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Edgar, Jr. et al.

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(54) **METHOD, APPARATUS AND SYSTEM FOR REMOVING MOTION ARTIFACTS FROM MEASUREMENTS OF BODILY PARAMETERS**

5,368,026 A 11/1994 Swedlow et al.
5,368,224 A 11/1994 Richardson et al.
5,398,680 A 3/1995 Polson et al.

(List continued on next page.)

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OTHER PUBLICATIONS

Dowla, et al., Neural Networks and Wavelet Analysis in the Computer Interpretation of Pulse Oximetry Data, Neural Networks for Signal Processing VI—Proc. IEEE, 1996 IEEE Signal Process, Soc., IEEE Workshop, 0-7803-3550-3 (1996).

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(57) **ABSTRACT**

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Related U.S. Application Data

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A method for removing motion artifacts from devices for sensing bodily parameters and apparatus and system for effecting same. The method includes analyzing segments of measured data representing bodily parameters and possibly noise from motion artifacts. Each segment of measured data may correspond to a single light signal transmitted and detected after transmission or reflection through bodily tissue. Each data segment is frequency analyzed to determine dominant frequency components. The frequency component which represents at least one bodily parameter of interest is selected for further processing. The segment of data is subdivided into subsegments, each subsegment representing one heartbeat. The subsegments are used to calculate a modified average pulse as a candidate output pulse. The candidate output pulse is analyzed to determine whether it is a valid bodily parameter and, if yes, it is output for use in calculating the at least one bodily parameter of interest without any substantial noise degradation. The above method may be applied to red and infrared pulse oximetry signals prior to calculating pulsatile blood oxygen concentration. Apparatus and systems disclosed incorporate methods disclosed according to the invention.

(51) **Int. Cl.⁷** **A61B 5/00**

(52) **U.S. Cl.** **600/323; 600/336; 600/310; 600/324**

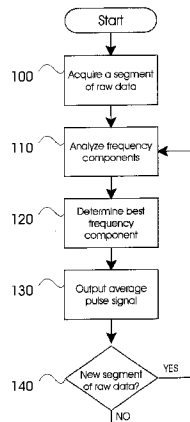
(58) **Field of Search** 600/309-311, 322-326, 600/330-331, 336, 473, 476; 356/39-41; 369/60.01

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,800,495 A *	1/1989	Smith	600/322
4,942,877 A *	7/1990	Sakai et al.	600/323
4,955,379 A *	9/1990	Hall	600/366
5,025,791 A	6/1991	Niwa	
5,190,038 A	3/1993	Polson et al.	
5,266,417 A	7/1993	Swedlow et al.	
5,299,120 A *	3/1994	Kaestle	600/310
5,349,952 A *	9/1994	McCarthy et al.	600/473
5,351,685 A	10/1994	Potratz	

34 Claims, 11 Drawing Sheets



US 6,393,311 B1

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U.S. PATENT DOCUMENTS

5,431,170 A	7/1995	Matthews	5,800,348 A	9/1998	Kaestle	
5,448,991 A	9/1995	Polson et al.	5,803,910 A	9/1998	Potratz	
5,482,036 A	1/1996	Diab et al.	5,820,550 A	10/1998	Polson et al.	
5,490,505 A	2/1996	Diab et al.	5,852,638 A	* 12/1998	Chen et al.	375/344
5,555,882 A	9/1996	Richardson et al.	5,853,364 A	12/1998	Baker, Jr. et al.	
5,588,427 A	12/1996	Tien	5,885,213 A	3/1999	Richardson et al.	
5,632,272 A	5/1997	Diab et al.	5,919,134 A	7/1999	Diab	
5,645,060 A	7/1997	Yorkey	5,934,277 A	8/1999	Mortz	
5,685,299 A	11/1997	Diab et al.	6,067,462 A	* 5/2000	Diab et al.	600/310
5,713,355 A	2/1998	Richardson et al.	6,098,038 A	* 9/2000	Hermansky et al.	704/226
5,743,263 A	4/1998	Baker, Jr.	6,122,535 A	* 9/2000	Kaestle et al.	600/322
5,769,785 A	6/1998	Diab et al.				

* cited by examiner

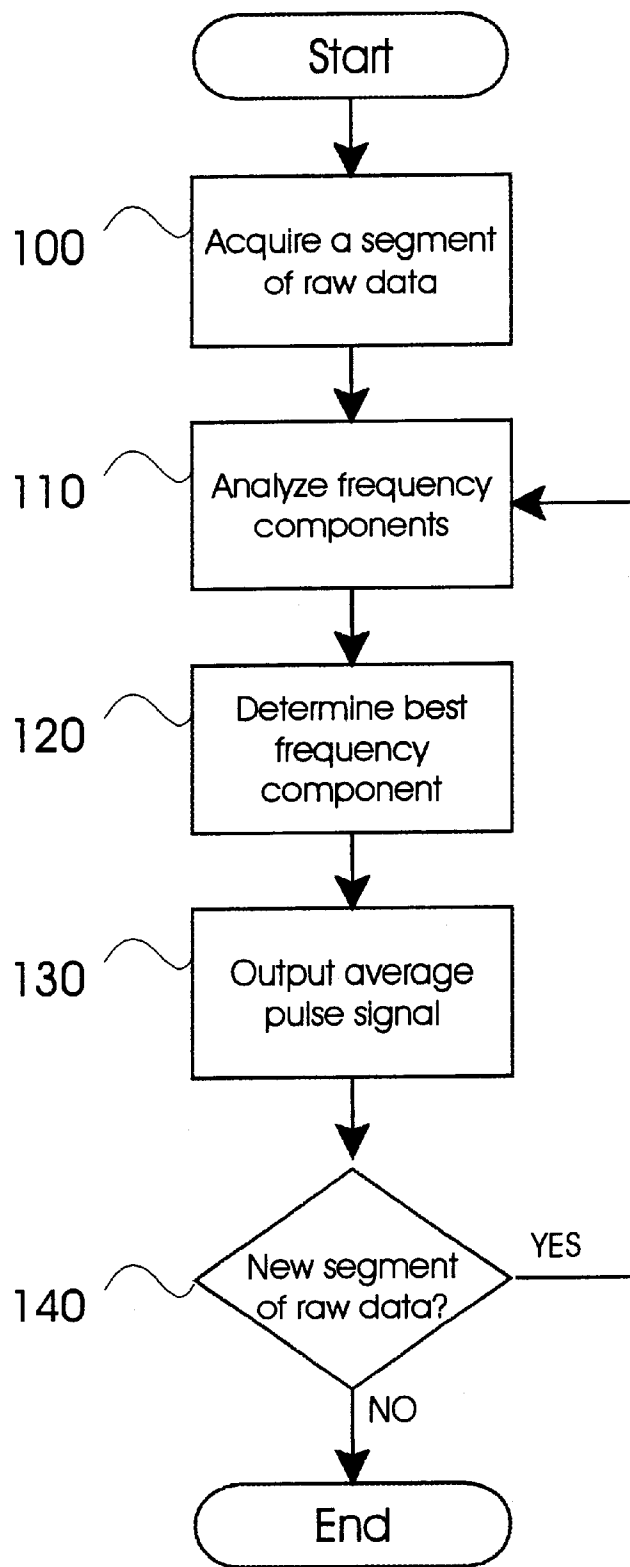
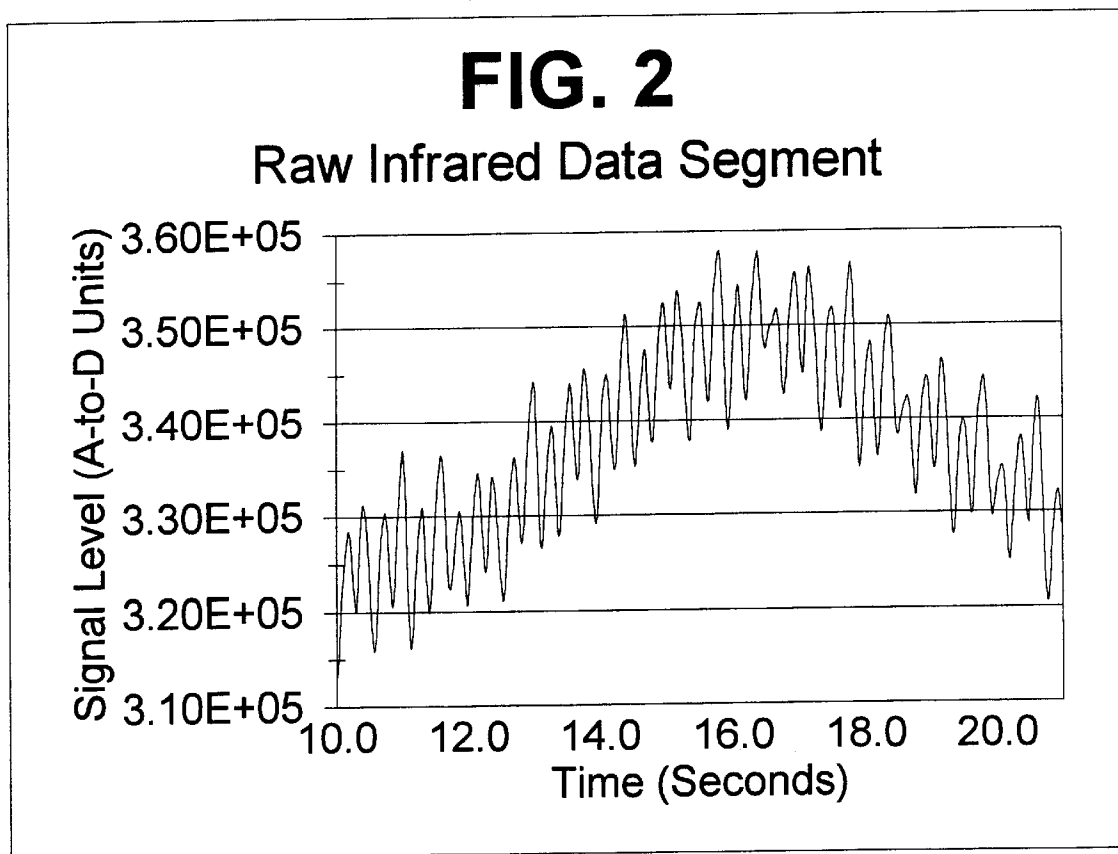
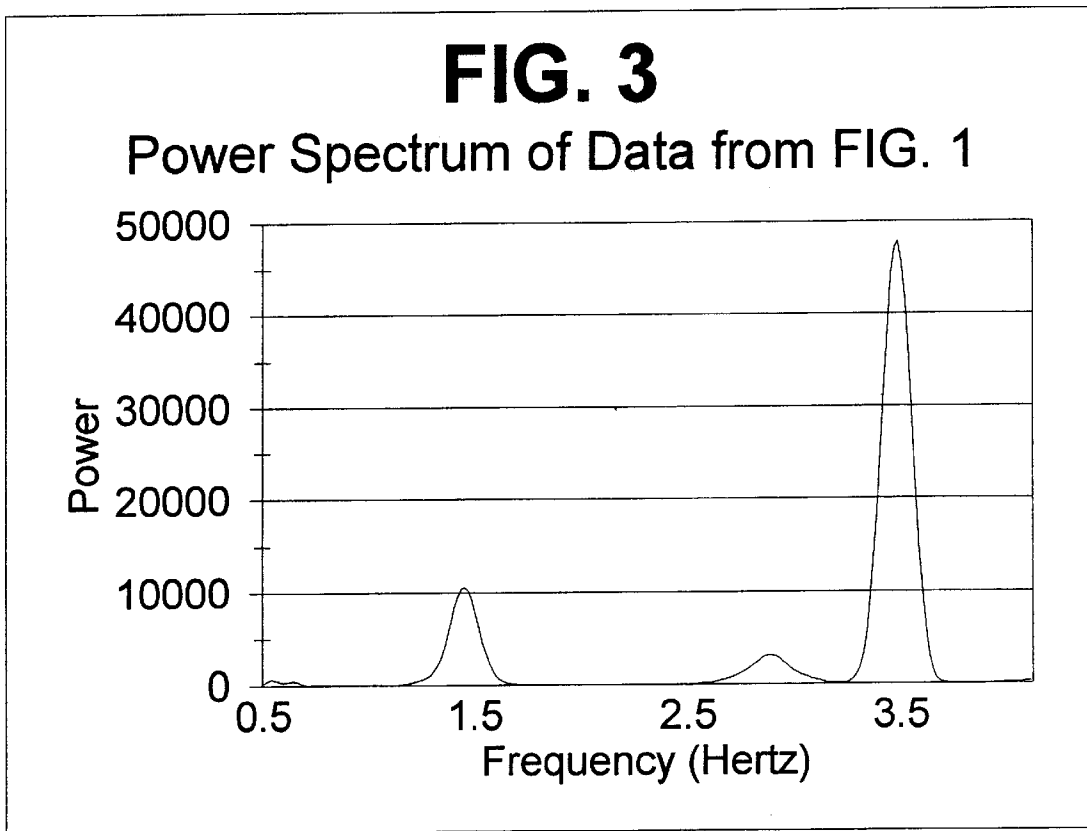


FIG. 1





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