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(54) **PULSE OXIMETRY DATA CONFIDENCE INDICATOR**

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(52) **U.S. Cl.** ..... **600/310**; 600/324

(58) **Field of Classification Search** ..... 600/309-310, 600/322-324, 330, 331, 336

See application file for complete search history.

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

3,875,930 A 4/1975 Silva et al.  
4,193,393 A 3/1980 Schlager

(Continued)

**FOREIGN PATENT DOCUMENTS**

DE	3723566	1/1989
EP	617912	10/1994
EP	813102	5/1997
WO	WO 98/43071	10/1998
WO	WO 00/38569	7/2000
WO	WO 00/40147	7/2000
WO	WO 00/56209	9/2000
WO	WO 00/61000	10/2000

**OTHER PUBLICATIONS**

Webster's New World Dictionary of AMERICAN English, Webster's New World, Third College Edition, p. 30.\*

Michael W. Wukitsch et al., "Pulse Oximetry: Analysis of Theory, Technology, and Practice," Journal of Clinical Monitoring, vol. 4, No. 4, pp. 290-301 (Oct. 1998).

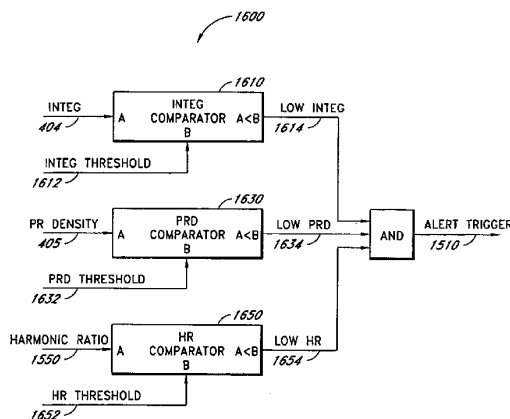
\* cited by examiner

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(57) **ABSTRACT**

A data confidence indicator includes a plurality of physiological data and a plurality of signal quality measures derived from a physiological sensor output, and a plurality of comparator outputs each responsive to one of the measures and a corresponding one of a plurality of thresholds. An alert trigger output combines the comparator outputs. A low signal quality warning is generated in response to the alert trigger output, wherein the thresholds are set so that the warning occurs during a time period when there is low confidence in the data. The alert may be in the form of a message generated on the pulse oximeter display to warn that the accuracy of saturation and pulse rate measurements may be compromised. A confidence-based alarm utilizes signal quality measures to reduce the probability of false alarms when data confidence is low and to reduce the probability of missed events when data confidence is high.

**24 Claims, 24 Drawing Sheets**



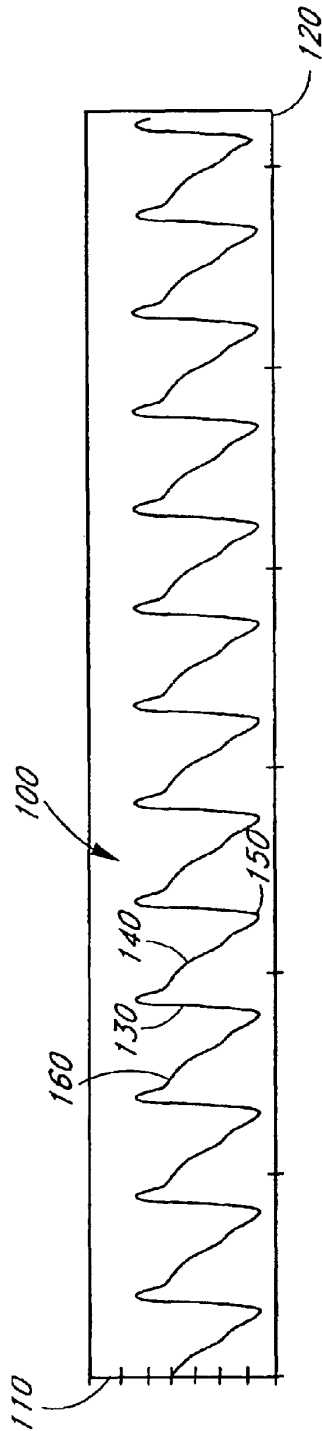
Apple Inc.  
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US 6,996,427 B2

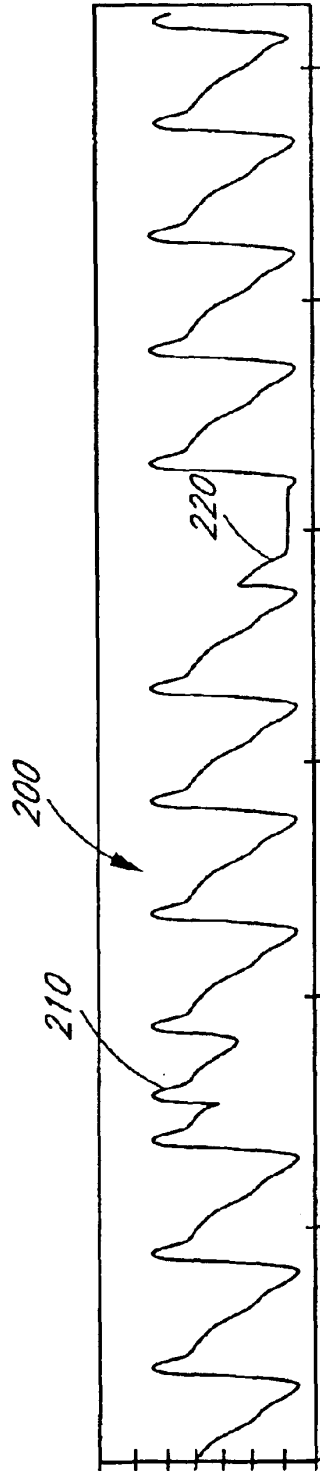
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U.S. PATENT DOCUMENTS

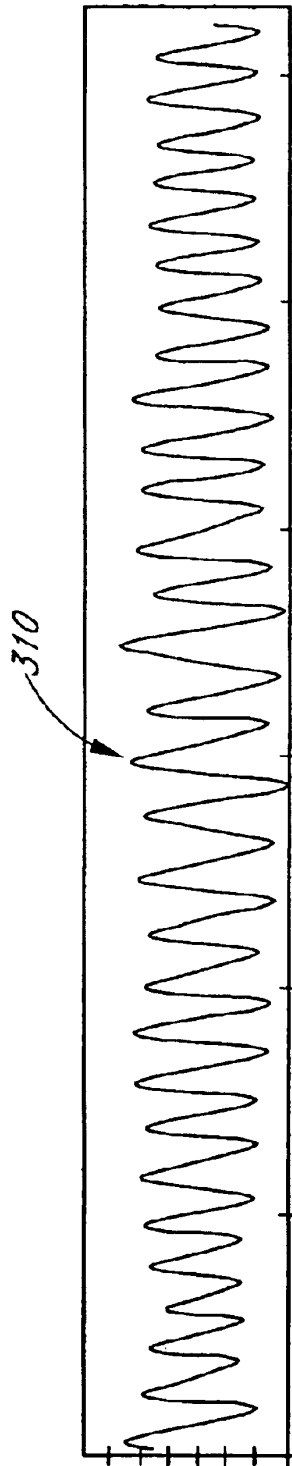
4,222,044 A	9/1980	Boschung		6,110,522 A	8/2000	Lepper, Jr. et al.
4,694,200 A	9/1987	Hetyei		6,122,535 A	9/2000	Kaestle et al.
4,714,341 A	12/1987	Hamaguri et al.		6,151,516 A	11/2000	Kiani-Azarbayjany et al.
4,800,495 A	1/1989	Smith		6,152,754 A	11/2000	Gerhardt et al.
4,863,265 A	* 9/1989	Flower et al. ....	356/41	6,157,850 A	12/2000	Diab et al.
4,869,253 A	* 9/1989	Craig et al. ....	600/323	6,165,005 A	12/2000	Mills et al.
4,960,128 A	10/1990	Gordon et al.		6,184,521 B1	2/2001	Coffin, IV et al.
5,019,974 A	* 5/1991	Beckers .....	600/316	6,206,830 B1	3/2001	Diab et al.
5,163,438 A	11/1992	Gordon et al.		6,229,856 B1	5/2001	Diab et al.
5,199,048 A	3/1993	Wakabayashi		6,236,872 B1	5/2001	Diab et al.
5,246,003 A	9/1993	DeLonzor		6,256,523 B1	7/2001	Diab et al.
5,299,120 A	3/1994	Kaestle		6,263,222 B1	7/2001	Diab et al.
5,337,744 A	8/1994	Branigan		6,278,522 B1	8/2001	Lepper, Jr. et al.
5,372,134 A	12/1994	Richardson		6,280,213 B1	8/2001	Tobler et al.
5,431,170 A	7/1995	Mathews		6,285,896 B1	9/2001	Tobler et al.
5,452,717 A	9/1995	Branigan et al.		6,334,065 B1	12/2001	Al-Ali et al.
5,482,036 A	1/1996	Diab et al.		6,339,715 B1	1/2002	Bahr et al.
5,485,847 A	* 1/1996	Baker, Jr. ....	600/323	6,349,228 B1	2/2002	Kiani et al.
5,490,505 A	2/1996	Diab et al.		6,360,114 B1	3/2002	Diab et al.
5,494,043 A	2/1996	O'Sullivan et al.		6,371,921 B1	4/2002	Caro et al.
5,517,988 A	5/1996	Gerhard		6,377,829 B1	4/2002	Al-Ali
5,533,511 A	7/1996	Kaspari et al.		6,388,240 B2	5/2002	Schulz et al.
5,590,649 A	1/1997	Caro et al.		6,397,091 B2	5/2002	Diab et al.
5,595,176 A	* 1/1997	Yamaura .....	600/323	6,415,166 B1 *	7/2002	Van Hoy et al. .... 600/323
5,632,272 A	* 5/1997	Diab et al. ....	600/323	6,430,525 B1	8/2002	Weber et al.
5,638,816 A	6/1997	Kiani-Azarbayjany et al.		6,463,311 B1	10/2002	Diab
5,638,818 A	6/1997	Diab et al.		6,470,199 B1	10/2002	Kopotic et al.
5,645,440 A	7/1997	Tobler et al.		6,501,975 B2	12/2002	Diab et al.
5,685,299 A	11/1997	Diab et al.		6,515,273 B2	2/2003	Al-Ali
D393,830 S	4/1998	Tobler et al.		6,525,386 B1	2/2003	Mills et al.
5,743,262 A	4/1998	Lepper, Jr. et al.		6,526,300 B1	2/2003	Kiani et al.
5,751,911 A	5/1998	Goldman		6,541,756 B2	4/2003	Schulz et al.
5,758,644 A	6/1998	Diab et al.		6,542,764 B1	4/2003	Al-Ali et al.
5,760,910 A	6/1998	Lepper, Jr. et al.		6,580,086 B1	6/2003	Schulz et al.
5,769,785 A	6/1998	Diab et al.		6,584,336 B1	6/2003	Ali et al.
5,782,757 A	7/1998	Diab et al.		6,597,933 B2	7/2003	Kiani et al.
5,785,659 A	7/1998	Caro et al.		6,606,511 B1	8/2003	Ali et al.
5,791,347 A	8/1998	Flaherty et al.		6,632,181 B2	10/2003	Flaherty et al.
5,810,734 A	9/1998	Caro et al.		6,640,116 B2	10/2003	Diab
5,810,740 A	* 9/1998	Paisner .....	600/515	6,643,530 B2	11/2003	Diab et al.
5,819,007 A	10/1998	Elghazzawi		6,650,917 B2	11/2003	Diab et al.
5,823,950 A	10/1998	Diab et al.		6,654,624 B2	11/2003	Diab et al.
5,830,131 A	11/1998	Caro et al.		6,658,276 B2	12/2003	Pishney et al.
5,830,135 A	11/1998	Bosque et al.		6,671,531 B2	12/2003	Al-Ali et al.
5,833,618 A	11/1998	Caro et al.		6,678,543 B2	1/2004	Diab et al.
5,860,919 A	1/1999	Kiani-Azarbayjany et al.		6,684,090 B2 *	1/2004	Ali et al. .... 600/323
5,865,736 A	2/1999	Baker, Jr. et al.		6,697,656 B1	2/2004	Al-Ali
5,890,929 A	4/1999	Mills et al.		6,697,658 B2	2/2004	Al-Ali
5,904,654 A	5/1999	Wohlmann et al.		RE38,476 E	3/2004	Diab et al.
5,919,134 A	7/1999	Diab		6,699,194 B1	3/2004	Diab et al.
5,934,925 A	8/1999	Tobler et al.		6,714,804 B2	3/2004	Al-Ali et al.
5,940,182 A	8/1999	Lepper, Jr. et al.		RE38,492 E	4/2004	Diab et al.
5,967,994 A	* 10/1999	Wang .....	600/509	6,725,075 B2	4/2004	Al-Ali
5,995,855 A	11/1999	Kiani et al.		6,745,060 B2	6/2004	Diab et al.
5,997,343 A	12/1999	Mills et al.		6,760,607 B2	7/2004	Al-Ali
6,002,952 A	12/1999	Diab et al.		6,770,028 B1	8/2004	Ali et al.
6,006,119 A	* 12/1999	Soller et al. ....	600/322	6,771,994 B2	8/2004	Kiani et al.
6,011,986 A	1/2000	Diab et al.		6,792,300 B1	9/2004	Diab et al.
6,027,452 A	2/2000	Flaherty et al.		6,813,511 B2	11/2004	Diab et al.
6,036,642 A	3/2000	Diab et al.		6,816,741 B2	11/2004	Diab
6,045,509 A	4/2000	Caro et al.		6,822,564 B2	11/2004	Al-Ali
6,047,201 A	* 4/2000	Jackson, III .....	600/344	6,826,419 B2	11/2004	Diab et al.
6,067,462 A	5/2000	Diab et al.		6,830,711 B2	12/2004	Mills et al.
6,080,111 A	* 6/2000	Pao-Lang .....	600/503	6,850,787 B2	2/2005	Weber et al.
6,081,735 A	6/2000	Diab et al.		6,850,788 B2	2/2005	Al-Ali
6,083,172 A	7/2000	Baker, Jr. et al.		6,852,083 B2	2/2005	Caro et al.
6,088,607 A	7/2000	Diab et al.		6,861,639 B2	3/2005	Al-Ali
				6,898,452 B2	5/2005	Al-Ali et al.



*Fig. 1*



*Fig. 2*



*Fig. 3A*

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