-beam of FIG. 5 taken in vertical and transverse cross section along lines 6-6 but including an upper pin formed of a resilient material instead of a relieved undersurface of the upper pin for enhanced vertical flexure.

FIG. 10 is an upper left isometric view of a distal portion ("E-beam") of a sixth version of the force adjusted firing bar of FIG. 2 having resilient material upon a bottom foot to enhance vertical flexure.

FIG. 11 is a front view in elevation taken in vertical and transverse cross section through the padded lower foot of the end effector (staple applying assembly) of the surgical stapling and severing instrument of FIG. 1.

FIG. 12 is a left view in elevation of a distal portion ("E-beam") of a seventh version of the force adjusted firing bar of FIG. 2 having a proximally and upwardly extended spring arm attached to a lower foot to enhance vertical flexure.

FIG. 13 is a left top isometric view of a distal portion ("E-beam") of an eighth version of the force adjusted firing bar of FIG. 2 having a spring washer encompassing a lower foot to enhance vertical flexure.

FIG. 14 is a cross-sectional end view of another staple applying assembly or end effector of the present invention in a clamped or closed position.

FIG. 15 is a partial perspective view of the staple applying assembly of FIG. 14 with some of the elements thereof shown in cross-section.

FIG. 16 is a cross-sectional end view of another staple applying assembly or end effector of the present invention in a clamped or closed position.

FIG. 17 is a partial perspective view of the staple applying assembly of FIG. 16 with some of the elements thereof shown in cross-section.

FIG. 18 is a partial perspective of a staple applying assembly of the present invention clamping a piece of tissue that has been partially cut and stapled.

FIG. 19 is a bottom view of an anvil embodiment of the present invention;

FIG. 20 is a longitudinal cross-sectional view of a staple applying assembly employing the anvil embodiment depicted in FIG. 19.

FIG. 21 is a cross-sectional end view of the staple applying assembly of FIG. 20 taken along line 21-21 in FIG. 20, with some elements shown in solid form for clarity.

FIG. 22 is another longitudinal cross-sectional view of the staple applying assembly of FIGS. 20 and 21 clamping a piece of tissue therein, wherein the tissue has varying cross-sectional thicknesses.

FIG. 23 is another partial longitudinal cross-sectional view of the staple applying assembly of FIGS. 20-22 clamping another piece of tissue therein.

FIG. 24 is another partial longitudinal cross-sectional of the staple applying assembly of FIGS. 20-23 clamping another piece of tissue therein.

FIG. 25 is an end cross-sectional view of another staple applying assembly of the present invention in a clamped position.

FIG. 26 is longitudinal cross-sectional view of another staple applying assembly of the present invention.

FIG. 27 is a cross-sectional view of a portion of another staple applying assembly of the present invention with a piece of tissue clamped and stapled therein.

FIG. 28 is a top view of a portion of a biasing plate embodiment of the present invention.

FIG. 29 is a cross-sectional view of a portion of the biasing plate of FIG. 28 taken along line 29-29 in FIG. 28.

FIG. 30 is an end cross-sectional view of another staple applying assembly of the present invention with some elements shown in solid form for clarity.

FIG. 30A is an end cross-sectional view of another staple applying assembly of the present invention with some elements shown in solid form for clarity.

FIG. 31 is a longitudinal cross-sectional view of the staple applying assembly of FIG. 30 with tissue clamped and stapled therein.

FIG. 32 is another longitudinal cross-sectional view of the staple applying assembly of FIG. 31 with another portion of tissue clamped and stapled therein.

FIG. 33 is another longitudinal cross-sectional view of the staple applying assembly of FIGS. 30-32 fluidically coupled

to a fluid reservoir supported by a handle assembly of various embodiments of the present invention.

FIG. 34 is a longitudinal cross-sectional view of a staple applying assembly of other embodiments of the present invention wherein tissue of varying thickness is clamped therein.

FIG. 35 is an enlarged cross-sectional view of a portion of the staple applying assembly of FIG. 34.

FIG. 36 is an exploded perspective view of a collapsible staple driver embodiment of the present invention.

FIG. 37 is a cross-sectional view of the collapsible staple driver embodiment of FIG. 36 in a first (uncollapsed) position.

FIG. 38 is an exploded perspective view of another collapsible staple driver embodiment of the present invention.

FIG. 39 is a cross-sectional view of the collapsible staple driver embodiment of FIG. 38 in a first (uncollapsed) position.

FIG. 40 is a perspective view of another collapsible staple driver embodiment of the present invention in a first (uncollapsed) position.

FIG. 41 is an exploded perspective view of the collapsible staple driver embodiment of FIG. 40.

FIG. 42 is a cross-sectional view of the collapsible staple driver embodiment of FIGS. 40 and 41 in a first (uncollapsed) position.

FIG. 43 is another cross-sectional view of the collapsible staple driver embodiment of FIGS. 40-42 after compression forces have been applied thereto.

FIG. 44 is an exploded perspective view of another collapsible staple driver embodiment of the present invention.

FIG. 45 is a cross-sectional view of the collapsible staple driver embodiment of FIG. 44 in a first (uncollapsed) position.

FIG. 46 is an exploded perspective view of the collapsible staple driver embodiment of FIGS. 44 and 45 with some of the elements thereof shown in cross-section.

FIG. 47 is an exploded front view of another collapsible staple driver embodiment of the present invention.

FIG. 48 is another front view of the collapsible staple driver of FIG. 47 in a first (uncollapsed) position.

FIG. 49 is another front view of the staple driver of FIGS. 47 and 48 after it has been compressed to a fully collapsed position.

FIG. 50 is an exploded assembly view of another collapsible staple driver embodiment of the present invention.

FIG. 51 is an exploded front view of the collapsible staple driver embodiment of FIG. 50.

FIG. 52 is another front view of the collapsible staple driver embodiment of FIGS. 50 and 51 after being compressed into a fully collapsed position.

FIG. 53 is a perspective view of another collapsible staple driver embodiment of the present invention;

FIG. 54 is a side elevational view of the collapsible staple driver of FIG. 53 in a first (uncollapsed) position.

FIG. 55 is another side elevational view of the collapsible staple driver of FIGS. 53 and 54 after being compressed to a fully collapsed position.

#### DETAILED DESCRIPTION

Turning to the Drawings, wherein like numerals denote like components throughout the several views, in FIG. 1, a surgical stapling and severing instrument 10 includes a handle portion 12 that is manipulated to position an implement portion 14 including a fastening end effector, depicted as a staple applying assembly 16, distally attached to an

elongate shaft 18. The implement portion 14 is sized for insertion through a cannula of a trocar (not shown) for an endoscopic or laparoscopic surgical procedure with an upper jaw (anvil) 20 and a lower jaw 22 of the staple applying assembly 16 closed by depression of a closure trigger 24 toward a pistol grip 26 of the handle portion 12, which advances an outer closure sleeve 28 of the elongate shaft 18 to pivot shut the anvil 20.

Once inserted into an insufflated body cavity or lumen, the surgeon may rotate the implement portion 14 about its longitudinal axis by twisting a shaft rotation knob 30 that engages across a distal end of the handle 12 and a proximal end of the elongate shaft 18. Thus positioned, the closure trigger 24 may be released, opening the anvil 20 so that tissue may be grasped and positioned. Once satisfied with the tissue held in the staple applying assembly 16, the surgeon depresses the closure trigger 24 until locked against the pistol grip 26, clamping tissue inside of the staple applying assembly 16.

Then a firing trigger 32 is depressed, drawn toward the closure trigger 24 and pistol grip 26, thereby applying a firing force or motion thereto to distally advance a firing member from an unfired position. The firing member is depicted as including a proximal firing rod 34 attached to a distal firing bar 36, that is supported within a frame ground 38 that connects the handle portion 12 to the staple applying assembly 16. During the staple firing motion, the firing bar 36 engages an elongate staple channel 40 and actuates a staple cartridge 42 contained therein, both forming the lower jaw 22. The firing bar 36 also engages the closed anvil 20. After releasing the firing trigger 32 to apply a retraction force or motion to the firing bar 36, depression of a closure release button 44 unclamps the closure trigger 24 so that the closure sleeve 28 may be retracted to pivot and open the anvil 20 to release the severed and stapled tissue from the staple applying assembly 16.

It should be appreciated that spatial terms such as vertical, horizontal, right, left etc., are given herein with reference to the figures assuming that the longitudinal axis of the surgical instrument 10 is co-axial to the central axis of the elongate shaft 18, with the triggers 24, 32 extending downwardly at an acute angle from the bottom of the handle assembly 12. In actual practice, however, the surgical instrument 10 may be oriented at various angles and, as such, these spatial terms are used relative to the surgical instrument 10 itself. Further, "proximal" is used to denote a perspective of a clinician who is behind the handle assembly 12 who places the implement portion 14 distal, or away from him or herself.

In FIG. 2, the staple applying assembly 16 is closed upon compressed tissue 46. In FIGS. 2-3, the firing bar 36 has a proximal portion 48 that is attached to a distal E-beam 50 that translates within the staple applying assembly 16. As depicted with the firing bar 36 retracted, a vertical portion 52 of the E-beam 50 resides essentially aft of the staple cartridge 42, as after a new staple cartridge 42 has been inserted into the elongate staple channel 40. An upper pin 54 that extends laterally from an upper portion of the vertical portion 52 of the E-beam 50 initially resides within an anvil pocket 56 recessed near a proximal pivoting end of the anvil 20. As the E-beam 50 is distally advanced during the staple firing motion, the vertical portion 52 passes through a narrow longitudinal anvil slot 58 (FIGS. 1, 11) formed in a staple forming undersurface 60 of the anvil 20, a proximally open vertical slot 62 formed in cartridge 42 and an underlying longitudinal channel slot 64 formed in the elongate staple channel 40.

In FIGS. 2, 11, the narrow longitudinal anvil slot 58 (FIG. 2) communicates upwardly to a laterally widened longitudinal anvil channel 66 sized to slidingly receive the upper pin

54. The longitudinal channel slot 64 communicates downwardly to a laterally widened longitudinal channel track 68 that receives a lower foot 70, which is sized to slide therein and is attached at a bottom of the vertical portion 52 of the E-beam 50. A laterally widened middle pin 72 extending from the vertical portion 52 of the E-beam 50 is positioned to slide along a top surface of a bottom tray 74 of the staple cartridge 42, which in turn rests upon the elongate staple channel 40. A longitudinal firing recess 75 formed in the staple cartridge 42 above the bottom tray 74 is sized to allow the middle pin 72 to translate through the staple cartridge 42.

A distal driving surface 76 of the vertical portion 52 of the E-beam 50 is positioned to translate through the proximally open vertical slot 62 of the staple cartridge 42 and distally drive a wedge sled 78 proximally positioned in the staple cartridge 42. The vertical portion 52 of the E-beam 50 includes a cutting surface 80 along a distal edge above the distal driving surface 76 and below the upper pin 54 that severs the clamped tissue 46 simultaneously with this stapling.

With particular reference to FIG. 11, it should be appreciated that the wedge sled 78 drives upwardly staple drivers 82 that in turn drive upwardly staples 83 out of staple apertures 84 formed in a staple body 85 of the staple cartridge 42 to form against the undersurface 60 of the anvil 20 which is in confronting relationship relative to an upper surface 43 of staple cartridge 42 (FIG. 2).

In FIGS. 2, 11, advantageously, the illustrative spacing, denoted by arrow 86 (FIG. 2), between the upper pin 54 is compliantly biased toward a compressed state wherein 0.015 inches of compressed tissue 46 is contained in the staple applying assembly 16. However, a larger amount of compressed tissue 46 up to about 0.025 inches is allowed by an inherent flexure of the E-beam 50. Excessive flexure, of perhaps up to 0.030 inches, is avoided should the length of staples be insufficient to form with the additional height. It should be appreciated that these dimensions are illustrative for a staple height of 0.036 inches. The same would be true for each category of staple, however.

In FIG. 4, a first version of a compliant E-beam 50a includes top and bottom horizontal slits 90, 92 from a distal edge of the vertical portion 52a, perhaps formed by electro drilling machine (EDM). The vertical portion 52a thus contains a vertically compliant top distally projecting arm 94 containing the upper pin 54, a knife flange 96 containing the cutting surface 80, and a lower vertical portion 98 containing the distal driving surface 76, middle pin 72 and lower foot 70. The horizontal slits 90, 92 allow a compliant vertical spacing by allowing the top distally arm 94 to pivot upwardly to adjust to increased force from compressed tissue 46 (not shown).

In FIGS. 5-6, a second version of a compliant E-beam 50b includes left and right lower relieved areas 110, 112 formed into an upper pin 54b to each side of the vertical portion 52, leaving left and right lower bearing points 114, 116 respectively. The outboard position of the bearing points 114, 116 provides a long moment arm to exert the force to flex. It should be appreciated given the benefit of the present disclosure that the dimensions of the relieved areas 110, 112 and the choice of materials for the compliant E-beam 50b may be selected for a desired degree of flexure, given the staple size and other considerations.

In FIG. 7, a third version of a compliant E-beam 50c is as described above in FIGS. 5-6 with further flexure provided by left and right upper narrow relieved areas 120, 122 formed into opposite top root surfaces of an upper pin 54c proximate to the vertical portion 52.

In FIG. 8, a fourth version of a compliant E-beam 50d is as described for FIGS. 2-3 with an added feature of a composite/laminate vertical portion 52d that includes a central resilient vertical layer 130 sandwiched between left and right vertical layers 132, 134 that support respectively left and right portions 136, 138 of an upper pin 54d. As the left and right portions 136, 138 are flexed either up or down, the resulting bowing of the left and right vertical layers 132, 134 are accommodated by a corresponding compression or expansion of the central resilient vertical layer 130.

In FIG. 9, a fifth version of a compliant E-beam 50e is as described for FIGS. 2-3 with an added feature of a discrete upper pin 54e formed of a more flexible material that is inserted through a horizontal aperture 140 through a vertical portion 52e. Thus, left and right outer ends 142, 144 of the discrete upper pin 54e flex in accordance with loading forces.

Alternatively or in addition to incorporating flexure into an upper pin 54, in FIGS. 10-11, a sixth version of a compliant E-beam 50f as described for FIGS. 2-3 further includes resilient pads 150 that are attached to upper surfaces 152 of the bottom foot 70. The resilient pads 150 adjust the spacing of the upper pin 54 in accordance to the compression force experienced at the bottom foot 70.

In FIG. 12, a seventh version of a compliant E-beam 50g is as described above for FIGS. 2-3 with the added feature of a bottom foot (shoe) 70g having an upwardly aft extended spring finger 160 that resiliently urges the E-beam 50g downwardly to adjust vertical spacing in accordance with loading force.

In FIG. 13, an eighth version of a compliant E-beam 50h is as described above in FIGS. 2-3 with the added feature of an oval spring washer 170 resting upon the bottom foot 70 encircling the vertical portion 52 and having an upwardly bowed central portion 172 that resiliently urges the E-beam 50h downwardly to adjust vertical spacing in accordance with loading force.

For another example, a compliant E-beam consistent with aspects of the present invention may include engagement to an anvil similar to the engagement in the illustrative versions of two structures that slide against opposite sides of the elongate staple channel. Similarly, a compliant E-beam may engage a lower jaw by having a laterally widened portion that slides internally within a channel formed in a lower jaw structure.

As yet an additional example, in the illustrative version, the staple cartridge 42 is replaceable so that the other portions of the staple applying assembly 16 may be reused. It should be appreciated given the benefit of the present disclosure that applications consistent with the present invention may include a larger disposable portion, such as a distal portion of an elongate shaft and the upper and lower jaws with a staple cartridge permanently engaged as part of the lower jaw.

As yet another example, the illustrative E-beam advantageously affirmatively spaces the upper and lower jaws from each other. Thus, the E-beam has inwardly engaging surfaces that pull the jaws together during firing in instances where a larger amount of compressed tissue tends to spread the jaws. Thereby the E-beam prevents malformation of staples due to exceeding their effective length. In addition, the E-beam has outwardly engaging surfaces that push the jaws apart during firing in stances where a small amount of tissue or other structure attributes of the instrument tend to pinch the jaws together that may result in staple malformation. Either or both functions may be enhanced by applications consistent with aspects of the invention wherein inherent flexure in the E-beam adjusts to force to allow a degree of closing of the jaws or of opening of the jaws.

FIG. 14 is an end cross-sectional view of a surgical instrument 10a that has a staple applying assembly 16a of another embodiment of the present invention wherein like reference numerals are used to designate like elements and which employs an elongate channel 40a for supporting a staple cartridge 42 therein. In various embodiments, the channel 40a has resilient or flexible features configured to enable the staple applying assembly 40a to effectively accommodate different thicknesses of tissue. FIG. 15 is a partial perspective view of the staple applying assembly 16a with some components shown in cross-section for clarity. As can be seen in FIG. 14, in this embodiment, a first longitudinally extending relief area 180 and a second longitudinally extending relief area 184 are provided in the longitudinal channel 40a. The first longitudinally extending relief area 180 defines a first resilient or flexible channel ledge portion 182 and the second longitudinally extending relief area 184 defines a second resilient or flexible channel ledge portion 186. The elongate channel slot 64 through which the upper end 51 of the vertical portion 52 of the firing member in the form of E-beam 50 extends is formed between the free ends 183, 185 of the flexible ledges 182, 186, respectively. As can be further seen in FIG. 14, such arrangement permits the lower foot 70 of the E-beam 50 to bear upon the flexible ledge portions 182, 186 to accommodate differences in the thickness of the tissue clamped between the anvil 20 and the lower jaw 22 as the E-beam 50 transverses therethrough. It will be understood that the thickness 188 of the ledge portions 182, 186 may be selected to provided the desired amount of flexure to those portions of the elongate channel 40a. Also, the choice of materials for the elongate channel 40a may be selected for a desired degree of flexure, in view of the staple size and other considerations.

The elongate channel 40a as described above may be used in connection with a staple applying assembly that employs a conventional anvil 20. That is, the longitudinally extending anvil slot 58 may essentially have a "T" shape that is sized to accommodate the upper pins 54 and an upper end 51 of the vertical portion 52 of the E-beam 50. The embodiment depicted in FIGS. 14 and 15 employs an anvil 20a that has resilient or flexible features for further accommodating differences in tissue thicknesses clamped between the anvil 20a and the lower jaw 22. In particular, as can be seen in FIG. 14, a third longitudinally extending relief area 190 and a fourth longitudinally extending relief area 194 may be provided in the anvil 20a as shown. The third longitudinally extending relief area 190 defines a first anvil ledge portion 192 and the fourth longitudinally extending relief area 194 defines a second anvil ledge portion 196 upon which the upper pins 54 of the E-beam 50 may bear. Such arrangement provides a degree of flexure to the anvil 20a to accommodate differences in tissue thickness clamped between the anvil 20a and the lower jaw 22. It will be understood that the thickness 198 of the ledge portions 192, 196 may be selected to provided the desired amount of flexure to those portions of the anvil 20a. Also, the choice of materials for the anvil 20a may be selected for a desired degree of flexure, in view of the staple size and other considerations. Anvil 20a may be used in connection with the above-described channel arrangement as shown in FIGS. 14 and 15 or it may be employed with conventional channel arrangements without departing from the spirit and scope of the present invention.

The person of ordinary skill in the art will also appreciate that the anvil 20a and/or the channel 40a may be successfully employed with a conventional E-beam arrangement or any of the E-beam arrangements depicted herein. The E-beams disclosed herein may be reciprocatingly driven by control

arrangements housed within the handle assembly. Examples of such control arrangements are disclosed in U.S. Pat. No. 6,978,921, issued Dec. 27, 2005, which has been herein incorporated by reference. Other known firing member configurations and control arrangements for applying firing and retraction forces or motions thereto could conceivably be employed without departing from the spirit and scope of the present invention.

FIGS. 16 and 17 illustrate a staple applying assembly 16b that employs another version of a channel 40b and an anvil 20b that each have resilient or flexible portions to accommodate differences in tissue thicknesses clamped between the anvil 20b and the lower jaw 22b. As can be seen in those Figures, a first pair 200 of upper and lower longitudinally extending relieved or undercut areas 202, 204 are provided in the channel 40b to define a first cantilever-type support ledge 206 and a second pair 210 of relieved or undercut areas 212, 214 are provided in the channel 40b to define a second cantilever-type support ledge 216. The first pair relieved areas 202, 204 provide a degree of flexure to the first support ledge 206 to enable it to flex as illustrated by arrow 205. Likewise, the second pair 210 of relieved areas 212, 214 provide a degree of flexure to the second support ledge 216 to enable it to flex as illustrated by arrow 215. As with the above described embodiments, the thickness 208 of the support ledges 206 and 216 may be selected to provided the desired amount of flexure to those portions of the elongate channel 40b to accommodate different thicknesses of tissue. Also, the choice of materials for the elongate channel 40b may be selected for a desired degree of flexure, in view of the staple size and other considerations.

FIGS. 16 and 17 further illustrate an anvil 20b that has a T-shaped slot 58b that defines a first lateral wall portion 220 and a second lateral wall portion 222. In various embodiments, a first longitudinally extending undercut area 224 is provided in the first lateral wall portion 220 to define a resilient or flexible first ledge 226. Similarly, in various embodiments, a second longitudinally extending undercut area 228 is provided in the second lateral wall portion 222 to define a resilient or flexible second ledge 230. As can be seen in FIG. 16, the ends 227, 231 of the first and second ledges 226, 230, respectively serve to define a portion 59b of anvil slot 58b through which an upper end portion 51 of E-beam 50b extends. Such arrangement permits the upper pins 54b of the E-beam 50b may bear upon the first resilient ledge 226 and the second resilient ledge 230 to provide a degree of flexure to the anvil 20ab to accommodate differences in tissue thickness clamped between the anvil 20b and the lower jaw 22b. It will be understood that the thickness 232 of the ledges 226, 230 may be selected to provided the anvil 20b with a desired amount of flexure to accommodate different tissue thicknesses. Also, the choice of materials for the anvil 20b may be selected for a desired degree of flexure, in view of the staple size and other considerations. Anvil 20b may be used in connection with the above-described channel 40b shown in FIGS. 16 and 17 or it may be employed with a conventional channel arrangement. The skilled artisan will also appreciate that the anvil 20a and/or the channel 40bg may be successfully employed with a conventional E-beam arrangement or any of the E-beams described herein.

FIG. 18 illustrates the cutting and stapling of tissue 240 with any one of the various surgical cutting and stapling instrument embodiments of the present invention. A portion 242 of the tissue 240 illustrated in FIG. 18 has already been cut and stapled. After the clinician has cut and stapled the first portion 242, the instrument would be withdrawn to enable new staple cartridge 42 to be installed. FIG. 18 illustrates the

position of the implement portion 14 prior to commencing the second cutting and stapling process. As can be seen in that Figure, the portion 242 of the tissue 240 that has been stapled has a thickness 243 that is less than the thickness 245 of other portions 244 of the tissue 240.

FIG. 19 is a view of the underside of an anvil 20c that may be employed with a staple applying assembly 16c of various embodiments of the present invention. The anvil 20c includes and anvil body 21c that supports movable staple forming pockets that define different staple zones. In the embodiment depicted in FIG. 19, four left staple zones 252, 254, 256, 258 are provided on a left side 250 of the anvil slot 58c and four right staple zones 262, 264, 266, 268 are provided on a right side 260 of the anvil slot 58c within the anvil body 21c. The first left staple zone 252 is defined by a first left staple forming insert member 270 that has a series of staple forming pockets 272 therein. In this embodiment, three rows 274, 276, 278 of staple forming pockets 272 are provided in the insert 270. As can be seen in FIG. 19, the central row 276 of pockets 272 are slightly longitudinally offset from the outer two rows 274, 278 of pockets 272 and correspond to the arrangement of the corresponding staple apertures 84 in corresponding staple cartridges 42. Those of ordinary skill in the art will appreciate that such arrangement serves to result in the application of the staples 83 in a staggered manner as illustrated in FIG. 18.

Similarly, the second left staple zone 254 may be defined by a second left staple forming insert 280 that may have three rows 282, 284, 286 of staple forming pockets 272 therein. The third left staple zone 256 may be defined by a third left staple forming insert 290 that may have three rows 292, 294, 296 of staple forming pockets 272 therein. The fourth left staple zone 258 may be defined by a fourth left staple forming insert 300 that may have three rows 302, 304, 306 of staple forming pockets 272 therein. The first, second, third and fourth left staple forming inserts 270, 280, 290, 300 are longitudinally aligned in a left side cavity 251 provided in the anvil 20c on the left side 250 of the anvil slot 58.

The first right staple zone 262 may be defined by a first right staple forming insert member 310 that has a series of staple forming pockets 272 therein. In this embodiment, three rows 312, 314, 316 of staple forming pockets 272 are provided in the insert 310. As can be seen in FIG. 19, the central row 314 of staple forming pockets 272 are slightly longitudinally offset from the outer two rows 312, 316 and correspond to the arrangement of the corresponding staple apertures 84 in corresponding staple cartridges 42. Such arrangement serves to result in the application of the staples 83 in a staggered manner on the right side of the tissue cut line. The second right staple zone 264 may be defined by a second right insert 320 that may have three rows 322, 324, 326 of staple forming pockets 272 therein. The third right staple zone 266 may be defined by a third right staple forming insert 330 that may have three rows 332, 334, 336 of staple forming pockets 272 therein. The fourth right staple zone 268 may be defined by a fourth right staple forming insert 340 that may have three rows 342, 344, 346 of staple forming pockets 272 therein. The first, second, third, and fourth right staple forming inserts 310, 320, 330, 340 are longitudinally aligned in a right side cavity 261 provided in the anvil 20c on the right side 260 of the anvil slot 58. In various embodiments, the staple forming inserts may be fabricated from stainless steel or other suitable materials that are harder than the material from which the staples are fabricated. For example, the inserts may be successfully fabricated from other materials such as cobalt chromium, aluminum, 17-4 stainless steel, 300 series stainless steel, 400 series stainless steel, other precipitant hardened stainless steels, etc.

At least one biasing member or compliant member in the form of a wave spring 350 or other suitable biasing or compliant medium or member corresponding to each of the staple forming inserts 270, 280, 290, 300, 310, 320, 330, 340 is provided between the respective left staple forming inserts 270, 280, 290, 300 and the bottom of the left side cavity 251 as shown in FIGS. 20-23. Wave springs 350 or other suitable biasing or compliant medium or member is also provided between each of the right staple forming inserts 310, 320, 330, 340 and the bottom surface of the right side cavity 261. The wave springs 350 on the left side of the anvil slot 58c may be received in a corresponding spring cavity 253 and the wave springs 350 on the right side of the anvil cavity 58c may be received in a corresponding spring cavity 263. To biasingly retain each insert 270, 280, 290, 300, 310, 320, 330, 340 in the anvil 20c, each insert 270, 280, 290, 300, 310, 320, 330, 340 may be attached to its corresponding spring 350 or biasing member by, for example, adhesive or other fastener arrangements. In addition, each spring 350 may be attached to the anvil 20c by, for example, adhesive or other mechanical fastener arrangements to retain a portion of the wave spring 350 within its respective spring cavity 253 or 263. Such spring/biasing member arrangements serve to bias the inserts 270, 280, 290, 300, 310, 320, 330, 340 toward the tissue 240 and staples and essentially act as resilient "shock absorbers" to accommodate differences in tissue thicknesses. This advantage is illustrated in FIGS. 22-24.

In particular, as can be seen in FIG. 22, the portion 242 of the tissue 240 clamped in the proximal end 17b of the staple applying assembly 16c has a first thickness (arrow 243) that is thicker than the thickness (arrow 245) of the portion 244 of tissue 240 clamped in the central portion 17c of the staple applying assembly 16c. The thickness 245 of tissue portion 244 is greater than the thickness (arrow 247) of the portion 246 of tissue 240 that is clamped in the distal end 17a of the staple applying assembly 16c. Thus, the staples 83 formed in the distal portion 17a of the staple applying assembly 16c are more tightly formed than the staples 83 formed in the central portion 17c of the staple applying assembly 16c which are more tightly formed than those staples 83 formed in the proximal end 17b of the staple applying assembly 16c due to the differences in tissue thicknesses. FIG. 23 further illustrates the variations in staple formation heights based upon the variations in the thicknesses of the tissue clamped within the staple applying assembly 16c. FIG. 24 illustrates a condition wherein the tissue 240 clamped in the central portion 17c of the staple applying assembly 16c is thicker than the portions of tissue clamped in the distal and proximal ends of the staple applying assembly 16c. Thus, the formation heights of the staples in the central portion 17c will be higher than the staple formation heights of the staples associated with the proximal end 17b and distal end 17a of the staple applying assembly 16c.

Those of ordinary skill in the art will understand that the unique and novel features of the embodiments depicted in FIGS. 19-24 may also be employed in connection with a staple applying assembly that is essentially identical in construction and operation to staple applying assembly 16c described above, except that the staple forming inserts 270, 280, 290, 300, 310, 320, 330, 340 may have just one row of staple formation pockets 272 therein or two rows of staple formation pockets 272 therein. For example, FIG. 25 illustrates an embodiment that only applies two rows of staples on each side of the tissue cut line. Shown in that Figure are staple forming inserts 270d and 310d that only have two rows of staple forming pockets 272d each.



The skilled artisan will further understand that the number of staple forming inserts employed on each side of the anvil slot 58 may vary. For example a single longitudinally extending insert may be used on each side of the anvil slot 58. FIG. 26 illustrates another staple applying assembly 16e of the present invention that only employs one staple forming insert on each side of the anvil slot. FIG. 26 depicts a cross-sectional view of the left side of an anvil 20e that supports a single left staple forming insert 380 that is attached to a single wave spring 350e. Other biasing members or multiple wave springs or biasing members may also be employed. The biasing member or members 350e are supported in the left side cavity 251e and attached to the anvil 20e in one of the various manners described above. A similar right side insert (not shown) would be employed on the right side of the anvil slot 58. Furthermore, although FIGS. 19-24 depict use of four staple forming inserts on each side of the anvil slot greater numbers of staple forming inserts may be employed.

FIGS. 27-29 illustrate another staple applying assembly 16f of the present invention wherein a separate movable staple forming insert is provided for each staple 83. In particular, as can be seen in FIG. 27, a single staple forming insert 400 is provided for each staple 83. Each staple forming insert 400 may have staple forming pockets 404 formed on its underside 402 thereof for forming the ends of the corresponding staple 83. As with various embodiment described above, each insert 400 has a biasing member 412 associated therewith. In the example depicted in FIGS. 27-29, the biasing members 412 comprise stamped portions of a biasing plate 410. The biasing plate 410 may comprise a piece of metal or other suitable material wherein each biasing member 412 is stamped or otherwise cut and formed to correspond with a staple forming insert 400. The biasing plate 410 may comprise a single plate that is supported within a cavity 251f in the anvil 20f or multiple plates 410 may be employed on each side of the anvil slot. It will be understood that a similar arrangement may be employed on the right side of the anvil slot. Each staple forming insert 400 may be attached to its corresponding biasing member 412 by adhesive or other suitable fastener arrangement. Thus, it will be appreciated that a variety of different numbers and arrangements of movable staple forming inserts may be employed without departing from the spirit and scope of the present invention. In particular, at least one movable staple forming insert may be employed on each side of the anvil slot.

FIGS. 30-32 illustrate another staple applying assembly 16g of other embodiments of the present invention wherein the biasing or compliant medium between the staple forming inserts and the anvil comprises at least one fluid bladder. More specifically, as can be seen in FIG. 30, a left bladder 420 is positioned within a left side cavity 253g on the left side of the anvil slot 58g in the anvil 20g. Likewise, a right side bladder 430 is positioned with a right side cavity 263 in the anvil 20g. The series of left side staple forming inserts 270g, 280g, 290g, 300g may be attached to the left side bladder 430 by a suitable adhesive or other fastener arrangement. Likewise the right side staple forming inserts (not shown) may be attached to the right side bladder 430 by adhesive or other suitable fastener arrangements. In one embodiment, each bladder 420, 430 is sealed and partially filled with a liquid 432 such as, for example, glycerin oil or saline solution. Those of ordinary skill in the art will appreciate that such arrangement will permit the staple forming inserts to move to better accommodate variations in the thickness of the tissue clamped within the staple applying assembly 16g. For example, for tissues that have a relatively constant thickness, the liquid 432 will be relatively evenly distributed within each of the bladders 420,

430 to provide a relatively even support arrangement for the staple forming inserts. See FIG. 31. However, when a thicker portion of tissue is encountered, those staple forming inserts corresponding to the thicker tissue will be compressed into their respective anvil cavity thereby forcing the liquid in that part of the bladder to the portions of the bladder corresponding to the thinner tissue portions. See FIG. 32.

In some applications, it may be desirable for the clinician to be able to control the amount of pressure within the bladders 420, 430. For example, less pressure may be desirable when cutting and stapling more delicate tissues such as lung tissue and the like. More pressure may be desirable when cutting and stapling thicker tissues such as, for example, stomach tissue, intestine tissue, kidney tissue, etc. To provide the clinician with this additional flexibility, the bladders 420, 430 may each be fluidically coupled by a supply line 440 or conduit to a fluid reservoir 450 supported by the handle portion 12 of the instrument. In the embodiment illustrated in FIG. 33, the clinician can increase or decrease the amount of fluid within the bladders 420, 430 and resulting pressure therein by means of an adjustment mechanism 460 mounted to the fluid reservoir 450. In various embodiments, the adjustment mechanism 460 may comprise a piston 462 that is attached to an adjustment screw 464. By adjusting the adjustment screw 464 inward, the piston 462 forces fluid out of the reservoir 450 to the bladders 420, 430. Conversely, by reversing the adjustment screw 464, the piston 462 permits more fluid 432 to return or remain within the reservoir 450. To assist the clinician in determining the amount of pressure within that hydraulic system, generally designated as 405, a pressure gauge 470 may be employed as shown. Thus, for those tissues requiring a higher amount of pressure, the clinician can preset the pressure in the bladders 420, 430 to a pressure that is conducive to successfully clamp and staple that particular type of tissue. While a piston/screw arrangement has been described for controlling the pressure in the hydraulic system, the skilled artisan will understand that other control mechanisms could successfully be employed without departing from the spirit and scope of the present invention.

FIG. 30A illustrates another staple applying assembly 16h of other embodiments of the present invention wherein the biasing or compliant medium between the staple forming inserts and the anvil comprises at least one compressible polymer member. More specifically, as can be seen in FIG. 30A, a left compressible polymer member 420h is positioned within a left side cavity 253h on the left side of the anvil slot 58h in the anvil 20h. Likewise, a right side compressible polymer member 430h is positioned with a right side cavity 263h in the anvil 20h. The series of left side staple forming inserts 270h-300h may be attached to the left compressible polymer member 420h by a suitable adhesive or other fastener arrangement. Likewise the right side staple forming inserts 310h-340h may be attached to the right side compressible polymer member 430h by adhesive or other suitable fastener arrangements.

FIGS. 34-37 depict a unique and novel collapsible or compressible staple driver arrangement that enables the various staple drivers to accommodate different tissue thicknesses by collapsing or compressing in response to compression forces that the driver encounters during the firing process. As used herein, the term "firing process" refers to the process of driving the staple drivers towards the staple forming under-surface of the anvil. As was mentioned above, prior staple drivers were fabricated from stiff/rigid material designed to resist deflection and deformation when encountering compression forces during the firing process. A variety of such driver configurations are known. For example, some staple



drivers are configured to support a single staple and others are designed to support multiple staples. A discussion of single and double staple drivers and how they may be operably supported and fired within a staple cartridge is found in U.S. patent application Ser. No. 11/216,562, filed Sep. 9, 2005, entitled Staple Cartridges For Forming Staples Having Differing Formed Staple Heights to Frederick E. Shelton, IV, the disclosure of which is herein incorporated by reference.

FIG. 34 depicts a staple applying assembly 16*h* that includes an elongate channel 40*h* that has an anvil 20*h* pivotally coupled thereto in a known manner. The elongate channel 40*h* is configured to operably support a staple cartridge 42*h* therein. The anvil 20*h* has a staple forming undersurface 60*h* thereon that is adapted to confront the upper surface 43*h* of the staple cartridge 42*h* when the anvil 20*h* is pivoted to the closed position shown in FIG. 34. The staples 83 are each supported on a corresponding staple driver 500, the construction of which will be discussed in further detail below.

Each staple driver 500 may be movably supported within a corresponding staple channel 87*h* provided in the cartridge body 85*h* as shown in FIGS. 34 and 35. Also operably supported within the cartridge body 85*h* is a driving member or wedge sled 78 that is oriented for engagement by the E-beam firing member 50 during the firing process. See FIG. 34. As the E-beam firing member 50 and wedge sled 78 are driven distally through the elongate channel 40*h* and staple cartridge 42 in a known manner, the wedge sled 78 drives the staple drivers 500 upwardly within the cartridge body 85*h*. As the staple drivers 500 are driven upwardly toward the staple forming undersurface 60*h* of the anvil 20*h*, they carry with them their respective staple 83 or staples which are driven into forming engagement with the corresponding staple forming pockets 61*h* in the staple forming undersurface 60*h* of the anvil 20*h*. As the ends 88 of the staple 83 contact the forming pockets 61*h*, they are bent over thus providing the staple 83 with a shape that somewhat resembles a "B". While the various embodiments of the present invention have been described herein in connection with E-beam firing members, it is conceivable that these various embodiments may also be successfully employed with a variety of different firing member and driving member arrangements without departing from the spirit and scope of the present invention.

One collapsible staple driver embodiment of the present invention is depicted in FIGS. 36 and 37. As can be seen in those Figures, the collapsible or compressible staple driver 500 includes a base portion 502 and a staple supporting portion 520 that is movable from a first uncollapsed position relative to the base portion 502 in response to compression forces generated during the firing process. In various embodiments, the base portion 502 may have a forward support column segment 504 and a rearward support column segment 508 that is spaced from the forward support column segment 504 and is substantially integrally formed therewith. The base portion 502 may also have an upstanding side portion 510 that has a rib 512 protruding from a backside therefrom. The upstanding side portion 510 serves to define a receiving ledge 514 in the base portion 502 for receiving the staple supporting portion 520 thereon. Those of ordinary skill in the art will understand that when the staple supporting portion 520 is received on the ledge 514, the staple driver 500 is unable to collapse or compress any further.

The staple supporting portion 520 of the staple driver 500 may similarly include a forward support column segment 522 and rearward support column segment 524 that is spaced from the forward support column segment 522. When the staple supporting portion 520 is received on the base portion 502, the forward support column segments 504, 522 serve to form

a forward column portion 530 and the rearward column segments 508, 524 form a rearward column portion 532. A forward staple receiving groove 526 is formed in the forward support column segment 522 and a rearward staple receiving groove 528 is formed in the rearward support column segment 524. The forward staple receiving groove 526 and the rearward staple receiving groove 528 serve to support a staple 83 therein as illustrated in FIG. 35. The rib 512 and the forward column 530 and rearward column 532 may cooperate with corresponding channels (not shown) in the staple cartridge body 85 to provide lateral support to the staple driver 500 while permitting the driver to be driven upward within the cartridge body 85 during the firing process.

In various embodiments, a resistive attachment structure, generally designated as 540' is provided to support the staple supporting portion 520 in a first uncompressed or uncollapsed orientation relative to the base portion (FIG. 37) prior to encountering any compressive forces during the firing operation and to permit the staple supporting portion 520 and the base portion to move towards each other (collapse or compress) in response to the magnitude of the compression forces applied to the staple supporting portion 520 and base portion 520 during the staple firing operation. As can be seen in FIGS. 36 and 37, the resistive attachment structure 540' in various embodiments may comprise a pair of attachment rods 540 that protrude from the bottom 521 of the staple supporting portion 520 and correspond to holes or apertures 542 in the base portion 502. The rods 540 are sized and shaped relative to the holes 542 to establish an interference fit or "light press fit" (i.e., an interference of approximately 0.001 inches) therebetween such that when the staple supporting portion 520 and base driver portion 502 are compressed together during the staple firing operation as will be discussed in further detail below, the staple supporting portion 520 and the base portion 502 can compress toward each other to reduce the overall height of the staple driver 500 in relation to the amount of compression force encountered during the firing process. In various embodiments, for example, the staple supporting portion 520 and base portion 502 may be fabricated from the same material such as, for example, ULTEM®. In other embodiments, the base portion 502 and the staple supporting portion 520 may be fabricated from different materials. For example, staple supporting portion 520 may be fabricated from ULTEM® and the base portion 502 may be fabricated from glass or mineral filled ULTEM®. However, other materials could also be employed. For example, the base portion 502 could be fabricated from Nylon 6/6 or Nylon 6/12.

In various embodiments, a frictional or an interference fit of approximately 0.001 inch may be established between the attachment rods 540 and their corresponding holes 542. However, other degrees of interference fit may be employed to attain the desired amount and rate of driver compression in proportion to the magnitude of compression forces encountered when stapling a particular type/thickness of tissue. For example, in one embodiment, the degree of interference fit between the attachment rods 540 and their respective holes 542 may be approximately 0.002 to 0.005 inches for stapling tissues wherein it is anticipated that compression forces on the order of approximately 2-5 pounds may be generated during the firing operation.

FIG. 35 illustrates various ranges of travel and compression that the staple drivers 500 may experience when encountering tissues of varying thicknesses. More specifically, FIG. 35 illustrates a portion of tissue 560 clamped between the upper surface 43*h* of the staple cartridge 42*h* and the staple forming undersurface 60*h* of the anvil 20*h*. As illustrated in FIG. 35, the tissue 560 has three thicknesses. The thickest

portion of tissue is designated as **562** and comprises the portion of tissue that is on the right side of the Figure. The next thickness portion of tissue is designated as **564** and the thinnest portion of tissue **560** is designated as **566** and is on the left side of the Figure. For the purposes of this explanation, the staple driver associated with tissue portion **562** is designated as staple driver **500a**. The staple driver associated with tissue portion **564** is designated as staple driver **500b** and the staple driver associated with tissue portion **566** is designated as **500c**. It will be understood that staple drivers **500a**, **500b**, **500c**, may be identical in construction to staple driver **500** as described above.

Turning to staple driver **500a** first, as the staple driver **500a** is driven upwardly towards the staple forming undersurface **60h** of the anvil **20h** by the wedge sled (not shown in FIG. 35), it encounters the thick tissue portion **562** which resists the upward movement of the staple driver **500a**. Such resistive force (represented by arrow **570**) opposes the drive force (represented by arrow **572**) generated by the wedge sled and serves to overcome the amount of interference established between the attachment rods **540** and their respective holes **542** and forces the rods **540** deeper into their respective holes **542** to thereby permit the staple supporting portion **520a** of the staple driver **500a** and base portion **502a** to move toward each other. This movement of the staple supporting portion **520a** and base portion **502a** towards each other under a compressive force generated during the staple firing operation is referred to herein as "collapsing" or "compressing". When in the completely compressed position wherein the staple supporting portion **520a** is received on the ledge **514a** of the base portion **502a**, the staple supporting ledges **526a**, **528a** on the staple supporting portion **520a** may preferably support the bottom cross member **89** of the staple **83** above the upper surface **43h** of the staple cartridge **42h** to avoid catching the staple **83** on the staple cartridge **42h** when the staple applying assembly **16h** is withdrawn. The compressed height of the staple driver **500a** is designated by arrow **574** in FIG. 35.

Turning next to staple driver **500b** which corresponds to tissue portion **564**, because the tissue portion **564** is not as thick as tissue portion **562**, the resistive force **570b** encountered by the staple driver **500b** during the firing operation is not as great as resistive force **570**. Therefore, the attachment pins **540b** of staple driver **500b** are not advanced into their respective holes **542b** as far as the pins **540** of staple driver **500a** were advanced into their respective holes **542**. Thus, the compressed height **576** of staple driver **500b** is greater than the compressed height **574** of staple driver **500a**. As can also be seen in FIG. 35, the bottom portion **89** of the staple **83** supported in staple driver **500b** is supported above the upper surface **43h** of the staple cartridge **42h**.

Staple driver **500c** is associated with the thinnest tissue portion **566**. Thus, the resistive force **570c** encountered by the staple driver **500c** during the staple firing operation is less than the resistive force **570b** that was encountered by staple driver **500b**. Thus, the pins **540c** of staple driver **500c** are not advanced into their respective holes **542c** as far as the pins **540b** of staple driver **500b** were advanced into their respective holes **542b**. Thus, the compressed height **578** of staple driver **500c** is greater than the compressed height **576** of staple driver **500b**.

As can be further seen in FIG. 35, because the compressed height **578** of staple driver **500c** is greater than the compressed height **576** of staple driver **500b**, the staple **83c** supported by staple driver **500c** was compressed to a greater extent than the staple **83b** that was supported by staple driver **500b**. Thus, the formed height of staple **83c** is less than the

formed height of staple **83b** which is less than the formed height of staple **83a** as illustrated in FIG. 35.

Those of ordinary skill in the art will appreciate that the number, shape, composition and size of the attachment rods and their respective holes can vary from embodiment to embodiment without departing from the spirit and scope of the present invention. Such interrelationship between the attachment rods and their respective holes serves to establish an amount of frictional interference therebetween which can be overcome in relation to various compression forces encountered when clamping/stapling different thicknesses of tissue. In an alternative version, the attachment to rods **540** may be formed on the base portion **502** and the holes provided in the staple supporting portion **520**.

FIGS. 38 and 39 illustrate another staple driver **500d** embodiment of the present invention that may be substantially identical in construction and operation to the staple drivers **500** described above, except that the attachment rods **540d** are somewhat tapered or frusto-conically shaped. In various embodiments, for example, the ends **541d** of the attachment rods **540d** may be sized relative to holes **542** such that a light press fit is established therebetween when in the first uncollapsed state depicted in FIG. 39. The degree of taper of the attachment rods **540d** may be tailored to attain the desired amount of staple driver compression in relation to the magnitude of compression forces encountered during the staple firing process. Thus, in these embodiments, the magnitude of the interference fit between the attachment rods **540d** and the holes **542** increases as the staple driver **500d** encounters greater compression forces which drive the attachment rods **540d** deeper into their respective holes **542d**. In alternative embodiments, the attachment rods **540** may have a round shape and the holes **542** may be tapered to attain the desired amount and rate of staple driver compression in proportion to the amount of anticipated compression forces applied thereto during the firing operation. In an alternative version, the attachment rods **540d** may be formed on the base portion **502** and the holes **542** be formed in the staple supporting portion **520**.

FIGS. 40-43 illustrate another staple driver **500e** embodiment of the present invention that may be substantially identical in construction and operation to the staple drivers **500** described above, except that the attachment rods **540e** are configured or shaped to include an additional amount of material oriented to be sheared off of the remaining portion of the rods as the staple driver **500e** encounters compression forces during the firing operation. More specifically and with reference to FIG. 42, the attachment rods **540e** have a tip portion **541e** that is received within the corresponding hole **542e**. The tip portion **541e** may be sized relative to the hole **542e** such that a sliding fit is achieved therebetween or, in other embodiments, a small interference fit may be established between those components when in the first uncollapsed position. The remaining portion **543e** of each attachment rod **540e** may be provided or formed with an additional amount of material **545e** that is designed to be sheared therefrom as the staple driver **500e** encounters the anticipated compression forces during the firing operation. See FIG. 43. The additional material **545e** may extend completely around the circumference of the portion **543e** of each attachment rod **540e** or the material **543e** may comprise one or more segments oriented around the circumference of the attachment rod **540e**. For example, in the embodiment depicted in FIGS. 40-43, two segments **547e** of material **543e** are diametrically opposed on each attachment rod **540e** as shown. In various embodiments, the diametric distance between the segments may be somewhat larger than the diameter of the holes **542e**

to cause the segments **547e** to be sheared or removed from at least a portion of the rods **540e** as the staple driver **500e** encounters the anticipated compression forces during the firing operation.

The portions of additional material **543e** may comprise an integral portion of the attachment rod **540e** or the additional material **543e** may comprise a second material applied to the attachment rod **540e** and designed to shear off therefrom when the staple driver **500e** encounters the anticipated compression forces. In various embodiments, the base portion **502** may be fabricated from a material that is more rigid than the material from which attachment rods **540e** and/or the additional material **543e** are fabricated such that the base portion **502** facilitates the shearing off of additional material **543e** as the staple support portion **520e** and base portion **502e** are compressed together during the staple firing operation. In an alternative version, the attachment rods **540e** may be formed on the base portion **502** and the holes **542e** be provided in the staple supporting portion **520e**.

FIGS. **44-46** illustrate another staple driver **500f** of the present invention that may be substantially identical in construction and operation to the staple drivers **500** described above, except that the holes **542f** in the base portion **502f** may be hexagonally shaped or may have one or more surfaces therein designed to establish an interference fit with the attached rods **540** or to otherwise resist further entry of the attachment rods **540** into the holes **542f**. For example, the holes **542f** shown have a pair of flat surfaces **551f** formed therein that serve to establish an interference fit or a degree of frictional resistance between the attachment rods **540f** and the holes **542f** which can be overcome by the various compression forces encountered when clamping/stapling different thicknesses of tissue. In the embodiment depicted in FIGS. **44-46**, the attachment rods **540** have a substantially circular cross-sectional shape and the holes **542f** have flat surfaces **551** formed therein. In alternative embodiments, however, the holes **542** may be round and the flat surfaces may be formed on the attachment rods **540**. In an alternative version, the attachment rods **540** may be provided on the base portion **502f** and the holes **542f** be provided in the staple supporting portion **520**.

FIGS. **47-49** illustrate another staple driver **500g** of the present invention that comprises a base portion **502g** and a staple supporting portion **520g**. The staple supporting portion **520g** has staple supporting grooves (not shown) formed therein and a downwardly protruding tang **580** protruding from its undersurface **521g**. The tang **580** has two tapered surfaces **582** and is shaped to be received in a corresponding cavity **590** formed in the base portion **502g**. The cavity **590** is formed with tapered sides **572** and is sized to receive the tang **580** therein in the following manner. As the driver staple **500g** encounters the compression forces generated during the firing operation, the tang **580** is forced into the cavity **590**. FIG. **49** illustrates the staple driver **500g** in a fully collapsed or compressed position. The staple supporting portion **520g** and/or tang **580** may be fabricated from a material that is somewhat more compliant than the material from which the base portion **502g** is formed so that the tang **580** can be forced into the cavity **590** in the base portion **502g** without substantially distorting the base portion **502g** to the extent that it would hamper the ability of the staple driver **500g** to be fully driven to a final firing position. For example, the staple supporting portion and/or the tang **580** may be fabricated from ULTEM® and the base portion **502g** may be fabricated from glass filled Nylon to achieve the desired amount of driver compression when encountering the anticipated compression forces during the firing operation. In an alternative version, the tang **580**

may be provided on the base portion **502g** and the hole **590** be provided in the staple supporting portion **520g**.

FIGS. **50-52** illustrate another staple driver **500h** embodiment of the present invention that may be substantially identical in construction and operation to the staple drivers **500** described above, except that, instead of attachment rods, the staple supporting portion **520h** has two tapered tangs **600** protruding therefrom designed to be compressed into a V-shaped cavity **610** formed in the base portion **502h**. Prior to commencement of the firing operation, the staple supporting portion **520h** is supported on the base portion **502h** within the staple cartridge. As the staple supporting portion **520h** and the base portion **502h** are compressed together during the firing operation, the tapered tangs **600** are forced inwardly as shown in FIG. **52**. The degree to which the tangs **600** are compressed into the V-shaped cavity **610** is dependent upon the magnitude of the compression forces encountered during the firing operation.

The staple supporting portion **500h** and/or tangs **600** may be fabricated from a material that is somewhat more compliant than the material from which the base portion **502h** is formed so that the tangs **600** can be forced into the V-shaped cavity **610** in the base portion **502h** without substantially distorting the base portion **502h** to the extent that it would hamper the ability of the staple driver **500h** to be fully driven to a final firing position. For example, the staple supporting portion and/or the tangs **600** may be fabricated from Nylon with no fill and the base portion **502h** may be fabricated from ULTEM® with glass or mineral fill to achieve the desired amount of staple driver compression when encountering the anticipated compression forces during the firing operation. In an alternative version, the tangs **600** may be provided on the base portion **502h** and the cavity **610** may be provided in the staple supporting portion **520h**.

FIGS. **53-55** illustrate yet another staple driver **500i** embodiment of the present invention that includes a staple supporting portion **520i** that has V-shaped staple supporting grooves **630i**, **650i** therein. In this embodiment, the staple supporting portion **520i** has a first pair **620i** of two tapered tangs **622i**, **626i** protruding therefrom oriented to be compressed into the first V-shaped groove or cavity **630i** and a second pair **640i** of two tapered tangs **642i**, **646i** oriented to be compressed into the second V-shaped groove or cavity **650i**. More specifically and with reference to FIG. **54**, the first tang **622i** has an end **624i** that is spaced from an end **628i** of the second tang **626i** prior to commencement of the staple firing operation. When in the position illustrated in FIG. **54**, the ends **624i**, **628i** are biased outwardly into frictional contact with the upper side walls of the first V-shaped groove **630i** to retain the staple supporting portion **520i** in the uncollapsed position shown in FIG. **54**. Although not shown, the second pair **640i** of tangs **642i**, **646i** are also similarly configured as tangs **622i**, **626i** and serve to engage the second V-shaped groove **650i** in the same manner.

As the staple supporting portion **520i** and the base portion **502i** are compressed together during the firing operation, the ends **624i**, **628i** of the first tangs **622i**, **626i** and the ends of the second tangs **642i**, **646i** are biased toward each other to permit the tangs to be driven deeper into their respective grooves **630i**, **650i**. FIG. **55** illustrates the first pair **620i** of tangs **622i**, **626i** in their fully compressed state which also corresponds to the fully compressed state of the driver **500i**. The degree to which the tangs are compressed into their respective V-shaped grooves is dependent upon the magnitude of the compression forces encountered during the firing operation.

The staple supporting portion **500i** and/or tangs **622i**, **626i**, **642i**, **646i** may be fabricated from a material that is somewhat

more compliant than the material from which the base portion 502i is formed so that the tangs 622i, 626i, 642i, 646i can be forced into their respective V-shaped grooves in the base portion 502i without substantially distorting the base portion 502i to the extent that it would hamper the ability of the driver 500i to be fully driven to a final firing position. For example, the staple supporting portion 520i and/or the tangs 622i, 626i, 642i, 646i may be fabricated from ULTEM® and the base portion 502i may be fabricated from Nylon with glass or mineral fill to achieve the desired amount of driver compression when encountering the anticipated compression forces during the firing operation. In an alternative version, the tangs 622i, 626i, 642i, 646i may be provided on the base portion 502i and the V-shaped grooves 630i, 650i may be provided in the staple supporting portion 520i.

The various embodiments of the present invention described above and their respective equivalent structures represent vast improvements over prior staple applying assemblies and end effectors. Various embodiments of the present invention provide anvils and/or channels with flexible portions that permit the overall staple height to increase as the compression within the assembly increases due to tissue thickness. Other embodiments employ anvil arrangements that have flexible forming pockets that can be compressed away from the staple cartridge in response to variations in tissue thickness. In doing so, the inherent gap between the forming pocket and the cartridge increases which serves to increase the formed height of the staple. Such advantages can result in improved staple line consistency and provide better clinical outcomes.

While the present invention has been illustrated by description of several embodiments and while the illustrative embodiments have been described in considerable detail, it is not the intention of the applicant to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications may readily appear to those skilled in the art. For example, while various manually operated surgical instruments have been depicted for clarity, it should be appreciated that such devices may also be robotically manipulated. In addition, those skilled in the art will appreciate that the embodiments, features and improvements disclosed herein may be readily employed in connection with a variety of other known surgical cutter/staplers, staplers, etc. that may have application in open, laparoscopic, endoscopic and/or intraluminal surgical procedures. In particular, such unique and novel features may be practiced in connection with linear staplers, cutters, contour cutters, etc. Thus, the scope and protection afforded to the various embodiments disclosed herein should not be limited solely to endocutter-type surgical staplers.

While several embodiments of the invention have been described, it should be apparent, however, that various modifications, alterations and adaptations to those embodiments may occur to persons skilled in the art with the attainment of some or all of the advantages of the invention. For example, according to various embodiments, a single component may be replaced by multiple components, and multiple components may be replaced by a single component, to perform a given function or functions. This application is therefore intended to cover all such modifications, alterations and adaptations without departing from the scope and spirit of the disclosed invention as defined by the appended claims.

The devices disclosed herein can be designed to be disposed of after a single use, or they can be designed to be used multiple times. In either case, however, the device can be reconditioned for reuse after at least one use. Reconditioning can include a combination of the steps of disassembly of the

device, followed by cleaning or replacement of particular pieces, and subsequent reassembly. In particular, the device can be disassembled, and any number of particular pieces or parts of the device can be selectively replaced or removed in any combination. Upon cleaning and/or replacement of particular parts, the device can be reassembled for subsequent use either at a reconditioning facility, or by a surgical team immediately prior to a surgical procedure. Those of ordinary skill in the art will appreciate that the reconditioning of a device can utilize a variety of different techniques for disassembly, cleaning/replacement, and reassembly. Use of such techniques, and the resulting reconditioned device, are all within the scope of the present application.

Preferably, the invention described herein will be processed before surgery. First a new or used instrument is obtained and, if necessary, cleaned. The instrument can then be sterilized. In one sterilization technique, the instrument is placed in a closed and sealed container, such as a plastic or TYVEK® bag. The container and instrument are then placed in a field of radiation that can penetrate the container, such as gamma radiation, x-rays, or higher energy electrons. The radiation kills bacteria on the instrument and in the container. The sterilized instrument can then be stored in the sterile container. The sealed container keeps the instrument sterile until it is opened in the medical facility.

As used herein, the term "fluidically coupled" means that the elements are coupled together with an appropriate line or other means to permit the passage of pressurized gas therebetween. As used herein, the term "line" as used in "supply line" or "return line" refers to an appropriate passage formed from rigid or flexible conduit, pipe, tubing, etc. for transporting fluid from one component to another.

Any patent, publication, or other disclosure material, in whole or in part, that is said to be incorporated by reference herein is incorporated herein only to the extent that the incorporated materials does not conflict with existing definitions, statements, or other disclosure material set forth in this disclosure. As such, and to the extent necessary, the disclosure as explicitly set forth herein supersedes any conflicting material incorporated herein by reference. Any material, or portion thereof, that is said to be incorporated by reference herein, but which conflicts with existing definitions, statements, or other disclosure material set forth herein will only be incorporated to the extent that no conflict arises between that incorporated material and the existing disclosure material.

The invention which is intended to be protected is not to be construed as limited to the particular embodiments disclosed. The embodiments are therefore to be regarded as illustrative rather than restrictive. Variations and changes may be made by others without departing from the spirit of the present invention. Accordingly, it is expressly intended that all such equivalents, variations and changes which fall within the spirit and scope of the present invention as defined in the claims be embraced thereby.

What is claimed is:

1. A surgical instrument comprising:

an elongate staple channel having a longitudinal channel slot;

a staple cartridge operably supported within said elongate staple channel;

an elongate shaft operably coupled to said elongate staple channel;

an anvil pivotally attached to the elongate staple channel and being selectively pivotable between a closed position wherein a staple forming undersurface thereof is in confronting relationship to an upper surface of said staple cartridge supported within said elongate staple

25

channel and an open position wherein a distal end of said anvil is spaced from said upper surface of said staple cartridge, said anvil having a first longitudinally extending anvil ledge portion cantilevering inwardly from a first anvil portion and a second longitudinally extending anvil ledge portion cantilevering inwardly from a second anvil portion in spaced confronting relationship to said first anvil ledge portion to define a portion of an elongate anvil slot therebetween;

a first undercut area extending into said first anvil portion adjacent an upper surface of said first anvil ledge;

a second undercut area extending into said second anvil portion adjacent an upper surface of said second anvil ledge;

a control handle assembly proximally operably coupled through the elongate shaft to selectively apply opening and closing motions to said anvil; and

a firing member operably coupled to the control handle assembly through said elongate shaft for selective longitudinal reciprocating motion in the elongate staple channel such that one portion of said firing member extends through said anvil slot between a first and a second resilient anvil portion and another portion of said firing member extends through said longitudinal channel slot.

2. The surgical instrument of claim 1 wherein said firing member comprises:

a vertical portion wherein said one portion of said firing member comprises an upper end of said vertical portion and wherein said another portion of said firing member comprises a lower end of said vertical portion;

laterally extending pins protruding from the upper end of the vertical portion positioned to bear upon the first and second anvil ledges during firing translation of said firing member therein; and

a foot portion extending from the lower end of the vertical portion positioned to exert an inward compressive force on the elongate channel during firing translation.

3. The surgical instrument of claim 2 wherein said laterally extending pins are flexible relative to said upper end portion of said vertical portion of the firing member.

4. The surgical instrument of claim 1 wherein said first flexible portion of said anvil comprises at least one first staple insert movably supported within said anvil, said first staple insert having a first staple forming undersurface thereon and wherein said second flexible portion of said anvil comprises at least one second staple insert movably supported within said anvil and having a second staple forming undersurface thereon.

5. The surgical instrument of claim 4 further comprising: at least one first compliant member corresponding to each said first staple insert and supported between said corresponding first staple insert and a portion of said anvil; and

at least one second compliant member corresponding to each said second staple insert and supported between said corresponding second staple insert and another portion of said anvil.

6. The surgical instrument of claim 5 wherein each of said first and second compliant members is selected from the group of compliant members consisting of: springs, compressible polymer materials and fluid supporting bladders.

7. A surgical stapling instrument comprising:

an elongate staple channel having a longitudinal channel slot;

a staple cartridge operably supported within said elongate staple channel;

26

an elongate shaft operably coupled to said elongate staple channel;

an anvil pivotally attached to the elongate staple channel, said anvil comprising:

a first staple insert movably supported within said anvil, said first staple insert having a first staple forming undersurface thereon and defining a first staple zone; a first compliant member corresponding to said first staple insert and supported between said corresponding first staple insert and a portion of said anvil;

a second staple insert supported within said anvil and being independently movable relative to said first staple insert to define a second staple zone, said second staple insert having a second staple forming undersurface thereon; and

a second compliant member corresponding to said second staple insert and supported between said corresponding second staple insert and another portion of said anvil;

a control handle assembly proximally operably coupled through the elongate shaft to selectively apply opening and closing motions to said anvil; and

a firing member operably coupled to the control handle assembly through said elongate shaft for selective longitudinal reciprocating motion in the elongate staple channel such that one portion of said firing member extends through an anvil slot defined by said first and second staple inserts and another portion of said firing member extends through said longitudinal channel slot.

8. The surgical stapling instrument of claim 7 wherein each of said first and second compliant members is selected from the group of compliant members consisting of: springs, compressible polymer materials and fluid supporting bladders.

9. The surgical stapling instrument of claim 7 wherein said first and second staple zones are axially displaced from each other in said anvil.

10. The surgical stapling instrument of claim 7 wherein said first and second staple zones are laterally displaced from each other in said anvil.

11. The surgical stapling instrument of claim 10 wherein said first staple insert comprises at least one right side staple insert and wherein said second staple insert comprises at least one left side staple insert spaced laterally from said right side staple inserts to define said anvil slot therebetween.

12. The surgical stapling instrument of claim 11 wherein said right side insert comprises at least two right side staple inserts axially aligned on a right side of said anvil slot, each said right side staple insert independently movable relative to each other and having a corresponding right side compliant member associated therewith and wherein said left side insert comprises at least two left side staple inserted axially aligned on a left side of said anvil slot, each said left side staple insert independently movable relative to each other and having a corresponding left side compliant member associated therewith.

13. The surgical stapling instrument of claim 12 wherein each of said right and left compliant members is selected from the group of compliant members consisting of: springs, compressible polymer materials and fluid supporting bladders.

14. A surgical instrument, comprising:

a cartridge supporting assembly configured to operably support a staple cartridge therein;

an anvil body movably coupled to said cartridge supporting assembly and being selectively movable between an open position and a closed position in response to opening and closing motions respectively applied thereto, said anvil body having an elongate anvil slot therein and a resilient structure configured to flexibly interact with

27

said firing member during said staple firing motion to allow a distance between a staple forming undersurface associated with said anvil body and an upper surface of said staple cartridge supported within said cartridge supporting assembly to vary in relation to a thickness of tissue clamped therebetween, said resilient structure comprising:

at least one right insert movable relative to said anvil body on a first side of said anvil slot and having a first staple forming undersurface thereon; and

at least one left insert movable relative to said anvil body on a second side of said anvil slot and having a second staple forming undersurface thereon; and

a firing member operably supported relative to said cartridge supporting assembly and being selectively translatable from an unfired position to a fired position in response to a firing force applied to said firing member and to retract to an unfired position in response to a retraction force applied to said firing member.

**15.** The surgical instrument of claim **14** further comprising: a right compliant member supported between each right insert and said anvil body; and

a left compliant member supported between each said left insert and said anvil body.

**16.** The surgical instrument of claim **15** wherein said right compliant member comprises at least one right bladder at least partially filled with a fluid medium and wherein said left compliant member comprises at least one left bladder at least partially filled with the fluid medium.

**17.** The surgical instrument of claim **16** wherein each of said right and left bladders are fluidically coupled to a fluid reservoir having a pressure adjustment mechanism operably supported therein for selectively increasing or decreasing fluid pressure in said right and left bladders.

**18.** The surgical instrument of claim **14** wherein said at least one right insert comprises a plurality of right inserts that correspond in number to a number of right staples in a staple cartridge supported within said cartridge supporting assembly and wherein said at least one left insert comprises a plurality of left inserts that correspond in number to a number of left staples in the staple cartridge.

**19.** The surgical instrument of claim **18** further comprising: at least one right biasing plate supported within said anvil body on a right side of said anvil slot and supporting a plurality of right biasing members wherein each said right biasing member corresponds to one of said right inserts; and

at least one left biasing plate supported within said anvil body on a left side of said anvil slot and supporting a plurality of left biasing members wherein each said left biasing member corresponds to one of said left inserts.

**20.** A surgical instrument, comprising:

a cartridge supporting assembly configured to operably support a staple cartridge therein, said cartridge supporting assembly having a first longitudinally extending ledge cantilevering inwardly from a first portion of said cartridge supporting assembly and a second longitudinally extending ledge cantilevering inwardly in spaced confronting relationship relative to said first ledge, said first and second ledge defining an elongate channel track thereunder and an elongate slot therebetween that extends into said elongate channel track;

an anvil movably coupled to said cartridge supporting assembly and being selectively movable between an open position and a closed position in response to opening and closing motions respectively applied thereto;

28

a firing member operably supported relative to said cartridge supporting assembly and being selectively translatable from an unfired position to a fired position in a staple firing motion in response to a firing force applied to said firing member and to retract to an unfired position in response to a retraction force applied to said firing member, said firing member having a vertical portion movably received in said elongate slot for axial travel therein and a lower foot movably received in said elongate channel track for axial travel therein, and wherein an upper portion of said firing member movably engages said anvil when said anvil is in said closed position;

at least one first undercut area in said first portion of said cartridge supporting assembly and at least one second undercut area in said second portion of said cartridge supporting assembly to enable said first and second ledges, respectively to flexibly interact with said firing member during said staple firing motion to allow a distance between a staple forming undersurface of said anvil and the upper surface of a staple cartridge supported within said cartridge supporting assembly to vary in relation to a thickness of tissue clamped therebetween.

**21.** The surgical instrument of claim **20** wherein said at least one first undercut area comprises:

a first upper undercut area in said first portion of said cartridge supporting assembly; and

a first lower undercut area in said second portion of said cartridge supporting assembly and wherein said at least one second undercut area comprises:

a second upper undercut area in said second portion of said cartridge supporting assembly; and

a second lower undercut area in said second portion of said cartridge supporting assembly.

**22.** A surgical instrument comprising:

an elongate staple channel having a longitudinal channel slot;

a staple cartridge operably supported within said elongate staple channel;

an elongate shaft operably coupled to said elongate staple channel;

an anvil pivotally attached to the elongate staple channel and being selectively pivotable between a closed position wherein a staple forming undersurface thereof is in confronting relationship to an upper surface of said staple cartridge supported within said elongate staple channel and an open position wherein a distal end of said anvil is spaced from said upper surface of said staple cartridge, said anvil having a first resilient anvil portion and a second resilient anvil portion spaced from said first resilient anvil portion to define a portion of an elongate anvil slot therebetween;

a control handle assembly proximally operably coupled through the elongate shaft to selectively apply opening and closing motions to said anvil; and

a firing member operably coupled to the control handle assembly through said elongate shaft for selective longitudinal reciprocating motion in the elongate staple channel such that one portion of said firing member extends through said anvil slot between said first and second resilient anvil portions and another portion of said firing member extends through said longitudinal channel slot, said firing member comprising:

a vertical portion wherein said one portion of said firing member comprises an upper end of said vertical portion and wherein said another portion of said firing member comprises a lower end of said vertical portion;

29

laterally extending pins protruding from the upper end of the vertical portion and being flexible relative thereto to bear upon the first and second resilient portions of said anvil during firing translation of said firing member therein; and

a foot portion extending from the lower end of the vertical portion positioned to exert an inward compressive force on the elongate channel during firing translation.

**23.** The surgical instrument of claim **22** wherein said first flexible portion of said anvil comprises at least one first staple insert movably supported within said anvil, said first staple insert having a first staple forming undersurface thereon and wherein said second flexible portion of said anvil comprises at least one second staple insert movably supported within said anvil and having a second staple forming undersurface thereon.

30

**24.** The surgical instrument of claim **23** further comprising: at least one first compliant member corresponding to each said first staple insert and supported between said corresponding first staple insert and a portion of said anvil; and

at least one second compliant member corresponding to each said second staple insert and supported between said corresponding second staple insert and another portion of said anvil.

**25.** The surgical instrument of claim **24** wherein each of said first and second compliant members is selected from the group of compliant members consisting of: springs, compressible polymer materials and fluid supporting bladders.

\* \* \* \* \*

专利名称(译)	具有柔性通道和铁砧特征的外科缝合器械具有可调节的钉高度		
公开(公告)号	<a href="#">US7467740</a>	公开(公告)日	2008-12-23
申请号	US11/540735	申请日	2006-09-29
[标]申请(专利权)人(译)	冯检谢尔顿IVê MORGAN JEROME - [R MURRAY迈克尔 TIMM RICHARDW 斯皮维JAMES† VOEGELE JAMESW FUGIKAWA LESLIE中号 TIMPERMAN EUGENE大号		
申请(专利权)人(译)	冯检谢尔顿IVê MORGAN JEROME - [R MURRAY迈克尔 TIMM RICHARDW 斯皮维JAMES† VOEGELE JAMESW FUGIKAWA LESLIE中号 TIMPERMAN EUGENE大号		
当前申请(专利权)人(译)	爱惜康内镜手术 , INC.		
[标]发明人	SHELTON IV FREDERICK E MORGAN JEROME R MURRAY MICHAEL A TIMM RICHARD W SPIVEY JAMES T VOEGELE JAMES W FUGIKAWA LESLIE M TIMPERMAN EUGENE L		
发明人	SHELTON, IV, FREDERICK E. MORGAN, JEROME R. MURRAY, MICHAEL A. TIMM, RICHARD W. SPIVEY, JAMES T. VOEGELE, JAMES W. FUGIKAWA, LESLIE M TIMPERMAN, EUGENE L.		
IPC分类号	A61B17/04		
CPC分类号	A61B17/07207 A61B2017/00535 A61B2017/00557 A61B2017/07242 A61B2017/0725 A61B2017/07278 A61B2017/320052 A61B2017/32113 A61B2019/302 A61B2019/481 A61B19/30 A61B90/03 A61B2090/032 A61B2090/08021		
其他公开文献	US20070083234A1		
外部链接	<a href="#">Espacenet</a> <a href="#">USPTO</a>		
摘要(译)			



用于内窥镜或腹腔镜插入手术部位以同时缝合和切断组织的手术器械包括上颌（砧）和下颌（钉仓接合到细长钉通道）之间的力调节间隔，使得高度为钉的形成对应于组织的厚度，但是不超过钉的长度可以适应的高度范围。特别地，弹性结构可以形成为支撑钉仓的细长通道中的一个或多个，可枢转地附接到细长通道的砧座，和/或包括切割组织的切割表面（刀）的击发构件在与砧座接合的顶销和与细长通道接合的下脚之间。弹性响应于被夹紧的组织施加的力，以改变砧座和支撑在细长通道内的钉仓之间的间隔。

