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**United States Patent** [19]  
**Bryars et al.**

[11] **Patent Number:** **5,807,267**  
[45] **Date of Patent:** **Sep. 15, 1998**

- [54] **HEART PULSE MONITOR** 5,243,992 9/1993 Eckerle et al. .... 128/690
- [75] Inventors: **John D. Bryars**, Encinitas; **David Cavanaugh**, San Diego, both of Calif. 5,301,154 4/1994 Suga ..... 128/690
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- 5,558,096 9/1996 Palatnik ..... 128/687

- [73] Assignee: **Advanced Body Metrics Corporation**, Rancho Santa Fe, Calif.
- [21] Appl. No.: **512,712**
- [22] Filed: **Aug. 8, 1995**

*Primary Examiner*—Robert L. Nasser  
*Attorney, Agent, or Firm*—G. Donald Weber, Jr.

[57] **ABSTRACT**

The invention herein described is intended to provide the user with a reliable heart rate monitor that is a completely self contained unit and is capable of providing accurate readings while the wearer is moving about. The use of piezoelectric sensing elements eliminates the power drain caused by LEDs and similar devices. The sensing element mounting means disclosed herein is devised to greatly reduce the noise introduced into the pulse signal by body motion. The use of optical sensors in a staring mode and optical sensors in a pulsed mode is also presented. The effects of noise are further reduced by employing digital signal processing algorithms to find the heart pulse intermixed with noise signals and present the heart pulse rate in beats per minute on a display. The resulting device permits the visual monitoring of the heart pulse rate in a human body in a consistent, error-free manner.

**Related U.S. Application Data**

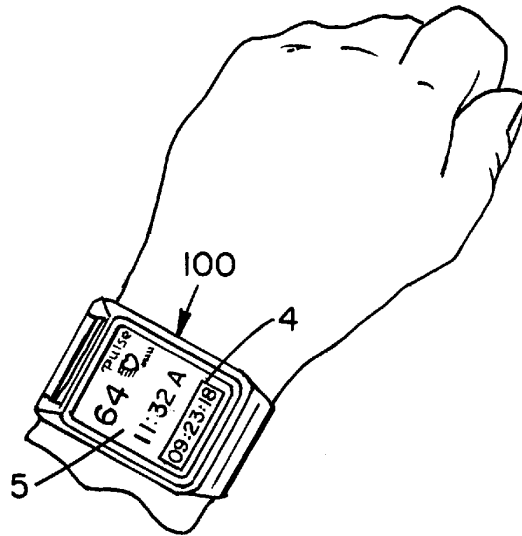
- [63] Continuation-in-part of Ser. No. 462,152, Jun. 5, 1995, which is a continuation of Ser. No. 252,605, Jun. 1, 1994, abandoned.
- [51] **Int. Cl.<sup>6</sup>** ..... **A61B 5/00**
- [52] **U.S. Cl.** ..... **600/500; 600/477; 600/479; 600/503**
- [58] **Field of Search** ..... 128/672, 666, 128/687-690, 706, 707; 600/500-503; 5/476-475

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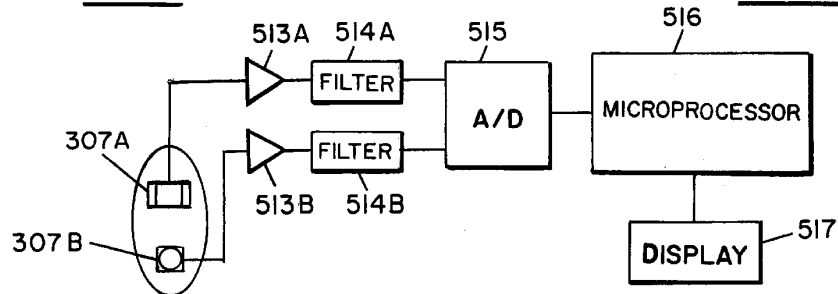
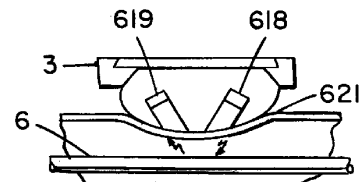
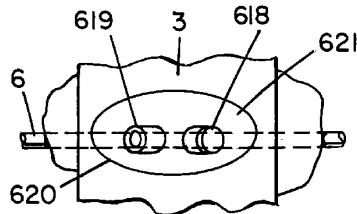
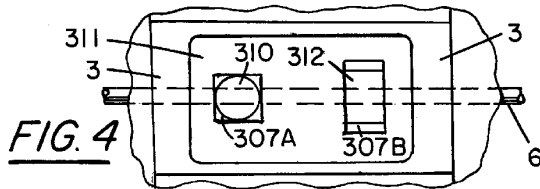
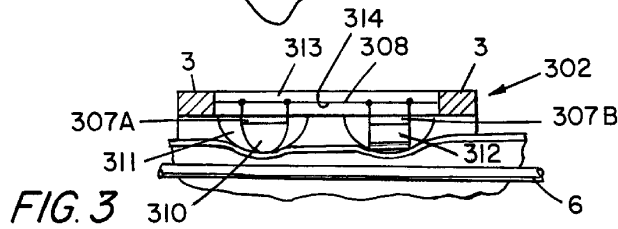
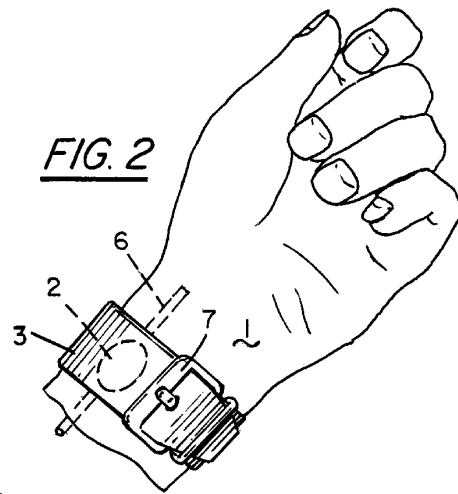
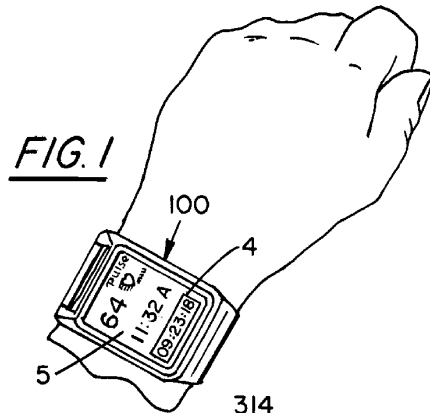
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**27 Claims, 4 Drawing Sheets**



Apple Inc.  
APL1024



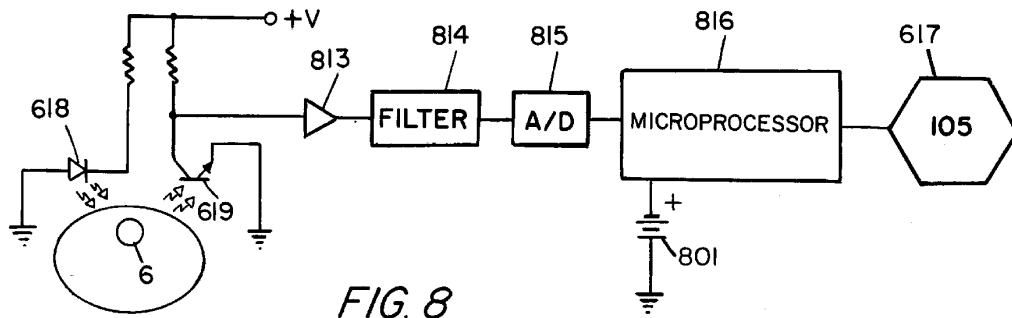


FIG. 8

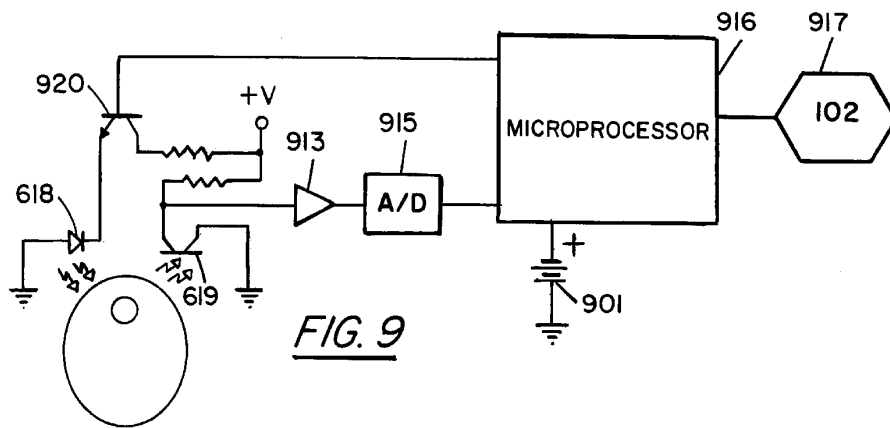


FIG. 9

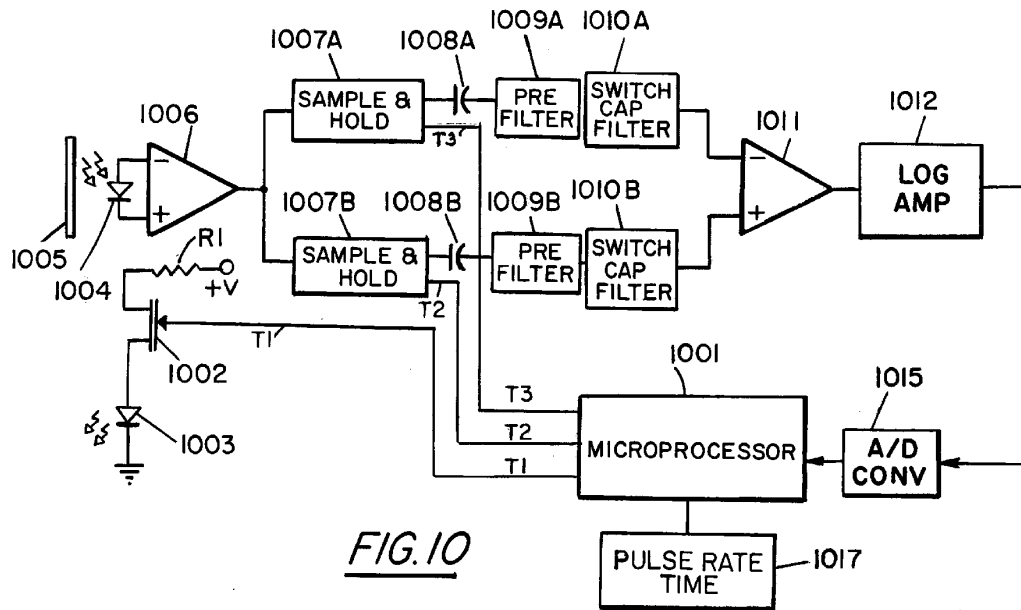
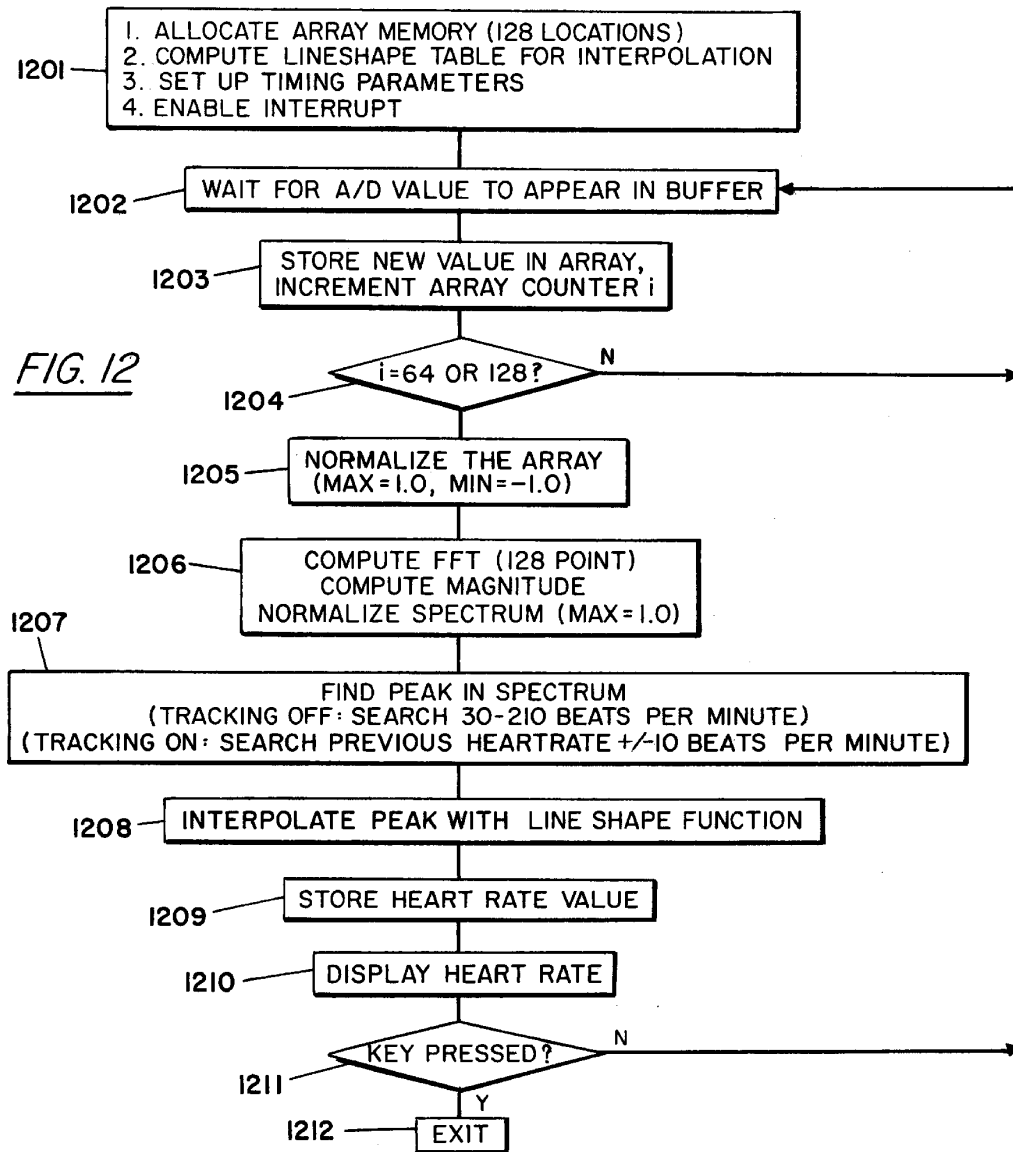
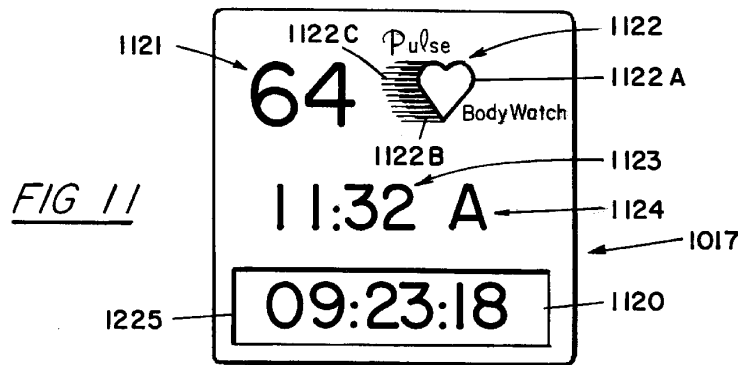


FIG. 10



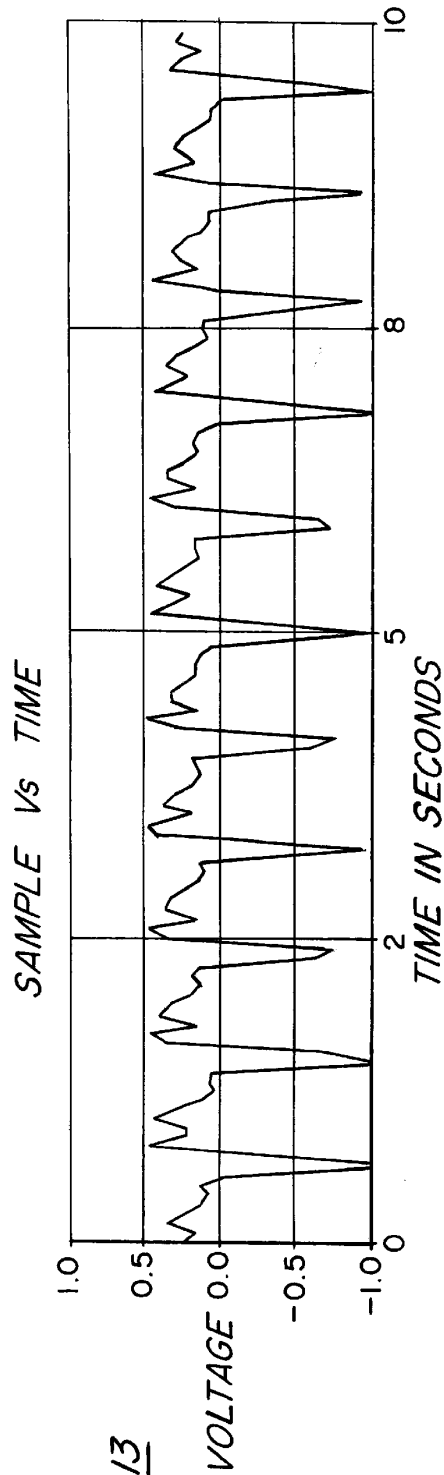


FIG. 13

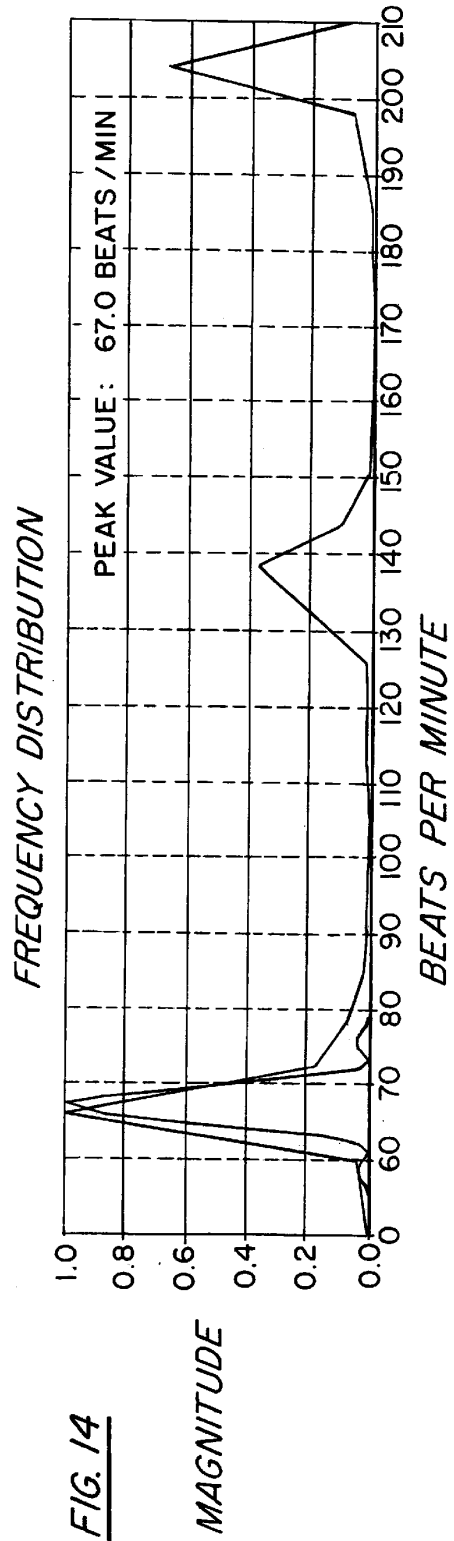


FIG. 14

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