US009386953B2

(12) **United States Patent**
Al-Ali

(10) **Patent No.: US 9,386,953 B2**
(45) **Date of Patent: Jul. 12, 2016**

(54) **METHOD OF STERILIZING A REUSABLE PORTION OF A NONINVASIVE OPTICAL PROBE**

(75) Inventor: **Ammar Al-Ali**, San Juan Capistrano, CA (US)

(73) Assignee: **Masimo Corporation**, Irvine, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 148 days.

(21) Appl. No.: **13/209,324**

(22) Filed: **Aug. 12, 2011**

(65) **Prior Publication Data**

US 2011/0301444 A1 Dec. 8, 2011

Related U.S. Application Data

(63) Continuation of application No. 11/415,600, filed on May 2, 2006, now Pat. No. 8,000,761, which is a continuation of application No. 10/741,777, filed on Dec. 19, 2003, now Pat. No. 7,039,449, which is a continuation of application No. 10/128,721, filed on Apr. 23, 2002, now Pat. No. 6,725,075, which is a continuation of application No. 09/456,666, filed on Dec. 9, 1999, now Pat. No. 6,377,829.

(51) **Int. Cl.**

H01R 43/16	(2006.01)
A61B 5/00	(2006.01)
A61B 5/1455	(2006.01)

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

CPC ***A61B 5/6826*** (2013.01); ***A61B 5/14552*** (2013.01); ***A61B 5/6838*** (2013.01); *Y10T 137/4478* (2015.04)

(58) **Field of Classification Search**

CPC C12Q 1/22; C12Q 1/26; G01N 2021/1793; G01N 21/35; G01N 2201/0221; H01S 5/141; H01S 5/4031; A61B 5/0071; A61B 5/0075; A61B 5/0261; Y10T 137/4478; G01J 3/108; G02B 23/26

USPC 29/874, 603.09, 825, 831, 846; 600/310, 322, 323, 344

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,621,643 A	11/1986	New, Jr. et al.
4,848,901 A	7/1989	Hood, Jr.
4,865,038 A	9/1989	Rich et al.

(Continued)

FOREIGN PATENT DOCUMENTS

EP	0 313 238 A2	10/1988
WO	WO 01/41634 A2	6/2001

OTHER PUBLICATIONS

http://www.masimo.com/systemo.htm, "System Overview & Performance", 2 pages, reviewed on Sep. 17, 1999.

(Continued)

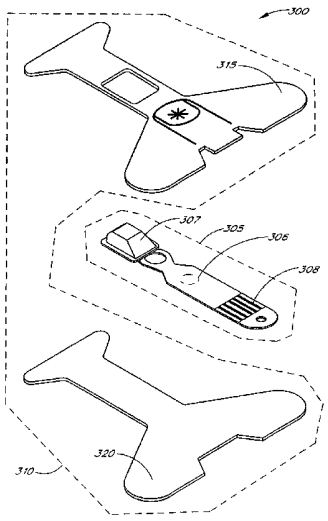
Primary Examiner — Thiem Phan

(74) *Attorney, Agent, or Firm* — Knobbe Martens Olson & Bear LLP

(57) **ABSTRACT**

A pulse oximeter sensor has both a reusable and a disposable portion. The reusable portion of the sensor preserves the relatively long-lived and costly emitter, detector and connector components. The disposable portion of the sensor is the relatively inexpensive adhesive tape component that is used to secure the sensor to a measurement site, typically a patient's finger or toe. The disposable portion of the sensor is removably attached to the reusable portion in a manner that allows the disposable portion to be readily replaced when the adhesive is expended or the tape becomes soiled or excessively worn. The disposable portion may also contain an information element useful for sensor identification or for security purposes to insure patient safety.

8 Claims, 11 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

4,942,877 A 7/1990 Sakai et al.
4,960,128 A 10/1990 Gordon et al.
4,964,408 A 10/1990 Hink et al.
5,041,187 A 8/1991 Hink et al.
5,069,213 A 12/1991 Polczynski
5,090,410 A 2/1992 Saper et al.
5,158,326 A 10/1992 Yamamoto et al.
5,163,438 A 11/1992 Gordon et al.
5,170,786 A 12/1992 Thomas et al.
5,209,230 A 5/1993 Swedlow et al.
5,319,355 A 6/1994 Russek
5,337,744 A 8/1994 Branigan
5,341,805 A 8/1994 Stavridi et al.
D353,195 S 12/1994 Savage et al.
D353,196 S 12/1994 Savage et al.
5,377,676 A 1/1995 Vari et al.
D359,546 S 6/1995 Savage et al.
5,431,170 A 7/1995 Mathews
D361,840 S 8/1995 Savage et al.
D362,063 S 9/1995 Savage et al.
5,452,717 A 9/1995 Branigan et al.
D363,120 S 10/1995 Savage et al.
5,456,252 A 10/1995 Vari et al.
5,460,182 A 10/1995 Goodman et al.
5,479,934 A 1/1996 Imran
5,482,036 A 1/1996 Diab et al.
5,490,505 A 2/1996 Diab et al.
5,494,043 A 2/1996 O'Sullivan et al.
5,533,511 A 7/1996 Kaspari et al.
5,534,851 A 7/1996 Russek
5,561,275 A 10/1996 Savage et al.
5,562,002 A 10/1996 Lalin
5,590,649 A 1/1997 Caro et al.
5,602,924 A 2/1997 Durand et al.
5,632,272 A 5/1997 Diab et al.
5,638,816 A 6/1997 Kiani-Azarbayjany et al.
5,638,818 A 6/1997 Diab et al.
5,645,440 A 7/1997 Tobler et al.
5,660,567 A 8/1997 Nirlich et al.
5,673,693 A 10/1997 Solenberger
5,678,544 A 10/1997 DeLonzor et al.
5,685,299 A 11/1997 Diab et al.
5,720,293 A 2/1998 Quinn et al.
393,830 A 4/1998 Tobler et al.
5,743,262 A 4/1998 Lepper, Jr. et al.
5,758,644 A 6/1998 Diab et al.
5,760,910 A 6/1998 Lepper, Jr. et al.
5,769,785 A 6/1998 Diab et al.
5,782,757 A 7/1998 Diab et al.
5,785,659 A 7/1998 Caro et al.
5,791,347 A 8/1998 Flaherty et al.
5,810,734 A 9/1998 Caro et al.
5,823,950 A 10/1998 Diab et al.
5,830,131 A 11/1998 Caro et al.
5,833,618 A 11/1998 Caro et al.
5,860,919 A 1/1999 Kiani-Azarbayjany et al.
5,890,929 A 4/1999 Mills et al.
5,904,654 A 5/1999 Wohltmann et al.
5,919,133 A 7/1999 Taylor et al.
5,919,134 A 7/1999 Diab
5,934,925 A 8/1999 Tobler et al.
5,940,182 A 8/1999 Lepper, Jr. et al.
5,987,343 A 11/1999 Kinast
5,995,855 A 11/1999 Kiani et al.
5,997,343 A 12/1999 Mills et al.
5,999,834 A 12/1999 Wang et al.
6,002,952 A 12/1999 Diab et al.
6,011,986 A 1/2000 Diab et al.
6,014,576 A 1/2000 Raley
6,023,541 A 2/2000 Merchant et al.
6,027,452 A 2/2000 Flaherty et al.
6,036,642 A 3/2000 Diab et al.
6,045,509 A 4/2000 Caro et al.
6,061,584 A 5/2000 Lovejoy et al.
6,067,462 A 5/2000 Diab et al.
6,081,735 A 6/2000 Diab et al.
6,088,607 A 7/2000 Diab et al.
6,110,522 A 8/2000 Lepper, Jr. et al.
6,124,597 A 9/2000 Shehada
6,128,521 A 10/2000 Marro et al.
6,129,675 A 10/2000 Jay
6,144,868 A 11/2000 Parker
6,151,516 A 11/2000 Kiani-Azarbayjany et al.
6,152,754 A 11/2000 Gerhardt et al.
6,157,850 A 12/2000 Diab et al.
6,165,005 A 12/2000 Mills et al.
6,184,521 B1 2/2001 Coffin, IV et al.
6,206,830 B1 3/2001 Diab et al.
6,229,856 B1 5/2001 Diab et al.
6,232,609 B1 5/2001 Snyder et al.
6,236,872 B1 5/2001 Diab et al.
6,241,683 B1 6/2001 Macklem et al.
6,253,097 B1 6/2001 Aronow et al.
6,256,523 B1 7/2001 Diab et al.
6,263,222 B1 7/2001 Diab et al.
6,278,522 B1 8/2001 Lepper, Jr. et al.
6,280,213 B1 8/2001 Tobler et al.
6,285,896 B1 9/2001 Tobler et al.
6,301,493 B1 10/2001 Marro et al.
6,308,089 B1 10/2001 von der Ruhr et al.
6,317,627 B1 11/2001 Ennen et al.
6,321,100 B1 11/2001 Parker
6,325,761 B1 12/2001 Jay
6,334,065 B1 12/2001 Al-Ali et al.
6,343,224 B1 1/2002 Parker
6,349,228 B1 2/2002 Kiani et al.
6,360,114 B1 3/2002 Diab et al.
6,368,283 B1 4/2002 Xu et al.
6,371,921 B1 4/2002 Caro et al.
6,377,829 B1 4/2002 Al-Ali
6,388,240 B2 5/2002 Schulz et al.
6,397,091 B2 5/2002 Diab et al.
6,430,437 B1 8/2002 Marro
6,430,525 B1 8/2002 Weber et al.
6,463,311 B1 10/2002 Diab
6,470,199 B1 10/2002 Kopotic et al.
6,501,975 B2 12/2002 Diab et al.
6,505,059 B1 1/2003 Kollias et al.
6,515,273 B2 2/2003 Al-Ali
6,519,487 B1 2/2003 Parker
6,525,386 B1 2/2003 Mills et al.
6,526,300 B1 2/2003 Kiani et al.
6,541,756 B2 4/2003 Schulz et al.
6,542,764 B1 4/2003 Al-Ali et al.
6,571,113 B1 5/2003 Fein et al.
6,580,086 B1 6/2003 Schulz et al.
6,580,948 B2 6/2003 Haupert et al.
6,584,336 B1 6/2003 Ali et al.
6,595,316 B2 7/2003 Cybulski et al.
6,597,932 B2 7/2003 Tian et al.
6,597,933 B2 7/2003 Kiani et al.
6,600,940 B1 7/2003 Fein et al.
6,606,511 B1 8/2003 Ali et al.
6,632,181 B2 10/2003 Flaherty et al.
6,639,668 B1 10/2003 Trepagnier
6,640,116 B2 10/2003 Diab
6,643,530 B2 11/2003 Diab et al.
6,650,917 B2 11/2003 Diab et al.
6,654,624 B2 11/2003 Diab et al.
6,658,276 B2 12/2003 Kianl et al.
6,661,161 B1 12/2003 Lanzo et al.
6,671,531 B2 12/2003 Al-Ali et al.
6,678,543 B2 1/2004 Diab et al.
6,684,090 B2 1/2004 Ali et al.
6,684,091 B2 1/2004 Parker
6,697,656 B1 2/2004 Al-Ali
6,697,657 B1 2/2004 Shehada et al.
6,697,658 B2 2/2004 Al-Ali
RE38,476 E 3/2004 Diab et al.
6,699,194 B1 3/2004 Diab et al.
6,714,804 B2 3/2004 Al-Ali et al.
RE38,492 E 4/2004 Diab et al.
6,721,582 B2 4/2004 Trepagnier et al.
6,721,585 B1 4/2004 Parker

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,725,075 B2 4/2004 Al-Ali
6,728,560 B2 4/2004 Kollias et al.
6,735,459 B2 5/2004 Parker
6,745,060 B2 6/2004 Diab et al.
6,760,607 B2 7/2004 Al-Ali
6,770,028 B1 8/2004 Ali et al.
6,771,994 B2 8/2004 Kiani et al.
6,792,300 B1 9/2004 Diab et al.
6,813,511 B2 11/2004 Diab et al.
6,816,741 B2 11/2004 Diab
6,822,564 B2 11/2004 Al-Ali
6,826,419 B2 11/2004 Diab et al.
6,830,711 B2 12/2004 Mills et al.
6,850,787 B2 2/2005 Weber et al.
6,850,788 B2 2/2005 Al-Ali
6,852,083 B2 2/2005 Caro et al.
6,861,639 B2 3/2005 Al-Ali
6,898,452 B2 5/2005 Al-Ali et al.
6,920,345 B2 7/2005 Al-Ali et al.
6,931,268 B1 8/2005 Kiani-Azarbayjany et al.
6,934,570 B2 8/2005 Kiani et al.
6,939,305 B2 9/2005 Flaherty et al.
6,943,348 B1 9/2005 Coffin, IV
6,950,687 B2 9/2005 Al-Ali
6,961,598 B2 11/2005 Diab
6,970,792 B1 11/2005 Diab
6,979,812 B2 12/2005 Al-Ali
6,985,764 B2 1/2006 Mason et al.
6,993,371 B2 1/2006 Kiani et al.
6,996,427 B2 2/2006 Ali et al.
6,999,904 B2 2/2006 Weber et al.
7,003,338 B2 2/2006 Weber et al.
7,003,339 B2 2/2006 Diab et al.
7,015,451 B2 3/2006 Dalke et al.
7,024,233 B2 4/2006 Ali et al.
7,027,849 B2 4/2006 Al-Ali
7,030,749 B2 4/2006 Al-Ali
7,039,449 B2 5/2006 Al-Ali
7,041,060 B2 5/2006 Flaherty et al.
7,044,918 B2 5/2006 Diab
7,067,893 B2 6/2006 Mills et al.
7,096,052 B2 8/2006 Mason et al.
7,096,054 B2 8/2006 Abdul-Hafiz et al.
7,132,641 B2 11/2006 Schulz et al.
7,142,901 B2 11/2006 Kiani et al.
7,149,561 B2 12/2006 Diab
7,186,966 B2 3/2007 Al-Ali
7,190,261 B2 3/2007 Al-Ali
7,215,984 B2 5/2007 Diab
7,215,986 B2 5/2007 Diab
7,221,971 B2 5/2007 Diab
7,225,006 B2 5/2007 Al-Ali et al.
7,225,007 B2 5/2007 Al-Ali
RE39,672 E 6/2007 Shehada et al.
7,239,905 B2 7/2007 Kiani-Azarbayjany et al.
7,245,953 B1 7/2007 Parker
7,254,429 B2 8/2007 Schurman et al.
7,254,431 B2 8/2007 Al-Ali
7,254,433 B2 8/2007 Diab et al.
7,254,434 B2 8/2007 Schulz et al.
7,272,425 B2 9/2007 Al-Ali
7,274,955 B2 9/2007 Kiani et al.
D554,263 S 10/2007 Al-Ali
7,280,858 B2 10/2007 Al-Ali et al.
7,289,835 B2 10/2007 Mansfield et al.
7,292,883 B2 11/2007 De Felice et al.
7,295,866 B2 11/2007 Al-Ali
7,328,053 B1 2/2008 Diab et al.
7,332,784 B2 2/2008 Mills et al.
7,340,287 B2 3/2008 Mason et al.
7,341,559 B2 3/2008 Schulz et al.
7,343,186 B2 3/2008 Lamego et al.
D566,282 S 4/2008 Al-Ali et al.
7,355,512 B1 4/2008 Al-Ali
7,356,365 B2 4/2008 Schurman
7,371,981 B2 5/2008 Abdul-Hafiz
7,373,193 B2 5/2008 Al-Ali et al.
7,373,194 B2 5/2008 Weber et al.
7,376,453 B1 5/2008 Diab et al.
7,377,794 B2 5/2008 Al Ali et al.
7,377,899 B2 5/2008 Weber et al.
7,383,070 B2 6/2008 Diab et al.
7,415,297 B2 8/2008 Al-Ali et al.
7,428,432 B2 9/2008 Ali et al.
7,438,683 B2 10/2008 Al-Ali et al.
7,440,787 B2 10/2008 Diab
7,454,240 B2 11/2008 Diab et al.
7,467,002 B2 12/2008 Weber et al.
7,469,157 B2 12/2008 Diab et al.
7,471,969 B2 12/2008 Diab et al.
7,471,971 B2 12/2008 Diab et al.
7,483,729 B2 1/2009 Al-Ali et al.
7,483,730 B2 1/2009 Diab et al.
7,489,958 B2 2/2009 Diab et al.
7,496,391 B2 2/2009 Diab et al.
7,496,393 B2 2/2009 Diab et al.
D587,657 S 3/2009 Al-Ali et al.
7,499,741 B2 3/2009 Diab et al.
7,499,835 B2 3/2009 Weber et al.
7,500,950 B2 3/2009 Al-Ali et al.
7,509,154 B2 3/2009 Diab et al.
7,509,494 B2 3/2009 Al-Ali
7,510,849 B2 3/2009 Schurman et al.
7,526,328 B2 4/2009 Diab et al.
7,530,942 B1 5/2009 Diab
7,530,949 B2 5/2009 Al Ali et al.
7,530,955 B2 5/2009 Diab et al.
7,563,110 B2 7/2009 Al-Ali et al.
7,596,398 B2 9/2009 Al-Ali et al.
7,618,375 B2 11/2009 Flaherty
D606,659 S 12/2009 Kiani et al.
7,647,083 B2 1/2010 Al-Ali et al.
D609,193 S 2/2010 Al-Ali et al.
D614,305 S 4/2010 Al-Ali et al.
RE41,317 E 5/2010 Parker
7,729,733 B2 6/2010 Al-Ali et al.
7,734,320 B2 6/2010 Al-Ali
7,761,127 B2 7/2010 Al-Ali et al.
7,761,128 B2 7/2010 Al-Ali et al.
7,764,982 B2 7/2010 Dalke et al.
D621,516 S 8/2010 Kiani et al.
7,791,155 B2 9/2010 Diab
7,801,581 B2 9/2010 Diab
7,822,452 B2 10/2010 Schurman et al.
RE41,912 E 11/2010 Parker
7,844,313 B2 11/2010 Kiani et al.
7,844,314 B2 11/2010 Al-Ali
7,844,315 B2 11/2010 Al-Ali
7,865,222 B2 1/2011 Weber et al.
7,873,497 B2 1/2011 Weber et al.
7,880,606 B2 2/2011 Al-Ali
7,880,626 B2 2/2011 Al-Ali et al.
7,891,355 B2 2/2011 Al-Ali et al.
7,894,868 B2 2/2011 Al-Ali et al.
7,899,507 B2 3/2011 Al-Ali et al.
7,899,518 B2 3/2011 Trepagnier et al.
7,904,132 B2 3/2011 Weber et al.
7,909,772 B2 3/2011 Popov et al.
7,910,875 B2 3/2011 Al-Ali
7,919,713 B2 4/2011 Al-Ali et al.
7,937,128 B2 5/2011 Al-Ali
7,937,129 B2 5/2011 Mason et al.
7,937,130 B2 5/2011 Diab et al.
7,941,199 B2 5/2011 Kiani
7,951,086 B2 5/2011 Flaherty et al.
7,957,780 B2 6/2011 Lamego et al.
7,962,188 B2 6/2011 Kiani et al.
7,962,190 B1 6/2011 Diab et al.
7,976,472 B2 7/2011 Kiani
7,988,637 B2 8/2011 Diab
7,990,382 B2 8/2011 Kiani
7,991,446 B2 8/2011 Al-Ali et al.
8,000,761 B2 8/2011 Al-Ali
8,008,088 B2 8/2011 Bellott et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

RE42,753 E 9/2011 Kiani-Azarbayjany et al.
8,019,400 B2 9/2011 Diab et al.
8,028,701 B2 10/2011 Al-Ali et al.
8,029,765 B2 10/2011 Bellott et al.
8,036,728 B2 10/2011 Diab et al.
8,046,040 B2 10/2011 Ali et al.
8,046,041 B2 10/2011 Diab et al.
8,046,042 B2 10/2011 Diab et al.
8,048,040 B2 11/2011 Kiani
8,050,728 B2 11/2011 Al-Ali et al.
RE43,169 E 2/2012 Parker
8,118,620 B2 2/2012 Al-Ali et al.
8,126,528 B2 2/2012 Diab et al.
8,128,572 B2 3/2012 Diab et al.
8,130,105 B2 3/2012 Al-Ali et al.
8,145,287 B2 3/2012 Diab et al.
8,150,487 B2 4/2012 Diab et al.
8,175,672 B2 5/2012 Parker
8,180,420 B2 5/2012 Diab et al.
8,182,443 B1 5/2012 Kiani
8,185,180 B2 5/2012 Diab et al.
8,190,223 B2 5/2012 Al-Ali et al.
8,190,227 B2 5/2012 Diab et al.
8,203,438 B2 6/2012 Kiani et al.
8,203,704 B2 6/2012 Merritt et al.
8,224,411 B2 7/2012 Al-Ali et al.
8,228,181 B2 7/2012 Al-Ali
8,229,533 B2 7/2012 Diab et al.
8,233,955 B2 7/2012 Al-Ali et al.
8,244,325 B2 8/2012 Al-Ali et al.
8,255,026 B1 8/2012 Al-Ali
8,255,027 B2 8/2012 Al-Ali et al.
8,255,028 B2 8/2012 Al-Ali et al.
8,260,577 B2 9/2012 Weber et al.
8,265,723 B1 9/2012 McHale et al.
8,274,360 B2 9/2012 Sampath et al.
8,301,217 B2 10/2012 Al-Ali et al.
8,310,336 B2 11/2012 Muhsin et al.
8,315,683 B2 11/2012 Al-Ali et al.
RE43,860 E 12/2012 Parker
8,337,403 B2 12/2012 Al-Ali et al.
8,346,330 B2 1/2013 Lamego
8,353,842 B2 1/2013 Al-Ali et al.
8,355,766 B2 1/2013 MacNeish, III et al.
8,359,080 B2 1/2013 Diab et al.
8,364,223 B2 1/2013 Al-Ali et al.
8,364,226 B2 1/2013 Diab et al.
8,374,665 B2 2/2013 Lamego
8,385,995 B2 2/2013 Al-ali et al.
8,385,996 B2 2/2013 Smith et al.
8,388,353 B2 3/2013 Kiani et al.
8,399,822 B2 3/2013 Al-Ali
8,401,602 B2 3/2013 Kiani
8,405,608 B2 3/2013 Al-Ali et al.
8,414,499 B2 4/2013 Al-Ali et al.
8,418,524 B2 4/2013 Al-Ali
8,423,106 B2 4/2013 Lamego et al.
8,428,967 B2 4/2013 Olsen et al.
8,430,817 B1 4/2013 Al-Ali et al.
8,437,825 B2 5/2013 Dalvi et al.
8,455,290 B2 6/2013 Siskavich
8,457,703 B2 6/2013 Al-Ali
8,457,707 B2 6/2013 Kiani
8,463,349 B2 6/2013 Diab et al.
8,466,286 B2 6/2013 Bellot et al.
8,471,713 B2 6/2013 Poeze et al.
8,473,020 B2 6/2013 Kiani et al.
8,483,787 B2 7/2013 Al-Ali et al.
8,489,364 B2 7/2013 Weber et al.
8,498,684 B2 7/2013 Weber et al.
8,509,867 B2 8/2013 Workman et al.
8,515,509 B2 8/2013 Bruinsma et al.
8,523,781 B2 9/2013 Al-Ali
8,529,301 B2 9/2013 Al-Ali et al.
8,532,727 B2 9/2013 Ali et al.
8,532,728 B2 9/2013 Diab et al.
D692,145 S 10/2013 Al-Ali et al.
8,547,209 B2 10/2013 Kiani et al.
8,548,548 B2 10/2013 Al-Ali
8,548,550 B2 10/2013 Al-Ali et al.
8,560,032 B2 10/2013 Al-Ali et al.
8,560,034 B1 10/2013 Diab et al.
8,570,167 B2 10/2013 Al-Ali
8,570,503 B2 10/2013 Vo et al.
8,571,618 B1 10/2013 Lamego et al.
8,571,619 B2 10/2013 Al-Ali et al.
8,577,431 B2 11/2013 Lamego et al.
8,584,345 B2 11/2013 Al-Ali et al.
8,588,880 B2 11/2013 Abdul-Hafiz et al.
8,600,467 B2 12/2013 Al-Ali et al.
8,606,342 B2 12/2013 Diab
8,626,255 B2 1/2014 Al-Ali et al.
8,630,691 B2 1/2014 Lamego et al.
8,634,889 B2 1/2014 Al-Ali et al.
8,641,631 B2 2/2014 Sierra et al.
8,652,060 B2 2/2014 Al-Ali
8,663,107 B2 3/2014 Kiani
8,666,468 B1 3/2014 Al-Ali
8,667,967 B2 3/2014 Al-Ali et al.
8,670,811 B2 3/2014 O'Reilly
8,670,814 B2 3/2014 Diab et al.
8,676,286 B2 3/2014 Weber et al.
8,682,407 B2 3/2014 Al-Ali
RE44,823 E 4/2014 Parker
RE44,875 E 4/2014 Kiani et al.
8,690,799 B2 4/2014 Telfort et al.
8,700,112 B2 4/2014 Kiani
8,702,627 B2 4/2014 Telfort et al.
8,706,179 B2 4/2014 Parker
8,712,494 B1 4/2014 MacNeish, III et al.
8,715,206 B2 5/2014 Telfort et al.
8,718,735 B2 5/2014 Lamego et al.
8,718,737 B2 5/2014 Diab et al.
8,720,249 B2 5/2014 Al-Ali
8,721,541 B2 5/2014 Al-Ali et al.
8,721,542 B2 5/2014 Al-Ali et al.
8,723,677 B1 5/2014 Kiani
8,740,792 B1 6/2014 Kiani et al.
8,754,776 B2 6/2014 Poeze et al.
8,755,535 B2 6/2014 Telfort et al.
8,755,856 B2 6/2014 Diab et al.
8,755,872 B1 6/2014 Marinow
8,761,850 B2 6/2014 Lamego
8,764,671 B2 7/2014 Kiani
8,768,423 B2 7/2014 Shakespeare et al.
8,771,204 B2 7/2014 Telfort et al.
8,777,634 B2 7/2014 Kiani et al.
8,781,543 B2 7/2014 Diab et al.
8,781,544 B2 7/2014 Al-Ali et al.
8,781,549 B2 7/2014 Al-Ali et al.
8,788,003 B2 7/2014 Schurman et al.
8,790,268 B2 7/2014 Al-Ali
8,801,613 B2 8/2014 Al-Ali et al.
8,821,397 B2 9/2014 Al-Ali et al.
8,821,415 B2 9/2014 Al-Ali et al.
8,830,449 B1 9/2014 Lamego et al.
8,831,700 B2 9/2014 Schurman et al.
8,840,549 B2 9/2014 Al-Ali et al.
8,847,740 B2 9/2014 Kiani et al.
8,849,365 B2 9/2014 Smith et al.
8,852,094 B2 10/2014 Al-Ali et al.
8,852,994 B2 10/2014 Wojtczuk et al.
8,868,147 B2 10/2014 Stippick et al.
8,868,150 B2 10/2014 Al-Ali et al.
8,870,792 B2 10/2014 Al-Ali et al.
8,886,271 B2 11/2014 Kiani et al.
8,888,539 B2 11/2014 Al-Ali et al.
8,888,708 B2 11/2014 Diab et al.
8,892,180 B2 11/2014 Weber et al.
8,897,847 B2 11/2014 Al-Ali
8,909,310 B2 12/2014 Lamego et al.
8,911,377 B2 12/2014 Al-Ali
8,912,909 B2 12/2014 Al-Ali et al.
8,920,317 B2 12/2014 Al-Ali et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,921,699 B2 12/2014 Al-Ali et al.
8,922,382 B2 12/2014 Al-Ali et al.
8,929,964 B2 1/2015 Al-Ali et al.
8,942,777 B2 1/2015 Diab et al.
8,948,834 B2 2/2015 Diab et al.
8,948,835 B2 2/2015 Diab
8,965,471 B2 2/2015 Lamego
8,983,564 B2 3/2015 Al-Ali
8,989,831 B2 3/2015 Al-Ali et al.
8,996,085 B2 3/2015 Kiani et al.
8,998,809 B2 4/2015 Kiani
9,028,429 B2 5/2015 Telfort et al.
9,037,207 B2 5/2015 Al-Ali et al.
9,060,721 B2 6/2015 Reichgott et al.
9,066,666 B2 6/2015 Kiani
9,066,680 B1 6/2015 Al-Ali et al.
9,072,474 B2 7/2015 Al-Ali et al.
9,078,560 B2 7/2015 Schurman et al.
9,084,569 B2 7/2015 Weber et al.
9,095,316 B2 8/2015 Welch et al.
9,106,038 B2 8/2015 Telfort et al.
9,107,625 B2 8/2015 Telfort et al.
9,107,626 B2 8/2015 Al-Ali et al.
9,113,831 B2 8/2015 Al-Ali
9,113,832 B2 8/2015 Al-Ali
9,119,595 B2 9/2015 Lamego
9,131,881 B2 9/2015 Diab et al.
9,131,882 B2 9/2015 Al-Ali et al.
9,131,883 B2 9/2015 Al-Ali
9,131,917 B2 9/2015 Telfort et al.
9,138,180 B1 9/2015 Coverston et al.
9,138,182 B2 9/2015 Al-Ali et al.
9,138,192 B2 9/2015 Weber et al.
9,142,117 B2 9/2015 Muhsin et al.
9,153,112 B1 10/2015 Kiani et al.
9,153,121 B2 10/2015 Kiani et al.
9,161,696 B2 10/2015 Al-Ali et al.
9,161,713 B2 10/2015 Al-Ali et al.
9,167,995 B2 10/2015 Lamego et al.
9,176,141 B2 11/2015 Al-Ali et al.
9,186,102 B2 11/2015 Bruinsma et al.
2009/0247984 A1 10/2009 Lamego et al.
2009/0275844 A1 11/2009 Al-Ali
2010/0004518 A1 1/2010 Vo et al.
2010/0030040 A1 2/2010 Poeze et al.
2011/0001605 A1 1/2011 Kiani et al.
2011/0082711 A1 4/2011 Poeze et al.
2011/0105854 A1 5/2011 Kiani et al.
2011/0208015 A1 8/2011 Welch et al.
2011/0213212 A1 9/2011 Al-Ali
2011/0230733 A1 9/2011 Al-Ali
2011/0237911 A1 9/2011 Lamego et al.
2012/0059267 A1 3/2012 Lamego et al.
2012/0179006 A1 7/2012 Jansen et al.
2012/0209082 A1 8/2012 Al-Ali
2012/0209084 A1 8/2012 Olsen et al.
2012/0227739 A1 9/2012 Kiani
2012/0283524 A1 11/2012 Kiani et al.
2012/0296178 A1 11/2012 Lamego et al.
2012/0319816 A1 12/2012 Al-Ali
2012/0330112 A1 12/2012 Lamego et al.
2013/0023775 A1 1/2013 Lamego et al.
2013/0041591 A1 2/2013 Lamego
2013/0045685 A1 2/2013 Kiani
2013/0046204 A1 2/2013 Lamego et al.
2013/0060147 A1 3/2013 Welch et al.
2013/0096405 A1 4/2013 Garfio
2013/0096936 A1 4/2013 Sampath et al.
2013/0190581 A1 7/2013 Al-Ali et al.
2013/0197328 A1 8/2013 Diab et al.
2013/0211214 A1 8/2013 Olsen
2013/0243021 A1 9/2013 Siskavich
2013/0253334 A1 9/2013 Al-Ali et al.
2013/0296672 A1 11/2013 O'Neil et al.
2013/0317370 A1 11/2013 Dalvi et al.
2013/0324808 A1 12/2013 Al-Ali et al.
2013/0331670 A1 12/2013 Kiani
2013/0338461 A1 12/2013 Lamego et al.
2014/0012100 A1 1/2014 Al-Ali et al.
2014/0051953 A1 2/2014 Lamego et al.
2014/0058230 A1 2/2014 Abdul-Hafiz et al.
2014/0034353 A1 3/2014 Al-Ali et al.
2014/0066783 A1 3/2014 Kiani et al.
2014/0077956 A1 3/2014 Sampath et al.
2014/0081100 A1 3/2014 Muhsin et al.
2014/0081175 A1 3/2014 Telfort
2014/0094667 A1 4/2014 Schurman et al.
2014/0100434 A1 4/2014 Diab et al.
2014/0114199 A1 4/2014 Lamego et al.
2014/0120564 A1 5/2014 Workman et al.
2014/0121482 A1 5/2014 Merritt et al.
2014/0121483 A1 5/2014 Kiani
2014/0127137 A1 5/2014 Bellott et al.
2014/0129702 A1 5/2014 Lamego et al.
2014/0135588 A1 5/2014 Al-Ali et al.
2014/0142401 A1 5/2014 Al-Ali et al.
2014/0163344 A1 6/2014 Al-Ali
2014/0163402 A1 6/2014 Lamego et al.
2014/0166076 A1 6/2014 Kiani et al.
2014/0171763 A1 6/2014 Diab
2014/0180038 A1 6/2014 Kiani
2014/0180154 A1 6/2014 Sierra et al.
2014/0194709 A1 7/2014 Al-Ali et al.
2014/0194711 A1 7/2014 Al-Ali
2014/0194766 A1 7/2014 Al-Ali et al.
2014/0206963 A1 7/2014 Al-Ali
2014/0213864 A1 7/2014 Abdul-Hafiz et al.
2014/0243627 A1 8/2014 Diab et al.
2014/0266790 A1 9/2014 Al-Ali et al.
2014/0275808 A1 9/2014 Poeze et al.
2014/0275835 A1 9/2014 Lamego et al.
2014/0275871 A1 9/2014 Lamego et al.
2014/0275872 A1 9/2014 Merritt et al.
2014/0275881 A1 9/2014 Lamego et al.
2014/0288400 A1 9/2014 Diab et al.
2014/0303520 A1 10/2014 Telfort et al.
2014/0316228 A1 10/2014 Blank et al.
2014/0323825 A1 10/2014 Al-Ali et al.
2014/0330092 A1 11/2014 Al-Ali et al.
2014/0330098 A1 11/2014 Merritt et al.
2014/0330099 A1 11/2014 Al-Ali et al.
2014/0333440 A1 11/2014 Kiani
2014/0336481 A1 11/2014 Shakespeare et al.
2014/0343436 A1 11/2014 Kiani
2015/0018650 A1 1/2015 Al-Ali et al.

OTHER PUBLICATIONS

http://www.masimo.com/pandt.htm, "Products & Technology", 1 page, reviewed on Sep. 17, 1999.
http://www.masimo.com/cables.htm, "Patient Cables", 1 page, reviewed on Sep. 17, 1999.
http://www.masimo.com/adt.htm, "Inop adt—Adult Disposable Digit Sensor", 1 page, reviewed on Sep. 17, 1999.
http://www.mrequipment.com/products/pulse_oximetry.htm, "MR Equipment Magnetic Resonance Equipment Corporation, Pulse Oximetry in MRI Model 3500 Pulse Oximeter", 2 pages, reviewed on Sep. 17, 1999.
http://www.mrequipment.com/products/oximetry_patient_mntrg.htm, "MR Equipment Magnetic Resonance Equipment Corporation, MR-Compatible High-Performance Optical Fiber Sensors Pulse Oximetry Sensors for MRI Fiber Optic Sensors for use with MR-Compatible Pulse Oximeter", 2 pages, reviewed on Sep. 17, 1999.
Masimo Corporation, "Discrete Saturation Transform Example", reviewed on Sep. 17, 1999.
MSP Industry Alert, "Masimo to Introduce NR7 at ASA", pp. 18, 19, and the front and back cover, vol. 3, No. 3, Fall 2001.
US 8,845,543, 09/2014, Diab et al. (withdrawn)

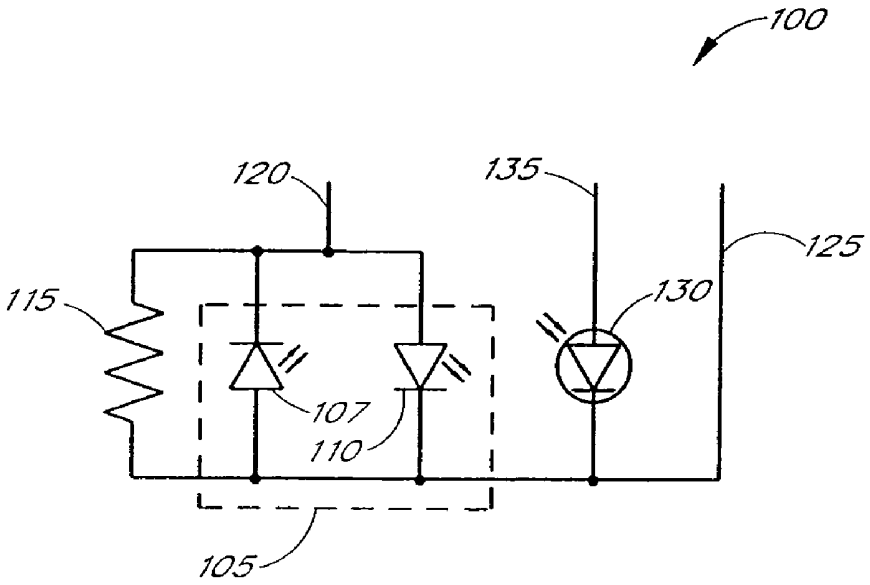


FIG. 1

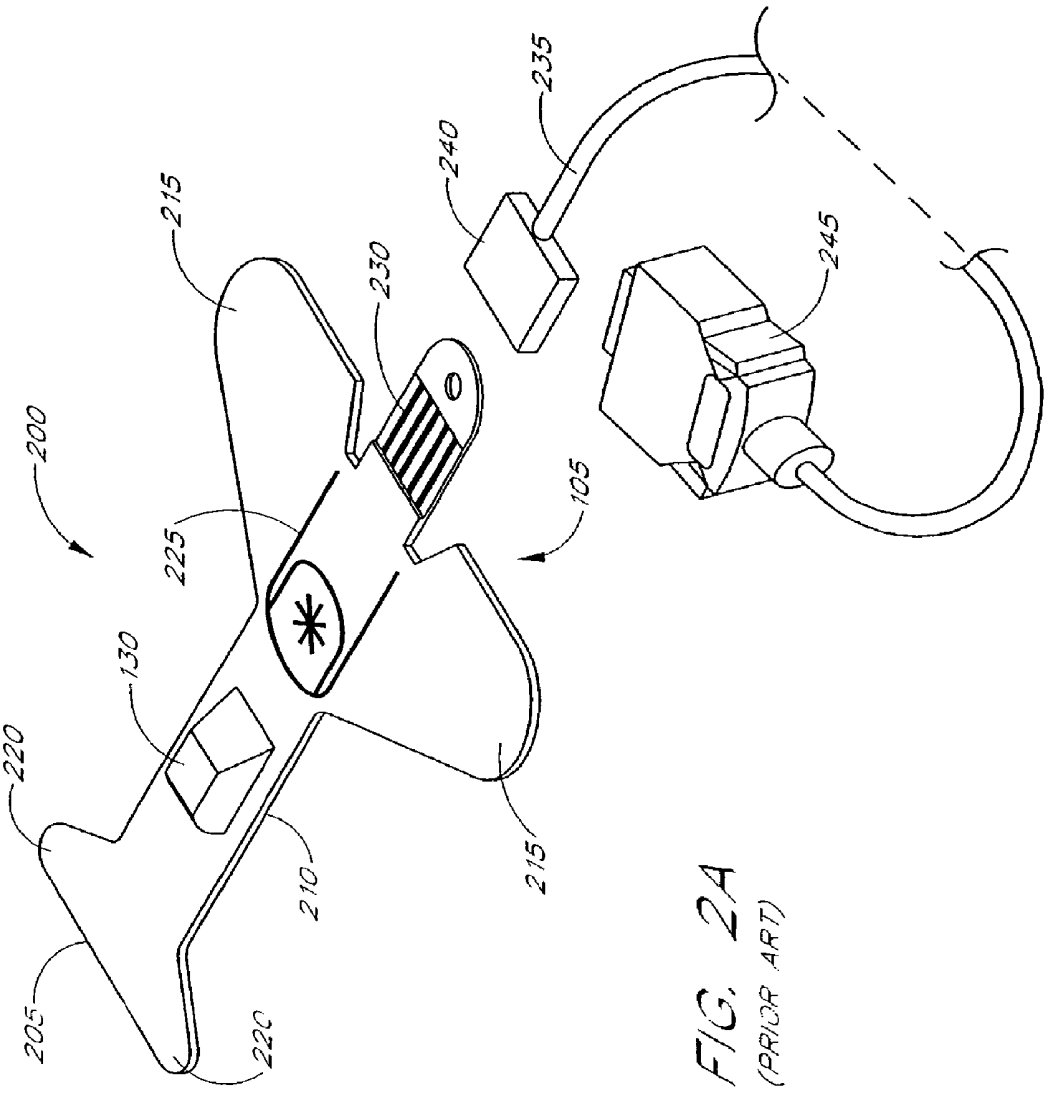


FIG. 2A
(PRIOR ART)

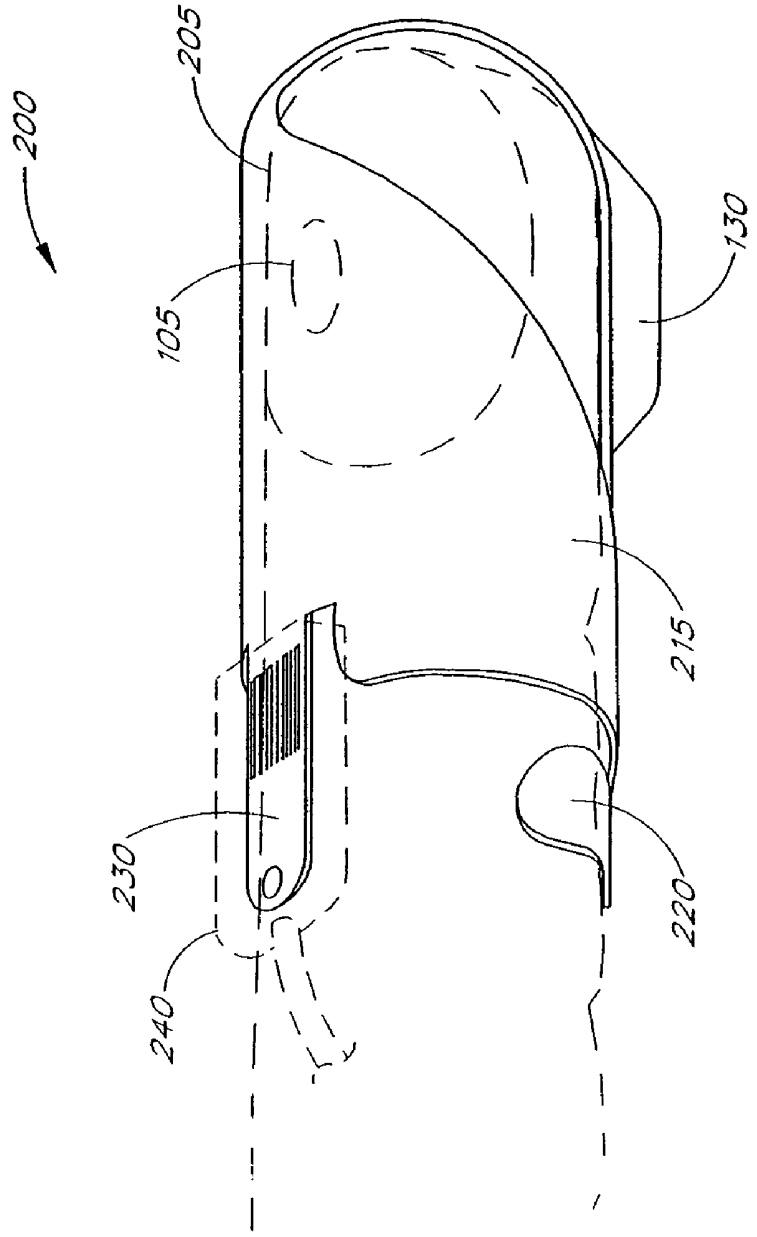


FIG. 2B
(PRIOR ART)

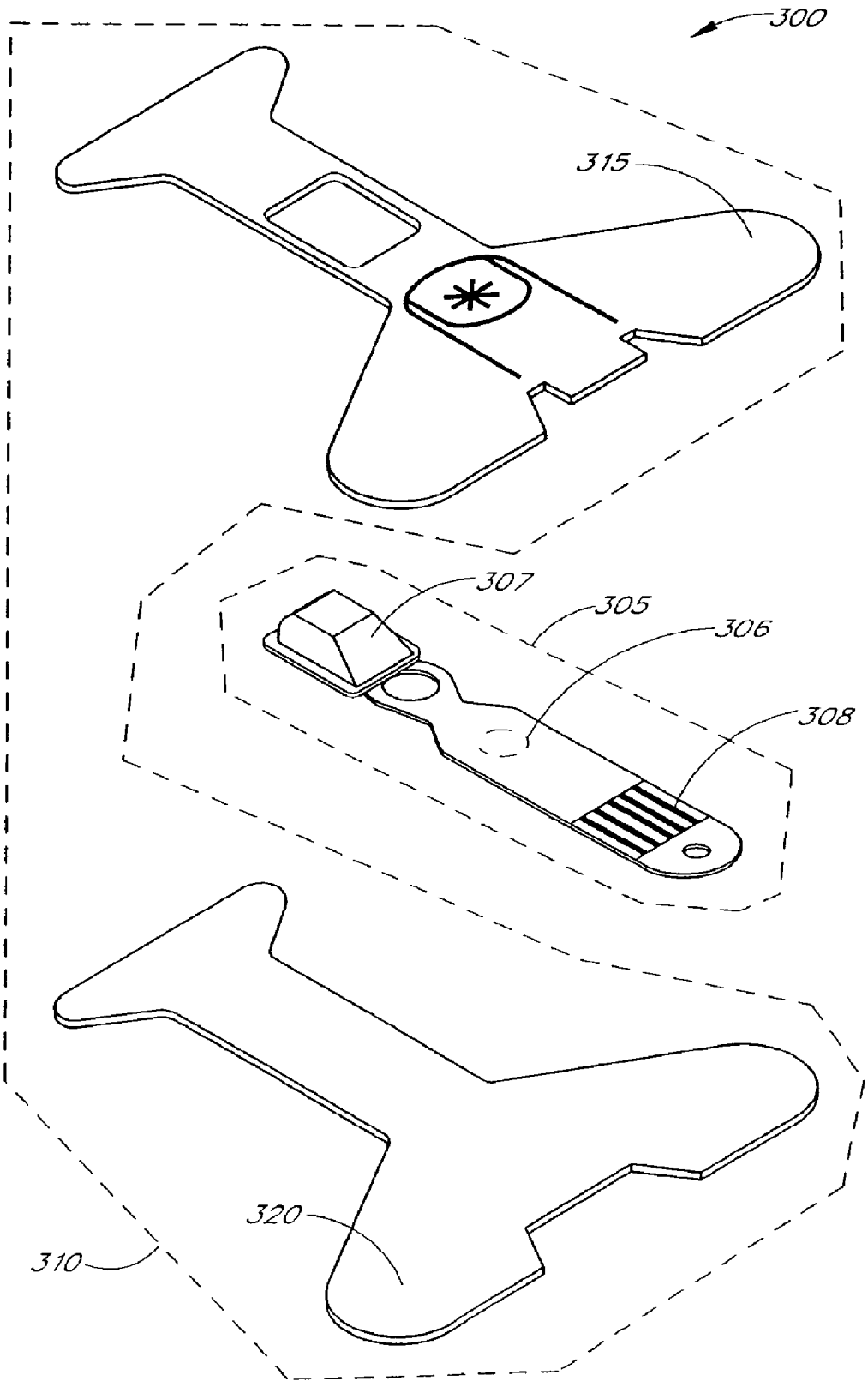


FIG. 3

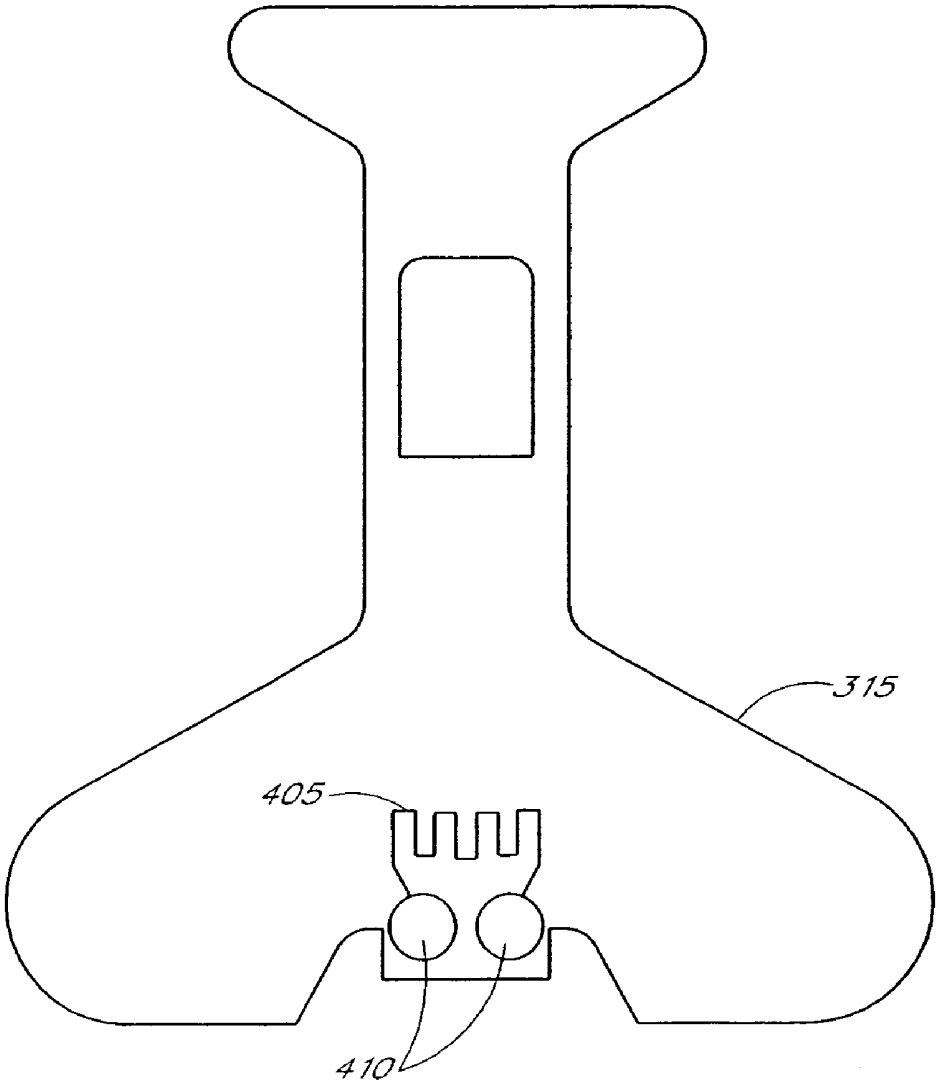


FIG. 4

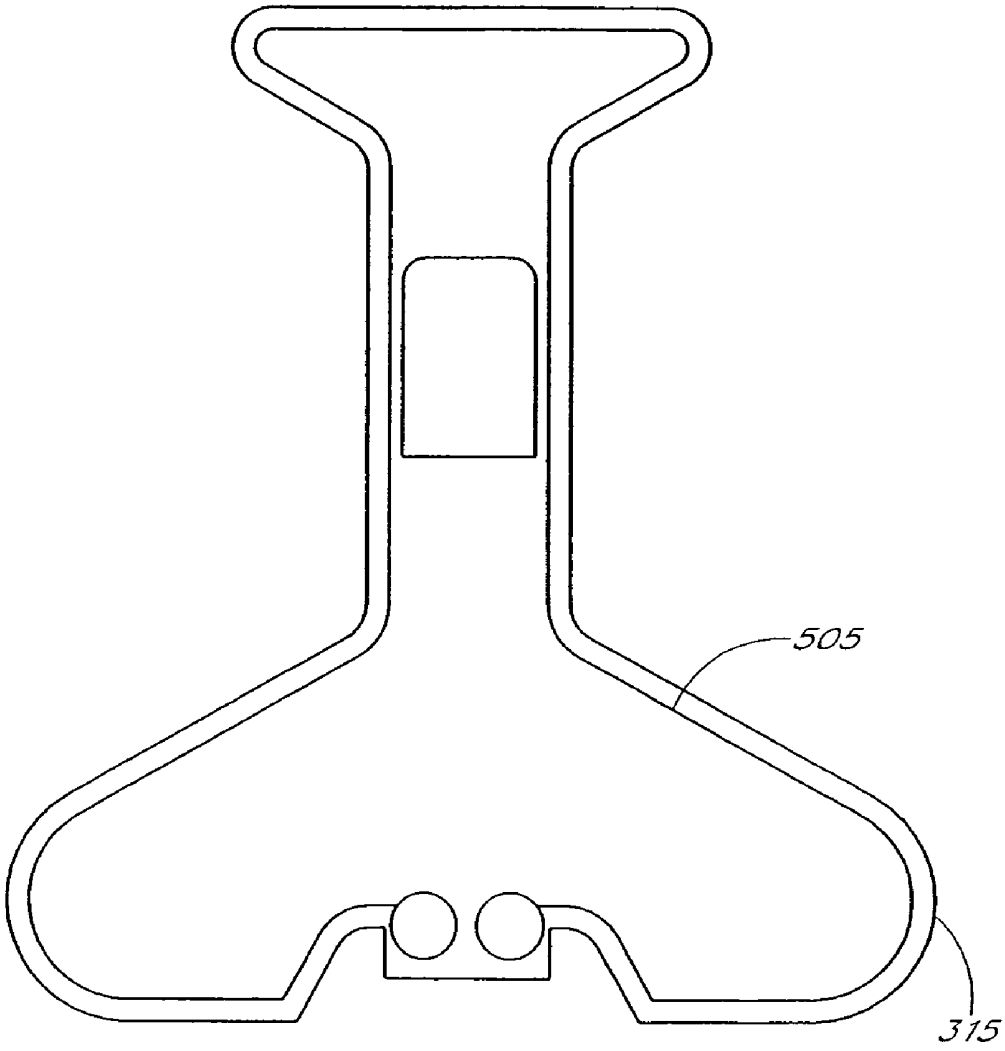


FIG. 5

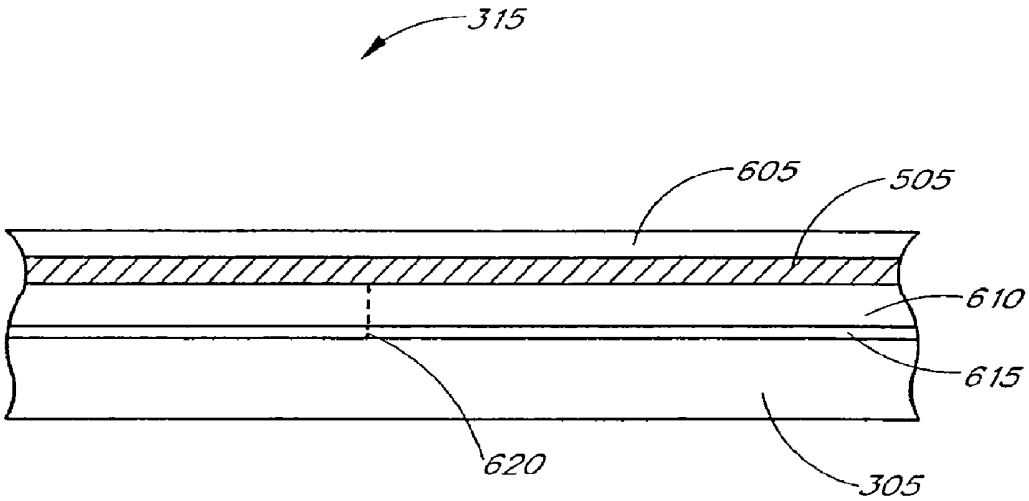


FIG. 6A

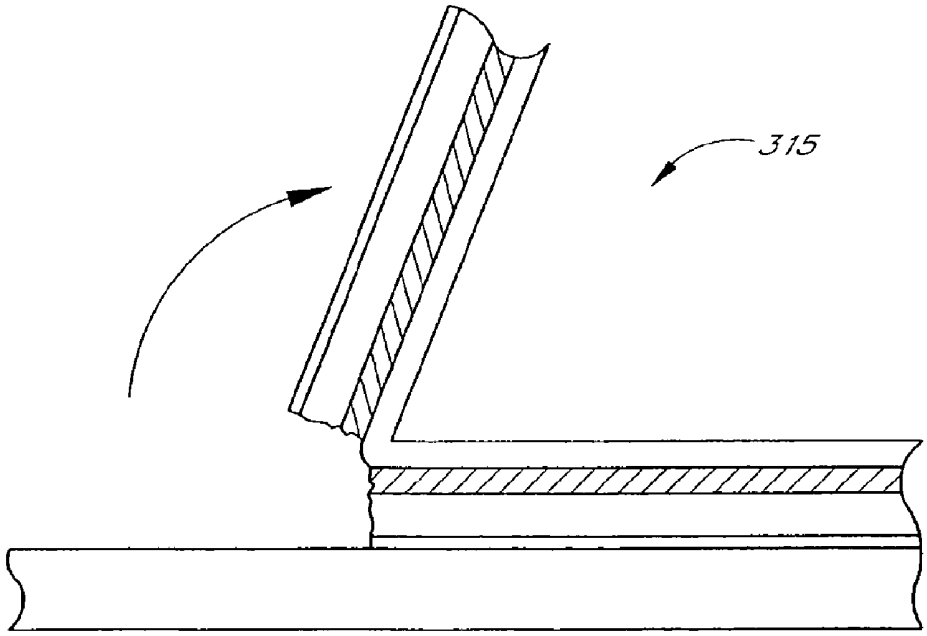


FIG. 6B

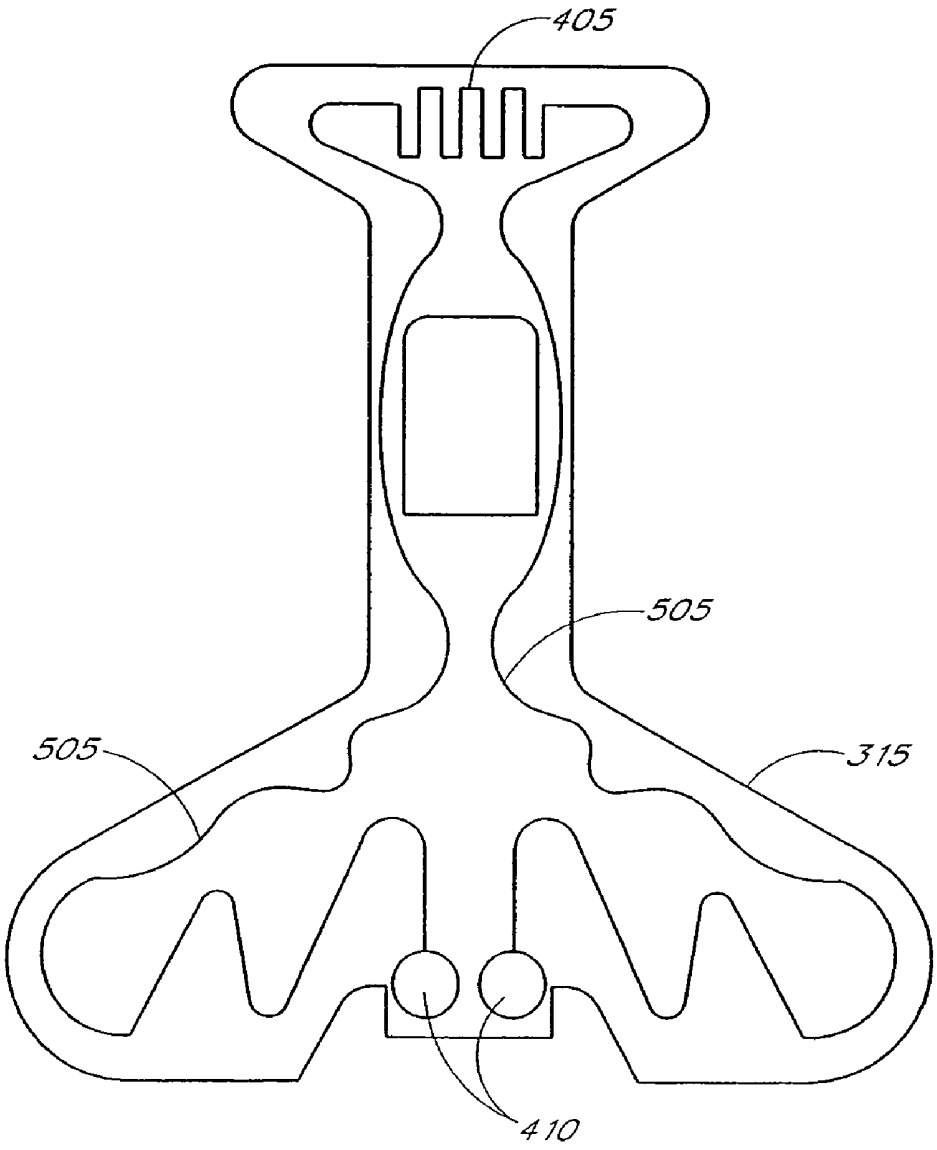


FIG. 7

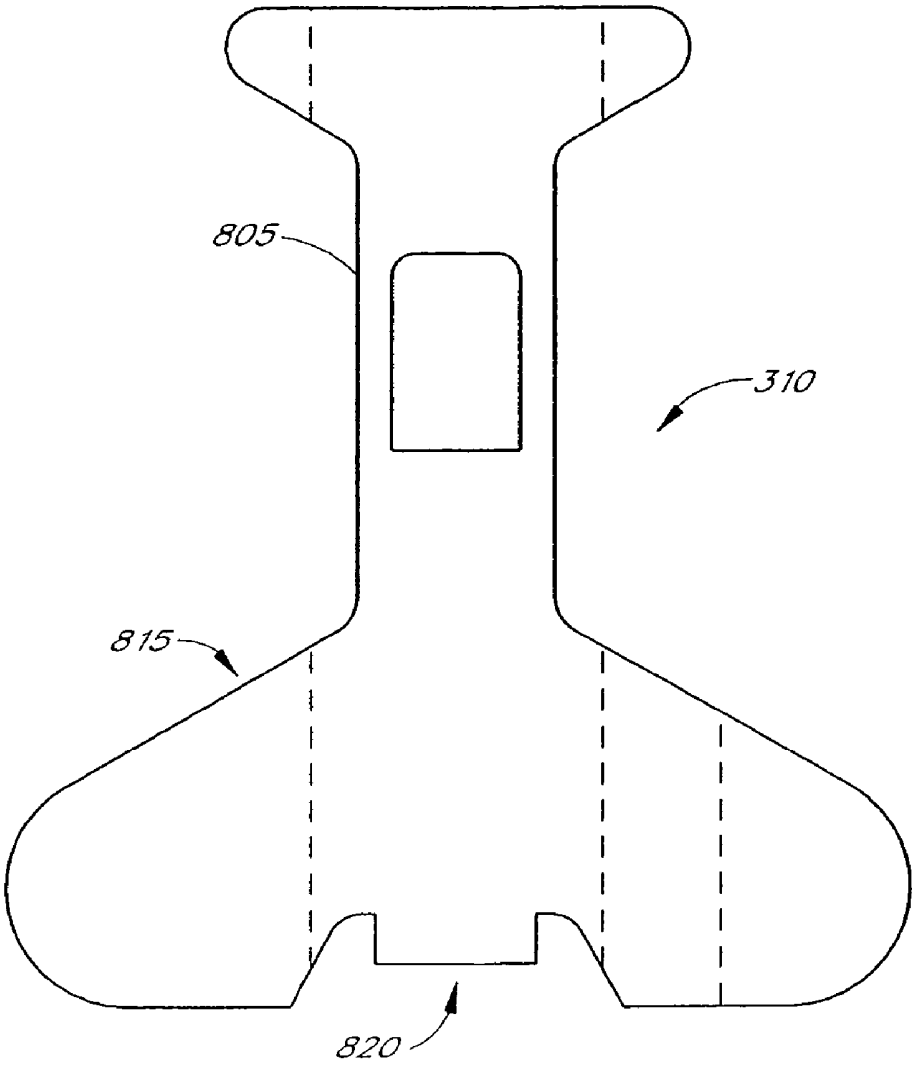


FIG. 8A

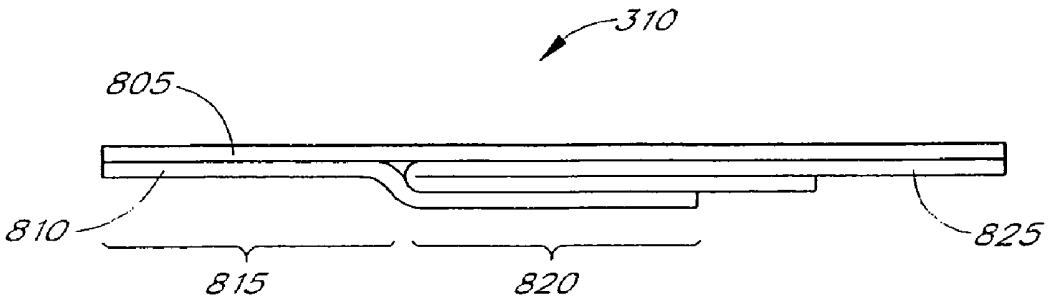


FIG. 8B

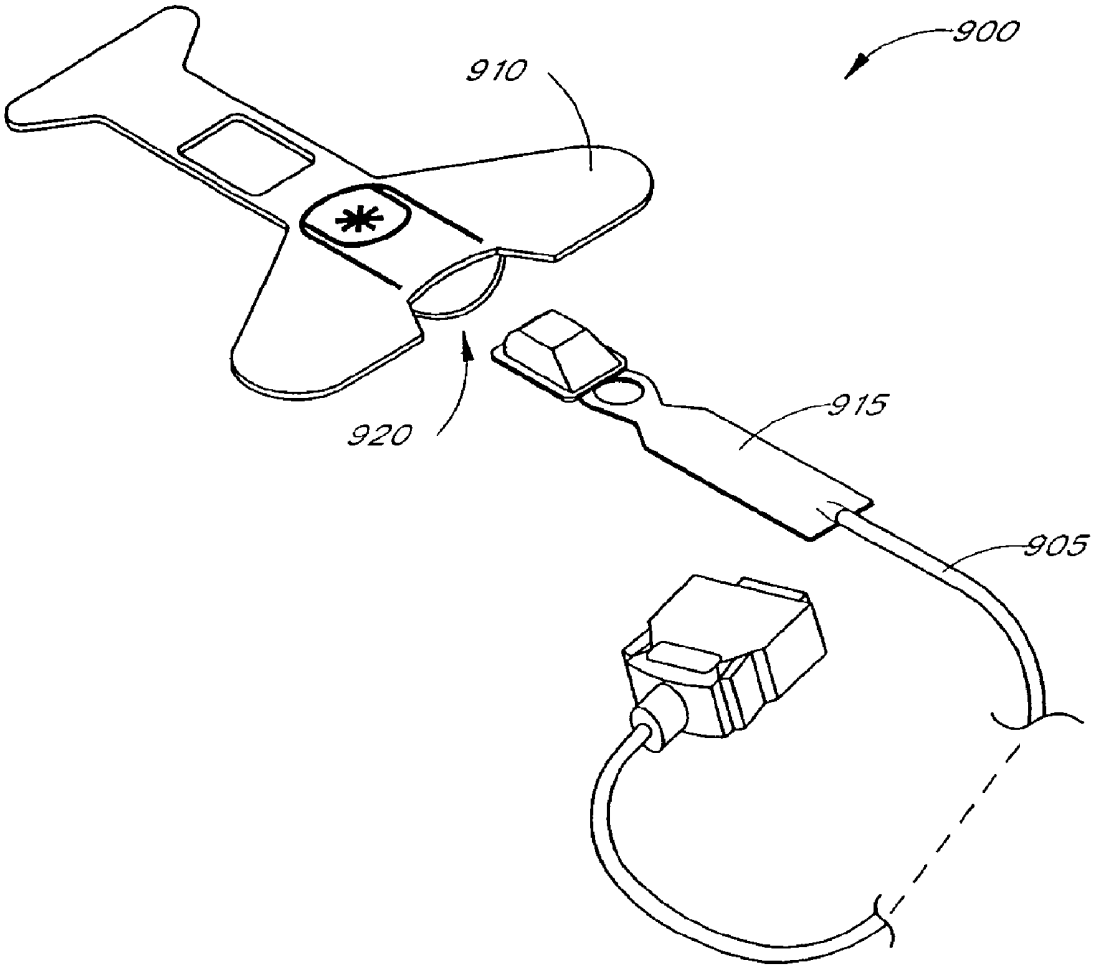


FIG. 9A

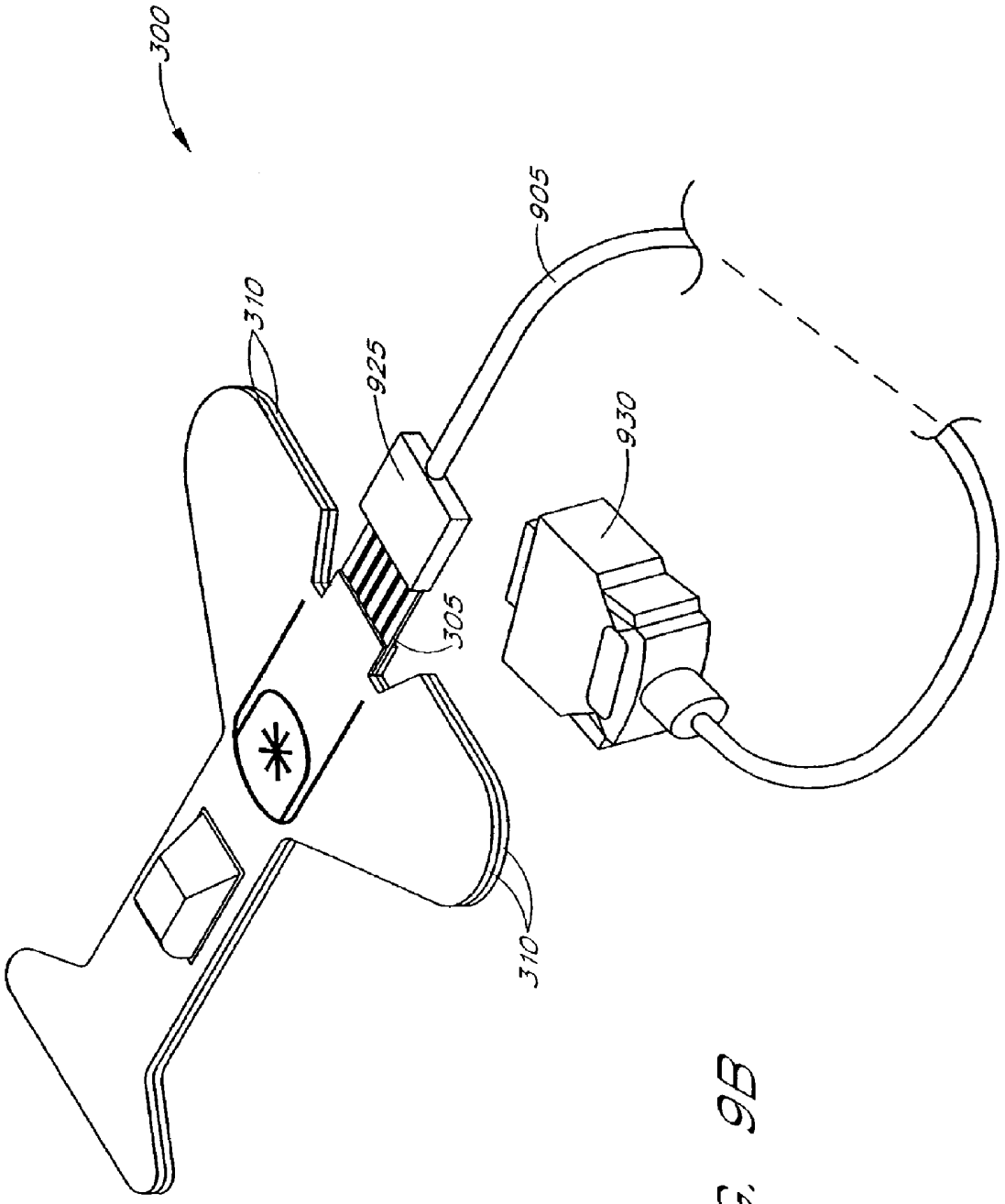


FIG. 9B

METHOD OF STERILIZING A REUSABLE PORTION OF A NONINVASIVE OPTICAL PROBE

PRIORITY CLAIM TO RELATED APPLICATIONS

The present application claims priority benefit under 35 U.S.C. §120 to, and is a continuation of U.S. patent application Ser. No. 11/415,600, filed on May 2, 2006, entitled "Resposable Pulse Oximetry Sensor," now U.S. Pat. No. 8,000,761, which is a continuation of U.S. patent application Ser. No. 10/741,777, filed on Dec. 19, 2003, entitled "Resposable Pulse Oximetry Sensor," now U.S. Pat. No. 7,039,449, which is a continuation of U.S. patent application Ser. No. 10/128,721, filed on Apr. 23, 2002, entitled "Resposable Pulse Oximetry Sensor," now U.S. Pat. No. 6,725,075, which is a continuation U.S. patent application Ser. No. 09/456,666, filed Dec. 12, 1999, entitled "Resposable Pulse Oximetry Sensor," now U.S. Pat. No. 6,377,829. The present application incorporates the foregoing disclosures herein by reference.

FIELD OF THE INVENTION

The present invention relates in general to sensors for measuring oxygen content in the blood, and, in particular, relates to resposable (reusable/disposable) sensors having an information element contained therein.

BACKGROUND

Early detection of low blood oxygen is critical in a wide variety of medical applications. For example, when a patient receives an insufficient supply of oxygen in critical care and surgical applications, brain damage and death can result in just a matter of minutes. Because of this danger, the medical industry developed oximetry, a study and measurement of the oxygen status of blood. One particular type of oximetry, pulse oximetry, is a widely accepted noninvasive procedure for measuring the oxygen saturation level of arterial blood, an indicator of the oxygen status of the blood. A pulse oximeter relies on a sensor attached to a patient in order to measure the blood oxygen saturation.

Conventionally, a pulse oximeter sensor has a red emitter, an infrared emitter, and a photodiode detector. The sensor is typically attached to a patient's finger, earlobe, or foot. For a finger, the sensor is configured so that the emitters project light through the outer tissue of the finger and into the blood vessels and capillaries contained inside. The photodiode is positioned at the opposite side of the finger to detect the emitted light as it emerges from the outer tissues of the finger. The photodiode generates a signal based on the emitted light and relays that signal to an oximeter. The oximeter determines blood oxygen saturation by computing the differential absorption by the arterial blood of the two wavelengths (red and infrared) emitted by the sensor.

Conventional sensors are either disposable or reusable. A disposable sensor is typically attached to the patient with an adhesive wrap, providing a secure contact between the patient's skin and the sensor components. A reusable sensor is typically a clip that is easily attached and removed, or reusable circuitry that employs a disposable attachment mechanism, such as an adhesive tape or bandage.

The disposable sensor has the advantage of superior performance due to conformance of the sensor to the skin and the rejection of ambient light. However, repeated removal and reattachment of the adhesive tape results in deterioration of the adhesive properties and tearing of the tape. Further, the tape eventually becomes soiled and is a potential source of cross-patient contamination. The disposable sensor must then be thrown away, wasting the long-lived emitters, photodiode and related circuitry.

On the other hand, the clip-type reusable sensor has the advantage of superior cost savings in that the reusable pulse sensor does not waste the long-lived and expensive sensor circuitry. However, as mentioned above, the clip-type reusable sensor does not conform as easily to differing patient skin shape, resulting in diminished sensitivity and increased ambient light.

Similar to the clip-type reusable sensor, the circuit-type reusable sensor advantageously does not waste the sensor circuitry. On the other hand, the circuit-type reusable sensor fails to provide quality control over the attachment mechanism. Much like the disposable sensors, the attachment mechanism for the circuit-type reusable sensor may become soiled or damaged, thereby leading to cross-patient contamination or improper attachment. Moreover, because the reusable circuit is severable from the attachment mechanism, operators are free to use attachment mechanisms that are either unsafe or improper with regard to a particular type of reusable circuitry.

Based on the foregoing, significant and costly drawbacks exist in conventional disposable and reusable oximetry sensors. Thus, a need exists for an oximetry sensor that incorporates the advantages found in the disposable and reusable sensors, without the respective disadvantages.

SUMMARY OF THE INVENTION

Accordingly, one aspect of the present invention is to provide a reusable/disposable (resposable) sensor having a disposable adhesive tape component that can be removed from other reusable sensor components. This hybrid sensor combines the longevity and associated cost advantages of the reusable sensor with the performance features of the disposable.

In one embodiment of the resposable sensor, the disposable tape includes an information element along with a mechanism for the electrical connection of the information element to the emitters. The information element provides an indication to an attached oximeter of various aspects of the sensor.

According to another embodiment, the information element provides an indication of the sensor type. According to yet another embodiment, the information element provides an indication of the operating characteristics of the sensor. In yet another embodiment, the information element provides security and quality control. For instance, the information element advantageously indicates that the sensor is from an authorized supplier.

According to yet another embodiment, the information element is advantageously located in the disposable portion and configured to be in communication with the reusable portion via a breakable conductor. The breakable conductor is also located within the disposable portion such that excessive wear of the disposable portion results in isolation of the information element, thereby indicating that the disposable portion should be replaced. Moreover, the information element may comprise one or more passive or active components, ranging from a single coding resistor to an active circuit, such as a transistor network, a memory device, or a central processing component.

Therefore, one aspect of the present invention is a pulse oximetry sensor including a reusable portion having an emitter configured to transmit light through tissue, a detector

configured to receive light from tissue, a first contact, an external connector configured to attach to a monitor, and electrical circuitry configured to provide electrical communications to and from the external connector, the emitter, the detector and the first contact. The pulse oximetry sensor also includes a disposable portion configured to attach the reusable portion to the tissue. The disposable portion has an information element, a breakable conductor, and a second contact electrically connecting the information element and the breakable conductor, the second contact configured to create an electrical connection to the first contact when the disposable portion is combined with the reusable portion.

Another aspect of the present invention is a resposable sensor for noninvasively measuring a physiological parameter in tissue. The resposable sensor includes a reusable portion and a disposable portion. The disposable portion has at least one of an information element and a conductor electrically connected to the reusable portion. Moreover, the disposable portion is configured to secure the reusable portion to a measurement site.

Another aspect of the present invention is a method of providing disposable oximeter sensor elements. The method includes forming a disposable housing configured to receive a reusable electronic circuit. The method also includes forming at least one of an information element and a conductor associated with the disposable housing and configured to be disconnected from the reusable electronic circuit when the disposable housing is damaged, overused, or repeatedly attached.

Another aspect of the present invention is a method of providing reusable oximeter sensor elements. This includes forming a reusable electronic circuit configured to electrically connect with electronic components of a disposable housing and to employ the disposable housing for attachment to a measurement site.

Another aspect of the present invention is a method of measuring a tissue characteristic. This method includes creating a sensor through combining reusable electronic circuitry with a first disposable material such that an electrical connection is made between the reusable electronic circuitry and electronic components associated with the first disposable material. Moreover, the method includes attaching the sensor to a measurement site, removing the sensor, separating the reusable electronic circuitry from the first disposable material, and recombining the reusable electronic circuitry with a second disposable material.

Another aspect of the present invention is a pulse oximeter having a sensor including a reusable portion and a disposable portion. The disposable portion includes an information element electrically connected to the reusable portion through a breakable conductor. The breakable conductor is configured to electrically disconnect the information element from the reusable portion in the event of overuse, damage, or excessive reattachment of the disposable portion. Moreover, the pulse oximeter includes a monitor, and a cable for connecting the sensor to the monitor.

Yet another aspect of the present invention is a pulse oximeter sensor element having a disposable material that incorporates electronic components. The disposable material is configured to removably receive reusable oximeter sensor elements such that the electronic components electrically connect with the reusable oximeter sensor elements. Moreover, the disposable material is configured to secure the reusable oximeter sensor elements to a measurement site.

Another aspect of the present invention is a pulse oximeter sensor element including reusable electronic circuitry configured to electrically connect with electronic components of a disposable material and to employ the disposable material for attachment to a measurement site.

Another aspect of the present invention is a resposable sensor for measuring a tissue aspect. The resposable sensor includes a face tape, a base tape removably attached to the face tape, and reusable measurement circuitry removably secured between the face tape and the base tape. The reusable measurement circuitry is also configured to connect to an external monitor and configured to measure an aspect of tissue at a measurement site. Moreover, the face tape includes at least one of an information element and a breakable conductor connected to the reusable measurement circuitry when the reusable measurement circuitry is secured to the face tape.

Another aspect of the present invention is a resposable sensor having a reusable emitter and detector removably connected to a patient cable. The resposable sensor also includes a replaceable envelope having electronic circuitry configured to attach to the reusable emitter and detector such that the electronic circuitry monitors at least one characteristic of the resposable sensor. Moreover, the replaceable envelope is configured to removably receive the reusable emitter and detector and configured to secure the reusable emitter and detector to a measurement site.

Yet another aspect of the present invention is a pulse oximetry sensor having an emitter, a detector and a connector. The emitter is configured to transmit light through tissue and the detector is configured to receive light from tissue to measure a physiological parameter. Further, the connector is configured to provide electrical communications between the detector and emitter and a monitor. The pulse oximetry sensor includes a reusable portion having the emitter, the detector, the connector and a first contact in communication with the connector. Moreover, the sensor includes a disposable portion having a second contact, an information element and a conductive element disposed on an adhesive substrate configured to secure the reusable portion to a measurement site. The disposable portion removably attaches to the reusable portion in a first position such that the first contact contacts the second contact. The disposable portion detaches from the reusable portion in a second position. Also, the conductive element has a continuity condition connecting the information element to the second contact so that the information element is in communication with the connector. The conductive element has a discontinuity condition isolating the information element from the second contact and the connector. The discontinuity condition results from use of the disposable portion substantially beyond a predetermined amount.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates a circuit diagram of a conventional disposable sensor having an information element.

FIGS. **2**A and **2**B illustrate perspective views of the conventional disposable sensor.

FIG. **3** illustrates an exploded view of a resposable sensor having two disposable tape layers, according to one embodiment of the invention.

FIG. **4** illustrates a top view of one of the disposable tape layers of FIG. **3** incorporating an information element.

FIG. **5** illustrates a top view of one of the disposable tape layers of FIG. **3** incorporating a breakable conductor.

FIGS. **6**A and **6**B illustrate cross-sectional views of a portion of the disposable tape layer of FIG. **5**.

FIG. **7** illustrates a top view of one of the disposable tape layers of FIG. **3** incorporating the information element with a breakable conductor.

FIGS. **8**A and **8**B illustrate a top view and a side view, respectively, of one of the disposable layers of FIG. **3** configured as a fold-over tape.

FIG. **9**A illustrates a perspective view of a resposable sensor having a disposable portion configured as a tape sleeve and a reusable portion directly attached to a patient cable, according to another embodiment of the invention.

FIG. **9**B illustrates a perspective view of a resposable sensor having a reusable portion removably attached to a patient cable, according to another embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The configuration of an information element for an oximeter sensor and method of reading an information element with an attached oximeter is described in U.S. Pat. No. 5,758,644, assigned to the assignee of the current application, and incorporated by reference herein. Accordingly, the configuration and the implementation of an information element will be greatly summarized as follows.

FIG. **1** illustrates a conventional oximeter sensor circuit **100**. The oximeter sensor circuit **100** includes an emitter **105** comprising a first LED **107** and a second LED **110**. The oximeter sensor circuit further includes an information element comprising a resistor **115**. The first LED **107**, the second LED **110** and the resistor **115** are connected in parallel. The parallel connection has a common input electrical connection **120** and a common return **125**. The oximeter sensor circuit **100** also includes a photodetector **130** having an input electrical connection **135** connected to one end and having the common return **125** connected to the other end.

As mentioned, the resistor **115** is provided as an information element that can be read by an attached oximeter. In order to read the resistor **115**, the oximeter drives the oximeter sensor circuit **100** at a level where the emitter **105** draws effectively insignificant current. As is well understood in the art, the emitter **105** becomes active only if driven at a voltage above a threshold level. Thus, at this low level, significantly all of the current through the input electrical connection **120** flows through the resistor **115**. By reducing the drive voltage across the input electrical connection **120** and common return **125** to a low enough level to not activate the emitter **105**, the emitter **105** is effectively removed from the oximeter sensor circuit **100**. Thus, the oximeter can determine the value of the resistor **115**.

The value of the resistor **115** can be preselected to indicate, for example, the type of sensor (e.g., adult, pediatric, or neonatal), the operating wavelength, or other parameters about the sensor. The resistor **115** may also be utilized for security and quality control purposes. For example, the resistor **115** may be used to ensure that the oximeter sensor circuit **100** is configured properly for a given oximeter. For instance, the resistor **115** may be utilized to indicate that the oximeter sensor circuit **100** is from an authorized supplier.

An information element other than the resistor **115** may also be utilized. The information element need not be a passive device. Coding information may also be provided through an active circuit, such as a transistor network, memory chip, or other identification device.

Furthermore, it will be understood by a skilled artisan that a number of different circuit configurations can be implemented that allow the oximeter sensor circuit **100** to include an information element. For example, the emitter **105** and the information element may each have individual electrical connections.

As mentioned above, the resistor **115** is preselected such that at low drive voltages, it is the only circuit element sensed by the oximeter. On the other hand, the resistor **115** can also be preselected be of a sufficiently high value that when the drive voltage rises to a level sufficient to drive the emitter **105**, the resistor **115** is effectively removed from the oximeter sensor circuit **100**. Thus, the resistor **115** does not affect normal operations of the emitter **105**. In summary, an information element may form an integral part of the oximeter sensor circuit **100** by providing valuable information to the attached oximeter.

FIGS. **2**A and **2**B illustrate a conventional disposable sensor **200**. The disposable sensor **200** includes an adhesive substrate **205** having an elongated center portion **210** with front and rear flaps, **215** and **220**, extending outward from the elongated center portion **210**. The adhesive substrate **205** may also have an image **225** superimposed on the adhesive substrate **205** so as to indicate proper use.

The elongated center portion **210** includes the oximeter sensor circuit **100** of FIG. **1**. For example, the emitter **105** is housed on an underside of the elongated center portion **210** approximately beneath the superimposed image **225**. Thus, as shown in FIG. **2**A, the emitter **105** may be housed approximately beneath the asterisk superimposed on the image of a fingernail. On the other hand, the photodetector **130** is housed on the topside of the elongated center portion **210** in proximity with the rear flaps **220**.

The elongated center portion **210** further includes an electrical connector **230** to drive the emitter **105** and to receive an output from the photodetector **130**. The electrical connector **230** is preferably configured to attach to a connector cable **235** via a sensor connector **240**. Also, the connector cable **235** attaches to or connects with an oximeter via an oximeter connector **245**.

FIG. **2**B illustrates an example of how the disposable sensor **200** wraps the front and rear flaps **215** and **220** around a finger such that the adhesive substrate **205** provides a secure contact between the patient's skin, the emitter **105** and the photodetector **130**. FIG. **2**B also illustrates an example of the sensor connector **240** (shown in broken lines) encompassing the electrical connector **230**.

As shown in FIGS. **1**-**2**B, the conventional disposable sensor **200** integrates the components of the conventional oximeter sensor circuit **100** such that disposal of the disposable sensor **200** includes disposal of the longer lasting, expensive circuitry found therein.

FIG. **3** illustrates an exploded view of one embodiment of a resposable (reusable/disposable) sensor **300** according to the present invention. In this embodiment, the resposable sensor **300** includes a reusable portion **305** having an emitter **306**, a photodetector **307** and an electrical connector **308**. The resposable sensor also includes a disposable portion **310** having a face tape layer **315** and a clear base tape layer **320**. As shown in FIG. **3**, the disposable portion **310** attaches to the reusable portion **305** by sandwiching the reusable portion **305** between a face tape layer **315** and a clear base tape layer **320**.

According to this embodiment, conventional adhesives or other attaching methodology may be used to removably attach the face tape layer **315** to the clear base tape layer **320**. Furthermore, the adhesive properties associated with the base of the conventional disposable sensor **200** may be the same as the adhesive properties on the base of the clear base tape layer **320**, as both portions are provided to attach to the patient's skin.

As mentioned, the disposable portion **310** removably attaches to the reusable portion **305** in, for example, a sandwich or layered style. After removably attaching the dispos-

able portion **310** to the reusable portion **305**, the resposable sensor **300** functions similar to the disposable sensor **200**, i.e., the resposable sensor **300** wraps flaps around a patient's tissue such that the emitter **306** and the photodetector **307** align on opposite sides of the tissue. However, in contrast to the disposable sensor **200**, the resposable sensor **300** provides for reuse of the reusable portion **305**. For example, when the disposable portion **310** becomes contaminated, worn, or defective, rather than discarding the entire resposable sensor **300**, the disposable portion **310** is removed such that the reusable portion **305** may be re-removably attached to a new disposable portion **310**. The discarding of the disposable portion **310** completely avoids cross-contamination through the reuse of adhesive tapes between patients without wasting the more costly and longer lasting sensor circuitry of the resposable portion **305**. Note that optional sterilization procedures may be advantageously performed on the reusable portion **305** before reattachment to either the new disposable portion **310** or to the patient, in order to further ensure patient safety.

FIG. **4** illustrates a top view of an embodiment of the face tape layer **315** of the disposable portion **310** of the resposable sensor **300**. According to this embodiment, the face tape layer **315** further includes an information element **405** as an integral part of the face tape layer **315**. In this embodiment, the information element **405** is a resistive element made by depositing a conductive ink trace having a predetermined length and width. As is known in the art, the length, width and conductivity of the conductive ink trace determines the resistance of the resistive element. The information element **405** is deposited between contacts **410** that are also implemented with conductive ink. It will be understood by a skilled artisan that a variety of methods can be used for mating the contacts **410** with the electrical circuitry of the reusable portion **305**. For example, the contacts **410** may advantageously physically touch the leads or the electrical connector **308** such that the reusable portion **305** is electrically configured to include the information element **405**. Such a configuration employs the oximeter sensor circuit **100** of FIG. **1**, having elements thereof distributed in both the reusable portion **305** and the disposable portion **310** of the resposable sensor **300**.

In the foregoing embodiment, the disposable portion **310** comprises the information element **405** along with the face tape layer **315** and the clear base layer **320**. As mentioned, the disposable portion **310** is removably attached to the reusable portion **305** and is employed in a similar manner as the disposable sensor **200**. In contrast to the disposable sensor **200**, when the disposable portion **310** of the resposable sensor **300** becomes worn, the disposable portion **310** and the information element **405** are discarded and the reusable portion **305** is saved. By discarding the information element, the attached oximeter can perform quality control. For example, if the reusable portion **305** is reattached to a patient using either a simple adhesive or any other non-authorized disposable mechanism, the resposable sensor **300** will not include the information element **405**. As mentioned above, an attached oximeter can recognize the absence of the information element **405** and create an appropriate response indicating inappropriate use of the reusable portion **305** of the resposable sensor **300**.

FIG. **5** illustrates a top view of yet another embodiment of the face tape layer **315** of the disposable portion **310** of the resposable sensor **300**. In this embodiment, the face tape layer **315** includes a breakable conductor **505** comprising a conductive ink trace located approximately along the periphery of the face tape layer **315**. This location ensures that a tear along the periphery of the face tape layer **315** results in a tear, or electrical discontinuity, in the breakable conductor **505**. For example, FIGS. **6**A and **6**B illustrate the face tape layer **315** in which the breakable conductor **505** is layered between a tape stock **605** and a tape base **610**. The reusable portion **305** of the resposable sensor **300** then attaches to the tape base **610** through a pressure sensitive adhesive (PSA) **615**. The PSA **615**, the conductor **505** and the tape base **610** include a score **620** such that multiple attachment and removal of the resposable sensor **300** will result in a peripheral tear, or electrical discontinuity, in the breakable conductor **505**, as illustrated in FIG. **6**B.

Thus, like the information element **405**, the breakable conductor **505** also provides security and quality control functions. In particular, repeated use of the disposable portion **305** of the resposable sensor **300** advantageously severs at least one part of the breakable conductor **505**. An attached oximeter can detect such severance and initiate an appropriate notification to, for example, monitoring medical personnel. Providing security and quality control through a breakable conductor advantageously assists in controlling problems with patient contamination or improper attachment due to weakened adhesives.

FIG. **7** illustrates yet another embodiment of the face tape layer **315**. In this embodiment, the face tape layer **315** combines the breakable conductor **505** and the information element **405**. In this embodiment, the breakable conductor **505** is printed in a serpentine pattern to further increase the probability of a discontinuity upon the tearing of any portion of the face tape layer **315**. This combination of the information element **405** and the breakable conductor **505** advantageously adds significant safety features. For example, in this embodiment, the information element **405** is connected serially with the breakable conductor **505** and in parallel with the emitter **306** of the reusable portion **305**. Therefore, any discontinuity or tear in the breakable conductor **505** separates the information element **405** from the circuitry of the reusable portion **305**.

According to the foregoing embodiment, the attached oximeter receives an indication of both overuse and misuse of the resposable sensor **300**. For example, overuse is detected through the tearing and breaking of the breakable conductor **505**, thereby removing the information element **405** from the resposable sensor **300** circuitry. In addition, misuse through employment of disposable portions **310** from unauthorized vendors is detected through the absence of the information element **405**. Moreover, misuse from purposeful shorting of the contacts **410** is detected by effectively removing the emitter **306** from the circuit, thereby rendering the resposable sensor **300** inoperative. Therefore, the resposable sensor **300** of this embodiment advantageously provides a multitude of problem indicators to the attached oximeter. By doing so, the resposable sensor **300** advantageously prevents the likelihood of contamination, adhesive failure, and misuse. The resposable sensor **300** also advantageously maintains the likelihood of quality control.

A skilled artisan will recognize that the concepts of FIGS. **3-7** may be combined in total or in part in a wide variety of devices. For example, either or both of the breakable conductor **505** and the information element **405** may advantageously be traced into the clear base tape layer **320** rather than into the face tape layer **315**.

FIGS. **8**A and **8**B illustrate yet another embodiment of the disposable portion **310** of the resposable sensor **300** according to the present invention. As shown in this embodiment, the disposable portion **310** includes a face tape layer **805** and a clear base tape layer **810**. According to this embodiment, the clear base tape layer **810** includes a preattached section **815** and a fold over section **820**. The preattached section **815**

attaches approximately one third of the face tape layer **805** to the clear base tape layer **810**. On the other hand, the fold over section **820** forms a flap configured to create a cavity between the face tape layer **805** and the clear base tape layer **810**. The cavity is configured to receive the reusable portion **305** of the resposable sensor **300**. According to one embodiment, a release liner **825** fills the cavity and separates the face tape layer **805** from the clear base tape layer **810**. When the release liner **825** is removed, newly exposed adhesive on the fold over section **820** and the face tape layer **805** removably attaches the reusable portion **305** between the face tape layer **805** and fold over section **820** of the clear base tape layer **810**.

According to another embodiment, the cavity is so formed that adhesive is not needed. For example, the fold over section **820** may comprise resilient material that can form a friction fit relationship so as to fix the reusable portion **305** in an appropriate position relative to the disposable portion **310**. On the other hand, the fold over section **820** may also comprise material having other than resilient or adhesive properties, but still allow for proper placement of the reusable portion **305** and disposable portion **310** on the patient. For example, hook-and-loop type materials like VELCRO® may be used.

It will be understood that a skilled artisan would recognize that the fold over embodiment of the responsible sensor **300** may employ the properties discussed in relation to FIGS. **3-7**, such as the information element **405** and the breakable wire **505**.

FIG. **9**A illustrates an embodiment of a resposable sensor **900** integrated with an attached patient cable **905**, according to another embodiment of the invention. In this embodiment, a disposable portion **910** is attached to a reusable portion **915** by removably inserting the reusable portion **915** into a tape envelope **920** formed in the disposable portion **910**.

A skilled artisan will recognize that the disposable portion **910** may include the information element **405**, the breakable wire **505**, or both. Inclusion of one or both of these electronic components in the resposable sensor **900** advantageously provides the security, quality control, and safety features described in the foregoing embodiments.

FIG. **9**B illustrates an embodiment of a resposable sensor **300** of FIG. **3**, according to another embodiment of the invention. According to this embodiment, the resposable sensor **300** removably attaches to the patient cable **905** via a sensor connector **925**. The patient cable **905** then attaches to an oximeter via an oximeter connector **930**. Use of the sensor connector **925** enables the replacement of both the reusable portion **305** of the resposable sensor **300** without replacement of the sensor connector **925** or patient cable **905**. In such an embodiment, the disposable portion **310** would follow a different, more frequent, replacement schedule than that of the reusable portion **305**.

A skilled artisan will recognize that the variety of configurations described above that include the information element **405**, the breakable wire **505**, or both, may be incorporated into the embodiment of FIG. **9**B.

Although the foregoing invention has been described in terms of certain preferred embodiments, other embodiments will be apparent to those of ordinary skill in the art. For example, select aspects of FIGS. **3-9**B may be combined. For example, the envelope configured disposable portion **910** of FIG. **9**A may be combined with the reusable portion **305** of FIG. **3**.

Additionally, other combinations, omissions, substitutions and modifications will be apparent to the skilled artisan in view of the disclosure herein. Accordingly, the present invention is not intended to be limited by the reaction of the preferred embodiments, but is to be defined by reference to the appended claims.

What is claimed is:

1. A method of sterilizing a reusable portion of a noninvasive optical probe to assemble a new noninvasive optical probe, the method comprising:

removing said noninvasive optical probe from a patient, said probe comprising a reusable element and a separable disposable positioning mechanism, the disposable positioning mechanism including a first information memory storage element that remains attached to the disposable positioning mechanism when the reusable element is separated from the disposable positioning mechanism, the disposable positioning mechanism further including an adhesive side capable of removably securing the reusable element to a measurement site on said patient, the reusable element including a light source capable of emitting light at different wavelengths, a light detector capable of detecting the light after it has been attenuated by the patient's body tissue, and a plurality of conductors, wherein the light source and the light detector form part of the reusable element when the reusable element is separated from the disposable positioning mechanism;

separating said reusable element from said disposable positioning mechanism;

sterilizing at least said reusable element; and

combining said reusable element with a different disposable positioning mechanism to form a second optical probe, said combining including electrically connecting a second information memory storage element of said second optical probe, wherein said second information memory storage element forms a portion of said different disposable positioning mechanism.

2. The method of claim **1**, comprising creating a communication link between said second optical probe and a patient monitor configured to provide drive signals to said light source and receive signals responsive to physiological parameters of said patient from said light detector over said link, wherein said creating causes said monitor to receive data responsive to information stored on said second information memory storage element.

3. The method of claim **2**, wherein said creating said link comprises electrically and mechanically attaching a cable associated with said reusable element to said monitor.

4. The method of claim **1**, wherein said combining comprises sandwiching said reusable element between tape layers, one tape layer including said adhesive side capable of removably securing the reusable element to the measurement site.

5. The method of claim **1**, wherein the first and second information memory storage elements comprise a resistor.

6. The method of claim **1**, wherein the first and second information memory storage elements comprise a memory chip.

7. The method of claim **1**, wherein the first and second information memory storage elements comprise an identification device.

8. The method of claim **1**, wherein the first and second information memory storage elements comprise an active circuit.

* * * * *

专利名称(译)	对非侵入性光学探针的可重复使用部分进行灭菌的方法		
公开(公告)号	US9386953	公开(公告)日	2016-07-12
申请号	US13/209324	申请日	2011-08-12
[标]申请(专利权)人(译)	AL ALI AMMAR		
申请(专利权)人(译)	AL-ALI AMMAR		
当前申请(专利权)人(译)	Masimo公司		
[标]发明人	AL ALI AMMAR		
发明人	AL-ALI, AMMAR		
IPC分类号	H01R43/16 A61B5/1455 A61B5/00 A61B5/145		
CPC分类号	A61B5/6826 A61B5/14552 A61B5/6838 Y10T137/4478		
优先权	11/415600 2011-08-16 US 10/741777 2006-05-02 US 10/128721 2004-04-20 US 09/456666 2002-04-23 US		
其他公开文献	US20110301444A1		
外部链接	Espacenet USPTO		

摘要(译)

脉冲血氧计传感器具有可重复使用和一次性部分。传感器的可重复使用部分保留了相对长寿命且昂贵的发射器，探测器和连接器组件。传感器的一次性部分是相对便宜的胶带组件，其用于将传感器固定到测量部位，通常是患者的手指或脚趾。传感器的一次性部分可拆卸地连接到可再用部分上，使得当粘合剂消耗或者带弄脏或过度磨损时，一次性部分可以容易地更换。一次性部分还可以包含用于传感器识别或用于安全目的的信息元件，以确保患者安全。