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United States Patent [19] Oberg et al.

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[54] **METHOD AND APPARATUS FOR ANALYZING HEART AND RESPIRATORY FREQUENCIES PHOTOPLETHYSMOGRAPHICALLY**

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[51] **Int. Cl.⁶** **A61B 5/0205**
[52] **U.S. Cl.** **128/671; 128/687; 128/666**
[58] **Field of Search** **128/633, 664-667, 128/670-671, 668, 687-690**

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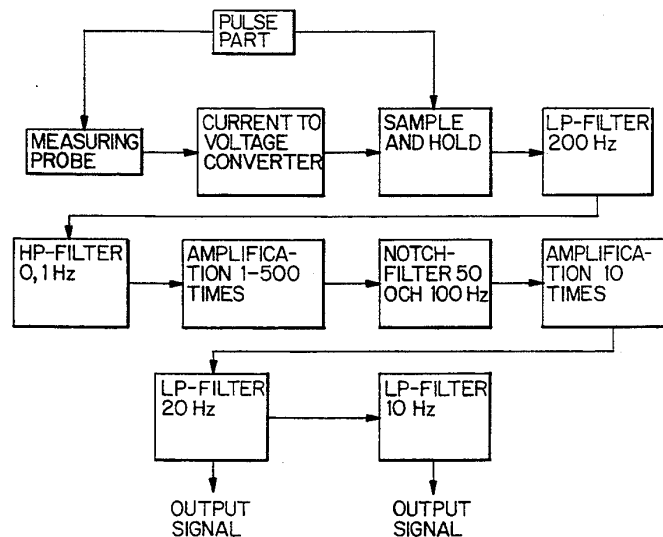
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[57] **ABSTRACT**

A pulse-frequency analyzing monitor which is provided with an optical sensor and which is intended for measuring photoplethysmographically the blood circulation of a subject, such as a body part of a human being or an animal, includes a light source, preferably a light-emitting diode for infrared light, fibre optics, a detector unit for detecting the alternating voltage, or AC-component of a generated PPG-signal for the purpose of determining the heart frequency of the subject, an electronic amplifying unit and a presentation unit, for instance an oscilloscope or a display unit. The apparatus also includes means for separating from the detected PPG-signal a signal component which indicates the respiration frequency of the subject. The PPG-signal is coupled to a filter, preferably a digital filter, which enables limit frequencies and the degree of amplification to be set. The digital filter may be a component of a microprocessor which is able to eliminate disturbances, for instance disturbances emanating from 50 Hz stray light, in addition to separating signals concerning the heart and respiration frequency of the subject. The invention also relates to a method of carrying out such photoplethysmographic measuring processes.

11 Claims, 4 Drawing Sheets



Apple Inc.
APL1062

FIG. 1

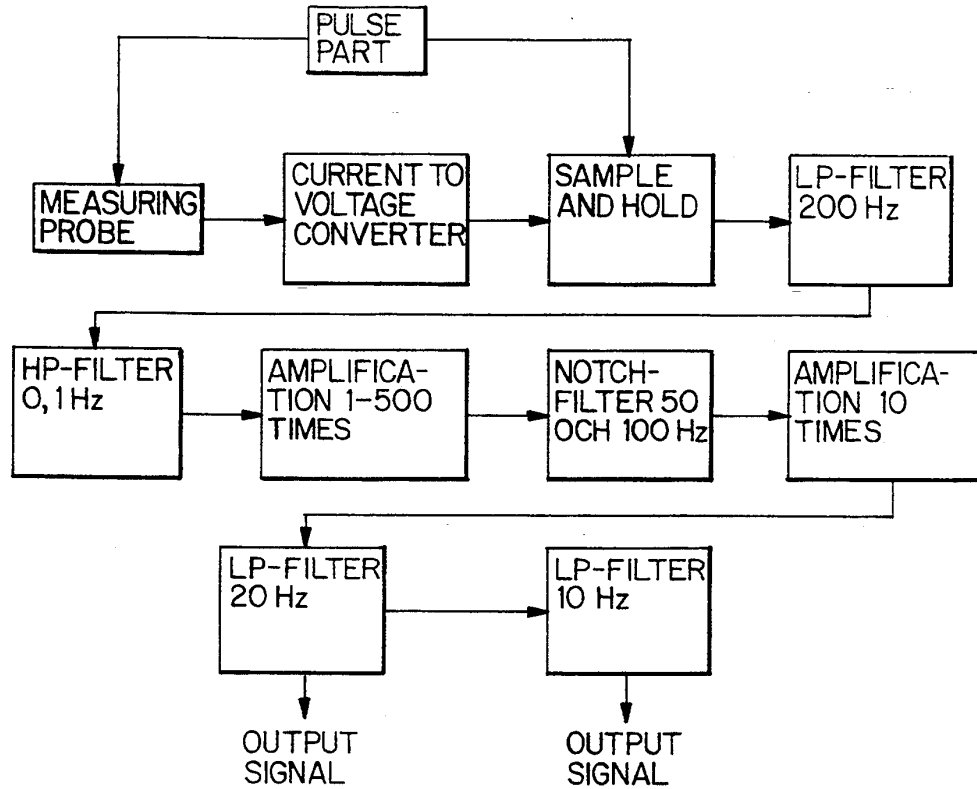
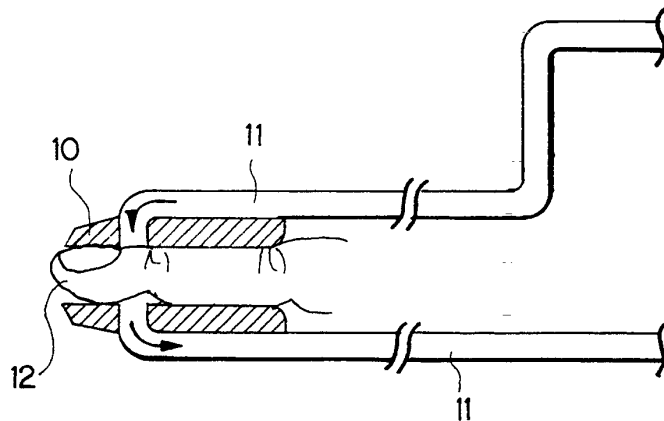


FIG. 6



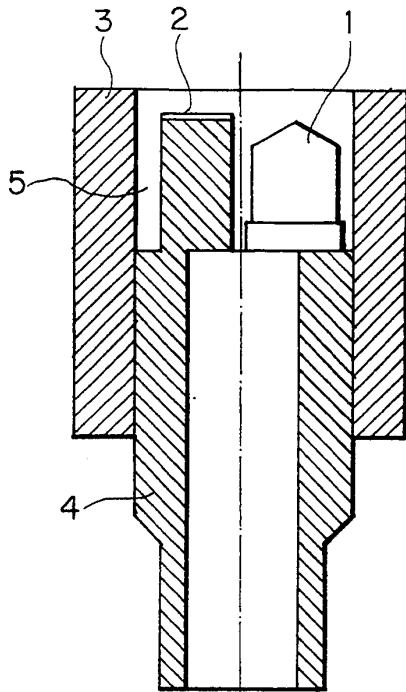


FIG. 2

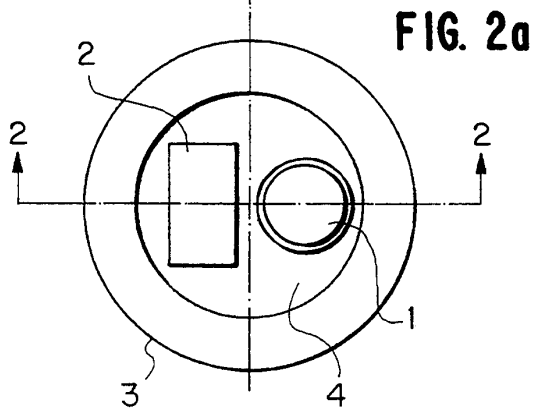


FIG. 2a

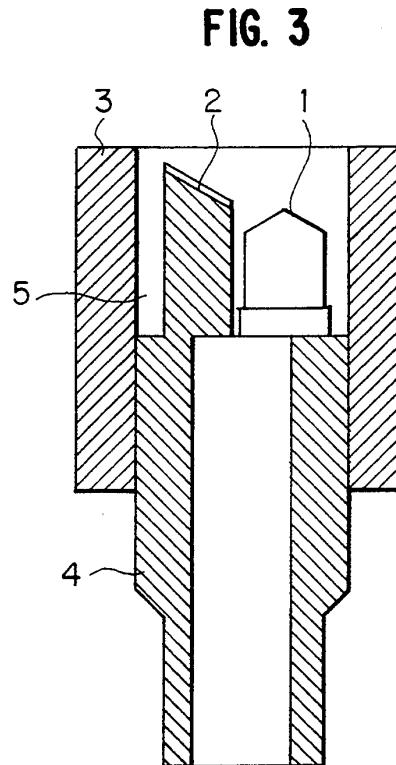


FIG. 3

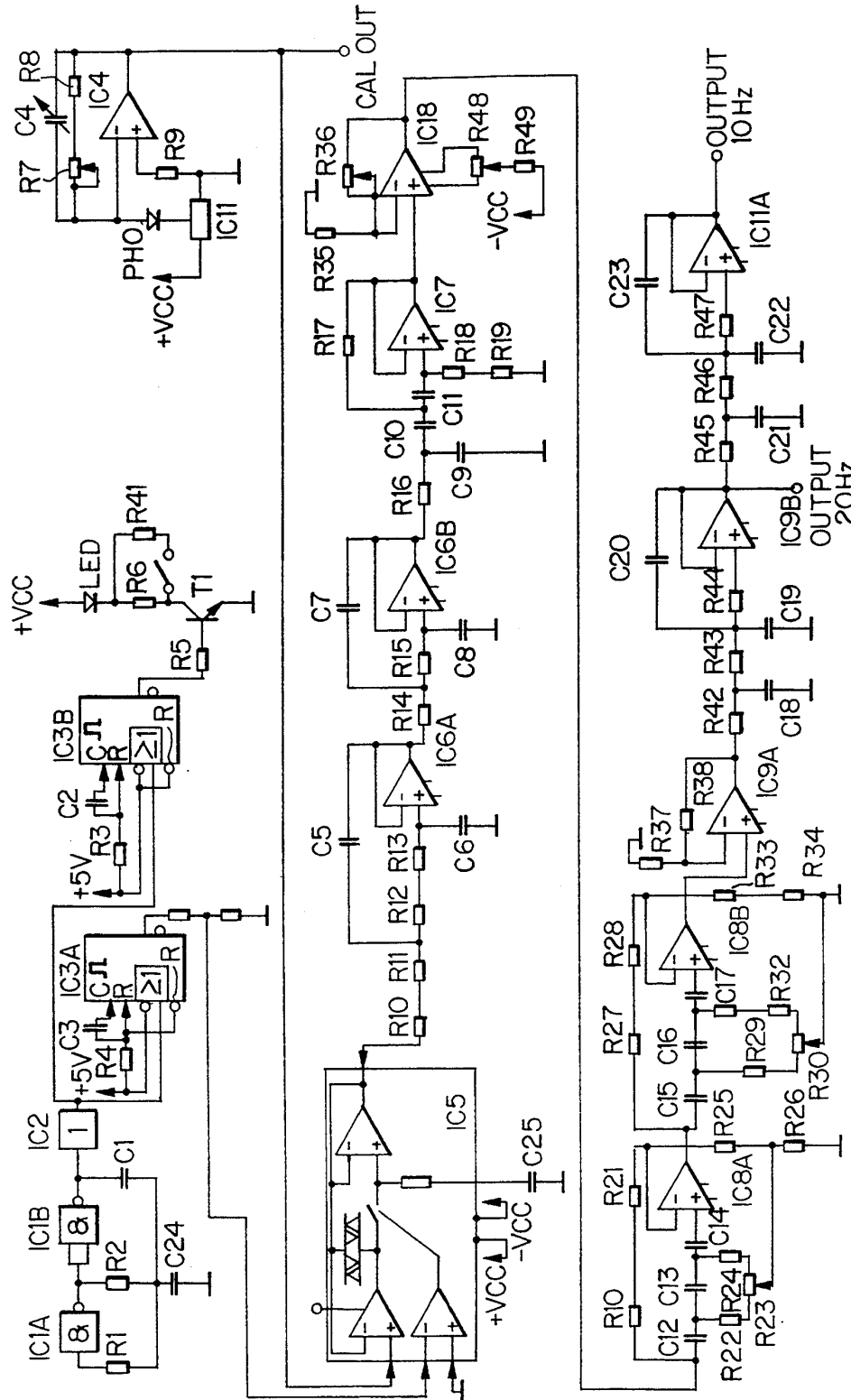
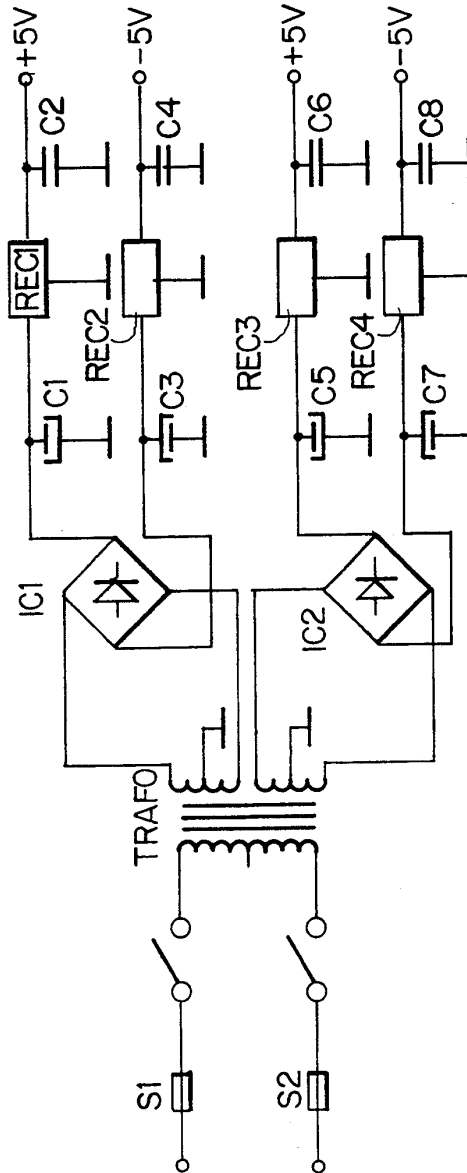


FIG. 4

FIG. 5



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