US008597575B2

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

(10) **Patent No.: US 8,597,575 B2**
(45) **Date of Patent: *Dec. 3, 2013**

(54) **ANALYTE MONITORING DEVICES AND METHODS THEREFOR**

(75) Inventors: **Mark K. Sloan**, Hayward, CA (US); **R. Curtis Jennewine**, San Francisco, CA (US)

(73) Assignee: **Abbott Diabetes Care Inc.**, Alameda, CA (US)

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

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **13/556,142**

(22) Filed: **Jul. 23, 2012**

(65) **Prior Publication Data**

US 2012/0289806 A1 Nov. 15, 2012

Related U.S. Application Data

(63) Continuation of application No. 11/396,182, filed on Mar. 31, 2006, now Pat. No. 8,226,891.

(51) **Int. Cl.**
G01N 33/50 (2006.01)
A61B 5/157 (2006.01)

(52) **U.S. Cl.**
USPC **422/82.02**; 604/504; 435/14; 435/970; 705/3

(58) **Field of Classification Search**
USPC 422/82.02, 82.01; 604/504; 435/14, 435/970; 705/3
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,755,036	A	7/1956	Mikko
3,260,656	A	7/1966	Ross, Jr.
3,304,413	A	2/1967	Lehmann et al.
3,581,062	A	5/1971	Aston
3,651,318	A	3/1972	Czekajewski
3,653,841	A	4/1972	Klein
3,698,386	A	10/1972	Fried
3,719,564	A	3/1973	Lilly, Jr. et al.
3,768,014	A	10/1973	Smith et al.
3,776,832	A	12/1973	Oswin et al.
3,837,339	A	9/1974	Aisenberg et al.
3,919,051	A	11/1975	Koch et al.
3,926,760	A	12/1975	Allen et al.
3,949,388	A	4/1976	Fuller
3,972,320	A	8/1976	Kalman
3,979,274	A	9/1976	Newman
4,003,379	A	1/1977	Ellinwood, Jr.

(Continued)

FOREIGN PATENT DOCUMENTS

AU	2003/259741	2/2004
CA	2495648	2/2004

(Continued)

OTHER PUBLICATIONS

Abruna, H. D., et al., "Rectifying Interfaces Using Two-Layer Films of Electrochemically Polymerized Vinylpyridine and Vinylbipyridine Complexes of Ruthenium and Iron on Electrodes", *Journal of the American Chemical Society*, vol. 103, No. 1, 1981, pp. 1-5.

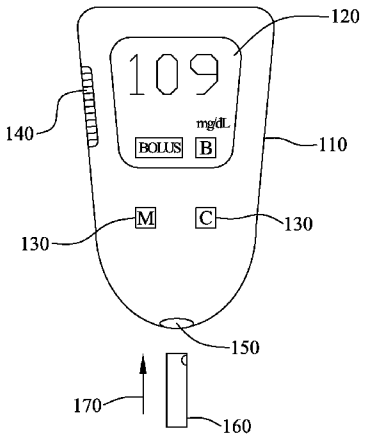
(Continued)

Primary Examiner — Paul Hyun
(74) *Attorney, Agent, or Firm* — Jackson & Co., LLP

(57) **ABSTRACT**

Method and apparatus for performing a discrete glucose testing and bolus dosage determination including a glucose meter with bolus calculation function are provided.

17 Claims, 5 Drawing Sheets



100

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,008,717	A	2/1977	Kowarski
4,016,866	A	4/1977	Lawton
4,021,718	A	5/1977	Konrad
4,036,749	A	7/1977	Anderson
4,055,175	A	10/1977	Clemens et al.
4,059,406	A	11/1977	Fleet
4,076,596	A	2/1978	Connery et al.
4,098,574	A	7/1978	Dappen
4,100,048	A	7/1978	Pompei et al.
4,129,128	A	12/1978	McFarlane
4,151,845	A	5/1979	Clemens
4,154,231	A	5/1979	Russell
4,168,205	A	9/1979	Danninger et al.
4,172,770	A	10/1979	Semersky et al.
4,178,916	A	12/1979	McNamara
4,193,026	A	3/1980	Finger et al.
4,206,755	A	6/1980	Klein
4,224,125	A	9/1980	Nakamura et al.
4,240,438	A	12/1980	Updike et al.
4,240,889	A	12/1980	Yoda et al.
4,245,634	A	1/1981	Albisser et al.
4,247,297	A	1/1981	Berti et al.
4,271,449	A	6/1981	Grogan
4,318,784	A	3/1982	Higgins et al.
4,327,725	A	5/1982	Cortese et al.
4,331,869	A	5/1982	Rollo
4,340,458	A	7/1982	Lerner et al.
4,344,438	A	8/1982	Schultz
4,349,728	A	9/1982	Phillips et al.
4,352,960	A	10/1982	Dormer et al.
4,356,074	A	10/1982	Johnson
4,365,637	A	12/1982	Johnson
4,366,033	A	12/1982	Richter et al.
4,375,399	A	3/1983	Havas et al.
4,384,586	A	5/1983	Christiansen
4,390,621	A	6/1983	Bauer
4,392,933	A	7/1983	Nakamura et al.
4,401,122	A	8/1983	Clark, Jr.
4,404,066	A	9/1983	Johnson
4,407,959	A	10/1983	Tsuji et al.
4,417,588	A	11/1983	Houghton et al.
4,418,148	A	11/1983	Oberhardt
4,420,564	A	12/1983	Tsuji et al.
4,425,920	A	1/1984	Bourland et al.
4,427,004	A	1/1984	Miller et al.
4,427,770	A	1/1984	Chen et al.
4,431,004	A	2/1984	Bessman et al.
4,436,094	A	3/1984	Cerami
4,440,175	A	4/1984	Wilkins
4,441,968	A	4/1984	Emmer et al.
4,444,892	A	4/1984	Malmros
4,450,842	A	5/1984	Zick et al.
4,458,686	A	7/1984	Clark, Jr.
4,461,691	A	7/1984	Frank
4,467,811	A	8/1984	Clark, Jr.
4,469,110	A	9/1984	Slama
4,475,901	A	10/1984	Kraegen et al.
4,477,314	A	10/1984	Richter et al.
4,478,976	A	10/1984	Goertz et al.
4,483,924	A	11/1984	Tsuji et al.
4,484,987	A	11/1984	Gough
4,494,950	A	1/1985	Fischell
4,509,531	A	4/1985	Ward
4,512,348	A	4/1985	Uchigaki et al.
4,522,690	A	6/1985	Venkatasetty
4,524,114	A	6/1985	Samuels et al.
4,526,661	A	7/1985	Steckhan et al.
4,527,240	A	7/1985	Kvitash
4,534,356	A	8/1985	Papadakis
4,538,616	A	9/1985	Rogoff
4,543,955	A	10/1985	Schroeppel
4,545,382	A	10/1985	Higgins et al.
4,552,840	A	11/1985	Riffer
4,560,534	A	12/1985	Kung et al.
4,569,589	A	2/1986	Neufeld
4,571,292	A	2/1986	Liu et al.
4,573,994	A	3/1986	Fischell et al.
4,581,336	A	4/1986	Malloy et al.
4,595,011	A	6/1986	Phillips
4,595,479	A	6/1986	Kimura et al.
4,601,707	A	7/1986	Albisser et al.
4,619,754	A	10/1986	Niki et al.
4,619,793	A	10/1986	Lee
4,627,445	A	12/1986	Garcia et al.
4,627,908	A	12/1986	Miller
4,633,878	A	1/1987	Bombardien
4,633,881	A	1/1987	Moore et al.
4,637,403	A	1/1987	Garcia et al.
4,648,408	A	3/1987	Hutcheson et al.
4,650,547	A	3/1987	Gough
4,653,513	A	3/1987	Dombrowski
4,654,197	A	3/1987	Lilja et al.
4,655,880	A	4/1987	Liu
4,655,885	A	4/1987	Hill et al.
4,658,463	A	4/1987	Sugita et al.
4,671,288	A	6/1987	Gough
4,674,652	A	6/1987	Aten et al.
4,679,562	A	7/1987	Luksha
4,680,268	A	7/1987	Clark, Jr.
4,682,602	A	7/1987	Prohaska
4,684,537	A	8/1987	Graetzel et al.
4,685,463	A	8/1987	Williams
4,685,903	A	8/1987	Cable et al.
4,686,624	A	8/1987	Blum et al.
4,703,324	A	10/1987	White
4,703,756	A	11/1987	Gough et al.
4,711,245	A	12/1987	Higgins et al.
4,717,673	A	1/1988	Wrighton et al.
4,721,601	A	1/1988	Wrighton et al.
4,721,677	A	1/1988	Clark, Jr.
4,726,378	A	2/1988	Kaplan
4,726,716	A	2/1988	McGuire
4,731,726	A	3/1988	Allen, III
4,749,985	A	6/1988	Corsberg
4,750,496	A	6/1988	Reinhardt
4,757,022	A	7/1988	Shults et al.
4,758,323	A	7/1988	Davis et al.
4,759,371	A	7/1988	Franetzki
4,759,828	A	7/1988	Young et al.
4,764,416	A	8/1988	Ueyama et al.
4,776,944	A	10/1988	Janata et al.
4,777,953	A	10/1988	Ash et al.
4,779,618	A	10/1988	Mund et al.
4,781,798	A	11/1988	Gough
4,784,736	A	11/1988	Lonsdale et al.
4,795,707	A	1/1989	Niiyama et al.
4,796,634	A	1/1989	Huntsman et al.
4,803,625	A	2/1989	Fu et al.
4,805,624	A	2/1989	Yao et al.
4,813,424	A	3/1989	Wilkins
4,815,469	A	3/1989	Cohen et al.
4,820,399	A	4/1989	Senda et al.
4,822,337	A	4/1989	Newhouse et al.
4,830,959	A	5/1989	McNeil et al.
4,832,797	A	5/1989	Vadgama et al.
4,835,372	A	5/1989	Gombrich et al.
RE32,947	E	6/1989	Dormer et al.
4,837,049	A	6/1989	Byers et al.
4,840,893	A	6/1989	Hill et al.
RE32,974	E	7/1989	Porat et al.
4,844,076	A	7/1989	Lesho et al.
4,845,035	A	7/1989	Fanta et al.
4,848,351	A	7/1989	Finch
4,854,322	A	8/1989	Ash et al.
4,856,340	A	8/1989	Garrison
4,857,713	A	8/1989	Brown
4,858,617	A	8/1989	Sanders
4,870,561	A	9/1989	Love et al.
4,871,351	A	10/1989	Feingold
4,871,440	A	10/1989	Nagata et al.
4,874,499	A	10/1989	Smith et al.
4,874,500	A	10/1989	Madou et al.
4,890,620	A	1/1990	Gough
4,890,621	A	1/1990	Hakky

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,894,137 A 1/1990 Takizawa et al.
4,897,162 A 1/1990 Lewandowski et al.
4,897,173 A 1/1990 Nankai et al.
4,899,839 A 2/1990 Dessertine et al.
4,909,908 A 3/1990 Ross et al.
4,911,794 A 3/1990 Parce et al.
4,917,800 A 4/1990 Lonsdale et al.
4,919,141 A 4/1990 Zier et al.
4,919,767 A 4/1990 Vadgama et al.
4,920,969 A 5/1990 Suzuki
4,920,977 A 5/1990 Haynes
4,923,586 A 5/1990 Katayama et al.
4,925,268 A 5/1990 Iyer et al.
4,927,516 A 5/1990 Yamaguchi et al.
4,931,795 A 6/1990 Gord
4,934,369 A 6/1990 Maxwell
4,935,105 A 6/1990 Churchouse
4,935,345 A 6/1990 Guibeau et al.
4,936,956 A 6/1990 Wrighton
4,938,860 A 7/1990 Wogoman
4,942,127 A 7/1990 Wada et al.
4,944,299 A 7/1990 Silvian
4,945,045 A 7/1990 Forrest et al.
4,950,378 A 8/1990 Nagata
4,953,552 A 9/1990 DeMarzo
4,954,129 A 9/1990 Giuliani et al.
4,957,115 A 9/1990 Selker
4,958,632 A 9/1990 Duggan
4,968,400 A 11/1990 Shimomura et al.
4,969,468 A 11/1990 Byers et al.
4,970,145 A 11/1990 Bennetto et al.
4,974,929 A 12/1990 Curry
4,979,509 A 12/1990 Hakky
4,986,271 A 1/1991 Wilkins
4,990,845 A 2/1991 Gord
4,991,582 A 2/1991 Byers et al.
4,994,068 A 2/1991 Hufnagle
4,994,167 A 2/1991 Shults et al.
4,995,402 A 2/1991 Smith et al.
5,000,180 A 3/1991 Kuypers et al.
5,001,054 A 3/1991 Wagner
5,002,054 A 3/1991 Ash et al.
5,007,427 A 4/1991 Suzuki et al.
5,016,172 A 5/1991 Dessertine
5,016,201 A 5/1991 Bryan et al.
5,019,974 A 5/1991 Beckers
5,034,192 A 7/1991 Wrighton et al.
5,035,860 A 7/1991 Kleingeld et al.
5,036,860 A 8/1991 Leigh et al.
5,036,861 A 8/1991 Sembrowich et al.
5,037,527 A 8/1991 Hayashi et al.
5,049,487 A 9/1991 Phillips et al.
5,050,612 A 9/1991 Matsumura
5,051,688 A 9/1991 Murase et al.
5,055,171 A 10/1991 Peck
5,058,592 A 10/1991 Whisler
5,063,081 A 11/1991 Cozzette et al.
5,068,536 A 11/1991 Rosenthal
5,070,535 A 12/1991 Hochmair et al.
5,073,500 A 12/1991 Saito et al.
5,077,476 A 12/1991 Rosenthal
5,078,854 A 1/1992 Burgess et al.
5,082,550 A 1/1992 Rishpon et al.
5,082,786 A 1/1992 Nakamoto
5,084,828 A 1/1992 Kaufman et al.
5,089,112 A 2/1992 Skotheim et al.
5,094,951 A 3/1992 Rosenberg
5,095,904 A 3/1992 Seligman et al.
5,096,560 A 3/1992 Takai et al.
5,096,836 A 3/1992 Macho et al.
5,097,834 A 3/1992 Skrabal
5,101,814 A 4/1992 Palti
5,106,365 A 4/1992 Hernandez
5,108,564 A 4/1992 Szuminsky et al.
5,109,850 A 5/1992 Blanco et al.
5,111,539 A 5/1992 Hiruta et al.
5,111,818 A 5/1992 Suzuji et al.
5,114,678 A 5/1992 Crawford et al.
5,120,420 A 6/1992 Nankai et al.
5,120,421 A 6/1992 Glass et al.
5,122,925 A 6/1992 Inpyn
5,124,661 A 6/1992 Zelin et al.
5,126,034 A 6/1992 Carter et al.
5,126,247 A 6/1992 Palmer et al.
5,130,009 A 7/1992 Marsoner et al.
5,133,856 A 7/1992 Yamaguchi et al.
5,134,391 A 7/1992 Okada
5,135,003 A 8/1992 Souma
5,139,023 A 8/1992 Stanley et al.
5,140,393 A 8/1992 Hijikihigawa et al.
5,141,868 A 8/1992 Shanks et al.
5,161,532 A 11/1992 Joseph
5,165,407 A 11/1992 Wilson et al.
5,168,046 A 12/1992 Hamamoto et al.
5,174,291 A 12/1992 Schoonen et al.
5,176,644 A 1/1993 Srisathapat et al.
5,176,662 A 1/1993 Bartholomew et al.
5,182,707 A 1/1993 Cooper et al.
5,184,359 A 2/1993 Tsukamura et al.
5,185,256 A 2/1993 Nankai et al.
5,190,041 A 3/1993 Palti
5,192,415 A 3/1993 Yoshioka et al.
5,192,416 A 3/1993 Wang et al.
5,193,539 A 3/1993 Schulman et al.
5,193,540 A 3/1993 Schulman et al.
5,197,322 A 3/1993 Indravudh
5,198,367 A 3/1993 Aizawa et al.
5,200,051 A 4/1993 Cozzette et al.
5,202,261 A 4/1993 Musho et al.
5,205,920 A 4/1993 Oyama et al.
5,206,145 A 4/1993 Cattell
5,208,154 A 5/1993 Weaver et al.
5,209,229 A 5/1993 Gilli
5,215,887 A 6/1993 Saito
5,216,597 A 6/1993 Beckers
5,217,442 A 6/1993 Davis
5,217,595 A 6/1993 Smith et al.
5,227,042 A 7/1993 Zawodzinski et al.
5,229,282 A 7/1993 Yoshioka et al.
5,236,143 A 8/1993 Dragon
5,237,993 A 8/1993 Skrabal
5,245,314 A 9/1993 Kah et al.
5,246,867 A 9/1993 Lakowicz et al.
5,250,439 A 10/1993 Musho et al.
5,251,126 A 10/1993 Kahn et al.
5,257,971 A 11/1993 Lord et al.
5,257,980 A 11/1993 Van Antwerp et al.
5,261,401 A 11/1993 Baker et al.
5,262,035 A 11/1993 Gregg et al.
5,262,305 A 11/1993 Heller et al.
5,264,103 A 11/1993 Yoshioka et al.
5,264,104 A 11/1993 Gregg et al.
5,264,105 A 11/1993 Gregg et al.
5,264,106 A 11/1993 McAleer et al.
5,265,888 A 11/1993 Yamamoto et al.
5,266,179 A 11/1993 Nankai et al.
5,269,212 A 12/1993 Peters et al.
5,271,815 A 12/1993 Wong
5,272,060 A 12/1993 Hamamoto et al.
5,275,159 A 1/1994 Griebel
5,278,079 A 1/1994 Gubinski et al.
5,279,294 A 1/1994 Anderson et al.
5,282,950 A 2/1994 Dietze et al.
5,284,156 A 2/1994 Schramm et al.
5,285,792 A 2/1994 Sjoquist et al.
5,286,362 A 2/1994 Hoenes et al.
5,286,364 A 2/1994 Yacynych et al.
5,288,636 A 2/1994 Pollmann et al.
5,289,497 A 2/1994 Jackobson et al.
5,291,887 A 3/1994 Stanley et al.
5,293,546 A 3/1994 Tadros et al.
5,293,877 A 3/1994 O'Hara et al.
5,299,571 A 4/1994 Mastrototaro
5,304,468 A 4/1994 Phillips et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,307,263 A 4/1994 Brown
5,309,919 A 5/1994 Snell et al.
5,310,885 A 5/1994 Maier et al.
5,320,098 A 6/1994 Davidson
5,320,725 A 6/1994 Gregg et al.
5,322,063 A 6/1994 Allen et al.
5,324,303 A 6/1994 Strong et al.
5,324,316 A 6/1994 Schulman et al.
5,326,449 A 7/1994 Cunningham
5,333,615 A 8/1994 Craelius et al.
5,337,258 A 8/1994 Dennis
5,337,747 A 8/1994 Neftei
5,340,722 A 8/1994 Wolfbeis et al.
5,342,408 A 8/1994 deCoriolis et al.
5,342,789 A 8/1994 Chick et al.
5,352,348 A 10/1994 Young et al.
5,356,348 A 10/1994 Bellio et al.
5,356,786 A 10/1994 Heller et al.
5,358,135 A 10/1994 Robbins et al.
5,358,514 A 10/1994 Schulman et al.
5,360,404 A 11/1994 Novacek et al.
5,364,797 A 11/1994 Olson et al.
5,366,609 A 11/1994 White et al.
5,368,028 A 11/1994 Palti
5,370,622 A 12/1994 Livingston et al.
5,371,687 A 12/1994 Holmes, II et al.
5,371,734 A 12/1994 Fischer
5,372,133 A 12/1994 Hogen Esch
5,372,427 A 12/1994 Padovani et al.
5,376,070 A 12/1994 Purvis et al.
5,376,251 A 12/1994 Kaneko et al.
5,377,258 A 12/1994 Bro
5,378,628 A 1/1995 Gratzel et al.
5,379,238 A 1/1995 Stark
5,379,764 A 1/1995 Barnes et al.
5,380,422 A 1/1995 Negishi et al.
5,382,346 A 1/1995 Uenoyama et al.
5,387,327 A 2/1995 Khan
5,390,671 A 2/1995 Lord et al.
5,391,250 A 2/1995 Cheney, II et al.
5,393,903 A 2/1995 Gratzel et al.
5,395,504 A 3/1995 Saurer et al.
5,399,823 A 3/1995 McCusker
5,400,782 A 3/1995 Beaubiah
5,400,794 A 3/1995 Gorman
5,408,999 A 4/1995 Singh et al.
5,410,326 A 4/1995 Goldstein
5,410,471 A 4/1995 Alyfuku et al.
5,410,474 A 4/1995 Fox
5,411,647 A 5/1995 Johnson et al.
5,413,690 A 5/1995 Kost et al.
5,422,246 A 6/1995 Koopal et al.
5,425,868 A 6/1995 Pedersen
5,431,160 A 7/1995 Wilkins
5,431,691 A 7/1995 Snell et al.
5,431,921 A 7/1995 Thombre
5,433,710 A 7/1995 Van Antwerp et al.
5,437,973 A 8/1995 Vadgama et al.
5,437,999 A 8/1995 Dieboid et al.
5,438,271 A 8/1995 White et al.
5,445,611 A 8/1995 Eppstein et al.
5,445,920 A 8/1995 Saito
5,456,692 A 10/1995 Smith, Jr. et al.
5,456,940 A 10/1995 Funderburk
5,458,140 A 10/1995 Eppstein et al.
5,460,618 A 10/1995 Harreld
5,462,525 A 10/1995 Srisathapat et al.
5,462,645 A 10/1995 Albery et al.
5,466,218 A 11/1995 Srisathapat et al.
5,467,778 A 11/1995 Catt et al.
5,469,846 A 11/1995 Khan
5,472,317 A 12/1995 Field et al.
5,476,460 A 12/1995 Montalvo
5,477,855 A 12/1995 Schindler et al.
5,482,473 A 1/1996 Lord et al.
5,484,404 A 1/1996 Schulman et al.
5,487,751 A 1/1996 Radons et al.
5,491,474 A 2/1996 Suni et al.
5,494,562 A 2/1996 Maley et al.
5,496,453 A 3/1996 Uenoyama et al.
5,497,772 A 3/1996 Schulman et al.
5,499,243 A 3/1996 Hall
5,501,956 A 3/1996 Wada et al.
5,505,709 A 4/1996 Funderburk
5,505,713 A 4/1996 Van Antwerp et al.
5,507,288 A 4/1996 Bocker et al.
5,508,171 A 4/1996 Walling et al.
5,509,410 A 4/1996 Hill et al.
5,514,103 A 5/1996 Srisathapat et al.
5,514,253 A 5/1996 Davis et al.
5,514,718 A 5/1996 Lewis et al.
5,518,006 A 5/1996 Mawhirt et al.
5,520,787 A 5/1996 Hanagan et al.
5,522,865 A 6/1996 Schulman et al.
5,525,511 A 6/1996 D'Costa
5,526,120 A 6/1996 Jina et al.
5,527,307 A 6/1996 Srisathapat et al.
5,529,676 A 6/1996 Maley et al.
5,531,878 A 7/1996 Vadgama et al.
5,538,511 A 7/1996 Van Antwerp et al.
5,544,196 A 8/1996 Tiedemann, Jr. et al.
5,545,152 A 8/1996 Funderburk et al.
5,545,191 A 8/1996 Mann et al.
5,549,113 A 8/1996 Halleck et al.
5,549,115 A 8/1996 Morgan et al.
5,552,027 A 9/1996 Birkle et al.
5,554,166 A 9/1996 Lange et al.
5,556,524 A 9/1996 Albers
5,560,357 A 10/1996 Faupei et al.
5,562,713 A 10/1996 Silvian
5,565,085 A 10/1996 Ikeda et al.
5,567,302 A 10/1996 Song et al.
5,568,806 A 10/1996 Cheney, II et al.
5,569,186 A 10/1996 Lord et al.
5,569,212 A 10/1996 Brown
5,573,647 A 11/1996 Maley et al.
5,575,895 A 11/1996 Ikeda et al.
5,580,527 A 12/1996 Bell et al.
5,580,794 A 12/1996 Allen
5,581,206 A 12/1996 Chevallier et al.
5,582,184 A 12/1996 Erickson et al.
5,582,697 A 12/1996 Ikeda et al.
5,582,698 A 12/1996 Flaherty et al.
5,584,813 A 12/1996 Livingston et al.
5,586,553 A 12/1996 Halili et al.
5,589,326 A 12/1996 Deng et al.
5,593,852 A 1/1997 Heller et al.
5,594,906 A 1/1997 Holmes, II et al.
5,596,150 A 1/1997 Arndy et al.
5,596,994 A 1/1997 Bro
5,600,301 A 2/1997 Robinson, III
5,601,435 A 2/1997 Quy
5,601,694 A 2/1997 Maley et al.
5,605,152 A 2/1997 Slate et al.
5,609,575 A 3/1997 Larson et al.
5,611,900 A 3/1997 Worden et al.
5,615,135 A 3/1997 Waclawsky et al.
5,615,671 A 4/1997 Schoonen et al.
5,616,222 A 4/1997 Maley et al.
5,617,851 A 4/1997 Lipkovker
5,623,925 A 4/1997 Swenson et al.
5,623,933 A 4/1997 Amano et al.
5,628,309 A 5/1997 Brown
5,628,310 A 5/1997 Rao et al.
5,628,890 A 5/1997 Carter et al.
5,629,981 A 5/1997 Nerlikar
5,637,095 A 6/1997 Nason et al.
5,640,764 A 6/1997 Strojnik
5,640,954 A 6/1997 Pfeiffer et al.
5,643,212 A 7/1997 Coutre et al.
5,647,853 A 7/1997 Feldmann et al.
5,650,062 A 7/1997 Ikeda et al.
5,651,767 A 7/1997 Schulman et al.
5,651,869 A 7/1997 Yoshioka et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,653,239 A 8/1997 Pompei et al.
5,659,454 A 8/1997 Vermesse
5,660,163 A 8/1997 Schulman et al.
5,665,065 A 9/1997 Colman et al.
5,665,222 A 9/1997 Heller et al.
5,667,983 A 9/1997 Abel et al.
5,670,031 A 9/1997 Hintsche et al.
5,678,571 A 10/1997 Brown
5,679,690 A 10/1997 Andre et al.
5,680,858 A 10/1997 Hansen et al.
5,682,233 A 10/1997 Brinda
5,686,717 A 11/1997 Knowles et al.
5,695,623 A 12/1997 Michel et al.
5,695,949 A 12/1997 Galen et al.
5,701,894 A 12/1997 Cherry et al.
5,704,922 A 1/1998 Brown
5,707,502 A 1/1998 McCaffrey et al.
5,708,247 A 1/1998 McAleer et al.
5,710,630 A 1/1998 Essenpreis et al.
5,711,001 A 1/1998 Bussan et al.
5,711,297 A 1/1998 Iliff et al.
5,711,861 A 1/1998 Ward et al.
5,711,862 A 1/1998 Sakoda et al.
5,711,868 A 1/1998 Maley et al.
5,718,234 A 2/1998 Warden et al.
5,720,733 A 2/1998 Brown
5,720,862 A 2/1998 Hamamoto et al.
5,721,783 A 2/1998 Anderson
5,722,397 A 3/1998 Eppstein
5,727,548 A 3/1998 Hill et al.
5,730,124 A 3/1998 Yamauchi
5,730,654 A 3/1998 Brown
5,735,273 A 4/1998 Kurnik et al.
5,735,285 A 4/1998 Albert et al.
5,741,211 A 4/1998 Renirie et al.
5,741,688 A 4/1998 Oxenboll et al.
5,746,217 A 5/1998 Erickson et al.
5,748,103 A 5/1998 Flach et al.
5,750,926 A 5/1998 Schulman et al.
5,758,290 A 5/1998 Nealon et al.
5,770,028 A 6/1998 Maley et al.
5,771,001 A 6/1998 Cobb
5,771,890 A 6/1998 Tamada
5,772,586 A 6/1998 Heinonen et al.
5,777,060 A 7/1998 Van Antwerp
5,779,665 A 7/1998 Mastrototaro et al.
5,781,024 A 7/1998 Blomberg et al.
5,782,814 A 7/1998 Brown et al.
5,785,681 A 7/1998 Indravudh
5,786,439 A 7/1998 Van Antwerp et al.
5,786,584 A 7/1998 Button et al.
5,788,678 A 8/1998 Van Antwerp
5,791,344 A 8/1998 Schulman et al.
5,792,117 A 8/1998 Brown
5,793,292 A 8/1998 Ivey
5,800,420 A 9/1998 Gross et al.
5,804,048 A 9/1998 Wong et al.
5,807,315 A 9/1998 Van Antwerp et al.
5,807,375 A 9/1998 Gross et al.
5,814,599 A 9/1998 Mitragotri et al.
5,820,551 A 10/1998 Hill et al.
5,820,570 A 10/1998 Erickson et al.
5,820,622 A 10/1998 Gross et al.
5,822,715 A 10/1998 Worthington et al.
5,825,488 A 10/1998 Kohl et al.
5,827,179 A 10/1998 Lichter et al.
5,827,183 A 10/1998 Kurnik et al.
5,827,184 A 10/1998 Netherly et al.
5,828,943 A 10/1998 Brown
5,830,064 A 11/1998 Bradish et al.
5,830,341 A 11/1998 Gilmartin
5,832,448 A 11/1998 Brown
5,834,224 A 11/1998 Ruger et al.
5,837,454 A 11/1998 Cozzette et al.
5,837,546 A 11/1998 Allen et al.
5,840,020 A 11/1998 Heinonen et al.
5,842,983 A 12/1998 Abel et al.
5,843,140 A 12/1998 Strojnik
5,846,702 A 12/1998 Deng et al.
5,846,744 A 12/1998 Athey et al.
5,851,197 A 12/1998 Marano et al.
5,854,078 A 12/1998 Asher et al.
5,854,189 A 12/1998 Kruse et al.
5,856,758 A 1/1999 Joffe et al.
5,857,967 A 1/1999 Frid et al.
5,857,983 A 1/1999 Douglas et al.
5,860,917 A 1/1999 Comanor et al.
5,872,713 A 2/1999 Douglas et al.
5,876,484 A 3/1999 Raskin et al.
5,879,163 A 3/1999 Brown et al.
5,879,311 A 3/1999 Duchon et al.
5,880,829 A 3/1999 Kauhaniemi et al.
5,882,494 A 3/1999 Van Antwerp
5,885,211 A 3/1999 Eppstein et al.
5,887,133 A 3/1999 Brown et al.
5,897,493 A 4/1999 Brown
5,898,025 A 4/1999 Burg et al.
5,899,855 A 5/1999 Brown
5,913,310 A 6/1999 Brown
5,917,346 A 6/1999 Gord
5,918,603 A 7/1999 Brown
5,925,021 A 7/1999 Castellano et al.
5,931,791 A 8/1999 Saltzstein et al.
5,933,136 A 8/1999 Brown
5,935,099 A 8/1999 Petterson
5,935,224 A 8/1999 Svancarek et al.
5,939,609 A 8/1999 Knapp et al.
5,940,801 A 8/1999 Brown
5,942,979 A 8/1999 Luppino
5,945,345 A 8/1999 Blatt et al.
5,947,921 A 9/1999 Johnson et al.
5,948,512 A 9/1999 Kubota et al.
5,950,632 A 9/1999 Reber et al.
5,951,300 A 9/1999 Brown
5,951,492 A 9/1999 Douglas et al.
5,951,521 A 9/1999 Mastrototaro et al.
5,951,836 A 9/1999 McAleer et al.
5,954,643 A 9/1999 Van Antwerp
5,954,685 A 9/1999 Tierney
5,954,700 A 9/1999 Kovelman
5,956,501 A 9/1999 Brown
5,957,854 A 9/1999 Besson et al.
5,957,890 A 9/1999 Mann et al.
5,957,958 A 9/1999 Schulman et al.
5,960,403 A 9/1999 Brown
5,961,451 A 10/1999 Reber et al.
5,964,993 A 10/1999 Blubaugh, Jr. et al.
5,965,380 A 10/1999 Heller et al.
5,968,839 A 10/1999 Blatt et al.
5,971,922 A 10/1999 Arita et al.
5,971,941 A 10/1999 Simons et al.
5,974,124 A 10/1999 Schlueter, Jr. et al.
5,977,476 A 11/1999 Guha et al.
5,981,294 A 11/1999 Blatt et al.
5,989,409 A 11/1999 Kurnik et al.
5,994,476 A 11/1999 Shin et al.
5,995,860 A 11/1999 Sun et al.
5,997,476 A 12/1999 Brown
5,999,848 A 12/1999 Gord et al.
5,999,849 A 12/1999 Gord et al.
6,001,067 A 12/1999 Shults et al.
6,002,954 A 12/1999 Van Antwerp et al.
6,002,961 A 12/1999 Mitragotri et al.
6,004,441 A 12/1999 Fujiwara et al.
6,011,984 A 1/2000 Van Antwerp et al.
6,014,577 A 1/2000 Henning et al.
6,018,678 A 1/2000 Mitragotri et al.
6,023,629 A 2/2000 Tamada
6,024,699 A 2/2000 Surwit et al.
6,026,320 A 2/2000 Carlson et al.
6,027,459 A 2/2000 Shain et al.
6,027,692 A 2/2000 Galen et al.
6,028,413 A 2/2000 Brockmann
6,032,059 A 2/2000 Henning et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,032,199 A 2/2000 Lim et al.
6,033,866 A 3/2000 Guo et al.
6,035,237 A 3/2000 Schulman et al.
6,040,194 A 3/2000 Chick et al.
6,041,253 A 3/2000 Kost et al.
6,043,437 A 3/2000 Schulman et al.
6,049,727 A 4/2000 Crothall
6,052,565 A 4/2000 Ishikura et al.
D424,696 S 5/2000 Ray et al.
6,056,718 A 5/2000 Funderburk et al.
6,063,459 A 5/2000 Velte
6,066,243 A 5/2000 Anderson et al.
6,067,474 A 5/2000 Schulman et al.
6,068,615 A 5/2000 Brown et al.
D426,638 S 6/2000 Ray et al.
D427,312 S 6/2000 Douglas
6,071,249 A 6/2000 Cunningham et al.
6,071,251 A 6/2000 Cunningham et al.
6,071,294 A 6/2000 Simons et al.
6,071,391 A 6/2000 Gotoh et al.
6,073,031 A 6/2000 Helstab et al.
6,081,736 A 6/2000 Colvin et al.
6,083,710 A 7/2000 Heller et al.
6,088,608 A 7/2000 Schulman et al.
6,091,975 A 7/2000 Daddona et al.
6,091,976 A 7/2000 Pfeiffer et al.
6,093,156 A 7/2000 Cunningham et al.
6,093,167 A 7/2000 Houben et al.
6,093,172 A 7/2000 Funderburk et al.
6,097,480 A 8/2000 Kaplan
6,097,831 A 8/2000 Wieck et al.
6,099,484 A 8/2000 Douglas et al.
6,101,478 A 8/2000 Brown
6,103,033 A 8/2000 Say et al.
6,106,780 A 8/2000 Douglas et al.
6,110,148 A 8/2000 Brown et al.
6,110,152 A 8/2000 Kovelman
6,113,578 A 9/2000 Brown
6,117,290 A 9/2000 Say et al.
6,119,028 A 9/2000 Schulman et al.
6,120,676 A 9/2000 Heller et al.
6,121,009 A 9/2000 Heller et al.
6,121,611 A 9/2000 Lindsay et al.
6,122,351 A 9/2000 Schlueter, Jr. et al.
6,125,978 A 10/2000 Ando et al.
6,134,461 A 10/2000 Say et al.
6,134,504 A 10/2000 Douglas et al.
6,139,718 A 10/2000 Kurnik et al.
6,141,573 A 10/2000 Kurnik et al.
6,142,939 A 11/2000 Eppstein et al.
6,143,164 A 11/2000 Heller et al.
6,144,837 A 11/2000 Quy
6,144,869 A 11/2000 Berner et al.
6,144,922 A 11/2000 Douglas et al.
6,148,094 A 11/2000 Kinsella
6,150,128 A 11/2000 Uretsky
6,151,586 A 11/2000 Brown
6,153,062 A 11/2000 Saito et al.
6,153,069 A 11/2000 Pottgen et al.
6,159,147 A 12/2000 Lichter et al.
6,161,095 A 12/2000 Brown
6,162,611 A 12/2000 Heller et al.
6,162,639 A 12/2000 Douglas
6,164,284 A 12/2000 Schulman et al.
6,167,362 A 12/2000 Brown et al.
6,168,563 B1 1/2001 Brown
6,170,318 B1 1/2001 Lewis
6,175,752 B1 1/2001 Say et al.
6,180,416 B1 1/2001 Kurnik et al.
6,186,145 B1 2/2001 Brown
6,192,891 B1 2/2001 Gravel et al.
6,193,873 B1 2/2001 Ohara et al.
D439,242 S 3/2001 Brown et al.
6,196,970 B1 3/2001 Brown
6,198,957 B1 3/2001 Green
6,200,265 B1 3/2001 Walsh et al.
6,201,979 B1 3/2001 Kurnik et al.
6,201,980 B1 3/2001 Darrow et al.
6,203,495 B1 3/2001 Bardy et al.
6,206,841 B1 3/2001 Cunningham et al.
6,207,400 B1 3/2001 Kwon
6,208,894 B1 3/2001 Schulman et al.
6,210,272 B1 4/2001 Brown
6,210,976 B1 4/2001 Sabbadini
6,212,416 B1 4/2001 Ward et al.
6,219,565 B1 4/2001 Cupp et al.
6,219,574 B1 4/2001 Cormier et al.
6,224,745 B1 5/2001 Baltruschat
6,232,130 B1 5/2001 Wolf
6,232,370 B1 5/2001 Kubota et al.
6,233,471 B1 5/2001 Berner et al.
6,233,539 B1 5/2001 Brown
6,239,925 B1 5/2001 Ardrey et al.
6,241,862 B1 6/2001 McAleer et al.
6,246,330 B1 6/2001 Nielsen
6,246,992 B1 6/2001 Brown
6,248,065 B1 6/2001 Brown
6,248,067 B1 6/2001 Causey, III et al.
6,248,093 B1 6/2001 Moberg
6,251,260 B1 6/2001 Heller et al.
6,252,032 B1 6/2001 Van Antwerp et al.
6,253,804 B1 7/2001 Safabash
6,254,586 B1 7/2001 Mann et al.
6,256,643 B1 7/2001 Cork et al.
6,259,587 B1 7/2001 Sheldon et al.
6,259,937 B1 7/2001 Schulman et al.
6,260,022 B1 7/2001 Brown
6,266,645 B1 7/2001 Simpson
6,267,724 B1 7/2001 Taylor
6,268,161 B1 7/2001 Han et al.
6,270,445 B1 8/2001 Dean, Jr. et al.
6,272,364 B1 8/2001 Kurnik
6,275,717 B1 8/2001 Gross et al.
6,280,416 B1 8/2001 Van Antwerp et al.
6,280,587 B1 8/2001 Matsumoto
6,281,006 B1 8/2001 Heller et al.
6,283,943 B1 9/2001 Dy et al.
6,284,126 B1 9/2001 Kurnik et al.
6,284,478 B1 9/2001 Heller et al.
6,293,925 B1 9/2001 Safabash et al.
6,294,281 B1 9/2001 Heller
6,295,463 B1 9/2001 Stenzler
6,295,506 B1 9/2001 Heinonen et al.
6,298,254 B2 10/2001 Tamada
6,299,578 B1 10/2001 Kurnik et al.
6,299,757 B1 10/2001 Feldman et al.
6,301,499 B1 10/2001 Carlson et al.
6,304,766 B1 10/2001 Colvin, Jr. et al.
6,306,104 B1 10/2001 Cunningham et al.
6,307,867 B1 10/2001 Roobol et al.
6,309,351 B1 10/2001 Kurnik et al.
6,309,884 B1 10/2001 Cooper et al.
6,313,749 B1 11/2001 Horne et al.
6,315,721 B2 11/2001 Schulman et al.
6,319,540 B1 11/2001 Van Antwerp et al.
6,326,160 B1 12/2001 Dunn et al.
6,329,161 B1 12/2001 Heller et al.
6,329,929 B1 12/2001 Weijand et al.
6,330,426 B2 12/2001 Brown et al.
6,330,464 B1 12/2001 Colvin, Jr. et al.
6,331,518 B2 12/2001 Hemm et al.
6,334,778 B1 1/2002 Brown
6,336,900 B1 1/2002 Alleckson et al.
6,338,790 B1 1/2002 Feldman et al.
6,340,421 B1 1/2002 Vachon et al.
6,341,232 B1 1/2002 Conn et al.
6,356,776 B1 3/2002 Berner et al.
6,359,270 B1 3/2002 Bridson
6,360,888 B1 3/2002 McIvor et al.
6,366,793 B1 4/2002 Bell et al.
6,366,794 B1 4/2002 Moussy et al.
6,368,141 B1 4/2002 Van Antwerp et al.
6,368,274 B1 4/2002 Van Antwerp et al.
6,370,410 B2 4/2002 Kurnik et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,377,828 B1 4/2002 Chaiken et al.
6,379,301 B1 4/2002 Worthington et al.
6,383,767 B1 5/2002 Polak
6,387,048 B1 5/2002 Schulman et al.
6,391,643 B1 5/2002 Chen et al.
6,393,318 B1 5/2002 Conn et al.
6,398,562 B1 6/2002 Butler et al.
6,405,066 B1 6/2002 Essenpreis et al.
6,413,393 B1 7/2002 Van Antwerp et al.
6,416,471 B1 7/2002 Kumar et al.
6,418,332 B1 7/2002 Mastrototaro et al.
6,424,847 B1 7/2002 Mastrototaro et al.
6,427,088 B1 7/2002 Bowman, IV et al.
6,434,409 B1 8/2002 Pfeiffer et al.
6,438,414 B1 8/2002 Conn et al.
6,440,068 B1 8/2002 Brown et al.
6,442,637 B1 8/2002 Hawkins et al.
6,442,672 B1 8/2002 Ganapathy
6,443,942 B2 9/2002 Van Antwerp et al.
6,449,255 B1 9/2002 Waclawsky et al.
6,454,710 B1 9/2002 Ballerstadt et al.
6,462,162 B2 10/2002 Van Antwerp et al.
6,464,848 B1 10/2002 Matsumoto
6,466,810 B1 10/2002 Ward et al.
6,468,222 B1 10/2002 Mault et al.
6,472,122 B1 10/2002 Schulman et al.
6,475,750 B1 11/2002 Han et al.
6,477,395 B2 11/2002 Schulman et al.
6,478,736 B1 11/2002 Mault
6,480,730 B2 11/2002 Darrow et al.
6,482,156 B2 11/2002 Iliff
6,482,158 B2 11/2002 Mault
6,482,604 B2 11/2002 Kwon
6,484,045 B1 11/2002 Holker et al.
6,484,046 B1 11/2002 Say et al.
6,485,138 B1 11/2002 Kubota et al.
6,493,069 B1 12/2002 Nagashimada et al.
6,494,830 B1 12/2002 Wessel
6,496,728 B2 12/2002 Li et al.
6,505,059 B1 1/2003 Kollias et al.
6,505,121 B1 1/2003 Russell
6,512,939 B1 1/2003 Colvin et al.
6,513,532 B2 2/2003 Mault et al.
6,514,718 B2 2/2003 Heller et al.
6,515,593 B1 2/2003 Stark et al.
6,520,326 B2 2/2003 McIvor et al.
6,529,755 B2 3/2003 Kurnik et al.
6,529,772 B2 3/2003 Carlson et al.
6,530,915 B1 3/2003 Eppstein et al.
6,534,322 B1 3/2003 Sabbadini
6,534,323 B1 3/2003 Sabbadini
6,535,753 B1 3/2003 Raskas
6,537,243 B1 3/2003 Henning et al.
6,540,675 B2 4/2003 Aceti et al.
6,541,266 B2 4/2003 Modzelweskei et al.
6,544,212 B2 4/2003 Galley et al.
6,546,269 B1 4/2003 Kurnik
6,549,796 B2 4/2003 Sohrab
6,551,276 B1 4/2003 Mann et al.
6,551,494 B1 4/2003 Heller et al.
6,553,244 B2 4/2003 Lesho et al.
6,554,798 B1 4/2003 Mann et al.
6,558,320 B1 5/2003 Causey, III et al.
6,558,321 B1 5/2003 Burd et al.
6,558,351 B1 5/2003 Steil et al.
6,560,471 B1 5/2003 Heller et al.
6,561,978 B1 5/2003 Conn et al.
6,562,001 B2 5/2003 Lebel et al.
6,564,105 B2 5/2003 Starkweather et al.
6,564,807 B1 5/2003 Schulman et al.
6,565,509 B1 5/2003 Say et al.
6,571,128 B2 5/2003 Lebel et al.
6,571,200 B1 5/2003 Mault
6,576,101 B1 6/2003 Heller et al.
6,576,117 B1 6/2003 Iketaki et al.
6,577,899 B2 6/2003 Lebel et al.
6,579,498 B1 6/2003 Eglise
6,579,690 B1 6/2003 Bonnecaze et al.
6,584,335 B1 6/2003 Haar et al.
6,585,644 B2 7/2003 Lebel et al.
6,587,705 B1 7/2003 Kim et al.
6,591,125 B1 7/2003 Buse et al.
6,591,126 B2 7/2003 Roeper et al.
6,594,514 B2 7/2003 Berner et al.
6,595,919 B2 7/2003 Berner et al.
6,595,929 B2 7/2003 Stivoric et al.
6,602,678 B2 8/2003 Kwon et al.
6,602,909 B1 8/2003 Jarowski
6,605,200 B1 8/2003 Mao et al.
6,605,201 B1 8/2003 Mao et al.
6,607,509 B2 8/2003 Bobroff et al.
6,608,562 B1 8/2003 Kimura et al.
6,610,012 B2 8/2003 Mault
6,611,206 B2 8/2003 Eshelman et al.
6,612,306 B1 9/2003 Mault
6,615,078 B1 9/2003 Burson et al.
6,616,613 B1 9/2003 Goodman
6,618,603 B2 9/2003 Varalli et al.
6,620,106 B2 9/2003 Mault
6,627,058 B1 9/2003 Chan
6,627,154 B1 9/2003 Goodman et al.
6,629,934 B2 10/2003 Mault et al.
6,633,772 B2 10/2003 Ford et al.
6,635,014 B2 10/2003 Starkweather et al.
6,641,533 B2 11/2003 Causey, III et al.
6,642,015 B2 11/2003 Vachon et al.
6,645,142 B2 11/2003 Braig et al.
6,645,368 B1 11/2003 Beaty et al.
6,648,821 B2 11/2003 Lebel et al.
6,653,091 B1 11/2003 Dunn et al.
6,654,625 B1 11/2003 Say et al.
6,656,114 B1 12/2003 Poulson et al.
6,658,396 B1 12/2003 Tang et al.
6,659,948 B2 12/2003 Lebel et al.
6,668,196 B1 12/2003 Villegas et al.
6,671,554 B2 12/2003 Gibson et al.
6,673,625 B2 1/2004 Satcher, Jr. et al.
6,682,938 B1 1/2004 Satcher, Jr. et al.
6,683,040 B2 1/2004 Bragulla et al.
6,687,522 B2 2/2004 Tamada
6,687,546 B2 2/2004 Lebel et al.
6,689,056 B1 2/2004 Kilcoyne et al.
6,690,276 B1 2/2004 Marino
6,693,069 B2 2/2004 Korber et al.
6,694,158 B2 2/2004 Polak
6,694,191 B2 2/2004 Starkweather et al.
6,695,860 B1 2/2004 Ward et al.
6,698,269 B2 3/2004 Baber et al.
6,701,270 B1 3/2004 Miller et al.
6,702,857 B2 3/2004 Brauker et al.
6,704,587 B1 3/2004 Kumar et al.
6,708,057 B2 3/2004 Marganroth
6,711,423 B2 3/2004 Colvin, Jr.
6,723,046 B2 4/2004 Lichtenstein et al.
6,728,560 B2 4/2004 Kollias et al.
6,731,976 B2 5/2004 Penn et al.
6,733,446 B2 5/2004 Lebel et al.
6,734,162 B2 5/2004 Van Antwerp et al.
6,735,479 B2 5/2004 Fabian et al.
6,736,777 B2 5/2004 Kim et al.
6,736,797 B1 5/2004 Larsen et al.
6,737,401 B2 5/2004 Kim et al.
6,738,654 B2 5/2004 Sohrab
6,740,075 B2 5/2004 Lebel et al.
6,741,163 B1 5/2004 Roberts
6,741,876 B1 5/2004 Scecina et al.
6,741,877 B1 5/2004 Shults et al.
6,746,582 B2 6/2004 Heller et al.
6,748,445 B1 6/2004 Darcy et al.
6,749,587 B2 6/2004 Flaherty
6,750,311 B1 6/2004 Van Antwerp et al.
6,758,810 B2 7/2004 Lebel et al.
6,766,183 B2 7/2004 Walsh et al.
6,766,201 B2 7/2004 Von Arx et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,768,425 B2 7/2004 Flaherty et al.
6,770,030 B1 8/2004 Schaupp et al.
6,770,729 B2 8/2004 Van Antwerp et al.
6,771,995 B2 8/2004 Kurnik et al.
6,773,563 B2 8/2004 Matsumoto
6,780,156 B2 8/2004 Haueter et al.
6,780,297 B2 8/2004 Matsumoto et al.
6,780,871 B2 8/2004 Glick et al.
6,784,274 B2 8/2004 Van Antwerp et al.
6,790,178 B1 9/2004 Mault et al.
6,794,195 B2 9/2004 Colvin, Jr.
6,800,451 B2 10/2004 Daniloff et al.
6,804,544 B2 10/2004 Van Antwerp et al.
6,809,507 B2 10/2004 Morgan et al.
6,809,653 B1 10/2004 Mann et al.
6,810,290 B2 10/2004 Lebel et al.
6,810,309 B2 10/2004 Sadler et al.
6,811,533 B2 11/2004 Lebel et al.
6,811,534 B2 11/2004 Bowman, IV et al.
6,811,659 B2 11/2004 Vachon
6,812,031 B1 11/2004 Carlsson
6,813,519 B2 11/2004 Lebel et al.
6,816,742 B2 11/2004 Kim et al.
6,835,553 B2 12/2004 Han et al.
RE38,681 E 1/2005 Kurnik et al.
6,840,912 B2 1/2005 Kloepfer et al.
6,844,023 B2 1/2005 Schulman et al.
6,849,237 B2 2/2005 Housefield et al.
6,850,790 B2 2/2005 Berner et al.
6,852,104 B2 2/2005 Blomquist
6,852,500 B1 2/2005 Hoss et al.
6,852,694 B2 2/2005 Van Antwerp et al.
6,853,854 B1 2/2005 Proniewicz et al.
6,856,928 B2 2/2005 Harmon
6,858,403 B2 2/2005 Han et al.
6,862,465 B2 3/2005 Shults et al.
6,862,466 B2 3/2005 Ackerman
6,872,200 B2 3/2005 Mann et al.
6,873,268 B2 3/2005 Lebel et al.
6,881,551 B2 4/2005 Heller et al.
6,882,940 B2 4/2005 Potts et al.
6,885,883 B2 4/2005 Parris et al.
6,889,331 B2 5/2005 Soerensen et al.
6,892,085 B2 5/2005 McIvor et al.
6,895,263 B2 5/2005 Shin et al.
6,895,265 B2 5/2005 Silver
6,899,683 B2 5/2005 Mault et al.
6,899,684 B2 5/2005 Mault et al.
6,902,207 B2 6/2005 Lickliter
6,902,905 B2 6/2005 Burson et al.
6,904,301 B2 6/2005 Raskas
6,907,127 B1 6/2005 Kravitz et al.
6,915,147 B2 7/2005 Lebel et al.
6,918,874 B1 7/2005 Hatch et al.
6,922,578 B2 7/2005 Eppstein et al.
RE38,775 E 8/2005 Kurnik et al.
6,923,764 B2 8/2005 Aceti et al.
6,923,936 B2 8/2005 Swanson et al.
6,927,246 B2 8/2005 Noronha et al.
6,931,327 B2 8/2005 Goode, Jr. et al.
6,932,894 B2 8/2005 Mao et al.
6,936,006 B2 8/2005 Sabra
6,936,029 B2 8/2005 Mann et al.
6,937,222 B2 8/2005 Numao
6,940,590 B2 9/2005 Colvin, Jr. et al.
6,941,163 B2 9/2005 Ford et al.
6,950,708 B2 9/2005 Bowman IV et al.
6,952,603 B2 10/2005 Gerber et al.
6,954,673 B2 10/2005 Von Arx et al.
6,955,650 B2 10/2005 Mault et al.
6,957,102 B2 10/2005 Silver et al.
6,957,107 B2 10/2005 Rogers et al.
6,958,705 B2 10/2005 Lebel et al.
6,968,294 B2 11/2005 Gutta et al.
6,968,375 B1 11/2005 Brown
6,971,274 B2 12/2005 Olin
6,974,437 B2 12/2005 Lebel et al.
6,978,182 B2 12/2005 Mazar et al.
6,979,326 B2 12/2005 Mann et al.
6,985,870 B2 1/2006 Martucci et al.
6,990,366 B2 1/2006 Say et al.
6,991,096 B2 1/2006 Gottlieb et al.
6,997,907 B2 2/2006 Safabash et al.
6,997,920 B2 2/2006 Mann et al.
6,998,247 B2 2/2006 Monfre et al.
6,999,810 B2 2/2006 Berner et al.
7,003,336 B2 2/2006 Holker et al.
7,003,340 B2 2/2006 Say et al.
7,003,341 B2 2/2006 Say et al.
7,004,901 B2 2/2006 Fish
7,005,857 B2 2/2006 Stiene et al.
7,011,630 B2 3/2006 Desai et al.
7,018,366 B2 3/2006 Easter
7,018,568 B2 3/2006 Tierney
7,022,072 B2 4/2006 Fox et al.
7,024,236 B2 4/2006 Ford et al.
7,024,245 B2 4/2006 Lebel et al.
7,025,743 B2 4/2006 Mann et al.
7,027,931 B1 4/2006 Jones et al.
7,029,444 B2 4/2006 Shin et al.
7,039,810 B1 5/2006 Nichols
7,041,068 B2 5/2006 Freeman et al.
7,041,468 B2 5/2006 Drucker et al.
7,049,277 B2 5/2006 Bragulla et al.
7,052,251 B2 5/2006 Nason et al.
7,052,472 B1 5/2006 Miller et al.
7,052,483 B2 5/2006 Wojcik
7,056,302 B2 6/2006 Douglas
7,060,030 B2 6/2006 Von Arx et al.
7,074,307 B2 7/2006 Simpson et al.
7,081,195 B2 7/2006 Simpson et al.
7,089,780 B2 8/2006 Sunshine et al.
7,098,803 B2 8/2006 Mann et al.
7,108,778 B2 9/2006 Simpson et al.
7,110,803 B2 9/2006 Shults et al.
7,113,821 B1 9/2006 Sun et al.
7,114,502 B2 10/2006 Schulman et al.
7,124,027 B1 10/2006 Ernst et al.
7,125,382 B2 10/2006 Zhou et al.
7,133,710 B2 11/2006 Acosta et al.
7,134,999 B2 11/2006 Brauker et al.
7,136,689 B2 11/2006 Shults et al.
7,150,975 B2 12/2006 Tamada et al.
7,154,398 B2 12/2006 Chen et al.
7,155,112 B2 12/2006 Uno et al.
7,155,290 B2 12/2006 Von Arx et al.
7,163,511 B2 1/2007 Conn et al.
7,171,274 B2 1/2007 Starkweather et al.
7,174,199 B2 2/2007 Berner et al.
7,183,068 B2 2/2007 Burson et al.
7,183,102 B2 2/2007 Monfre et al.
7,189,341 B2 3/2007 Li et al.
7,190,988 B2 3/2007 Say et al.
7,192,450 B2 3/2007 Brauker et al.
7,198,606 B2 4/2007 Boecker et al.
7,221,977 B1 5/2007 Weaver et al.
7,226,442 B2 6/2007 Sheppard et al.
7,226,978 B2 6/2007 Tapsak et al.
7,228,162 B2 6/2007 Ward et al.
7,228,163 B2 6/2007 Ackerman
7,233,817 B2 6/2007 Yen
7,241,266 B2 7/2007 Zhou et al.
7,261,691 B1 8/2007 Asomani
7,267,665 B2 9/2007 Steil et al.
7,276,029 B2 10/2007 Goode, Jr. et al.
7,278,983 B2 10/2007 Ireland et al.
7,291,107 B2 11/2007 Hellwig et al.
7,295,867 B2 11/2007 Berner et al.
7,297,112 B2 11/2007 Zhou et al.
7,299,082 B2 11/2007 Feldman et al.
7,310,544 B2 12/2007 Brister et al.
7,324,012 B2 1/2008 Mann et al.
7,335,294 B2 2/2008 Heller et al.
7,354,420 B2 4/2008 Steil et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,364,592 B2 4/2008 Carr-Brendel et al.
7,366,556 B2 4/2008 Brister et al.
7,379,765 B2 5/2008 Petisce et al.
7,398,183 B2 7/2008 Holland et al.
7,402,153 B2 7/2008 Steil et al.
7,404,796 B2 7/2008 Ginsberg
7,408,132 B2 8/2008 Wambsganss et al.
7,424,318 B2 9/2008 Brister et al.
7,460,898 B2 12/2008 Brister et al.
7,467,003 B2 12/2008 Brister et al.
7,471,972 B2 12/2008 Rhodes et al.
7,494,465 B2 2/2009 Brister et al.
7,497,827 B2 3/2009 Brister et al.
7,519,408 B2 4/2009 Rasdal et al.
7,547,281 B2 6/2009 Hayes et al.
7,569,030 B2 8/2009 Lebel et al.
7,583,990 B2 9/2009 Goode, Jr. et al.
7,591,801 B2 9/2009 Brauker et al.
7,599,726 B2 10/2009 Goode, Jr. et al.
7,613,491 B2 11/2009 Boock et al.
7,615,007 B2 11/2009 Shults et al.
7,618,369 B2 11/2009 Hayter et al.
7,632,228 B2 12/2009 Brauker et al.
7,637,868 B2 12/2009 Saint et al.
7,640,048 B2 12/2009 Dobbles et al.
7,651,596 B2 1/2010 Petisce et al.
7,654,956 B2 2/2010 Brister et al.
7,657,297 B2 2/2010 Simpson et al.
7,699,775 B2 4/2010 Desai et al.
7,701,052 B2 4/2010 Borland et al.
7,711,402 B2 5/2010 Shults et al.
7,713,574 B2 5/2010 Brister et al.
7,715,893 B2 5/2010 Kamath et al.
7,768,387 B2 8/2010 Fennell et al.
7,813,809 B2 10/2010 Strother et al.
7,948,369 B2 5/2011 Fennell et al.
8,000,918 B2 8/2011 Fjield et al.
8,010,174 B2 8/2011 Goode et al.
8,149,103 B2 4/2012 Fennell et al.
2001/0011224 A1 8/2001 Brown
2001/0016310 A1 8/2001 Brown et al.
2001/0016682 A1 8/2001 Berner et al.
2001/0016683 A1 8/2001 Darrow et al.
2001/0020124 A1 9/2001 Tamada
2001/0029340 A1 10/2001 Mault et al.
2001/0032278 A1 10/2001 Brown et al.
2001/0037060 A1 11/2001 Thompson et al.
2001/0037069 A1 11/2001 Carlson et al.
2001/0037366 A1 11/2001 Webb et al.
2001/0039504 A1 11/2001 Linberg et al.
2001/0041830 A1 11/2001 Varalli et al.
2001/0041831 A1 11/2001 Starkweather et al.
2001/0044581 A1 11/2001 Mault
2001/0044588 A1 11/2001 Mault
2001/0047125 A1 11/2001 Quy
2001/0047127 A1 11/2001 New et al.
2001/0049096 A1 12/2001 Brown
2001/0049470 A1 12/2001 Mault et al.
2002/0002326 A1 1/2002 Causey, III et al.
2002/0002328 A1 1/2002 Tamada
2002/0004640 A1 1/2002 Conn et al.
2002/0010414 A1 1/2002 Coston et al.
2002/0013522 A1 1/2002 Lav et al.
2002/0013538 A1 1/2002 Teller
2002/0016530 A1 2/2002 Brown
2002/0016719 A1 2/2002 Nemeth et al.
2002/0019022 A1 2/2002 Dunn et al.
2002/0019584 A1 2/2002 Schulze et al.
2002/0019586 A1 2/2002 Teller et al.
2002/0019748 A1 2/2002 Brown
2002/0026937 A1 3/2002 Mault
2002/0027164 A1 3/2002 Mault et al.
2002/0028995 A1 3/2002 Mault
2002/0040208 A1 4/2002 Flaherty et al.
2002/0042090 A1 4/2002 Heller et al.
2002/0047867 A1 4/2002 Mault et al.
2002/0049482 A1 4/2002 Fabian et al.
2002/0053637 A1 5/2002 Conn et al.
2002/0062069 A1 5/2002 Mault
2002/0063060 A1 5/2002 Gascoyne et al.
2002/0068858 A1 6/2002 Braig et al.
2002/0072784 A1 6/2002 Sheppard et al.
2002/0072858 A1 6/2002 Cheng
2002/0074162 A1 6/2002 Su et al.
2002/0077765 A1 6/2002 Mault
2002/0077766 A1 6/2002 Mault
2002/0081559 A1 6/2002 Brown et al.
2002/0083461 A1 6/2002 Hutcheson et al.
2002/0084196 A1 7/2002 Liamos et al.
2002/0087056 A1 7/2002 Aceti et al.
2002/0091312 A1 7/2002 Berner et al.
2002/0091796 A1 7/2002 Higginson et al.
2002/0093969 A1 7/2002 Lin et al.
2002/0103425 A1 8/2002 Mault
2002/0103499 A1 8/2002 Perez et al.
2002/0106709 A1 8/2002 Potts et al.
2002/0107433 A1 8/2002 Mault
2002/0107476 A1 8/2002 Mann et al.
2002/0109600 A1 8/2002 Mault et al.
2002/0118528 A1 8/2002 Su et al.
2002/0119711 A1 8/2002 Van Antwerp et al.
2002/0124017 A1 9/2002 Mault
2002/0126036 A1 9/2002 Flaherty et al.
2002/0128594 A1 9/2002 Das et al.
2002/0130042 A1 9/2002 Moerman et al.
2002/0133378 A1 9/2002 Mault et al.
2002/0147135 A1 10/2002 Schnell
2002/0161286 A1 10/2002 Gerber et al.
2002/0161288 A1 10/2002 Shin et al.
2002/0169394 A1 11/2002 Eppstein et al.
2002/0169635 A1 11/2002 Shillingburg
2002/0177764 A1 11/2002 Sohrab
2002/0193679 A1 12/2002 Malave et al.
2003/0004403 A1 1/2003 Drinan et al.
2003/0023182 A1 1/2003 Mault et al.
2003/0023317 A1 1/2003 Brauker et al.
2003/0028089 A1 2/2003 Galley et al.
2003/0028120 A1 2/2003 Mault et al.
2003/0032077 A1 2/2003 Itoh et al.
2003/0032867 A1 2/2003 Crothall et al.
2003/0032868 A1 2/2003 Graskov et al.
2003/0032874 A1 2/2003 Rhodes et al.
2003/0040683 A1 2/2003 Rule et al.
2003/0042137 A1 3/2003 Mao et al.
2003/0050537 A1 3/2003 Wessel
2003/0050546 A1 3/2003 Desai et al.
2003/0060692 A1 3/2003 Ruchti et al.
2003/0065257 A1 4/2003 Mault et al.
2003/0065273 A1 4/2003 Mault et al.
2003/0065274 A1 4/2003 Mault et al.
2003/0065275 A1 4/2003 Mault et al.
2003/0065308 A1 4/2003 Lebel et al.
2003/0076792 A1 4/2003 Theimer
2003/0081370 A1 5/2003 Haskell et al.
2003/0100040 A1 5/2003 Bonnecaze et al.
2003/0100821 A1 5/2003 Heller et al.
2003/0105407 A1 6/2003 Pearce et al.
2003/0108976 A1 6/2003 Braig et al.
2003/0114897 A1 6/2003 Von Arx et al.
2003/0119457 A1 6/2003 Standke
2003/0122021 A1 7/2003 McConnell et al.
2003/0125612 A1 7/2003 Fox et al.
2003/0130616 A1 7/2003 Steil et al.
2003/0134347 A1 7/2003 Heller et al.
2003/0135100 A1 7/2003 Kim et al.
2003/0135333 A1 7/2003 Aceti et al.
2003/0144579 A1 7/2003 Buss
2003/0146841 A1 8/2003 Koenig
2003/0153820 A1 8/2003 Berner et al.
2003/0153821 A1 8/2003 Berner et al.
2003/0158472 A1 8/2003 Sohrab
2003/0158707 A1 8/2003 Doi
2003/0168338 A1 9/2003 Gao et al.
2003/0175806 A1 9/2003 Rule et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2003/0176183 A1 9/2003 Drucker et al.
2003/0176933 A1 9/2003 Lebel et al.
2003/0181851 A1 9/2003 Mann et al.
2003/0181852 A1 9/2003 Mann et al.
2003/0187338 A1 10/2003 Say et al.
2003/0187525 A1 10/2003 Mann et al.
2003/0191376 A1 10/2003 Samuels et al.
2003/0191431 A1 10/2003 Mann et al.
2003/0195403 A1 10/2003 Berner et al.
2003/0195462 A1 10/2003 Mann et al.
2003/0199790 A1 10/2003 Boecker et al.
2003/0199791 A1 10/2003 Boecker et al.
2003/0199903 A1 10/2003 Boecker et al.
2003/0203498 A1 10/2003 Neel et al.
2003/0204290 A1 10/2003 Sadler et al.
2003/0208110 A1 11/2003 Mault et al.
2003/0208113 A1 11/2003 Mault et al.
2003/0208114 A1 11/2003 Ackerman
2003/0208133 A1 11/2003 Mault
2003/0208409 A1 11/2003 Mault
2003/0212317 A1 11/2003 Kovatchev et al.
2003/0212364 A1 11/2003 Mann et al.
2003/0212379 A1 11/2003 Bylund et al.
2003/0212579 A1 11/2003 Brown et al.
2003/0216630 A1 11/2003 Jersey-Willuhn et al.
2003/0217966 A1 11/2003 Tapsak et al.
2003/0226695 A1 12/2003 Mault
2003/0229514 A2 12/2003 Brown
2003/0232370 A1 12/2003 Trifiro
2003/0235817 A1 12/2003 Bartkowiak et al.
2004/0010207 A1 1/2004 Flaherty et al.
2004/0011671 A1 1/2004 Shults et al.
2004/0017300 A1 1/2004 Kotzin et al.
2004/0018486 A1 1/2004 Dunn et al.
2004/0030226 A1 2/2004 Quy
2004/0030531 A1 2/2004 Miller et al.
2004/0034289 A1 2/2004 Teller et al.
2004/0039255 A1 2/2004 Simonsen et al.
2004/0039256 A1 2/2004 Kawatahara et al.
2004/0039298 A1 2/2004 Abreu et al.
2004/0040840 A1 3/2004 Mao et al.
2004/0045879 A1 3/2004 Shults et al.
2004/0054263 A1 3/2004 Moerman et al.
2004/0059201 A1 3/2004 Ginsberg
2004/0063435 A1 4/2004 Sakamoto et al.
2004/0064068 A1 4/2004 DeNuzzio et al.
2004/0069164 A1 4/2004 Nakamura et al.
2004/0072357 A1 4/2004 Stiene et al.
2004/0073095 A1 4/2004 Causey, III et al.
2004/0096959 A1 5/2004 Stiene et al.
2004/0100376 A1 5/2004 Lye et al.
2004/0105411 A1 6/2004 Boatwright et al.
2004/0106858 A1 6/2004 Say et al.
2004/0108226 A1 6/2004 Polychronakos et al.
2004/0122353 A1 6/2004 Shahmirian et al.
2004/0122489 A1 6/2004 Mazar et al.
2004/0122530 A1 6/2004 Hansen et al.
2004/0133164 A1 7/2004 Funderburk et al.
2004/0138588 A1 7/2004 Saikley et al.
2004/0146909 A1 7/2004 Duong et al.
2004/0152622 A1 8/2004 Keith et al.
2004/0152961 A1 8/2004 Carlson et al.
2004/0153585 A1 8/2004 Kawatahara et al.
2004/0162473 A1 8/2004 Sohrab
2004/0164961 A1 8/2004 Bal et al.
2004/0167383 A1 8/2004 Kim et al.
2004/0167464 A1 8/2004 Ireland et al.
2004/0167801 A1 8/2004 Say et al.
2004/0171921 A1 9/2004 Say et al.
2004/0172284 A1 9/2004 Sullivan et al.
2004/0176672 A1 9/2004 Silver et al.
2004/0176913 A1 9/2004 Kawatahara et al.
2004/0186362 A1 9/2004 Brauker et al.
2004/0186365 A1 9/2004 Jin et al.
2004/0193025 A1 9/2004 Steil et al.
2004/0193090 A1 9/2004 Lebel et al.
2004/0197846 A1 10/2004 Hockersmith et al.
2004/0199059 A1 10/2004 Brauker et al.
2004/0202576 A1 10/2004 Aceti et al.
2004/0204687 A1 10/2004 Mogensen et al.
2004/0204868 A1 10/2004 Maynard et al.
2004/0206916 A1 10/2004 Colvin, Jr. et al.
2004/0208780 A1 10/2004 Faries, Jr. et al.
2004/0221057 A1 11/2004 Darcy et al.
2004/0225338 A1 11/2004 Lebel et al.
2004/0235446 A1 11/2004 Flaherty et al.
2004/0236200 A1 11/2004 Say et al.
2004/0248204 A1 12/2004 Moerman
2004/0249250 A1 12/2004 McGee et al.
2004/0249253 A1 12/2004 Racchini et al.
2004/0249254 A1 12/2004 Racchini et al.
2004/0249999 A1 12/2004 Connolly et al.
2004/0253736 A1 12/2004 Stout et al.
2004/0254429 A1 12/2004 Yang
2004/0254433 A1 12/2004 Bandis et al.
2004/0254434 A1 12/2004 Goodnow et al.
2004/0260363 A1 12/2004 Von Arx et al.
2004/0263354 A1 12/2004 Mann et al.
2004/0267300 A1 12/2004 Mace
2005/0003470 A1 1/2005 Nelson et al.
2005/0004439 A1 1/2005 Shin et al.
2005/0004494 A1 1/2005 Perez et al.
2005/0010087 A1 1/2005 Banet et al.
2005/0010269 A1 1/2005 Lebel et al.
2005/0016276 A1 1/2005 Guan et al.
2005/0027177 A1 2/2005 Shin et al.
2005/0027179 A1 2/2005 Berner et al.
2005/0027180 A1 2/2005 Goode, Jr. et al.
2005/0027181 A1 2/2005 Goode, Jr. et al.
2005/0027462 A1 2/2005 Goode, Jr. et al.
2005/0027463 A1 2/2005 Goode, Jr. et al.
2005/0031689 A1 2/2005 Shults et al.
2005/0033132 A1 2/2005 Shults et al.
2005/0038332 A1 2/2005 Saidara et al.
2005/0038680 A1 2/2005 McMahon
2005/0043598 A1 2/2005 Goode, Jr. et al.
2005/0043894 A1 2/2005 Fernandez
2005/0049473 A1 3/2005 Desai et al.
2005/0054909 A1 3/2005 Petisce et al.
2005/0065464 A1 3/2005 Talbot et al.
2005/0090607 A1 4/2005 Tapsak et al.
2005/0096511 A1 5/2005 Fox et al.
2005/0096512 A1 5/2005 Fox et al.
2005/0096516 A1 5/2005 Soykan et al.
2005/0112169 A1 5/2005 Brauker et al.
2005/0112544 A1 5/2005 Xu et al.
2005/0113653 A1 5/2005 Fox et al.
2005/0113657 A1 5/2005 Alarcon et al.
2005/0113658 A1 5/2005 Jacobson et al.
2005/0113886 A1 5/2005 Fischell et al.
2005/0114068 A1 5/2005 Chey et al.
2005/0116683 A1 6/2005 Cheng et al.
2005/0118726 A1 6/2005 Schultz et al.
2005/0121322 A1 6/2005 Say et al.
2005/0124873 A1 6/2005 Shults et al.
2005/0131346 A1 6/2005 Douglas
2005/0137471 A1 6/2005 Haar et al.
2005/0137530 A1 6/2005 Campbell et al.
2005/0143635 A1 6/2005 Kamath et al.
2005/0143636 A1 6/2005 Zhang et al.
2005/0148003 A1 7/2005 Kieth et al.
2005/0154271 A1 7/2005 Rasdal et al.
2005/0161346 A1 7/2005 Simpson et al.
2005/0171503 A1 8/2005 Van Den Berghe et al.
2005/0171513 A1 8/2005 Mann et al.
2005/0173245 A1 8/2005 Feldman et al.
2005/0176136 A1 8/2005 Burd et al.
2005/0177036 A1 8/2005 Shults et al.
2005/0177398 A1 8/2005 Watanabe et al.
2005/0181012 A1 8/2005 Saint et al.
2005/0182306 A1 8/2005 Sloan
2005/0182451 A1 8/2005 Griffin et al.
2005/0187720 A1 8/2005 Goode, Jr. et al.
2005/0192494 A1 9/2005 Ginsberg

(56) **References Cited**

U.S. PATENT DOCUMENTS

2005/0192557 A1 9/2005 Brauker et al.
2005/0195930 A1 9/2005 Spital et al.
2005/0199494 A1 9/2005 Say et al.
2005/0203360 A1 9/2005 Brauker et al.
2005/0203707 A1 9/2005 Tsutsui et al.
2005/0204134 A1 9/2005 Von Arx et al.
2005/0214892 A1 9/2005 Kovatchev et al.
2005/0215871 A1 9/2005 Feldman et al.
2005/0215872 A1 9/2005 Berner et al.
2005/0221504 A1 10/2005 Petruno et al.
2005/0239154 A1 10/2005 Feldman et al.
2005/0239156 A1 10/2005 Drucker et al.
2005/0241957 A1 11/2005 Mao et al.
2005/0245795 A1 11/2005 Goode, Jr. et al.
2005/0245799 A1 11/2005 Brauker et al.
2005/0245839 A1 11/2005 Stivoric et al.
2005/0245904 A1 11/2005 Estes et al.
2005/0251033 A1 11/2005 Scarantino et al.
2005/0251083 A1 11/2005 Carr-Brendel et al.
2005/0261660 A1 11/2005 Choi
2005/0267780 A1 12/2005 Ray et al.
2005/0271546 A1 12/2005 Gerber et al.
2005/0271547 A1 12/2005 Gerber et al.
2005/0272640 A1 12/2005 Doyle, III et al.
2005/0272985 A1 12/2005 Kotulla et al.
2005/0277164 A1 12/2005 Drucker et al.
2005/0287620 A1 12/2005 Heller et al.
2006/0001538 A1 1/2006 Kraft et al.
2006/0001550 A1 1/2006 Mann et al.
2006/0001551 A1 1/2006 Kraft et al.
2006/0003398 A1 1/2006 Heller et al.
2006/0004270 A1 1/2006 Bedard et al.
2006/0004271 A1 1/2006 Peyser et al.
2006/0007017 A1 1/2006 Mann et al.
2006/0015020 A1 1/2006 Neale et al.
2006/0015024 A1 1/2006 Brister et al.
2006/0016700 A1 1/2006 Brister et al.
2006/0019327 A1 1/2006 Brister et al.
2006/0020186 A1 1/2006 Brister et al.
2006/0020187 A1 1/2006 Brister et al.
2006/0020188 A1 1/2006 Kamath et al.
2006/0020189 A1 1/2006 Brister et al.
2006/0020190 A1 1/2006 Kamath et al.
2006/0020191 A1 1/2006 Brister et al.
2006/0020192 A1 1/2006 Brister et al.
2006/0025663 A1 2/2006 Talbot et al.
2006/0029177 A1 2/2006 Cranford, Jr. et al.
2006/0031094 A1 2/2006 Cohen et al.
2006/0036139 A1 2/2006 Brister et al.
2006/0036140 A1 2/2006 Brister et al.
2006/0036141 A1 2/2006 Kamath et al.
2006/0036142 A1 2/2006 Brister et al.
2006/0036143 A1 2/2006 Brister et al.
2006/0036144 A1 2/2006 Brister et al.
2006/0036145 A1 2/2006 Brister et al.
2006/0036187 A1 2/2006 Vos et al.
2006/0040402 A1 2/2006 Brauker et al.
2006/0052679 A1 3/2006 Kotulla et al.
2006/0058602 A1 3/2006 Kwiatkowski et al.
2006/0063218 A1 3/2006 Bartkowiak et al.
2006/0074564 A1 4/2006 Bartowiak et al.
2006/0129733 A1 6/2006 Sobelman
2006/0142651 A1 6/2006 Brister et al.
2006/0154642 A1 7/2006 Scannell
2006/0155180 A1 7/2006 Brister et al.
2006/0166629 A1 7/2006 Reggiardo
2006/0173260 A1 8/2006 Gaoni et al.
2006/0173406 A1 8/2006 Hayes et al.
2006/0173444 A1 8/2006 Choy et al.
2006/0183985 A1 8/2006 Brister et al.
2006/0189863 A1 8/2006 Peyser et al.
2006/0195029 A1 8/2006 Shults et al.
2006/0200112 A1 9/2006 Paul
2006/0202859 A1 9/2006 Mastrototaro et al.
2006/0222566 A1 10/2006 Brauker et al.
2006/0224109 A1 10/2006 Steil et al.
2006/0224141 A1 10/2006 Rush et al.
2006/0226985 A1 10/2006 Goodnow et al.
2006/0229512 A1 10/2006 Petisce et al.
2006/0247508 A1 11/2006 Fennell
2006/0247985 A1 11/2006 Liamos et al.
2006/0258918 A1 11/2006 Burd et al.
2006/0258929 A1 11/2006 Goode, Jr. et al.
2006/0263763 A1 11/2006 Simpson et al.
2006/0264785 A1 11/2006 Dring et al.
2006/0270922 A1 11/2006 Brauker et al.
2006/0272652 A1 12/2006 Stocker et al.
2006/0290496 A1 12/2006 Peeters et al.
2007/0016381 A1 1/2007 Kamath et al.
2007/0027381 A1 2/2007 Stafford
2007/0033074 A1 2/2007 Nitzan et al.
2007/0060814 A1 3/2007 Stafford
2007/0066873 A1 3/2007 Kamath et al.
2007/0071681 A1 3/2007 Gadkar et al.
2007/0073129 A1 3/2007 Shah et al.
2007/0078320 A1 4/2007 Stafford
2007/0078321 A1 4/2007 Mazza et al.
2007/0078322 A1 4/2007 Stafford
2007/0078323 A1 4/2007 Reggiardo et al.
2007/0090511 A1 4/2007 Borland et al.
2007/0093786 A1 4/2007 Goldsmith et al.
2007/0106135 A1 5/2007 Sloan et al.
2007/0124002 A1 5/2007 Estes et al.
2007/0149873 A1 6/2007 Say et al.
2007/0149874 A1 6/2007 Say et al.
2007/0149875 A1 6/2007 Ouyang et al.
2007/0151869 A1 7/2007 Heller et al.
2007/0161879 A1 7/2007 Say et al.
2007/0161880 A1 7/2007 Say et al.
2007/0163880 A1 7/2007 Woo et al.
2007/0168224 A1 7/2007 Letzt et al.
2007/0173706 A1 7/2007 Neinast et al.
2007/0173761 A1 7/2007 Kanderian et al.
2007/0179349 A1 8/2007 Hoyme et al.
2007/0179352 A1 8/2007 Randlov et al.
2007/0179370 A1 8/2007 Say et al.
2007/0179372 A1 8/2007 Say et al.
2007/0191699 A1 8/2007 Say et al.
2007/0191700 A1 8/2007 Say et al.
2007/0191701 A1 8/2007 Feldman et al.
2007/0203407 A1 8/2007 Hoss et al.
2007/0203408 A1 8/2007 Say et al.
2007/0203410 A1 8/2007 Say et al.
2007/0203411 A1 8/2007 Say et al.
2007/0203966 A1 8/2007 Brauker et al.
2007/0208247 A1 9/2007 Say et al.
2007/0213610 A1 9/2007 Say et al.
2007/0213657 A1 9/2007 Jennewine et al.
2007/0215491 A1 9/2007 Heller et al.
2007/0218097 A1 9/2007 Heller et al.
2007/0219496 A1 9/2007 Kamen et al.
2007/0222609 A1 9/2007 Duron et al.
2007/0232877 A1 10/2007 He
2007/0235331 A1 10/2007 Simpson et al.
2007/0244380 A1 10/2007 Say et al.
2007/0249919 A1 10/2007 Say et al.
2007/0249920 A1 10/2007 Say et al.
2007/0249922 A1 10/2007 Peyser et al.
2007/0282299 A1 12/2007 Hellwig
2007/0299617 A1 12/2007 Willis
2008/0004515 A1 1/2008 Jennewine et al.
2008/0004601 A1 1/2008 Jennewine et al.
2008/0009304 A1 1/2008 Fry
2008/0009692 A1 1/2008 Stafford
2008/0017522 A1 1/2008 Heller et al.
2008/0021666 A1 1/2008 Goode, Jr. et al.
2008/0029391 A1 2/2008 Mao et al.
2008/0033254 A1 2/2008 Kamath et al.
2008/0039702 A1 2/2008 Hayter et al.
2008/0045824 A1 2/2008 Tapsak et al.
2008/0055070 A1 3/2008 Bange et al.
2008/0058625 A1 3/2008 McGarraugh et al.
2008/0064937 A1 3/2008 McGarraugh et al.
2008/0067627 A1 3/2008 Boeck et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2008/0071156 A1 3/2008 Brister et al.
2008/0071157 A1 3/2008 McGarraugh et al.
2008/0071158 A1 3/2008 McGarraugh et al.
2008/0081977 A1 4/2008 Hayter et al.
2008/0083617 A1 4/2008 Simpson et al.
2008/0086042 A1 4/2008 Brister et al.
2008/0086044 A1 4/2008 Brister et al.
2008/0086273 A1 4/2008 Shults et al.
2008/0097289 A1 4/2008 Steil et al.
2008/0108942 A1 5/2008 Brister et al.
2008/0154513 A1 6/2008 Kovatchev et al.
2008/0161666 A1 7/2008 Feldman et al.
2008/0167543 A1 7/2008 Say et al.
2008/0172205 A1 7/2008 Breton et al.
2008/0183060 A1 7/2008 Steil et al.
2008/0183061 A1 7/2008 Goode et al.
2008/0183399 A1 7/2008 Goode et al.
2008/0188731 A1 8/2008 Brister et al.
2008/0188796 A1 8/2008 Steil et al.
2008/0189051 A1 8/2008 Goode et al.
2008/0194934 A1 8/2008 Ray et al.
2008/0194935 A1 8/2008 Brister et al.
2008/0194936 A1 8/2008 Goode et al.
2008/0194937 A1 8/2008 Goode et al.
2008/0194938 A1 8/2008 Brister et al.
2008/0195232 A1 8/2008 Carr-Brendel et al.
2008/0195967 A1 8/2008 Goode et al.
2008/0197024 A1 8/2008 Simpson et al.
2008/0200788 A1 8/2008 Brister et al.
2008/0200789 A1 8/2008 Brister et al.
2008/0200791 A1 8/2008 Simpson et al.
2008/0208025 A1 8/2008 Shults et al.
2008/0208113 A1 8/2008 Damiano et al.
2008/0214915 A1 9/2008 Brister et al.
2008/0214918 A1 9/2008 Brister et al.
2008/0228051 A1 9/2008 Shults et al.
2008/0228054 A1 9/2008 Shults et al.
2008/0242961 A1 10/2008 Brister et al.
2008/0255434 A1 10/2008 Hayter et al.
2008/0255437 A1 10/2008 Hayter
2008/0255808 A1 10/2008 Hayter
2008/0256048 A1 10/2008 Hayter
2008/0262469 A1 10/2008 Brister et al.
2008/0267823 A1 10/2008 Wang et al.
2008/0275313 A1 11/2008 Brister et al.
2008/0278331 A1 11/2008 Hayter et al.
2008/0278332 A1 11/2008 Fennell et al.
2008/0278333 A1 11/2008 Fennell et al.
2008/0281171 A1 11/2008 Fennell et al.
2008/0281179 A1 11/2008 Fennell et al.
2008/0281840 A1 11/2008 Fennell et al.
2008/0287761 A1 11/2008 Hayter
2008/0287762 A1 11/2008 Hayter
2008/0287763 A1 11/2008 Hayter
2008/0287764 A1 11/2008 Rasdal et al.
2008/0287765 A1 11/2008 Rasdal et al.
2008/0287766 A1 11/2008 Rasdal et al.
2008/0288180 A1 11/2008 Hayter
2008/0288204 A1 11/2008 Hayter et al.
2008/0296155 A1 12/2008 Shults et al.
2008/0300919 A1 12/2008 Charlton et al.
2008/0300920 A1 12/2008 Brown et al.
2008/0301158 A1 12/2008 Brown et al.
2008/0301665 A1 12/2008 Charlton et al.
2008/0306368 A1 12/2008 Goode, Jr. et al.
2008/0306434 A1 12/2008 Dobbles et al.
2008/0306435 A1 12/2008 Kamath et al.
2008/0306444 A1 12/2008 Brister et al.
2008/0312841 A1 12/2008 Hayter
2008/0312842 A1 12/2008 Hayter
2008/0312844 A1 12/2008 Hayter et al.
2008/0312845 A1 12/2008 Hayter et al.
2009/0005665 A1 1/2009 Hayter et al.
2009/0006034 A1 1/2009 Hayter et al.
2009/0006133 A1 1/2009 Weinert et al.
2009/0012379 A1 1/2009 Goode et al.
2009/0018424 A1 1/2009 Kamath et al.
2009/0030294 A1 1/2009 Petisce et al.
2009/0033482 A1 2/2009 Hayter et al.
2009/0036747 A1 2/2009 Hayter et al.
2009/0036758 A1 2/2009 Brauker et al.
2009/0036760 A1 2/2009 Hayter
2009/0036763 A1 2/2009 Brauker et al.
2009/0043181 A1 2/2009 Brauker et al.
2009/0043182 A1 2/2009 Brauker et al.
2009/0043525 A1 2/2009 Brauker et al.
2009/0043541 A1 2/2009 Brauker et al.
2009/0043542 A1 2/2009 Brauker et al.
2009/0045055 A1 2/2009 Rhodes et al.
2009/0048503 A1 2/2009 Dalal et al.
2009/0055149 A1 2/2009 Hayter et al.
2009/0062633 A1 3/2009 Brauker et al.
2009/0062635 A1 3/2009 Brauker et al.
2009/0062767 A1 3/2009 VanAntwerp et al.
2009/0063402 A1 3/2009 Hayter
2009/0076356 A1 3/2009 Simpson et al.
2009/0076360 A1 3/2009 Brister et al.
2009/0076361 A1 3/2009 Kamath et al.
2009/0085873 A1 4/2009 Betts et al.
2009/0099436 A1 4/2009 Brister et al.
2009/0105560 A1 4/2009 Solomon
2009/0105636 A1 4/2009 Hayter et al.
2009/0124877 A1 5/2009 Goode et al.
2009/0124878 A1 5/2009 Goode et al.
2009/0124879 A1 5/2009 Brister et al.
2009/0124964 A1 5/2009 Leach et al.
2009/0131768 A1 5/2009 Simpson et al.
2009/0131769 A1 5/2009 Leach et al.
2009/0131776 A1 5/2009 Simpson et al.
2009/0131777 A1 5/2009 Simpson et al.
2009/0137886 A1 5/2009 Shariati et al.
2009/0137887 A1 5/2009 Shariati et al.
2009/0143659 A1 6/2009 Li et al.
2009/0143660 A1 6/2009 Brister et al.
2009/0149717 A1 6/2009 Brauer et al.
2009/0156919 A1 6/2009 Brister et al.
2009/0156924 A1 6/2009 Shariati et al.
2009/0163790 A1 6/2009 Brister et al.
2009/0163791 A1 6/2009 Brister et al.
2009/0164190 A1 6/2009 Hayter
2009/0164239 A1 6/2009 Hayter et al.
2009/0164251 A1 6/2009 Hayter
2009/0178459 A1 7/2009 Li et al.
2009/0182217 A1 7/2009 Li et al.
2009/0192366 A1 7/2009 Mensinger et al.
2009/0192380 A1 7/2009 Shariati et al.
2009/0192722 A1 7/2009 Shariati et al.
2009/0192724 A1 7/2009 Brauker et al.
2009/0192745 A1 7/2009 Kamath et al.
2009/0192751 A1 7/2009 Kamath et al.
2009/0198118 A1 8/2009 Hayter et al.
2009/0203981 A1 8/2009 Brauker et al.
2009/0204340 A1 8/2009 Feldman et al.
2009/0204341 A1 8/2009 Brauker et al.
2009/0216100 A1 8/2009 Ebner et al.
2009/0216103 A1 8/2009 Brister et al.
2009/0240120 A1 9/2009 Mensinger et al.
2009/0240128 A1 9/2009 Mensinger et al.
2009/0240193 A1 9/2009 Mensinger et al.
2009/0242399 A1 10/2009 Kamath et al.
2009/0242425 A1 10/2009 Kamath et al.
2009/0247855 A1 10/2009 Boock et al.
2009/0247856 A1 10/2009 Boock et al.
2009/0253973 A1 10/2009 Bashan et al.
2009/0287073 A1 11/2009 Boock et al.
2009/0287074 A1 11/2009 Shults et al.
2009/0298182 A1 12/2009 Schulat et al.
2009/0299155 A1 12/2009 Yang et al.
2009/0299156 A1 12/2009 Simpson et al.
2009/0299162 A1 12/2009 Brauker et al.
2009/0299276 A1 12/2009 Brauker et al.
2009/0318789 A1 12/2009 Fennell et al.
2009/0318792 A1 12/2009 Fennell et al.
2010/0010324 A1 1/2010 Brauker et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2010/0010331	A1	1/2010	Brauker et al.
2010/0010332	A1	1/2010	Brauker et al.
2010/0014626	A1	1/2010	Fennell et al.
2010/0016687	A1	1/2010	Brauker et al.
2010/0016698	A1	1/2010	Rasdal et al.
2010/0022855	A1	1/2010	Brauker et al.
2010/0025238	A1	2/2010	Gottlieb et al.
2010/0030038	A1	2/2010	Brauker et al.
2010/0030053	A1	2/2010	Goode, Jr. et al.
2010/0030484	A1	2/2010	Brauker et al.
2010/0030485	A1	2/2010	Brauker et al.
2010/0036215	A1	2/2010	Goode, Jr. et al.
2010/0036216	A1	2/2010	Goode, Jr. et al.
2010/0036222	A1	2/2010	Goode, Jr. et al.
2010/0036223	A1	2/2010	Goode, Jr. et al.
2010/0036225	A1	2/2010	Goode, Jr. et al.
2010/0041971	A1	2/2010	Goode, Jr. et al.
2010/0045465	A1	2/2010	Brauker et al.
2010/0049024	A1	2/2010	Saint et al.
2010/0057040	A1	3/2010	Hayter
2010/0057041	A1	3/2010	Hayter
2010/0057042	A1	3/2010	Hayter
2010/0057044	A1	3/2010	Hayter
2010/0057057	A1	3/2010	Hayter et al.
2010/0063373	A1	3/2010	Kamath et al.
2010/0076283	A1	3/2010	Simpson et al.
2010/0081908	A1	4/2010	Dobbles et al.
2010/0081910	A1	4/2010	Brister et al.
2010/0087724	A1	4/2010	Brauker et al.
2010/0096259	A1	4/2010	Zhang et al.
2010/0099970	A1	4/2010	Shults et al.
2010/0099971	A1	4/2010	Shults et al.
2010/0105999	A1	4/2010	Dixon et al.
2010/0119693	A1	5/2010	Tapsak et al.
2010/0119881	A1	5/2010	Patel et al.
2010/0121169	A1	5/2010	Petisce et al.
2010/0152554	A1	6/2010	Steine et al.
2010/0160759	A1	6/2010	Celentano et al.
2010/0168538	A1	7/2010	Keenan et al.
2010/0198142	A1	8/2010	Sloan et al.
2010/0235439	A1	9/2010	Goodnow
2010/0267161	A1	10/2010	Wu et al.
2010/0312176	A1	12/2010	Lauer et al.
2010/0324403	A1	12/2010	Brister et al.
2011/0148905	A1	6/2011	Simmons et al.
2011/0230741	A1	9/2011	Liang et al.
2011/0257895	A1	10/2011	Brauker et al.

FOREIGN PATENT DOCUMENTS

CA	2498682	9/2005
CA	2555749	9/2005
CA	2632709	6/2007
CA	2615575	6/2008
CA	2701374	4/2009
DE	2903216	8/1979
DE	227029	9/1985
DE	3934299	10/1990
DE	4234553	1/1995
DE	4401400	7/1995
EP	0010375	4/1980
EP	0026995	4/1981
EP	0048090	3/1982
EP	0078636	5/1983
EP	0080304	6/1983
EP	0096228	12/1983
EP	0096288	12/1983
EP	0098592	1/1984
EP	0125139	11/1984
EP	0127958	12/1984
EP	0136362	4/1985
EP	0170375	2/1986
EP	0177743	4/1986
EP	0184909	6/1986
EP	0206218	12/1986
EP	0230472	8/1987
EP	0241309	10/1987
EP	0245073	11/1987
EP	0255291	2/1988
EP	0278647	8/1988
EP	0320109	6/1989
EP	0353328	2/1990
EP	0359831	3/1990
EP	0368209	5/1990
EP	0368290	5/1990
EP	0390390	10/1990
EP	0396788	11/1990
EP	0400918	12/1990
EP	0453283	10/1991
EP	0470290	2/1992
EP	0504835	9/1992
EP	0286118	1/1995
EP	0653718	5/1995
EP	0680727	11/1995
EP	0800082	10/1997
EP	0880936	12/1998
EP	0970655	1/2000
EP	1034734	9/2000
EP	1048264	11/2000
EP	1579690	11/2002
EP	1445746	8/2004
EP	1568309	8/2005
EP	1956371	8/2008
EP	2260757	12/2010
EP	1413245	6/2011
GB	1394171	5/1975
GB	1579690	11/1980
GB	1599241	9/1981
GB	2073891	10/1981
GB	2154003	8/1985
GB	2194892	3/1988
GB	2204408	11/1988
GB	2225637	6/1990
GB	2254436	10/1992
JP	54-041191	4/1979
JP	55-010581	1/1980
JP	55-010583	1/1980
JP	55-010584	1/1980
JP	55-012406	1/1980
JP	56-163447	12/1981
JP	57-070448	4/1982
JP	60-173457	9/1985
JP	60-173458	9/1985
JP	60-173459	9/1985
JP	60-210243	10/1985
JP	61-090050	5/1986
JP	62-085855	4/1987
JP	62-114747	5/1987
JP	63-058149	3/1988
JP	63-128252	5/1988
JP	63-139246	6/1988
JP	63-294799	12/1988
JP	63-317757	12/1988
JP	63-317758	12/1988
JP	1-114746	5/1989
JP	1-114747	5/1989
JP	1-124060	5/1989
JP	1-134244	5/1989
JP	1-156658	6/1989
JP	2-062958	3/1990
JP	2-120655	5/1990
JP	2-287145	11/1990
JP	2-310457	12/1990
JP	3-026956	2/1991
JP	3-028752	2/1991
JP	3-202764	9/1991
JP	5-072171	3/1993
JP	5-196595	8/1993
JP	6-190050	7/1994
JP	7-055757	3/1995
JP	7-072585	3/1995
JP	8-154903	6/1996
JP	8-285814	11/1996

(56) **References Cited**

FOREIGN PATENT DOCUMENTS

JP	8-285815	11/1996
JP	9-021778	1/1997
JP	9-101280	4/1997
JP	9-285459	11/1997
JP	10-170471	6/1998
JP	2000-000231	1/2000
JP	2000-116628	4/2000
SU	1281988	1/1987
WO	WO-85/05119	11/1985
WO	WO-86/00513	1/1986
WO	WO-87/00513	1/1987
WO	WO-87/06040	10/1987
WO	WO-89/02246	3/1989
WO	WO-89/05119	6/1989
WO	WO-89/08713	9/1989
WO	WO-90/00367	1/1990
WO	WO-90/05300	5/1990
WO	WO-90/05910	5/1990
WO	WO-91/01680	2/1991
WO	WO-91/04704	4/1991
WO	WO-91/15993	10/1991
WO	WO-92/01947	2/1992
WO	WO-92/13271	8/1992
WO	WO-94/20602	9/1994
WO	WO-94/27140	11/1994
WO	WO-95/28878	2/1995
WO	WO-95/06240	3/1995
WO	WO-96/07908	3/1996
WO	WO-96/25089	8/1996
WO	WO-96/30431	10/1996
WO	WO-96/35370	11/1996
WO	WO-97/02847	1/1997
WO	WO-97/19344	5/1997
WO	WO-97/20207	6/1997
WO	WO-97/41421	11/1997
WO	WO-97/42882	11/1997
WO	WO-97/42883	11/1997
WO	WO-97/42886	11/1997
WO	WO-97/42888	11/1997
WO	WO-97/43962	11/1997
WO	WO-97/46868	12/1997
WO	WO-98/09167	3/1998
WO	WO-98/24366	6/1998
WO	WO-98/35053	8/1998
WO	WO-98/52045	11/1998
WO	WO-98/52293	11/1998
WO	WO-99/05966	2/1999
WO	WO-99/32883	7/1999
WO	WO-99/56613	11/1999
WO	WO-00/13580	3/2000
WO	WO-00/18294	4/2000
WO	WO-00/19887	4/2000
WO	WO-00/20626	4/2000
WO	WO-00/33065	6/2000
WO	WO-00/49940	8/2000
WO	WO-00/59370	10/2000
WO	WO-00/60350	10/2000
WO	WO-00/62664	10/2000
WO	WO-00/62665	10/2000
WO	WO-00/74753	12/2000
WO	WO-00/78210	12/2000
WO	WO-00/78992	12/2000
WO	WO-01/24038	4/2001
WO	WO-01/33216	5/2001
WO	WO-01/52727	7/2001
WO	WO-01/52935	7/2001
WO	WO-01/54753	8/2001
WO	WO-01/57238	8/2001
WO	WO-01/57239	8/2001
WO	WO-01/67009	9/2001
WO	WO-02/13686	2/2002
WO	WO-02/16905	2/2002
WO	WO-02/17210	2/2002
WO	WO-02/058537	8/2002
WO	WO-02/078512	10/2002
WO	WO-03/036583	5/2003
WO	WO-03/076893	9/2003
WO	WO-03/082091	10/2003
WO	WO-03/085372	10/2003
WO	WO-2004/015539	2/2004
WO	WO-2004/061420	7/2004
WO	WO-2004/098405	11/2004
WO	WO-2005/041766	5/2005
WO	WO-2005/089103	9/2005
WO	WO-2006/024671	3/2006
WO	WO-2006/037109	4/2006
WO	WO-2006/079114	7/2006
WO	WO-2006/118947	11/2006
WO	WO-2006/119084	11/2006
WO	WO-2007/002189	1/2007
WO	WO-2007/007459	1/2007
WO	WO-2007/016399	2/2007
WO	WO-2007/027381	3/2007
WO	WO-2007/027788	3/2007
WO	WO-2007/041069	4/2007
WO	WO-2007/041070	4/2007
WO	WO-2007/041072	4/2007
WO	WO-2007/041248	4/2007
WO	WO-2007/056638	5/2007
WO	WO-2007/065285	6/2007
WO	WO-2007/101223	9/2007
WO	WO-2007/101260	9/2007
WO	WO-2007/120363	10/2007
WO	WO-2007/126444	11/2007
WO	WO-2007/053832	12/2007
WO	WO-2007/143225	12/2007
WO	WO-2007/149319	12/2007
WO	WO-2008/001366	1/2008
WO	WO-2008/003003	1/2008
WO	WO-2008/005780	1/2008
WO	WO-2008/021913	2/2008
WO	WO-2008/042760	4/2008
WO	WO-2008/086541	7/2008
WO	WO-2008/128210	10/2008
WO	WO-2008/130896	10/2008
WO	WO-2008/130897	10/2008
WO	WO-2008/130898	10/2008
WO	WO-2008/143943	11/2008
WO	WO-2008/150428	12/2008
WO	WO-2008/153825	12/2008
WO	WO-2009/018058	2/2009
WO	WO-2009/075697	6/2009
WO	WO-2009/086216	7/2009
WO	WO-2009/096992	8/2009
WO	WO-2009/097594	8/2009
WO	WO-2011/104616	9/2011
WO	WO-2010/077329	7/2012

OTHER PUBLICATIONS

Abstract of Japanese Publication No. JP-55-010581, Published Jan. 5, 1980.

Abstract of Japanese Publication No. JP-55-010583, Published Jan. 5, 1980.

Abstract of Japanese Publication No. JP-55-010584, Published Jan. 5, 1980.

Albery, W. J., et al., "Amperometric Enzyme Electrodes Part II: Conducting Salts as Electrode Materials for the Oxidation of Glucose Oxidase", *Journal of ElectroAnalytical Chemistry*, vol. 194, 1985, pp. 223-235.

Albery, W. J., et al., "Amperometric Enzyme Electrodes", *Philosophical Transactions of The Royal Society of London*, vol. 316, 1987, pp. 107-119.

Alcock, S. J., et al., "Continuous Analyte Monitoring to Aid Clinical Practice", *IEEE Engineering in Medicine and Biology Magazine*, 1994, pp. 319-325.

Anderson, L. B., et al., "Thin-Layer Electrochemistry: Steady-State Methods of Studying Rate Processes", *Journal of ElectroAnalytical Chemistry*, vol. 10, 1965, pp. 295-305.

Armour, J. C., et al., "Application of Chronic Intravascular Blood Glucose Sensor in Dogs", *Diabetes*, vol. 39, 1990, pp. 1519-1526.

Bartlett, P. N., et al., "Covalent Binding of Electron Relays to Glucose Oxidase", *Journal of the Chemical Society, Chemical Communications*, 1987, pp. 1603-1604.

(56) **References Cited**

OTHER PUBLICATIONS

Bartlett, P. N., et al., "Modification of Glucose Oxidase by Tetrathiafulvalene", *Journal of the Chemical Society, Chemical Communications*, 1990, pp. 1135-1136.

Bartlett, P. N., et al., "Strategies for the Development of Amperometric Enzyme Electrodes", *Biosensors*, vol. 3, 1987/88, pp. 359-379.

Bennion, N., et al., "Alternate Site Glucose Testing: A Crossover Design", *Diabetes Technology & Therapeutics*, vol. 4, No. 1, 2002, pp. 25-33.

Bindra, D. S., et al., "Design and in Vitro Studies of a Needle-Type Glucose Sensor for Subcutaneous Monitoring", *Analytical Chemistry*, vol. 63, No. 17, 1991, pp. 1692-1696.

Blank, T. B., et al., "Clinical Results From a Non-Invasive Blood Glucose Monitor", *Optical Diagnostics and Sensing of Biological Fluids and Glucose and Cholesterol Monitoring II, Proceedings of SPIE*, vol. 4624, 2002, pp. 1-10.

Bobbioni-Harsch, E., et al., "Lifespan of Subcutaneous Glucose Sensors and Their Performances During Dynamic Glycaemia Changes in Rats", *Journal of Biomedical Engineering*, vol. 15, 1993, pp. 457-463.

Boedeker Plastics, Inc., "Polyethylene Specifications", Web Page of Boedeker.com, 2007, pp. 1-3.

Brandt, J., et al., "Covalent Attachment of Proteins to Polysaccharide Carriers by Means of Benzoquinone", *Biochimica et Biophysica Acta*, vol. 386, 1975, pp. 196-202.

Brooks, S. L., et al., "Development of an On-Line Glucose Sensor for Fermentation Monitoring", *Biosensors*, vol. 3, 1987/88, pp. 45-56.

Brownlee, M., et al., "A Glucose-Controlled Insulin-Delivery System: Semisynthetic Insulin Bound to Lectin", *Science*, vol. 206, 1979, 1190-1191.

Cass, A. E., et al., "Ferricinum Ion As An Electron Acceptor for Oxido-Reductases", *Journal of ElectroAnalytical Chemistry*, vol. 190, 1985, pp. 117-127.

Cass, A. E., et al., "Ferrocene-Medicated Enzyme Electrode for Amperometric Determination of Glucose", *Analytical Chemistry*, vol. 56, No. 4, 1984, 667-671.

Castner, J. F., et al., "Mass Transport and Reaction Kinetic Parameters Determined Electrochemically for Immobilized Glucose Oxidase", *Biochemistry*, vol. 23 No. 10, 1984, 2203-2210.

Claremont, D. J., et al., "Biosensors for Continuous In Vivo Glucose Monitoring", *Proceedings of the Annual International Conference of the IEEE Engineering in Medicine and Biology Society*, vol. 10, 1988.

Clark Jr., L. C., et al., "Differential Anodic Enzyme Polarography for the Measurement of Glucose", *Oxygen Transport to Tissue: Instrumentation, Methods, and Physiology*, 1973, pp. 127-133.

Clark Jr., L. C., et al., "Electrode Systems for Continuous Monitoring in Cardiovascular Surgery", *Annals New York Academy of Sciences*, 1962, pp. 29-45.

Clark Jr., L. C., et al., "Long-term Stability of Electroenzymatic Glucose Sensors Implanted in Mice", *American Society of Artificial Internal Organs Transactions*, vol. XXXIV, 1988, pp. 259-265.

Clarke, W. L., et al., "Evaluating Clinical Accuracy of Systems for Self-Monitoring of Blood Glucose", *Diabetes Care*, vol. 10, No. 5, 1987, pp. 622-628.

Complaint, "*Abbott Diabetes Care, Inc.* v. *Dexcom, Inc.*", filed Aug. 11, 2005.

Complaint, Amended, "*Abbott Diabetes Care, Inc.* v. *Dexcom, Inc.*", filed Jun. 27, 2006.

Csoregi, E., et al., "Design and Optimization of a Selective Subcutaneously Implantable Glucose Electrode Based on 'Wired' Glucose Oxidase", *Analytical Chemistry*, vol. 67, No. 7, 1995, pp. 1240-1244.

Csoregi, E., et al., "Design, Characterization, and One-Point in Vivo Calibration of a Subcutaneously Implanted Glucose Electrode", *Analytical Chemistry*, vol. 66 No. 19, 1994, pp. 3131-3138.

Csoregi, E., et al., "On-Line Glucose Monitoring by Using Microdialysis Sampling and Amperometric Detection Based on 'Wired' Glucose Oxidase in Carbon Paste", *Mikrochimica Acta*, vol. 121, 1995, pp. 31-40.

Dai, W. S., et al., "Hydrogel Membranes with Mesh Size Asymmetry Based on the Gradient Crosslinking of Poly(vinyl alcohol)," *Journal of Membrane Science*, vol. 156, 1999, pp. 67-79.

Davis, G., "Electrochemical Techniques for the Development of Amperometric Biosensors", *Biosensors*, vol. 1, 1985, pp. 161-178.

Degani, Y., et al., "Direct Electrical Communication Between Chemically Modified Enzymes and Metal Electrodes. 1. Electron Transfer from Glucose Oxidase to Metal Electrodes via Electron Relays, Bound Covalently to the Enzyme", *The Journal of Physical Chemistry*, vol. 91, No. 6, 1987, pp. 1285-1289.

Degani, Y., et al., "Direct Electrical Communication Between Chemically Modified Enzymes and Metal Electrodes. 2. Methods for Bonding Electron-Transfer Relays to Glucose Oxidase and D-Amino-Acid Oxidase", *Journal of the American Chemical Society*, vol. 110, No. 8, 1988, pp. 2615-2620.

Degani, Y., et al., "Electrical Communication Between Redox Centers of Glucose Oxidase and Electrodes via Electrostatically and Covalently Bound Redox Polymers", *Journal of the American Chemical Society*, vol. 111, 1989, pp. 2357-2358.

Denisevich, P., et al., "Unidirectional Current Flow and Charge State Trapping at Redox Polymer Interfaces on Bilayer Electrodes: Principles, Experimental Demonstration, and Theory", *Journal of the American Chemical Society*, vol. 103, 1981, pp. 4727-4737.

Dicks, J. M., et al., "Ferrocene Modified Polypyrrole with Immobilised Glucose Oxidase and its Application in Amperometric Glucose Microbiosensors", *Annales de Biologie Clinique*, vol. 47, 1989, pp. 607-619.

Ellis, C. D., et al., "Selectivity and Directed Charge Transfer through an Electroactive Metallopolymer Film", *Journal of the American Chemical Society*, vol. 103, No. 25, 1981, pp. 7480-7483.

Engstrom, R. C., "Electrochemical Pretreatment of Glassy Carbon Electrodes", *Analytical Chemistry*, vol. 54, No. 13, 1982, pp. 2310-2314.

Engstrom, R. C., et al., "Characterization of Electrochemically Pretreated Glassy Carbon Electrodes", *Analytical Chemistry*, vol. 56, No. 2, 1984, pp. 136-141.

Feldman, B., et al., "A Continuous Glucose Sensor Based on Wired Enzyme™ Technology—Results from a 3-Day Trial in Patients with Type 1 Diabetes", *Diabetes Technology & Therapeutics*, vol. 5, No. 5, 2003, pp. 769-779.

Feldman, B., et al., "Correlation of Glucose Concentrations in Interstitial Fluid and Venous Blood During Periods of Rapid Glucose Change", *Abbott Diabetes Care, Inc. Freestyle Navigator Continuous Glucose Monitor Pamphlet*, 2004.

Feldman, B., et al., "Electron Transfer Kinetics at Redox Polymer/Solution Interfaces Using Microelectrodes and Twin Electrode Thin Layer Cells", *Journal of ElectroAnalytical Chemistry*, vol. 194, 1985, pp. 63-81.

Fischer, H., et al., "Intramolecular Electron Transfer Medicated by 4,4'-Bypyridine and Related Bridging Groups", *Journal of the American Chemical Society*, vol. 98, No. 18, 1976, pp. 5512-5517.

Flentge, F., et al., "An Enzyme-Reactor for Electrochemical Monitoring of Choline and Acetylcholine: Applications in High-Performance Liquid Chromatography, Bran Tissue, Microdialysis and Cerebrospinal Fluid," *Analytical Biochemistry*, vol. 204, 1992, pp. 305-310.

Foulds, N. C., et al., "Enzyme Entrapment in Electrically Conducting Polymers: Immobilisation of Glucose Oxidase in Polypyrrole and its Application in Amperometric Glucose Sensors", *Journal of the Chemical Society, Faraday Transactions 1*, vol. 82, 1986, pp. 1259-1264.

Foulds, N. C., et al , "Immobilization of Glucose Oxidase in Ferrocene-Modified Pyrrole Polymers", *Analytical Chemistry*, vol. 60, No. 22, 1988, pp. 2473-2478.

Frew, J. E., et al., "Electron-Transfer Biosensors", *Philosophical Transactions of The Royal Society of London*, vol. 316, 1987, pp. 95-106.

Godsland, I. F., et al., "Maximizing the Success Rate of Minimal Model Insulin Sensitivity Measurement in Humans: The Importance of Basal Glucose Levels," *Clinical Science*, vol. 101, 2001, pp. 1-9.

Gorton, L., et al., "Selective Detection in Flow Analysis Based on the Combination of Immobilized Enzymes and Chemically Modified Electrodes", *Analytica Chimica Acta*, vol. 250, 1991, pp. 203-248.

(56) **References Cited**

OTHER PUBLICATIONS

Graham, N. B., "Poly(ethylene oxide) and Related Hydrogels," *Hydrogels in Medicine and Pharmacy*, vol. II: *Polymers*, Chapter 4, 1987, pp. 95-113.

Gregg, B. A., et al., "Cross-Linked Redox Gels Containing Glucose Oxidase for Amperometric Bionsensor Applications", *Analytical Chemistry*, vol. 62, No. 3, 1990, pp. 258-263.

Gregg, B. A., et al., "Redox Polymer Films Containing Enzymes. 1. A Redox-Conducting Epoxy Cement: Synthesis, Characterization, and Electrocatalytic Oxidation of Hydroquinone", *Journal of Physical Chemistry*, vol. 95, No. 15, 1991, 5970-5975.

Hale, P. D., et al., "A New Class of Amperometric Biosensor Incorporating a Polymeric Electron-Transfer Mediator", *Journal of the American Chemical Society*, vol. 111, No. 9, 1989, pp. 3482-3484.

Hamilton, "Hamilton Needle Gauge Index", www.hamiltoncompany.com.

Harrison, D. J., et al., "Characterization of Perfluorosulfonic Acid Polymer Coated Enzyme Electrodes and a Miniatureized Integrated Potentiostat for Glucose Analysis in Whole Blood", *Analytical Chemistry*, vol. 60, No. 19, 1988, pp. 2002-2007.

Hawkridge, F. M., et al., "Indirect Coulometric Titration of Biological Electron Transport Components", *Analytical Chemistry*, vol. 45, No. 7, 1973, pp. 1021-1027.

Heller, A., "Electrical Connection Enzyme Redox Centers to Electrodes", *Journal of Physical Chemistry*, vol. 96, No. 9, 1990, pp. 3579-3587.

Heller, A., "Electrical Wiring of Redox Enzymes", *Accounts of Chemical Research* vol. 23, No. 5, 1990, 128-134.

Heller, A., et al., "Amperometric Biosensors Based on Three-Dimensional Hydrogel-Forming Epoxy Networks", *Sensors and Actuators B*, vol. 13-14, 1993, pp. 180-183.

Ianniello, R. M., et al., "Differential Pulse Voltammetric Study of Direct Electron Transfer in Glucose Oxidase Chemically Modified Graphite Electrodes", *Analytical Chemistry*, vol. 54, No. 7, 1982, pp. 1098-1101.

Ianniello, R. M., et al , "Immobilized Enzyme Chemically Modified Electrode as an Amperometric Sensor", *Analytical Chemistry*, vol. 53, No. 13, 1981, pp. 2090-2095.

Ikeda, T., et al., "Glucose Oxidase-Immobilized Benzoquinone-Carbon Paste Electrode as a Glucose Sensor", *Agricultural and Biological Chemistry*, vol. 49, No. 2, 1985, pp. 541-543.

Ikeda, T., et al., "Kinetics of Outer-Sphere Electron Transfers Between Metal Complexes in Solutions and Polymeric Films on Modified Electrodes", *Journal of the American Chemical Society*, vol. 103, No. 25, 1981, pp. 7422-7425.

Isermann, R., "Supervision, Fault-Detection and Fault-Diagnosis Methods—An Introduction", *Control Engineering Practice*, vol. 5, No. 5, 1997, pp. 639-652.

Isermann, R., et al., "Trends in the Application of Model-Based Fault Detection and Diagnosis of Technical Processes", *Control Engineering Practice*, vol. 5, No. 5, 1997, pp. 709-719.

Johnson, J. M., et al., "Potential-Dependent Enzymatic Activity in an Enzyme Thin-Layer Cell", *Analytical Chemistry*, vol. 54, No. 8, 1982, pp. 1377-1383.

Johnson, K. W., "Reproducible Electrodeposition of Biomolecules for the Fabrication of Miniature Electroenzymatic Biosensors", *Sensors and Actuators B*, vol. 5, 1991, pp. 85-89.

Johnson, K. W., et al., "In vivo Evaluation of an Electroenzymatic Glucose Sensor Implanted in Subcutaneous Tissue", *Biosensors & Bioelectronics*, vol. 7, 1992, pp. 709-714.

Johnson, P. C., "Peripheral Circulation", *John Wiley & Sons*, 1978, pp. 198.

Jonsson, G., et al., "An Amperometric Glucose Sensor Made by Modification of a Graphite Electrode Surface With Immobilized Glucose Oxidase and Adsorbed Mediator", *Biosensors*, vol. 1, 1985, pp. 355-368.

Josowicz, M., et al., "Electrochemical Pretreatment of Thin Film Platinum Electrodes", *Journal of the Electrochemical Society*, vol. 135 No. 1, 1988, pp. 112-115.

Jungheim, K., et al., "How Rapid Does Glucose Concentration Change in Daily Life of Patients with Type 1 Diabetes?", 2002, pp. 250.

Jungheim, K., et al., "Risky Delay of Hypoglycemia Detection by Glucose Monitoring at the Arm", *Diabetes Care*, vol. 24, No. 7, 2001, pp. 1303-1304.

Kaplan, S. M., "Wiley Electrical and Electronics Engineering Dictionary", *IEEE Press*, 2004, pp. 141, 142, 548, 549.

Katakis, I., et al., "Electrostatic Control of the Electron Transfer Enabling Binding of Recombinant Glucose Oxidase and Redox Polyelectrolytes", *Journal of the American Chemical Society*, vol. 116, No. 8, 1994, pp. 3617-3618.

Katakis, I., et al., "L-α-Glycerophosphate and L-Lactate Electrodes Based on the Electrochemical 'Wiring' of Oxidases", *Analytical Chemistry*, vol. 64, No. 9, 1992, pp. 1008-1013.

Kemp, G. J., "Theoretical Aspects of One-Point Calibration: Causes and Effects of Some Potential Errors, and Their Dependence on Concentration," *Clinical Chemistry*, vol. 30, No. 7, 1984, pp. 1163-1167.

Kenausis, G., et al., "'Wiring' of Glucose Oxidase and Lactate Oxidase Within a Hydrogel Made with Poly(vinyl pyridine) complexed with $[Os(4,4'\text{-dimethoxy-}2,2'\text{-bipyridine})_2Cl]^{+/2+}$", *Journal of the Chemical Society, Faraday Transactions*, vol. 92, No. 20, 1996, pp. 4131-4136.

Kerner, W., et al., "The Function of a Hydrogen Peroxide-Detecting Electroenzymatic Glucose Electrode is Markedly Impaired in Human Subcutaneous Tissue and Plasma," *Biosensors & Bioelectronics*, vol. 8, 1993, pp. 473-482.

Korf, J., et al., "Monitoring of Glucose and Lactate Using Microdialysis: Applications in Neonates and Rat Brain," *Developmental Neuroscience*, vol. 15, 1993, pp. 240-246.

Koudelka, M., et al., "In-Vivo Behaviour of Hypodermically Implanted Microfabricated Glucose Sensors", *Biosensors & Bioelectronics*, vol. 6, 1991, pp. 31-36.

Kulys, J., et al., "Mediatorless Peroxidase Electrode and Preparation of Bienzyme Sensors", *Bioelectrochemistry and Bioenergetics*, vol. 24, 1990, pp. 305-311.

Lager, W., et al., "Implantable Electrocatalytic Glucose Sensor", *Hormone Metabolic Research*, vol. 26, 1994, pp. 526-530.

Laurell, T., "A Continuous Glucose Monitoring System Based on Microdialysis",*Journal of Medical Engineering & Technology*, vol. 16, No. 5, 1992, pp. 187-193.

Lindner, E., et al., "Flexible (Kapton-Based) Microsensor Arrays of High Stability for Cardiovascular Applications", *Journal of the Chemical Society, Faraday Transactions*, vol. 89, No. 2, 1993, pp. 361-367.

Lortz, J., et al., "What is Bluetooth? We Explain the Newest Short-Range Connectivity Technology", *Smart Computing Learning Series, Wireless Computing*, vol. 8, Issue 5, 2002, pp. 72-74.

Maidan, R., et al., "Elimination of Electrooxidizable Interferant-Produced Currents in Amperometric Biosensors", *Analytical Chemistry*, vol. 64, No. 23, 1992, pp. 2889-2896.

Malin, S. F., et al., "Noninvasive Prediction of Glucose by Near-Infrared Diffuse Reflectance Spectoscopy", *Clinical Chemistry*, vol. 45, No. 9, 1999, pp. 1651-1658.

Marko-Varga, G., et al., "Enzyme-Based Biosensor as a Selective Detection Unit in Column Liquid Chromatography", *Journal of Chromatography A* , vol. 660, 1994, pp. 153-167.

Mastrototaro, J. J., et al., "An Electroenzymatic Glucose Sensor Fabricated on a Flexible Substrate", *Sensors and Actuators B*, vol. 5, 1991, pp. 139-144.

Mauras, N., et al., "Lack of Accuracy of Continuous Glucose Sensors in Healthy, Nondiabetic Children: Results of the Diabetes Research in Children Network (DirecNet) Accuracy Study," *Journal of Pediatrics*, 2004, pp. 770-775.

McGarraugh, G., et al., "Glucose Measurements Using Blood Extracted from the Forearm and the Finger", *TheraSense, Inc.*, 2001, 16 Pages.

McGarraugh, G., et al., "Physiological Influences on Off-Finger Glucose Testing", *Diabetes Technology & Therapeutics*, vol. 3, No. 3, 2001, pp. 367-376.

(56) **References Cited**

OTHER PUBLICATIONS

McKean, B. D., et al., "A Telemetry-Instrumentation System for Chronically Implanted Glucose and Oxygen Sensors", *IEEE Transactions on Biomedical Engineering*, vol. 35, No. 7, 1988, pp. 526-532.

McNeil, C. J., et al., "Thermostable Reduced Nicotinamide Adenine Dinucleotide Oxidase: Application to Amperometric Enzyme Assay", *Analytical Chemistry*, vol. 61, No. 1, 1989, pp. 25-29.

Miyawaki, O., et al., "Electrochemical and Glucose Oxidase Coenzyme Activity of Flavin Adenine Dinucleotide Covalently Attached to Glassy Carbon at the Adenine Amino Group", *Biochimica et Biophysica Acta*, vol. 838, 1985, pp. 60-68.

Moatti-Sirat, D., et al., "Evaluating In Vitro and In Vivo the Interference of Ascorbate and Acetaminophen on Glucose Detection by a Needle-Type Glucose Sensor",*Biosensors & Bioelectronics*, vol. 7, 1992, pp. 345-352.

Moatti-Sirat, D., et al., "Reduction of Acetaminophen Interference in Glucose Sensors by a Composite Nafion Membrane: Demonstration in Rats and Man", *Diabetologia*, vol. 37, 1994, pp. 610-616.

Moatti-Sirat, D., et al., "Towards Continuous Glucose Monitoring: In Vivo Evaluation of a Miniaturized Glucose Sensor Implanted for Several Days in Rat Subcutaneous Tissue", *Diabetologia*, vol. 35, 1992, pp. 224-330.

Morbiducci, U, et al., "Improved Usability of the Minimal Model of Insulin Sensitivity Based on an Automated Approach and Genetic Algorithms for Parameter Estimation", *Clinical Science*, vol. 112, 2007, pp. 257-263.

Mougiakakou, et al., "A Real Time Simulation Model of Glucose-Insulin Metabolism for Type 1 Diabetes Patients", *Proceedings of the 2005 IEEE*, 2005, pp. 298-301.

Nagy, G., et al., "A New Type of Enzyme Electrode: The Ascorbic Acid Eliminator Electrode", *Life Sciences*, vol. 31, No. 23, 1982, pp. 2611-2616.

Nakamura, S., et al., "Effect of Periodate Oxidation on the Structure and Properties of Glucose Oxidase", *Biochimica et Biophysica Acta.*, vol. 445, 1976, pp. 294-308.

Narasimham, K., et al., "p-Benzoquinone Activation of Metal Oxide Electrodes for Attachment of Enzymes", *Enzyme and Microbial Technology*, vol. 7, 1985, pp. 283-286.

Ohara, T. J., "Osmium Bipyridyl Redox Polymers Used in Enzyme Electrodes", *Platinum Metals Review*, vol. 39, No. 2, 1995, pp. 54-62.

Ohara, T. J., et al., "'Wired' Enzyme Electrodes for Amperometric Determination of Glucose or Lactate in the Presence of Interfering Substances", Analytical Chemistry, vol. 66, No. 15, 1994, pp. 2451-2457.

Ohara, T. J., et al., "Glucose Electrodes Based on Cross-Linked $[Os(bpy)_2Cl]^{+/2+}$ Complexed Poly(1-Vinylimidazole) Films", *Analytical Chemistry*, vol. 65, No. 23, 1993, pp. 3512-3517.

Olievier, C. N., et al., "In Vivo Measurement of Carbon Dioxide Tension with a Miniature Electrodes", *Pflugers Archiv: European Journal of Physiology*, vol. 373, 1978, pp. 269-272.

Paddock, R. M., et al., "Electrocatalytic Reduction of Hydrogen Peroxide via Direct Electron Transfer From Pyrolytic Graphite Electrodes to Irreversibly Adsorbed Cyctochrome C Peroxidase", *Journal of ElectroAnalytical Chemistry*, vol. 260, 1989, pp. 487-494.

Palleschi, G., et al., "A Study of Interferences in Glucose Measurements in Blood by Hydrogen Peroxide Based Glucose Probes", *Analytical Biochemistry*, vol. 159, 1986, pp. 114-121.

Pankratov, I., et al., "Sol-Gel Derived Renewable-Surface Biosensors", *Journal of ElectroAnalytical Chemistry*, vol. 393, 1995, pp. 35-41.

Parker, R., et al., "Robust H∞Glucose Control in Diabetes Using a Physiological Model", *AIChE Journal*, vol. 46, No. 12, 2000, pp. 2537-2549.

Pathak, C., et al., "Rapid Photopolymerization of Immunoprotective Gels in Contact with Cells and Tissue", *Journal of the American Chemical Society*, vol. 114, No. 21, 1992, pp. 8311-8312.

Pickup, J., "Developing Glucose Sensors for In Vivo Use", *Tibtech*, vol. 11, 1993, pp. 285-291.

Pickup, J., et al., "Implantable Glucose Sensors: Choosing the Appropriate Sensing Strategy", *Biosensors*, vol. 3, 1987/88, pp. 335-346.

Pickup, J., et al., "In Vivo Molecular Sensing in Diabetes Mellitus: An Implantable Glucose Sensor with Direct Electron Transfer", *Diabetologia*, vol. 32, 1989, pp. 213-217.

Pickup, J., et al., "Potentially-Implantable, Amperometric Glucose Sensors with Mediated Electron Transfer: Improving the Operating Stability",*Biosensors*, vol. 4, 1989, pp. 109-119.

Pishko, M. V., et al., "Amperometric Glucose Microelectrodes Prepared Through Immobilization of Glucose Oxidase in Redox Hydrogels", *Analytical Chemistry*, vol. 63, No. 20, 1991, pp. 2268-2272.

Poitout, V., et al., "A Glucose Monitoring System for on Line Estimation in Man of Blood Glucose Concentration Using a Miniaturized Glucose Sensor Implanted in the Subcutaneous Tissue and a Wearable Control Unit", *Diabetolgia*, vol. 36, 1993, pp. 658-663.

Poitout, V., et al., "Calibration in Dogs of a Subcutaneous Miniaturized Glucose Sensor Using a Glucose Meter for Blood Glucose Determination", *Biosensors & Bioelectronics*, vol. 7, 1992, pp. 587-592.

Poitout, V., et al., "In Vitro and In Vivo Evaluation in Dogs of a Miniaturized Glucose Sensor", *ASAIO Transactions*, vol. 37, No. 3, 1991, pp. M298-M300.

Pollak, A., et al., "Enzyme Immobilization by Condensation Copolymerization into Cross-Linked Polyacrylamide Gels", *Journal of the American Chemical Society*, vol. 102, No. 20, 1980, pp. 6324-6336.

Quinn, C. P., et al., "Kinetics of Glucose Delivery to Subcutaneous Tissue in Rats Measured with 0.3-mm Amperometric Microsensors", *The American Physiological Society*, 1995, E155-E161.

Reach, G., et al., "Can Continuous Glucose Monitoring Be Used for the Treatment of Diabetes?", *Analytical Chemistry*, vol. 64, No. 6, 1992, pp. 381-386.

Rebrin, K., et al., "Automated Feedback Control of Subcutaneous Glucose Concentration in Diabetic Dogs", *Diabetologia*, vol. 32, 1989, pp. 573-576.

Reusch, W., "Other Topics: Organometallic Chemistry: Organometallic Compounds: Main Group Organometallic Compounds," *Virtual Textbook of Organic Chemistry*, 1999, Rev. 2007, 25 pages.

Roe, J. N., et al., "Bloodless Glucose Measurements", *Critical Review in Therapeutic Drug Carrier Systems*, vol. 15, Issue 3, 1998, pp. 199-241.

Sacks (ED), "Guidelines and Recommendations for Laboratory Analysis in the Diagnosis and Management of Diabetes Mellitus," *The National Academy of Clinical Biochemistry Presents Laboratory Medicine Practice Guidlines*, vol. 13, 2002, pp. 8-11, 21-23, 52-56, 63.

Sakakida, M., et al., "Development of Ferrocene-Mediated Needle-Type Glucose Sensor as a Measure of True Subcutaneous Tissue Glucose Concentrations", *Artificial Organs Today*, vol. 2, No. 2, 1992, pp. 145-158.

Sakakida, M., et al., "Ferrocene-Mediated Needle-Type Glucose Sensor Covered with Newly Designed Biocompatible Membrane", *Sensors and Actuators B*, vol. 13-14, 1993, pp. 319-322.

Salehi, C., et al., "A Telemetry-Instrumentation System for Long-Term Implantable Glucose and Oxygen Sensors", *Analytical Letters*, vol. 29, No. 13, 1996, pp. 2289-2308.

Samuels, G. J., et al., "An Electrode-Supported Oxidation Catalyst Based on Ruthenium (IV). pH 'Encapsulation' in a Polymer Film", *Journal of the American Chemical Society*, vol. 103, No. 2, 1981, pp. 307-312.

Sasso, S. V., et al., "Electropolymerized 1,2-Diaminobenzene as a Means to Prevent Interferences and Fouling and to Stabilize Immobilized Enzyme in Electrochemical Biosensors", *Analytical Chemistry*, vol. 62 No. 11, 1990, pp. 1111-1117.

Scheller, F. W., et al., "Second Generation Biosensors," *Biosensors & Bioelectronics*, vol. 6, 1991, pp. 245-253.

Scheller, F., et al., "Enzyme Electrodes and Their Application", *Philosophical Transactions of the Royal Society of London B*, vol. 316, 1987, pp. 85-94.

(56) **References Cited**

OTHER PUBLICATIONS

Schmehl, R. H., et al., "The Effect of Redox Site Concentration on the Rate of Mediated Oxidation of Solution Substrates by a Redox Copolymer Film", *Journal of ElectroAnalytical Chemistry*, vol. 152, 1983, pp. 97-109.

Schmidt, F. J., et al., "Calibration of a Wearable Glucose Sensor", *The International Journal of Artificial Organs*, vol. 15, No. 1, 1992, pp. 55-61.

Schmidtke, D. W., et al., "Measurement and Modeling of the Transient Difference Between Blood and Subcutaneous Glucose Concentrations in the Rat After Injection of Insulin",*Proceedings of the National Academy of Sciences*, vol. 95, 1998, pp. 294-299.

Shaw, G. W., et al., "In Vitro Testing of a Simply Constructed, Highly Stable Glucose Sensor Suitable for Implantation in Diabetic Patients", *Biosensors & Bioelectronics*, vol. 6, 1991, pp. 401-406.

Shichiri, M., et al., "Glycaemic Control in Pancreatectomized Dogs with a Wearable Artificial Endocrine Pancreas", *Diabetologia*, vol. 24, 1983, pp. 179-184.

Shichiri, M., et al., "In Vivo Characteristics of Needle-Type Glucose Sensor—Measurements of Subcutaneous Glucose Concentrations in Human Volunteers", *Hormone and Metabolic Research Supplement Series*, vol. 20, 1988, pp. 17-20.

Shichiri, M., et al., "Membrane Design for Extending the Long-Life of an Implantable Glucose Sensor", *Diabetes Nutrition and Metabolism*, vol. 2, 1989, pp. 309-313.

Shichiri, M., et al., "Needle-type Glucose Sensor for Wearable Artificial Endocrine Pancreas", *Implantable Sensors for Closed-Loop Prosthetic Systems*, Chapter 15, 1985, pp. 197-210.

Shichiri, M., et al., "Telemetry Glucose Monitoring Device With Needle-Type Glucose Sensor: A Useful Tool for Blood Glucose Monitoring in Diabetic Individuals", *Diabetes Care*, vol. 9, No. 3, 1986, pp. 298-301.

Shichiri, M., et al., "Wearable Artificial Endocrine Pancreas With Needle-Type Glucose Sensor", *The Lancet*, 1982, pp. 1129-1131.

Shults, M. C., et al., "A Telemetry-Instrumentation System for Monitoring Multiple Subcutaneously Implanted Glucose Sensors", *IEEE Transactions on Biomedical Engineering*, vol. 41, No. 10, 1994, pp. 937-942.

Sittampalam, G., et al., "Surface-Modified Electrochemical Detector for Liquid Chromatography", *Analytical Chemistry*, vol. 55, No. 9, 1983, pp. 1608-1610.

Skoog, D. A., et al., "Evaluation of Analytical Data," *Fundamentals of Analytical Chemistry*, 1966, pp. 55.

Soegijoko, S., et al., "External Artificial Pancreas: A New Control Unit Using Microprocessor", *Hormone and Metabolic Research Supplement Series*, vol. 12, 1982, pp. 165-169.

Sprules, S. D., et al., "Evaluation of a New Disposable Screen-Printed Sensor Strip for the Measurement of NADH and Its Modification to Produce a Lactate Biosensor Employing Microliter Volumes", *Electroanalysis*, vol. 8, No. 6, 1996, pp. 539-543.

Sternberg, F., et al., "Calibration Problems of Subcutaneous Glucosensors when Applied 'In-Situ' in Man", *Hormone and Metabolic Research*, vol. 26, 1994, pp. 523-526.

Sternberg, R., et al., "Covalent Enzyme Coupling on Cellulose Acetate Membranes for Glucose Sensor Development", *Analytical Chemistry*, vol. 60, No. 24, 1988, pp. 2781-2786.

Sternberg, R., et al., "Study and Development of Multilayer Needle-Type Enzyme-Based Glucose Microsensors", *Biosensors*, vol. 4, 1988, pp. 27-40.

Suekane, M , "Immobilization of Glucose Isomerase", *Zettschrift fur Allgemeine Mikrobiologie*, vol. 22, No. 8, 1982, pp. 565-576.

Tajima, S., et al., "Simultaneous Determination of Glucose and 1,5-Anydroglucitol", *Chemical Abstracts*, vol. 111, No. 25, 1989, pp. 394.

Takamura, A., et al., Drug release from Poly(vinyl alcohol) Gel Prepared by Freeze-Thaw Procedure, *Journal of Controlled Release*, vol. 20, 1992, pp. 21-27.

Tarasevich, M. R., "Bioelectrocatalysis", *Comprehensive Treatise of Electrochemistry*, vol. 10, 1985, pp. 231-295.

Tatsuma, T., et al., "Enzyme Monolayer- and Bilayer-Modified Tin Oxide Electrodes for the Determination of Hydrogen Peroxide and Glucose", *Analytical Chemistry*, vol. 61, No. 21, 1989, pp. 2352-2355.

Taylor, C., et al., "'Wiring' of Glucose Oxidase Within a Hydrogel Made with Polyvinyl Imidazole Complexed with [(Os-4,4'-dimethoxy-2,2'-bipyridine)Cl]$^{+/2+}$", *Journal of ElectroAnalytical Chemistry*, vol. 396, 1995, pp. 511-515.

Thompson, M., et al., "In Vivo Probes: Problems and Perspectives", *Clinical Biochemistry*, vol. 19, 1986, pp. 255-261.

Travenol Laboratories, Inc., *An Introduction to "Eugly"*, Book 1, 1985, pp. 1-22.

Trojanowicz, M., et al., "Enzyme Entrapped Polypyrrole Modified Electrode for Flow-Injection Determination of Glucose", *Biosensors & Bioelectronics*, vol. 5, 1990, pp. 149-156.

Tsalikian, E., et al., "Accuracy of the GlucoWatch G2® Biographer and the Continuous Glucose Monitoring System During Hypoglycemia: Experience of the Diabetes Research in Children Network", *Diabetes Care*, vol. 27, No. 3, 2004, pp. 722-726.

Turner, A., et al., "Diabetes Mellitus: Biosensors for Research and Management", *Biosensors*, vol. 1, 1985, pp. 85-115.

Turner, R. F., et al., "A Biocompatible Enzyme Electrode for Continuous in vivo Glucose Monitoring in Whole Blood", *Sensors and Actuators B*, vol. 1, 1990, pp. 561-564.

Tuzhi, P., et al., "Constant Potential Pretreatment of Carbon Fiber Electrodes for In Vivo Electrochemistry", *Analytical Letters*, vol. 24, No. 6, 1991, pp. 935-945.

U.S. Patent Reexamination Application No. 90/007,903, Request for Reexamination of U.S. Patent No. 6,565,509 filed Jan. 25, 2006.

U.S. Patent Reexamination Application No. 90/007,910, Request for Reexamination of U.S. Patent No. 6,175,752 filed Feb. 1, 2006.

U.S. Patent Reexamination Application No. 90/007,913, Request for Reexamination of U.S. Patent No. 6,284,478 filed Feb. 1, 2006.

U.S. Patent Reexamination Application No. 90/007,914, Request for Reexamination of U.S. Patent No. 6,329,161 filed Feb. 1, 2006.

U.S. Patent Reexamination Application No. 90/008,172, Request for Reexamination of U.S. Patent No. 6,990,366 filed Aug. 16, 2006.

U.S. Patent Reexamination Application No. 90/008,173, Request for Reexamination of U.S. Patent No. 6,134,461 filed Aug. 16, 2006.

U.S. Patent Reexamination Application No. 90/008,457, Request for Reexamination of U.S. Patent No. 6,990,366 filed Jan. 23, 2007.

U.S. Patent Reexamination Application No. 90/008,665, Request for Reexamination of U.S. Patent No. 6,284,478 filed May 25, 2007.

U.S. Patent Reexamination Application No. 90/008,713, Request for Reexamination of U.S. Patent No. 6,329,161 filed Jul. 25, 2007.

Umana, M., "Protein-Modified Electrochemically Active Biomaterial Surface", *U.S. Army Research Office, Analytical and Chemical Sciences Research Triangle Institute*, 1988, pp. 1-9.

Updike, S. J., et al., "Principles of Long-Term Fully Implanted Sensors with Emphasis on Radiotelemetric Monitoring of Blood Glucose from Inside a Subcutaneous Foreign Body Capsule (FBC)", *Biosensors in the Body: Continuous in vivo Monitoring*, Chapter 4, 1997, pp. 117-137.

Urban, G., et al., "Miniaturized Thin-Film Biosensors Using Covalently Immobilized Glucose Oxidase", *Biosensors & Bioelectronics*, vol. 6, 1991, pp. 555-562.

Velho, G., et al., "In Vitro and In Vivo Stability of Electrode Potentials in Needle-Type Glucose Sensors", *Diabetes*, vol. 38, No. 2, 1989, pp. 164-171.

Velho, G., et al., "Strategies for Calibrating a Subcutaneous Glucose Sensor", *Biomedica Biochimica Acta*, vol. 48, 1989, pp. 957-964.

Von Woedtke, T., et al., "In Situ Calibration of Implanted Electrochemical Glucose Sensors", *Biomedica Biochimica Acta*, vol. 48, 1989, pp. 943-952.

Vreeke, M. S., et al., "Hydrogen Peroxide Electrodes Based on Electrical Connection of Redox Centers of Various Peroxidases to Electrodes through a Three-Dimensional Electron-Relaying Polymer Network",*Diagnostic Biosensors Polymers*, Chapter 15, 1993, pp. 180-193.

Vreeke, M., et al., "Hydrogen Peroxide and α-Nicotinamide Adenine Dinucleotide Sensing Amperometric Electrodes Based on Electrical Connection of Horseradish Peroxidase Redox Centers to Electrodes

(56) **References Cited**

OTHER PUBLICATIONS

through a Three-Dimensional Electron-Relaying Polymer Network",*Analytical Chemistry*, vol. 64 No. 24, 1992, pp. 3084-3090.

Wang, D. L., et al., "Miniaturized Flexible Amperometric Lactate Probe", *Analytical Chemistry*, vol. 65, No. 8, 1993, pp. 1069-1073.

Wang, J., et al., "Activation of Glassy Carbon Electrodes by Alternating Current Electrochemical Treatment", *Analytica Chimica Acta*, vol. 167, 1985, pp. 325-334.

Wang, J., et al., "Amperometric Biosensing of Organic Peroxides with Peroxidase-Modified Electrodes", *Analytica Chimica Acta*, vol. 254, 1991, pp. 81-88.

Wang, J., et al., "Screen-Printable Sol-Gel Enzyme-Containing Carbon Inks", *Analytical Chemistry*, vol. 68, No. 15, 1996, pp. 2705-2708.

Wang, J., et al., "Sol-Gel-Derived Metal-Dispersed Carbon Composite Amperometric Biosensors", *Electroanalysis*, vol. 9, No. 1, 1997, pp. 52-55.

Williams, D. L., et al., "Electrochemical-Enzymatic Analysis of Blood Glucose and Lactate", *Analytical Chemistry*, vol. 42 No. 1, 1970, pp. 118-121.

Wilson, G. S., et al., "Progress Toward the Development of an Implantable Sensor for Glucose", *Clinical Chemistry*, vol. 38, No. 9, 1992, pp. 1613-1617.

Yabuki, S., et al., "Electro-Conductive Enzyme Membrane", *Journal of the Chemical Society, Chemical Communications*, 1989, pp. 945-946.

Yang, C., et al., "A Comparison of Physical Properties and Fuel Cell Performance of Nafion and Zirconium Phosphate/Nafion Composite Membranes," *Journal of Membrane Science*, vol. 237, 2004, pp. 145-161.

Yang, L., et al., "Determination of Oxidase Enzyme Substrates Using Cross-Flow Thin-Layer Amperometry", *Electroanalysis*, vol. 8, No. 8-9, 1996, pp. 716-721.

Yao, S. J., et al., "The Interference of Ascorbate and Urea in Low-Potential Electrochemical Glucose Sensing", *Proceedings of the Twelfth Annual International Conference of the IEEE Engineering in Medicine and Biology Society*, vol. 12, Part 2, 1990, pp. 487-489.

Yao, T., "A Chemically-Modified Enzyme Membrane Electrode as an Amperometric Glucose Sensor", *Analytica Chimica Acta*, vol. 148, 1983, pp. 27-33.

Ye, L., et al., "High Current Density 'Wired' Quinoprotein Glucose Dehydrogenase Electrode", *Analytical Chemistry*, vol. 65 No. 3, 1993, pp. 238-241.

Yildiz, A., et al., "Evaluation of an Improved Thin-Layer Electrode", *Analytical Chemistry*, vol. 40, No. 7, 1968, pp. 1018-1024.

Zamzow, K., et al., "New Wearable Continuous Blood Glucose Monitor (BGM) and Artificial Pancreas (AP)", *Diabetes*, vol. 39, 1990, pp. 5A-20.

Zhang, Y., et al., "Application of Cell Culture Toxicity Tests to the Development of Implantable Biosensors", *Biosensors & Bioelectronics*, vol. 6, 1991, pp. 653-661.

Zhang, Y., et al., "Elimination of the Acetaminophen Interference in an Implantable Glucose Sensor", *Analytical Chemistry*, vol. 66, No. 7, 1994, pp. 1183-1188.

U.S. Appl. No. 11/396,182, Advisory Action mailed Oct. 20, 2010.

U.S. Appl. No. 11/396,182, Notice of Allowance mailed Apr. 27, 2012.

U.S. Appl. No. 11/396,182, Office Action mailed Apr. 5, 2011.

U.S. Appl. No. 11/396,182, Office Action mailed Aug. 5, 2010.

U.S. Appl. No. 11/396,182, Office Action mailed Feb. 17, 2012.

U.S. Appl. No. 11/396,182, Office Action mailed Feb. 19, 2010.

U.S. Appl. No. 12/630,689, Office Action mailed Jun. 20, 2012.

Bergman, R., et al., "Physiological Evaluation of Factors Controlling Glucose Tolerance in Man: Measurement of Insulin Sensitivity and Beta-cell Glucose Sensitivity From the Response to Intravenous Glucose", J. Clin. Invest., *The American Society for Clinical Investigation, Inc.*, vol. 68, 1981, pp. 1456-1467.

Diem, P., et al., "Clinical Performance of a Continuous Viscometric Affinity Sensor for Glucose", *Diabetes Technology & Therapeutics*, vol. 6, 2004, pp. 790-799.

Garg, S., et al., "Improvement in Glycemic Excursions with a Transcutaneous, Real-Time Continuous Glucose Sensor", *Diabetes Care*, vol. 29, No. 1, 2006, pp. 44-50.

Kondepati, V., et al., "Recent Progress in Analytical Instrumentation for Glycemic Control in Diabetic and Critically III Patients", *Analytical Bioanalytical Chemistry*, vol. 388, 2007, pp. 545-563.

Lo, B., et al., "Key Technical Challenges and Current Implementations of Body Sensor Networks", *Body Sensor Networks*, 2005, pp. 1-5.

Lodwig, V., et al., "Continuous Glucose Monitoring with Glucose Sensors: Calibration and Assessment Criteria", *Diabetes Technology & Therapeutics*, vol. 5, No. 4, 2003, pp. 573-587.

Salditt, P., "Trends in Medical Device Design and Manufacturing", *SMTA News and Journal of Surface Mount Technology*, vol. 17, 2004, pp. 19-24.

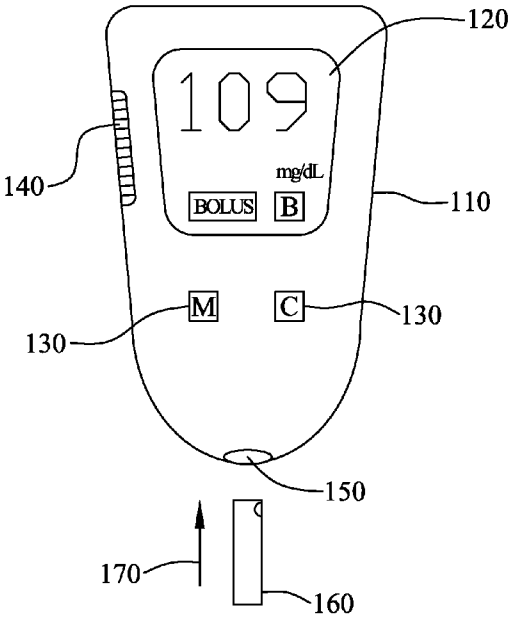
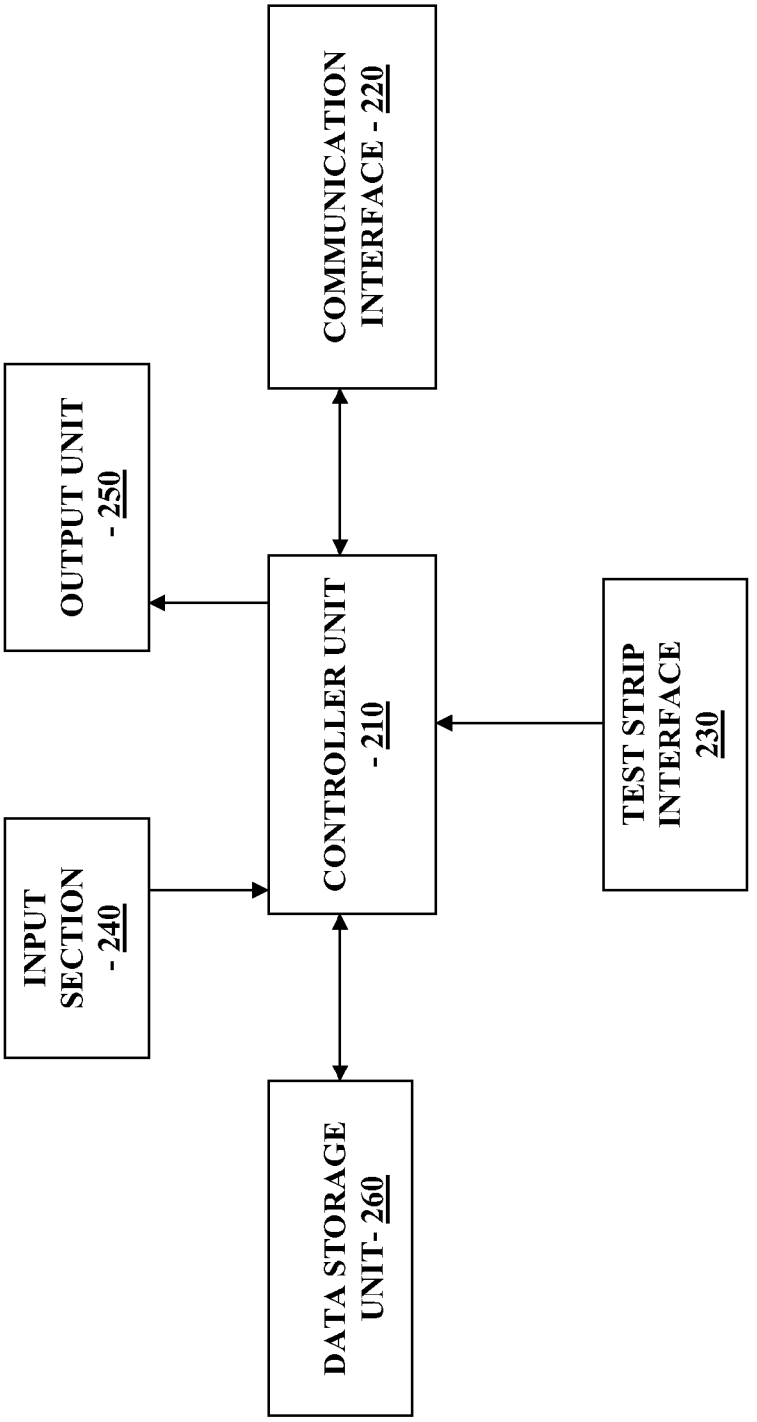


FIGURE 1


COMMUNICATION INTERFACE - 220
OUTPUT UNIT - 250
CONTROLLER UNIT - 210
TEST STRIP INTERFACE 230
INPUT SECTION - 240
DATA STORAGE UNIT- 260

200

FIGURE 2

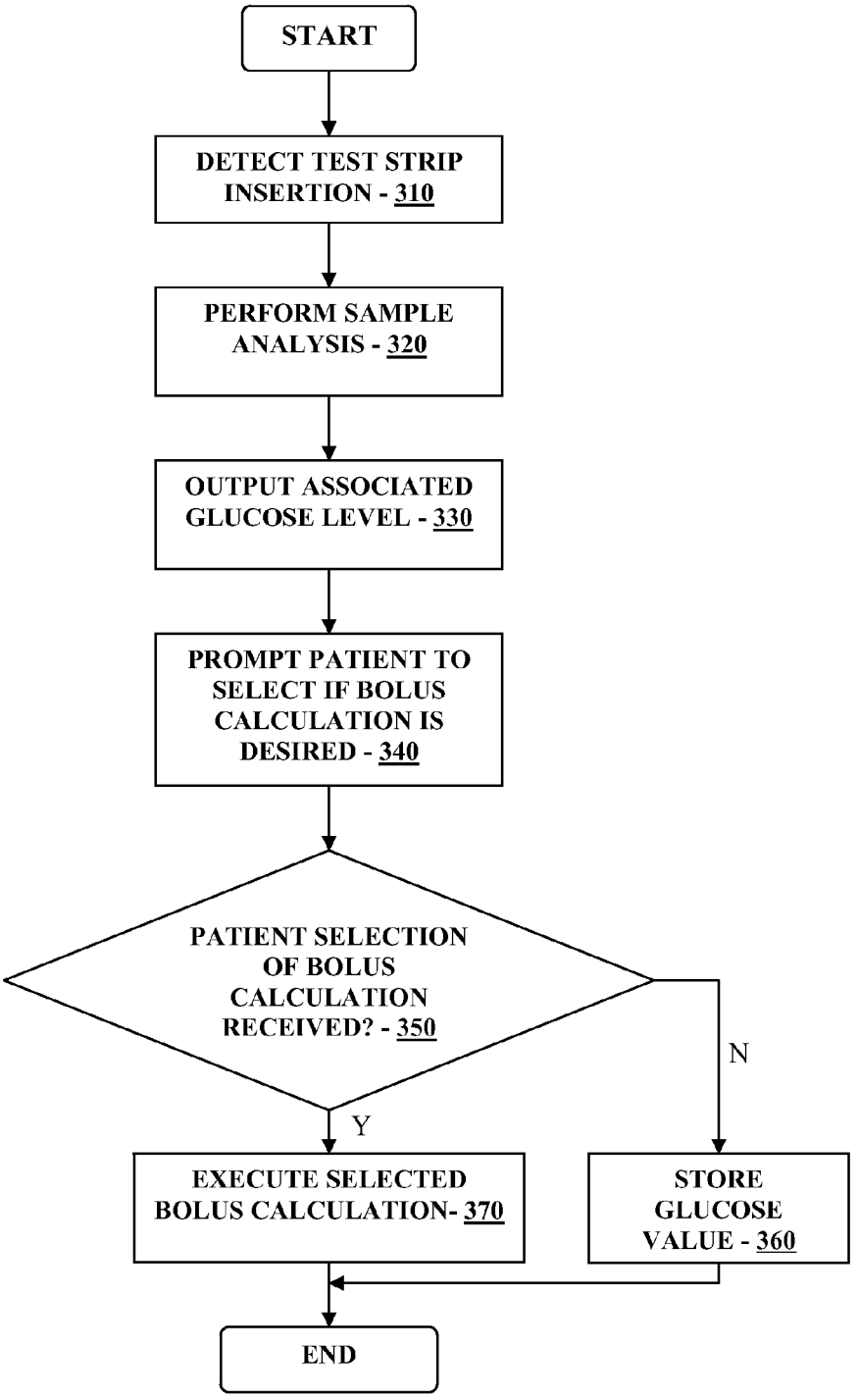

START
DETECT TEST STRIP INSERTION - 310
PERFORM SAMPLE ANALYSIS - 320
OUTPUT ASSOCIATED GLUCOSE LEVEL - 330
PROMPT PATIENT TO SELECT IF BOLUS CALCULATION IS DESIRED - 340
PATIENT SELECTION OF BOLUS CALCULATION RECEIVED? - 350
N
Y
EXECUTE SELECTED BOLUS CALCULATION- 370
STORE GLUCOSE VALUE - 360
END

FIGURE 3

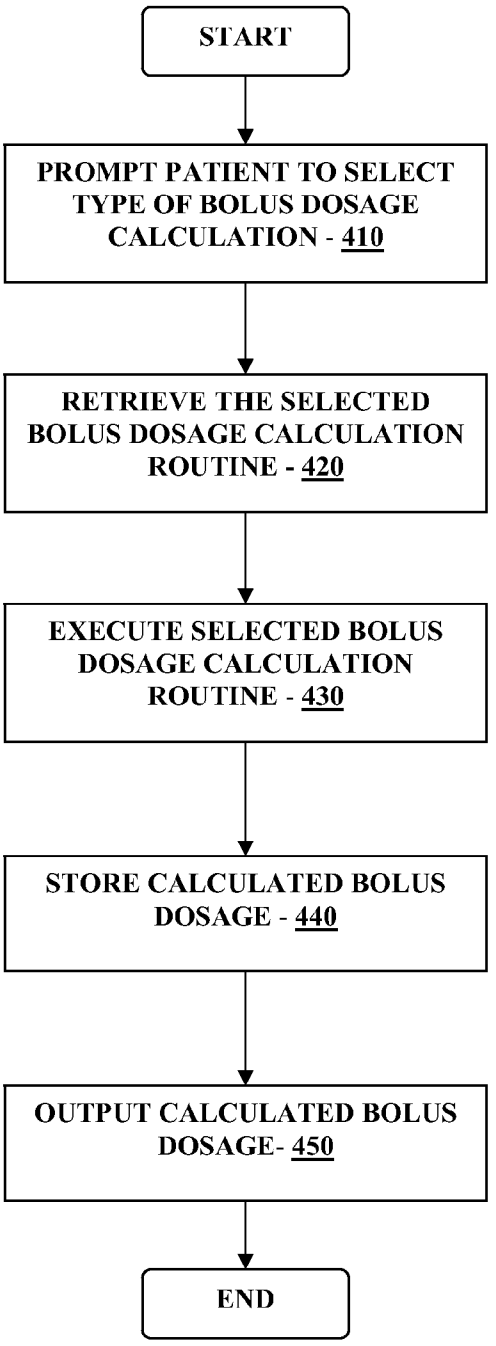

START
PROMPT PATIENT TO SELECT TYPE OF BOLUS DOSAGE CALCULATION - 410
RETRIEVE THE SELECTED BOLUS DOSAGE CALCULATION ROUTINE - 420
EXECUTE SELECTED BOLUS DOSAGE CALCULATION ROUTINE - 430
STORE CALCULATED BOLUS DOSAGE - 440
OUTPUT CALCULATED BOLUS DOSAGE- 450
END

FIGURE 4

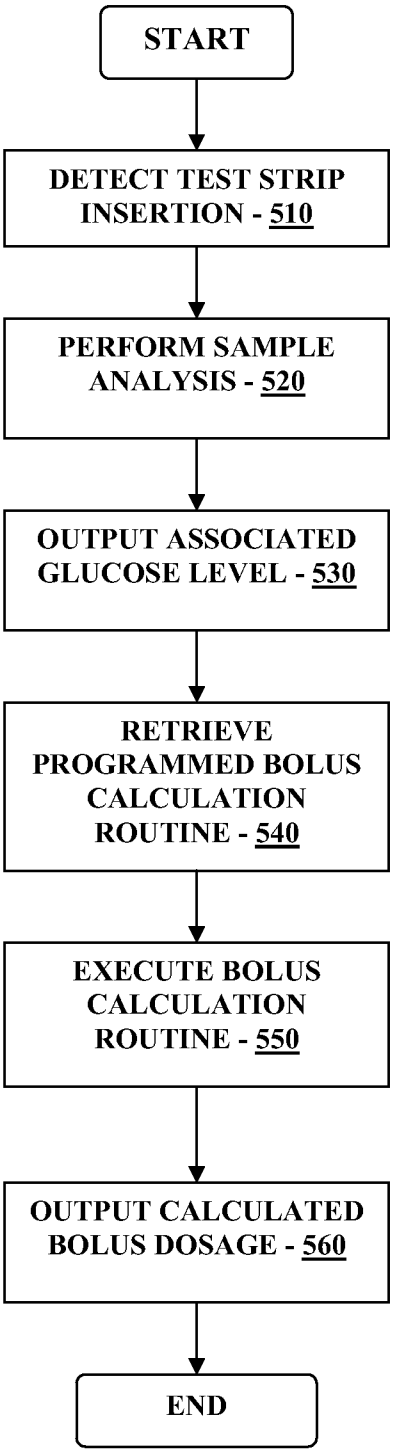

START
DETECT TEST STRIP INSERTION - 510
PERFORM SAMPLE ANALYSIS - 520
OUTPUT ASSOCIATED GLUCOSE LEVEL - 530
RETRIEVE PROGRAMMED BOLUS CALCULATION ROUTINE - 540
EXECUTE BOLUS CALCULATION ROUTINE - 550
OUTPUT CALCULATED BOLUS DOSAGE - 560
END

FIGURE 5

ANALYTE MONITORING DEVICES AND METHODS THEREFOR

RELATED APPLICATION

The present application is a continuation of U.S. patent application Ser. No. 11/396,182 filed Mar. 31, 2006, now U.S. Pat. No. 8,226,891, entitled "Analyte Monitoring Devices and Methods Therefor", the disclosure of which is incorporated herein by reference for all purposes.

BACKGROUND OF THE INVENTION

In diabetes management, there exist devices which allow diabetic patients to measure the blood glucose levels. One such device is a hand-held electronic meter such as a blood glucose meter such as Freestyle® blood glucose monitoring system available from Abbott Diabetes Care Inc., of Alameda, Calif. which receives blood samples via enzyme-based test strips. Typically, the patient lances a finger or alternate body site to obtain a blood sample, applies the drawn blood sample to the test strip, and the strip is inserted into a test strip opening or port in the meter housing. The blood glucose meter converts a current generated by the enzymatic reaction in the test strip to a corresponding blood glucose value which is displayed or otherwise provided to the patient to show the level of glucose at the time of testing.

Such periodic discrete glucose testing helps diabetic patients take any necessary corrective actions to better manage diabetic conditions. Presently available glucose meters have limited functionalities (for example, providing the glucose value measured using the test strip and storing the data for subsequent recall or display) and do not provide any additional information or capability to assist patients in managing diabetes. For example, Type-1 diabetic patients who require periodic infusion or injection of insulin, typically use glucose meters in addition to, for example, wearing an external infusion device, or a pen type injection device. Also, in the case of external infusion devices, because of the strip port on the meter receives the test strip (which is generally not a water tight seal), it is not desirable to incorporate the discrete glucose meter functionalities to the housing of the external infusion devices.

With the decreasing cost of electronic components and a corresponding increase in data processing capabilities of microprocessors, computational capability of electronic devices has been rapidly increasing. However, currently available glucose meters are generally configured with limited functionalities related to discrete glucose testing. In view of the foregoing, it would be desirable to have a glucose meter, such as a blood glucose meter, with various functionalities. Of interest are glucose meters that are capable of providing bolus dosage calculation, and the like, and which incorporate additional features related to diabetes management.

SUMMARY OF THE INVENTION

In view of the foregoing, in accordance with the various embodiments of the present invention, there are provided methods and system for incorporating the bolus calculation function into a blood glucose meter device which may be configured to perform data analysis and management based on, for example, the glucose level detected using the glucose meter.

These and other objects, features and advantages of the present invention will become more fully apparent from the following detailed description of the embodiments, the appended claims and the accompanying drawings.

BRIEF DESCRIPTION OF THE FIGURES

FIG. **1** is a glucose meter with bolus calculation function in accordance with one embodiment of the present invention;

FIG. **2** is a block diagram of the glucose meter with bolus calculation function of FIG. **1** in one embodiment of the present invention;

FIG. **3** is a flowchart illustrating the glucose level determination and bolus calculation procedure in accordance with one embodiment of the present invention;

FIG. **4** is a flowchart illustrating the bolus calculation procedure of FIG. **3** in accordance with one embodiment of the present invention; and

FIG. **5** is a flowchart illustrating the glucose level determination and bolus calculation procedure in accordance with another embodiment of the present invention.

DETAILED DESCRIPTION

As described in further detail below, in accordance with the various embodiments of the present invention, there are provided blood glucose meter devices that include bolus calculation functions and related data analysis capabilities incorporated in the glucose meter devices.

FIG. **1** shows a glucose meter with bolus calculation function in accordance with one embodiment of the present invention. Glucose meter with bolus calculation function **100** includes a housing **110** with a display unit **120** provided thereon. Also shown in FIG. **1** is a plurality of input buttons **130**, each configured to allow the user of the glucose meter with bolus calculation function **100** to input or enter data or relevant information associated with the operation of the glucose meter with bolus calculation function **100**. For example, the user of the glucose meter with bolus calculation function may operate the one or more input buttons **130** to enter a calibration code associated with a test strip **160** for use in conjunction with the glucose meter with bolus calculation function **100**. Additionally, the user may operate the one or more input buttons **130** to adjust time and/or date information, as well as other features or settings associated with the operation of the glucose meter with bolus calculation function **100**.

Referring back to FIG. **1**, also shown is input unit **140** which, in one embodiment, may be configured as a jog dial, or the like, and provided on the housing **110** of the glucose meter with bolus calculation function **100**. In one embodiment, as discussed in further detail below, the user or the patient may operate the input unit **140** to perform calculations and determinations associated with one or more bolus estimation function of the glucose meter with bolus calculation function **100**. Also shown in FIG. **1** is a strip port **150** which is configured to receive the test strip **160** (with blood sample provided thereon) substantially in the direction as shown by the directional arrow **170**.

In operation, when the test strip **160** with the patient's blood sample is inserted into the strip port **150** of the glucose meter with bolus calculation function **100**, a micro processor or a control unit **210** (FIG. **2**) of the glucose meter with bolus calculation function **100** may be configured to determine the associated glucose level in the blood sample, and display the determined glucose level on the display unit **120**.

In addition, in accordance with the various embodiments of the present invention, the glucose meter with bolus calculation function **100** may be configured to automatically enter

into a bolus determination mode to, for example, estimate the predetermined or pre-programmed bolus dosage amount based on information stored in the glucose meter with bolus calculation function **100** (such as the patient's insulin sensitivity, for example), and/or prompt the patient to provide additional information, such as the amount of carbohydrate to be ingested by the patient for determination of, for example, a carbohydrate bolus dosage determination. The patient may operate the input unit **140** in conjunction with the user interface menu provided on the display unit **120** to provide the appropriate information.

In another embodiment, the glucose meter with bolus calculation function **100** may be configured to prompt the patient to select whether to calculate a predetermined or preprogrammed bolus dosage amount such as, for example, a correction bolus or a carbohydrate bolus, following the display of the determined glucose level from the test strip **160**. In this manner, in one embodiment of the present invention, the glucose meter with bolus calculation function **100** may be configured to automatically prompt the user or patient to select whether a bolus dosage determination is desired following a glucose testing using the test strip **160**.

FIG. **2** is a block diagram of the glucose meter with bolus calculation function of FIG. **1** in one embodiment of the present invention. Referring to FIG. **2**, the glucose meter with bolus calculation function **200** includes a controller unit **210** operatively coupled to a communication interface **220** and configured for bidirectional communication. The controller unit **210** is further operatively coupled to a test strip interface **230**, an input section **240** (which, for example, may include the input unit **140** and the plurality of input buttons **130** as shown in FIG. **1**), an output unit **250**, and a data storage unit **260**.

Referring to FIG. **2**, in one embodiment of the present invention, the test strip interface **230** is configured to couple with the inserted test strip **160** for determination of the blood sample on the test strip **160**. In addition, the test strip interface **230** may include an illumination segment which may be configured to illuminate the strip port **150** (FIG. **1**) using a light emitting diode (LED), for example, during the test strip **160** insertion process to assist the user in properly and accurately inserting the test strip **160** into the strip port **150**.

Moreover, in a further aspect of the present invention, the test strip interface **230** may be additionally configured with a physical latch or securement mechanism internally provided within the housing **110** of the glucose meter with bolus calculation function **100** (FIG. **1**) such that when the test strip **160** is inserted into the strip port **150**, the test strip **160** is retained in the received position within the strip port **150** until the sample analysis is completed. Examples of such physical latch or securement mechanism may include a uni-directionally biased anchor mechanism, or a pressure application mechanism to retain the test strip **160** in place by applying pressure on one or more surfaces of the test strip **160** within the strip port **150**.

Referring back to FIG. **1**, the output unit **250** may be configured to output display data or information including the determined glucose level on the display unit **120** (FIG. **1**) of the glucose meter with bolus calculation function **100**. In addition, in still a further aspect of the present invention, the output unit **250** and the input section **240** may be integrated, for example, in the case where the display unit **120** is configured as a touch sensitive display where the patient may enter information or commands via the display area using, for example, a stylus or any other suitable input device, and where, the touch sensitive display is configured as the user interface in an icon driven environment, for example.

Referring yet again to FIG. **2**, the communication interface **220** in one embodiment of the present invention includes a wireless communication section configured for bi-directional radio frequency (RF) communication with other devices to transmit and/or receive data to and from the glucose meter with bolus calculation function **100**. In addition, the communication interface **220** may also be configured to include physical ports or interfaces such as a USB port, an RS-232 port, or any other suitable electrical connection port to allow data communication between the glucose meter with bolus calculation function **100** and other external devices such as a computer terminal (for example, at a physician's office or in hospital environment), an external infusion device such as insulin pumps, or other devices that is configured for similar complementary data communication.

In one embodiment, the wireless communication section of the communication interface **220** may be configured for infrared communication, Bluetooth® communication, or any other suitable wireless communication mechanism to enable the glucose meter with bolus calculation function to communication with other devices such as infusion devices, analyte monitoring devices, computer terminals, communication enabled mobile telephones, personal digital assistants, or any other communication devices which the patient or user of the glucose meter with bolus calculation function **100** may use in conjunction therewith, in managing the treatment of the diabetic condition.

FIG. **3** is a flowchart illustrating the glucose level determination and bolus calculation procedure in accordance with one embodiment of the present invention. Referring to FIG. **3**, a test strip is detected by the controller unit **210** (or the test strip interface **230**) **310** of the glucose meter with bolus calculation function **100** (FIG. **1**). Thereafter, the blood sample received from the inserted test strip **150** is analyzed **320** to determine the corresponding glucose level, and the determined glucose level is output **330** on the display unit **120** (FIG. **1**) for example, in units of mg/dL.

Referring back to FIG. **3**, after determining the glucose level and displaying the measured glucose level to the patient **330**, a prompt command is generated and output to the patient to select if the bolus calculation is desired **340**. More specifically, in one embodiment of the present invention, the controller unit **210** is configured to generate a command and display in the display unit **120** to query the user as to whether a bolus calculation determination is desired by the patient. Thereafter, a determination of whether or not the patient has selected to have the bolus dosage calculation performed by the controller unit **210** is made **350**. In one embodiment, the patient may operate one or more of the input buttons **130** or the input unit **140** to select whether or not to have the bolus calculation performed.

Referring again to FIG. **3**, if it is determined that the patient has selected not to have the bolus dosage determination performed, then the determined glucose value is stored **360**, e.g., in memory of the meter, and the routine terminates. For example, in one embodiment, the controller unit **210** (FIG. **2**) may be configured to store the determined glucose value in the data storage unit **260** with associated time and/or date information of when the glucose value determination is performed. In an alternate embodiment, the measured glucose value may be stored substantially concurrently with the display of the glucose value (for example, **330**).

On the other hand, if it is determined that the patient has selected to have the bolus dosage calculation performed, the glucose meter with bolus calculation function **100** is configured to enter the bolus dosage determination mode **370**,

described in further detail below in conjunction with FIG. **4**, where the desired type of bolus dosage is determined and provided to the patient.

FIG. **4** is a flowchart illustrating the bolus calculation procedure of FIG. **3** in accordance with one embodiment of the present invention. Referring to FIG. **4**, when the glucose meter with bolus calculation function **100** (FIG. **1**) enters the bolus dosage determination mode as described above, the controller unit **210** (FIG. **2**) is configured to prompt the patient (for example, by displaying the options to the patient on the display unit **120** (FIG. **1**)) to select the type of desired bolus dosage calculation **410**. For example, the controller unit **210** may be configured to output a list of available bolus dosage calculation options including, for example, a carbohydrate bolus, a correction bolus, a dual or extended bolus, a square wave bolus, or any other suitable bolus calculation function which may be programmed into the glucose meter with bolus calculation function **100** (and for example, stored in the data storage unit **260**).

Referring back to FIG. **4**, after the patient selects the desired bolus dosage calculation in response to the prompt for bolus type selection **410**, the selected bolus dosage calculation routine is retrieved **420** from the data storage unit **260**, thereafter executed **430**. In one embodiment, the execution of the selected bolus dosage calculation **430** may include one or more input prompts to the patient to enter additional information as may be required to perform the selected bolus dosage calculation.

For example, in the case of calculating a carbohydrate bolus, the patient may be prompted to provide or enter an estimate of the carbohydrate amount that the patient is planning on ingesting **430**. In this regard, a food database may be stored in the data storage unit **260** or elsewhere for easy access (e.g., a PC, PDA, telephone, or the like and to which the meter may be coupled (e.g., wirelessly or by physical connection) to easily retrieve such information) to conveniently determine the corresponding carbohydrate amount associated with the type of food which the patient will be ingesting. Alternatively, the patient may provide the actual estimated carbohydrate count if such information is readily available by the patient.

Alternatively, in the case of calculating a dual bolus, the patient is prompted to provide a time duration information for the extended portion of the bolus dosage to be infused or otherwise provided to the patient. Similarly, the patient may further be prompted to provide insulin sensitivity information, and any other information as may be necessary to determine the selected bolus dosage amount in conjunction with other relevant information such as insulin on board information, and the time of the most recently administered bolus (so as to provide a warning to the patient if a bolus dosage has been administered within a predetermined time period, and a subsequent administration of the additional bolus dosage may potentially be harmful).

Referring back to FIG. **4**, after the execution of the selected bolus dosage calculation routine **430**, the calculated bolus dosage amount is stored **440** in the data storage unit **260**, and the calculated bolus dosage amount is output displayed to the patient **450** on the display unit **120** of the glucose meter with bolus calculation function **100**, or audibly if the meter is so configured. In certain embodiments, storing and output displaying the calculated bolus dosage amount may be substantially concurrently performed, rather than sequentially.

FIG. **5** is a flowchart illustrating the glucose level determination and bolus calculation procedure in accordance with another embodiment of the present invention. Referring to FIG. **5**, a test strip **160** is inserted into the strip port of the glucose meter with bolus calculation function **510**, the blood sample on the test strip **160** is analyzed to determine the corresponding blood glucose level **520**, and thereafter, output displayed **530**.

Referring back to FIG. **5**, a determination of the blood glucose level from the blood sample received from the test strip **160**, is made **540**. The controller unit **210** (FIG. **2**) is configured to enter into the bolus dosage determination mode, and to execute pre-programmed or predetermined bolus calculation routine **550**, and thereafter, output display the calculated bolus dosage amount **560**. In this manner, in one embodiment of the present invention, the glucose meter with bolus calculation function **100** may be programmed or configured to automatically enter into the dosage determination mode upon completion of the blood sample analysis for glucose level determination.

In one embodiment of the present invention, the glucose meter with bolus calculation function **100** may be configured to execute different types of bolus dosage calculation based on the patient specified parameters. For example, the glucose meter with bolus calculation function **100** may be configured to perform a carbohydrate bolus determination when the test strip sample analysis is performed within a predetermined time period of a meal event. For example, the glucose meter with bolus calculation function **100** may be programmed by the patient to automatically select the carbohydrate bolus determination if the test strip blood sample analysis is performed within one hour prior to a meal time (which may be programmed into the glucose meter with bolus calculation function **100**).

Accordingly, as described herein, embodiments of the present invention, method and apparatus for performing discrete glucose testing and bolus dosage determination are provided.

An apparatus including a glucose meter in one embodiment of the present invention includes a housing having a display unit disposed thereon, a strip port coupled to the housing and a controller unit coupled to the housing, a controller configured to process one or more signals associated with data received from the test strip, and a controller (the same or different controller from the controller described above) configured to determined a bolus dosage based on the data received from the test strip.

The controller may be configured to display the determined bolus dosage on the display unit, where the displayed bolus dosage may be one or more of an alphanumeric display, a graphical display, a video display, an audio display, a vibratory output, or combinations thereof.

In a further aspect, the controller unit may be configured to determine the bolus dosage substantially automatically after receiving the data from the test strip.

In one embodiment, the apparatus may include an output unit configured to provide one or more of an audible notification, a vibratory notification, or combinations thereof.

Moreover, the bolus dosage determined by the controller unit may include one or more of a carbohydrate bolus, a correction bolus, an extended bolus, a dual bolus, or combinations thereof.

The apparatus in yet another embodiment may include an input unit coupled to the housing, where the controller unit may be configured to determine the bolus dosage in response to a command received from the input unit.

The input unit may include one or more of an input button, a touch sensitive screen, a jog wheel, or combinations thereof.

Further, the data received from the test strip may correspond to an analyte level which, in one embodiment may include a measured glucose level of a patient.

A computer program product for use with a glucose meter in accordance with a further embodiment of the present invention includes a computer readable storage medium having a computer program stored thereon which controls the meter to calculate a bolus dosage based on glucose information received from the meter.

In one aspect, the glucose meter may be configured to display the calculated bolus dosage. The bolus dosage displayed on the glucose meter may be one or more of an alphanumeric display, a graphical display, a video display, an audio display, a vibratory output, or combinations thereof.

In a further aspect, the bolus dosage may include one or more of a carbohydrate bolus, a correction bolus, an extended bolus, a dual bolus, or combinations thereof.

Also provided are methods of analyte monitoring. Embodiments include receiving an analyte sample, determining an analyte level corresponding to the analyte sample, and determining a bolus dosage amount substantially immediately after the analyte level determination.

In one embodiment, the method may include displaying one or more of the bolus dosage, the analyte level, or combinations thereof. Determining a bolus dosage in some embodiments may be automatically performed after the analyte level determination.

The method may include generating one or more of an audible notification, a vibratory notification, a visual notification, or combinations thereof, associated with one or more of the determined bolus dosage, the determined analyte level, or combinations thereof.

The bolus dosage determined in one embodiment may include one or more of a carbohydrate bolus, a correction bolus, an extended bolus, a dual bolus, or combinations thereof.

The various processes described above including the processes performed by the processor unit **210** in the software application execution environment of the glucose meter device **200** including the processes and routines described in conjunction with FIGS. **3-5**, may be embodied as computer programs developed using an object oriented language that allows the modeling of complex systems with modular objects to create abstractions that are representative of real world, physical objects and their interrelationships. The software required to carry out the inventive process, which may be stored in the storage unit **260** (FIG. **2**) of the glucose meter with bolus calculation function **100**, may be developed by a person of ordinary skill in the art and may include one or more computer program products.

A computer program product is also provided that is configured for use with a glucose meter. The program product includes a computer readable storage medium having a computer program stored thereon for calculating a bolus based on glucose information from the meter. For example, a meter controller may include a general purpose digital microprocessor or the like that may be programmed from such a computer readable medium carrying necessary program code for accomplishing the bolus function described herein. The programming may be provided remotely to the meter controller, e.g., through a communication channel, or previously saved in a computer program product such as memory or some other portable or fixed computer readable storage medium. For example, a magnetic or optical disk may carry the programming, which may be read by a reader of the meter and optionally stored in the meter memory of the meter. The computer program product may be any suitable product, such as a portable or fixed computer readable storage medium, including magnetic or optical disks or tape or RAM, or any other suitable device, either fixed or portable.

Various other modifications and alternations in the structure and method of operation of this invention will be apparent to those skilled in the art without departing from the scope and spirit of the invention. Although the invention has been described in connection with specific preferred embodiments, it should be understood that the invention as claimed should not be unduly limited to such specific embodiments.

What is claimed is:

1. An apparatus including an analyte meter, comprising:
- a housing having a display unit disposed thereon;
- a data storage unit disposed within the housing, the data storage unit storing meal event information;
- a strip port coupled to the housing and configured to receive a test strip that includes an analyte sample; and
- a controller unit coupled to the housing, the controller configured to determine an analyte level corresponding to the analyte sample, the controller further configured to detect when the test strip is received in the strip port, and to determine if the test strip is received in the strip port within a predetermined time period of a meal event; wherein when the test strip is determined as received in the strip port within the predetermined time period of the meal event, a carbohydrate bolus determination mode is automatically selected by the controller unit to determine a bolus dosage.

2. The apparatus of claim **1**, wherein the controller unit is further configured to display the determined bolus dosage on the display unit.

3. The apparatus of claim **2** wherein the displayed bolus dosage is one or more of an alphanumeric display, a graphical display, a video display, an audio display, a vibratory output, or combinations thereof.

4. The apparatus of claim **1** further including an output unit configured to provide one or more of an audible notification, a vibratory notification, or combinations thereof.

5. The apparatus of claim **1** wherein the bolus dosage determined by the controller unit includes one or more of a carbohydrate bolus, a correction bolus, an extended bolus, a dual bolus, or combinations thereof.

6. The apparatus of claim **1** further including an input unit coupled to the housing, wherein the controller unit is configured to determine the bolus dosage in response to a command received from the input unit.

7. The apparatus of claim **6** wherein the input unit includes one or more of an input button, a touch sensitive screen, a jog wheel, or combinations thereof.

8. The apparatus of claim **1** wherein the analyte level includes a glucose level of a patient.

9. A computer program product for use with an analyte meter, the program product comprising a computer readable storage medium having a computer program stored thereon which controls the meter to store meal event information, to receive data related to an analyte sample, to determine an analyte level corresponding to the received data related to the analyte sample, to detect when a test strip is received in a strip port, to determine if the test strip is received in the strip port within a predetermined time period of a meal event, and to automatically select a carbohydrate bolus determination mode to determine a bolus dosage amount when the test strip is determined as received in the strip port within the predetermined time period of the meal event.

10. The computer program product of claim **9** wherein the computer program instructs the analyte meter to display the determined bolus dosage.

11. The computer program product of claim **10** wherein the bolus dosage displayed on the analyte meter is one or more of

an alphanumeric display, a graphical display, a video display, an audio display, a vibratory output, or combinations thereof.

12. The computer program product of claim **9** wherein the bolus dosage includes one or more of a carbohydrate bolus, a correction bolus, an extended bolus, a dual bolus, or combinations thereof.

13. A method, comprising:

storing meal event information;

receiving an analyte sample;

determining an analyte level corresponding to the analyte sample;

detecting when a test strip is received in a strip port;

determining if the test strip is received in the strip port within a predetermined time period of a meal event; and

automatically selecting a carbohydrate bolus determination mode to determine a bolus dosage amount when the test strip is determined as received in the strip port within the predetermined time period of the meal event.

14. The method of claim **13** further including displaying one or more of the bolus dosage, the analyte level, or combinations thereof.

15. The method of claim **13** further including generating one or more of an audible notification, a vibratory notification, a visual notification, or combinations thereof, associated with one or more of the determined bolus dosage, the determined analyte level, or combinations thereof.

16. The method of claim **13** wherein the bolus dosage determined includes one or more of a carbohydrate bolus, a correction bolus, an extended bolus, a dual bolus, or combinations thereof.

17. The method of claim **13** wherein the analyte level includes a measured glucose level of a patient.

* * * * *