



US006801799B2

(12) **United States Patent**  
**Mendelson**

(10) **Patent No.:** **US 6,801,799 B2**  
(45) **Date of Patent:** **Oct. 5, 2004**

(54) **PULSE OXIMETER AND METHOD OF OPERATION**

(75) Inventor: **Yitzhak Mendelson**, Worcester, MA (US)

(73) Assignee: **Cybro Medical, Ltd.**, Haifa (IL)

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

(21) Appl. No.: **10/360,666**

(22) Filed: **Feb. 6, 2003**

(65) **Prior Publication Data**

US 2003/0144584 A1 Jul. 31, 2003

**Related U.S. Application Data**

(62) Division of application No. 09/939,391, filed on Aug. 24, 2001, now abandoned.

(30) **Foreign Application Priority Data**

Oct. 5, 2000 (IL) ..... 138884

(51) **Int. Cl.**<sup>7</sup> ..... **A61B 5/00**

(52) **U.S. Cl.** ..... **600/330; 600/322; 600/336**

(58) **Field of Search** ..... 600/310, 322, 600/323, 330, 336

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

|             |         |                 |        |
|-------------|---------|-----------------|--------|
| 3,638,640 A | 2/1972  | Shaw            |        |
| 3,799,672 A | 3/1974  | Vurek           | 356/41 |
| 3,847,483 A | 11/1974 | Shaw            | 356/41 |
| 3,998,550 A | 12/1976 | Konishi et al.  | 356/39 |
| 4,086,915 A | 5/1978  | Kofsky et al.   |        |
| 4,167,331 A | 9/1979  | Nielsen         | 356/39 |
| 4,266,554 A | 5/1981  | Hamaguri        |        |
| 4,357,105 A | 11/1982 | Loretz          | 356/40 |
| 4,407,290 A | 10/1983 | Wilber          |        |
| 4,446,871 A | 5/1984  | Imura           |        |
| 4,714,341 A | 12/1987 | Hamaguri et al. | 356/41 |

|             |         |                    |            |
|-------------|---------|--------------------|------------|
| 4,740,080 A | 4/1988  | Donohue et al.     | 356/326    |
| 4,773,422 A | 9/1988  | Isaacson et al.    |            |
| 4,796,636 A | 1/1989  | Branstetter et al. |            |
| 4,802,486 A | 2/1989  | Goodman et al.     |            |
| 4,819,649 A | 4/1989  | Rogers et al.      |            |
| 4,819,752 A | 4/1989  | Zelin              |            |
| 4,854,699 A | 8/1989  | Edgar, Jr.         | 356/41     |
| 4,859,057 A | 8/1989  | Taylor et al.      | 356/41     |
| 4,867,557 A | 9/1989  | Takatani et al.    | 356/41     |
| 4,892,101 A | 1/1990  | Cheung et al.      |            |
| 4,928,692 A | 5/1990  | Goodman et al.     |            |
| 4,934,372 A | 6/1990  | Corenman et al.    |            |
| 4,960,126 A | 10/1990 | Conlon             |            |
| 5,190,038 A | 3/1993  | Polson et al.      |            |
| 5,224,478 A | 7/1993  | Sakai et al.       |            |
| 5,348,004 A | 9/1994  | Hollub             |            |
| 5,349,519 A | 9/1994  | Kaestle            | 364/413.09 |

(List continued on next page.)

**FOREIGN PATENT DOCUMENTS**

|    |           |         |
|----|-----------|---------|
| WO | WO9403102 | 2/1994  |
| WO | WO0154573 | 8/2001  |
| WO | WO0184107 | 11/2001 |

**OTHER PUBLICATIONS**

*"Reflecance Pulse Oximetry at the Forehead of Newborns: The Influence of Varying Pressure on the Probe"; A. Carin M. Dassel, MD, et al.; Dept of Obstetrics and Gynecology, Univ. Hospital Groningen, Groningen; Journal of Clinical Monitoring 12: pp. 421-428, 1996.*

(List continued on next page.)

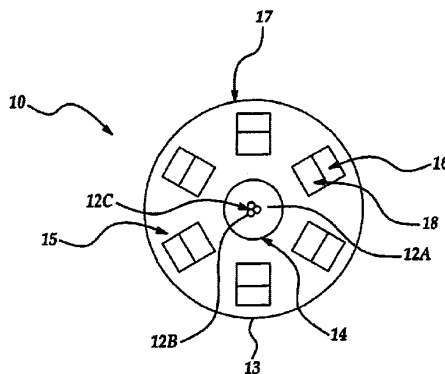
*Primary Examiner*—Eric F. Winakur

(74) *Attorney, Agent, or Firm*—Howard & Howard

(57) **ABSTRACT**

A sensor for use in an optical measurement device and a method for non-invasive measurement of a blood parameter. The sensor includes sensor housing, a source of radiation coupled to the housing, and a detector assembly coupled to the housing. The source of radiation is adapted to emit radiation at predetermined frequencies. The detector assembly is adapted to detect reflected radiation at least one predetermined frequency and to generate respective signals. The signals are used to determine the parameter of the blood.

**5 Claims, 6 Drawing Sheets**



Apple Inc.  
APL1053

## U.S. PATENT DOCUMENTS

|             |          |                        |         |
|-------------|----------|------------------------|---------|
| 5,355,880 A | 10/1994  | Thomas et al.          |         |
| 5,398,680 A | 3/1995   | Polson et al.          |         |
| 5,413,100 A | 5/1995   | Barthelemy et al.      |         |
| 5,421,329 A | 6/1995   | Casciani et al.        |         |
| 5,482,036 A | 1/1996   | Diab et al.            |         |
| 5,490,505 A | 2/1996   | Diab et al.            |         |
| 5,490,506 A | 2/1996   | Takatani et al.        |         |
| 5,494,032 A | * 2/1996 | Robinson et al. ....   | 600/323 |
| 5,517,988 A | 5/1996   | Gerhard                |         |
| 5,533,507 A | 7/1996   | Potratz                |         |
| 5,632,272 A | 5/1997   | Diab et al.            |         |
| 5,645,060 A | 7/1997   | Yorkey                 |         |
| 5,685,299 A | 11/1997  | Diab et al.            |         |
| 5,758,644 A | 6/1998   | Diab et al.            |         |
| 5,769,785 A | 6/1998   | Diab et al. ....       | 600/364 |
| 5,782,237 A | 7/1998   | Casciani et al.        |         |
| 5,823,950 A | 10/1998  | Diab et al. ....       | 600/310 |
| 5,842,981 A | 12/1998  | Larsen et al. ....     | 600/323 |
| 5,853,364 A | 12/1998  | Baker, Jr. et al. .... | 600/500 |
| 5,919,134 A | 7/1999   | Diab                   | 600/323 |
| 5,995,856 A | 11/1999  | Mannheimer et al. .... | 600/322 |
| 6,011,986 A | 1/2000   | Diab et al. ....       | 600/323 |
| 6,031,603 A | 2/2000   | Fine et al. ....       | 356/41  |
| 6,036,642 A | 3/2000   | Diab et al. ....       | 600/364 |
| 6,067,462 A | 5/2000   | Diab et al. ....       | 600/310 |
| 6,081,735 A | 6/2000   | Diab et al. ....       | 600/310 |
| 6,083,172 A | 7/2000   | Baker, Jr. et al. .... | 600/500 |

## OTHER PUBLICATIONS

*“Reflectance Pulse Oximetry—Principles and Obstetric Application in the Zurich System”*; Voker Konig, Renate Huch, and Albert Huch; Perinatal Physiology Research Dept., Dept. of Obstetrics, Computing 14: pp. 403–412, 1998.

*“Effect of location of the sensor on reflectance pulse oximetry”*; A.C. M. Dassel, Research Fellow et al. British Journal of Obstetrics and Gynecology; Aug. 1997, vol. 104, pp. 910–916.

*“Design and Evaluation of a New Reflectance Pulse Oximeter Sensor”*; Y. Mendelson, PhD, et al.; Worcester Polytechnic Institute, Biomedical Engineering Program, Worcester, MA 01609; Association for the Advancement of Medical Instrumentation, vol. 22, No. 4, 1988; pp. 167–173.

*“Skin Reflectance Pulse Oximetry: In Vivo Measurements from the Forearm and Calf”*; Y. Mednelson, PhD and M.J. McGinn, MSc; Dept. of Biomedical Engineering, Worcester Polytechnic Institute, Worcester, MA 01609; Journal of Clinical Monitoring, vol. 7, No. 1, 1991; pp. 7–12.

*“Experimental and Clinical Evaluation of a Noninvasive Reflectance Pulse Oximeter Sensor”*; Setsuo Takatani, PhD, et al.; Dept. of Surgery, Baylor College of Medicine, One Baylor Plaza, Houston, TX 77030; Journal of Clinical Monitoring, vol. 8, No. 4, Oct. 1992; pp. 257–266.

*“Wavelength Selection for Low-Saturation Pulse Oximetry”*; Paul D. Mannheimer, et al.; IEEE Transactions on Biomedical Engineering, vol. 44, No. 3, Mar. 1997; pp. 148–158.

*“Noninvasive Pulse Oximetry Utilizing Skin Reflectance Photoplethysmography”*; Yitzhak Mendelson and Burt D. Ochs; IEEE Transactions on Biomedical Engineering, vol. 35, No. 10, Oct. 1988; pp. 798–805.

*“Physio-optical considerations in the design of fetal pulse oximetry sensors”*; P.D. Mannheimer, M.E. Fein and J.R. Casciani; European Journal of Obstetrics & Gynecology and Reproductive Biology 72 Suppl. 1 (1997) S9–S19.

*“Fetal pulse oximetry: influence of tissue blood content and hemoglobin concentration in a new in-vitro model”*; Thomas Edrich, Gerhard Rall, Reinhold Knitza; European Journal of Obstetrics & Gynecology and Reproductive Biology 72 Suppl. 1 (1997) S29–S34.

\* cited by examiner

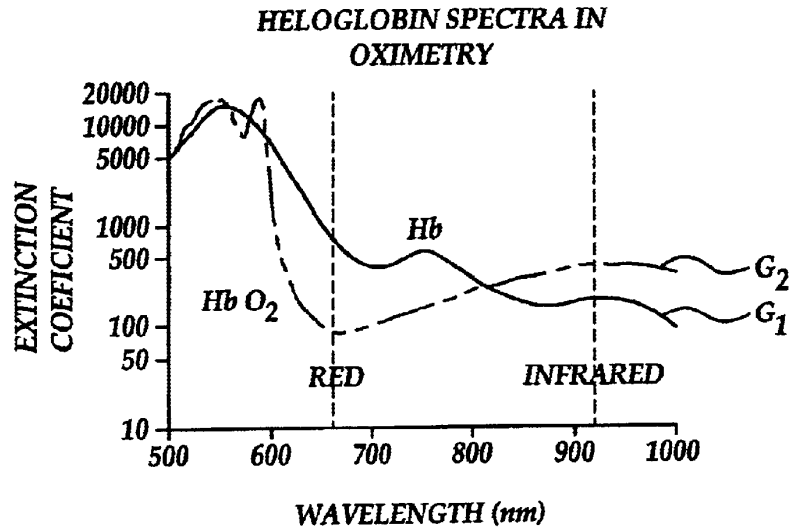


Figure 1

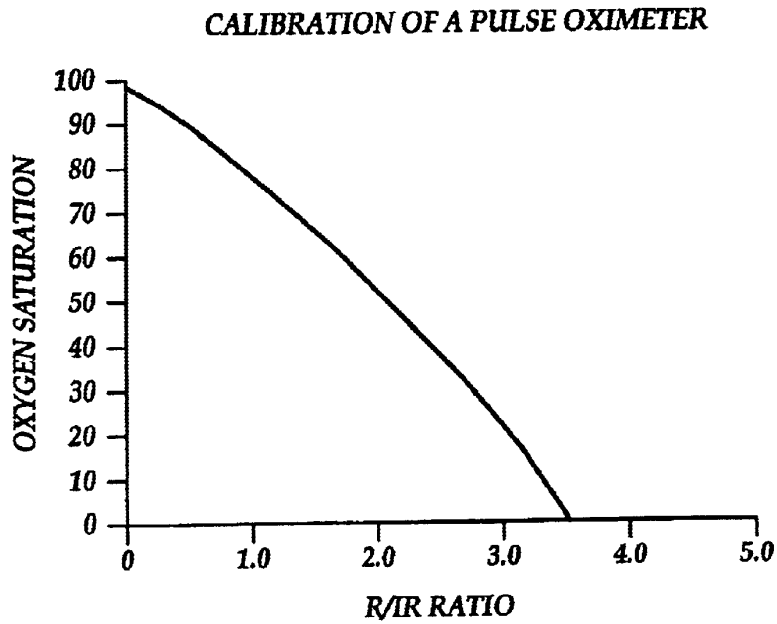


Figure 2

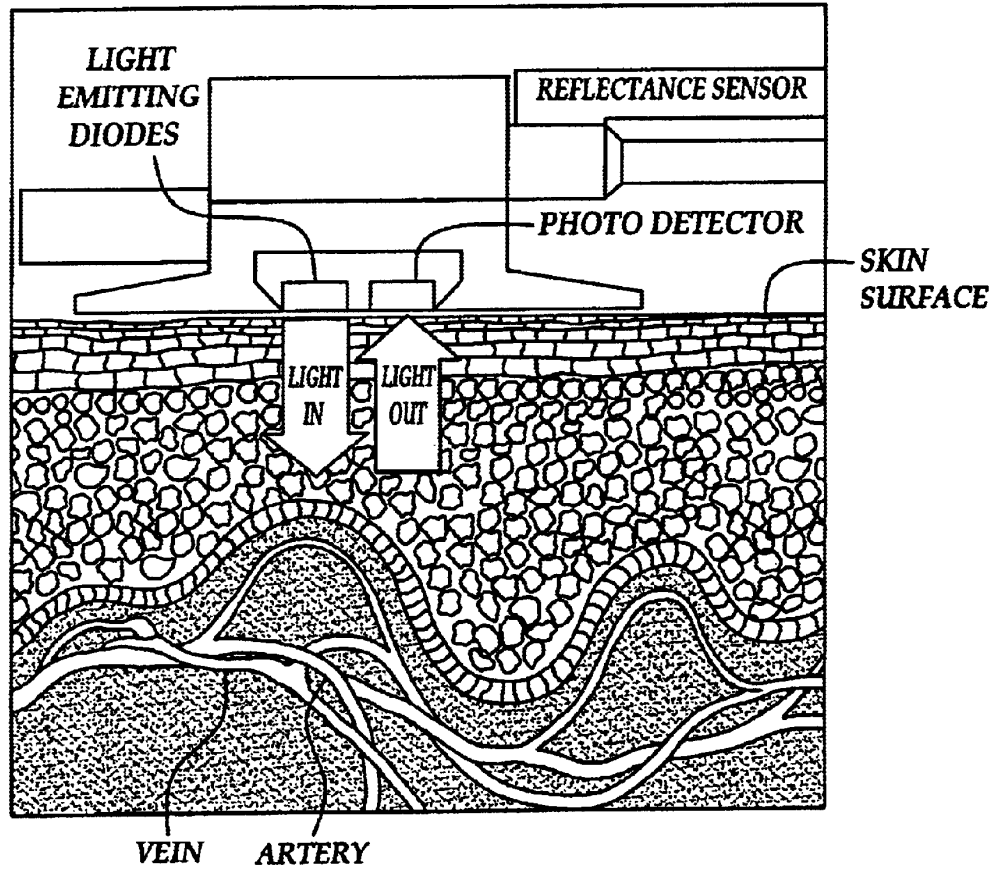


Figure 3

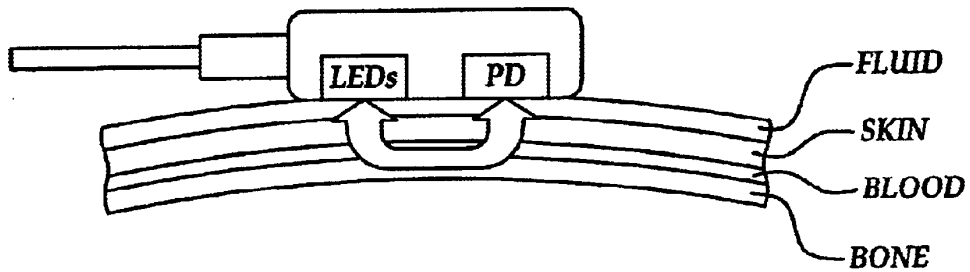


Figure 4

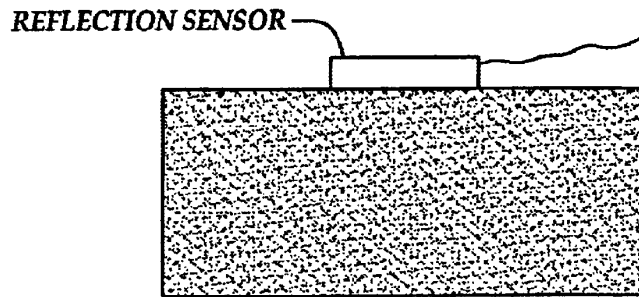


Figure 5A

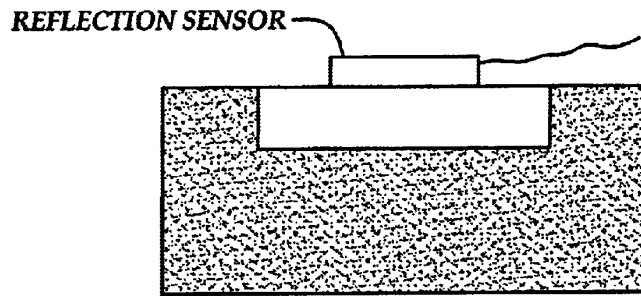


Figure 5B

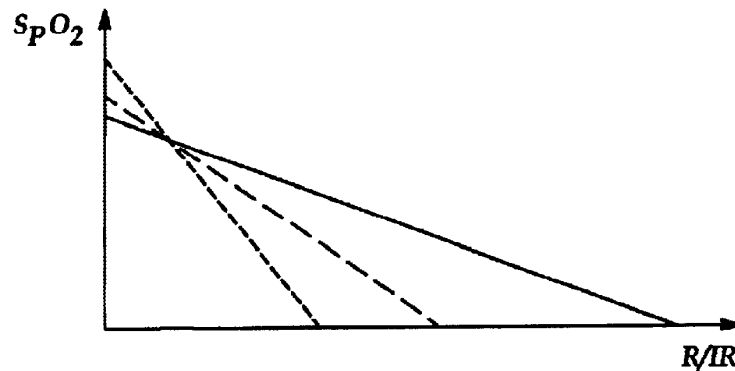


Figure 6

# Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

## Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

## Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

## Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

## API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

## LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

## FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

## E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.