



US005101825A

# United States Patent [19]

[11] Patent Number: **5,101,825**

Gravenstein et al.

[45] Date of Patent: **Apr. 7, 1992**

[54] **METHOD FOR NONINVASIVE INTERMITTENT AND/OR CONTINUOUS HEMOGLOBIN, ARTERIAL OXYGEN CONTENT, AND HEMATOCRIT DETERMINATION**

4,805,623 2/1989 Jobsis ..... 128/633

[75] Inventors: **Dietrich Gravenstein**, Gainesville, Fla.; **J. E. W. Beneken**, Helmond, Netherlands; **Samsun Lampotang**, Gainesville, Fla.; **Nikolaus Gravenstein**, Gainesville, Fla.; **Michael A. Brooks**, Gainesville, Fla.; **Gordon L. Gibby**, Gainesville, Fla.; **Robert J. Atwater**, Gainesville, Fla.

### OTHER PUBLICATIONS

"A New Instrument for the Simultaneous Measurement of Total Hemoglobin, % Oxyhemoglobin, % Carboxy-hemoglobin, % Methemoglobin, and Oxygen content in Whole Blood" by Brown; IEEE Trans. on Biomed. Eng., vol. BM627, No. 3, 3/80.

Donahoe, T. M., and R. L. Longini (1985) "A New Noninvasive Backscattering Oximeter," Proceeding of the IEEE 7th Annual Conference of the Engineering in Medicine and Biology Society, Sep. 27-30, 1985, vol. 1, IEEE (U.S.) 144-147.

Merrick, E. S., and T. J. Hayes (1976) "Continuous, Non-Invasive Measurements of Arterial Blood Oxygen Levels," Hewlett-Packard J. 28(2): 2-9.

[73] Assignee: **BlackBox, Inc.**, Gainesville, Fla.

[21] Appl. No.: **368,636**

[22] Filed: **Jun. 20, 1989**

Primary Examiner—David Shay

Attorney, Agent, or Firm—Saliwanchik & Saliwanchik

### Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 264,119, Oct. 28, 1988, abandoned.

[51] Int. Cl.<sup>5</sup> ..... **A61B 5/00**

[52] U.S. Cl. .... **128/633; 128/637; 128/664; 128/898**

[58] Field of Search ..... **128/633, 634, 665, 664, 128/898, 637; 606/10, 11, 13**

### ABSTRACT

Described here are a novel means and device for noninvasively quantifying important blood constituents. Total hemoglobin, arterial oxygen content, hematocrit, and other parameters can all be determined quickly and easily without the need for skin puncture or lengthy laboratory analysis. The invention described here concerns the simultaneous measurement of volume changes and changes in the mass of either oxyhemoglobin, total hemoglobin, or reduced hemoglobin. The data obtained by these measurements is used to quantify the parameters of interest.

### References Cited

#### U.S. PATENT DOCUMENTS

4,167,331 9/1979 Nielsen .  
4,704,029 11/1987 Van Heuvelen ..... 128/633

**14 Claims, 4 Drawing Sheets**

