



US006608562B1

(12) **United States Patent**  
**Kimura et al.**

(10) **Patent No.:** **US 6,608,562 B1**  
(45) **Date of Patent:** **Aug. 19, 2003**

(54) **VITAL SIGNAL DETECTING APPARATUS**

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(73) Assignee: **Denso Corporation**, Kariya (JP)

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(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 248 days.

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(21) Appl. No.: **09/651,078**

*Primary Examiner*—Benjamin C. Lee

(22) Filed: **Aug. 30, 2000**

(74) *Attorney, Agent, or Firm*—Posz & Bethards, PLC

(30) **Foreign Application Priority Data**

Aug. 31, 1999 (JP) ..... 11-245381  
Sep. 1, 1999 (JP) ..... 11-247316  
Sep. 2, 1999 (JP) ..... 11-249025

(57) **ABSTRACT**

(51) **Int. Cl.**<sup>7</sup> ..... **G08B 23/00**

A vital signal detecting apparatus comprises an attachable device to be attached to a finger, a sensor having a light-emitting device and a light-receiving device, and a transmitting circuit for transmitting a signal waveform as a pulse wave from the sensor to a pulse wave monitoring unit. The pulse wave detecting unit also has an attachment detecting circuit for detecting whether or not the attachable device is in an attached state by comparing a signal waveform obtained when the light-emitting device is on with a signal waveform obtained when the light-emitting device is off and an operation control circuit for controlling the operation of the sensor, the transmitting circuit and the attachment detecting circuit. Preferably, the light-transmitting plate is disposed above the light-emitting device and the light-receiving device to pass light therethrough, and the light transmitting plate may be an IR-cut filter capable of blocking light of wavelengths greater than 700 nm.

(52) **U.S. Cl.** ..... **340/573.1; 340/539; 600/502; 600/503; 600/300; 600/344; 600/521; 128/903**

(58) **Field of Search** ..... 340/573.1, 573.4, 340/539; 600/502, 503, 344, 300, 309, 485, 500, 508, 310, 549, 323, 521; 128/903; 988/411

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**13 Claims, 22 Drawing Sheets**

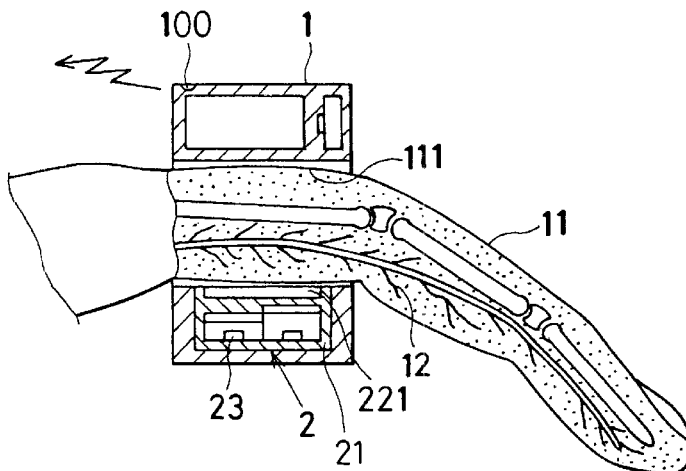


FIG. 1A

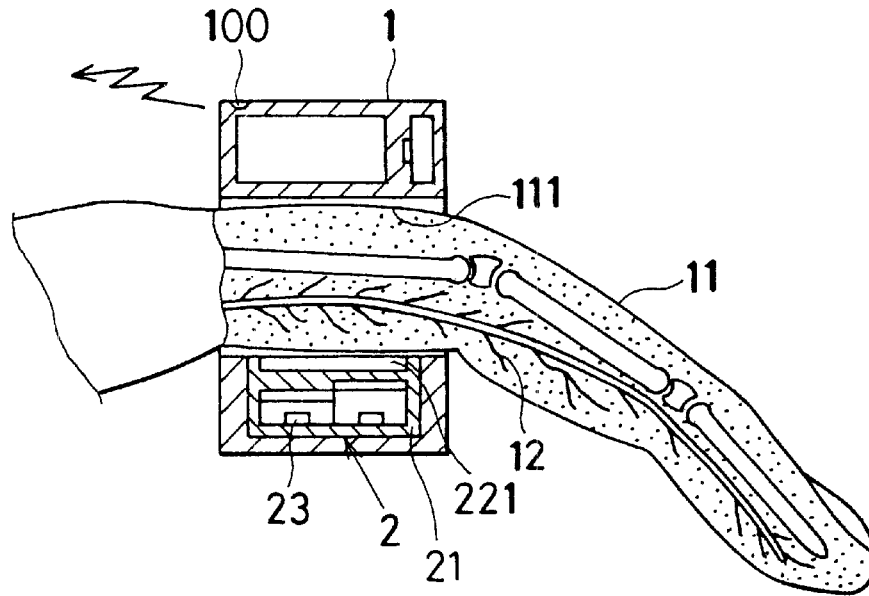


FIG. 1B

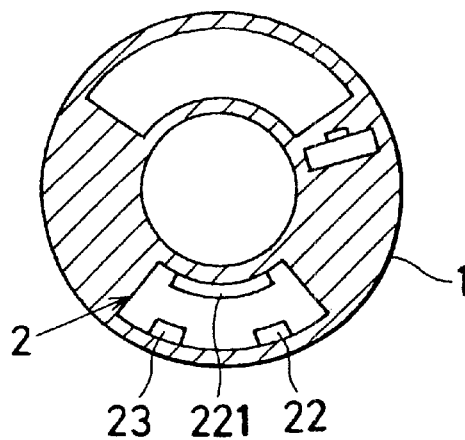


FIG. 2

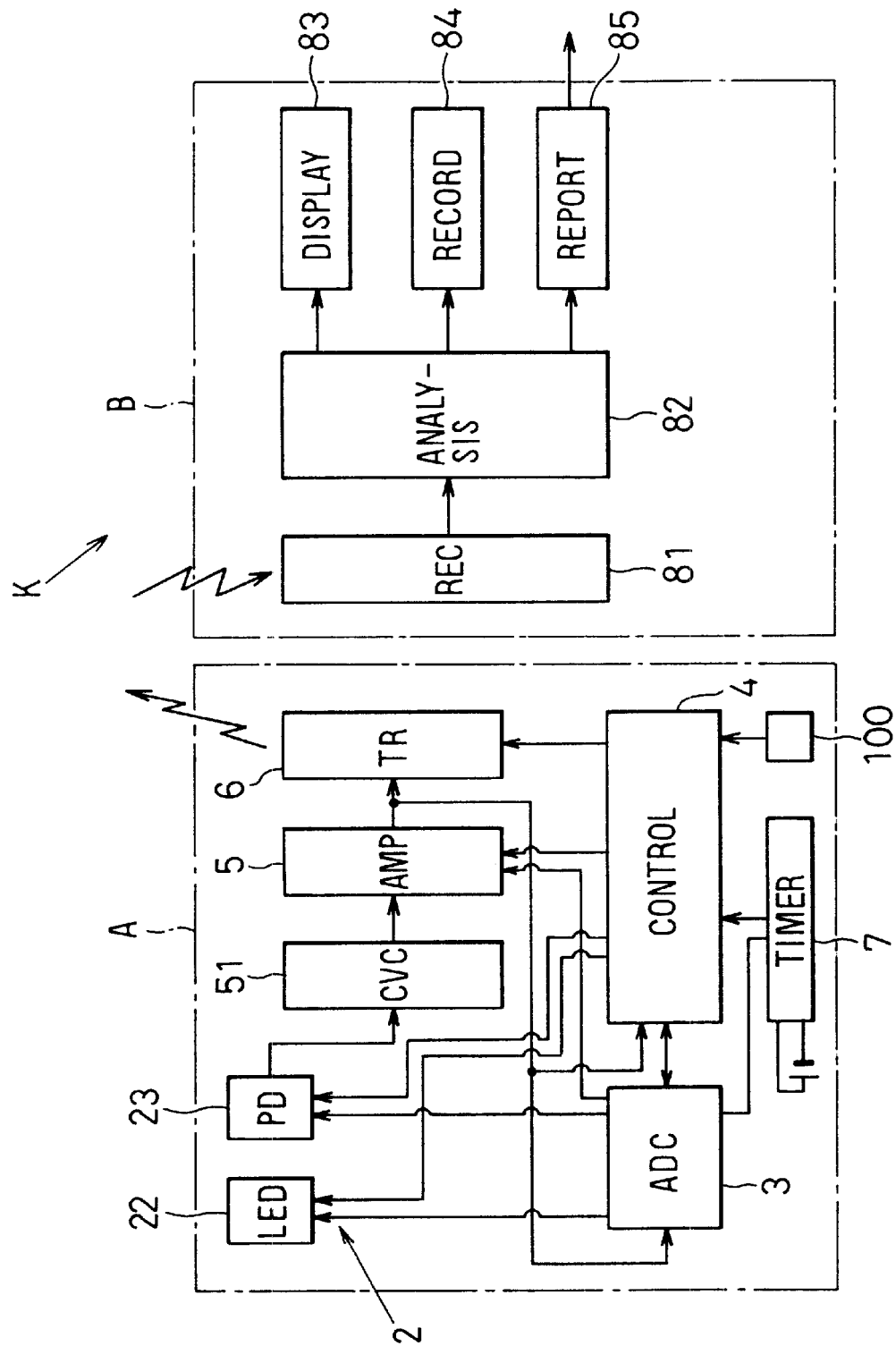


FIG. 3A1

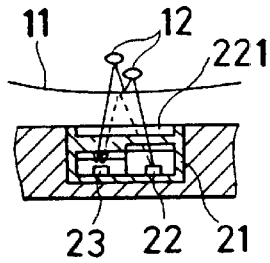


FIG. 3A2

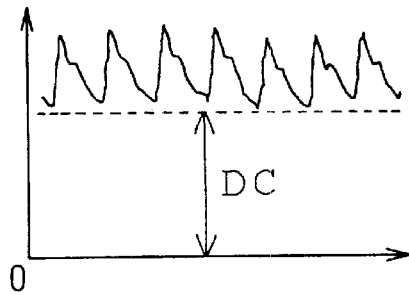


FIG. 3B1

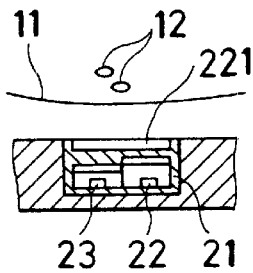


FIG. 3B2



FIG. 3C1

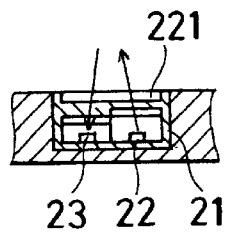


FIG. 3C2

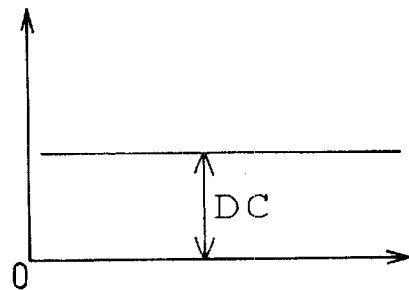


FIG. 3D1

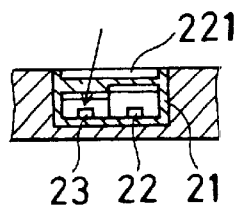
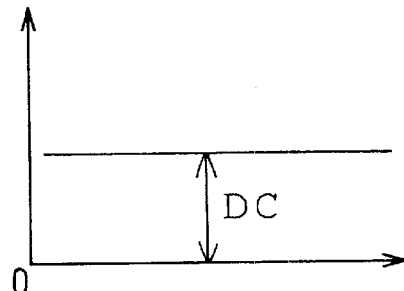
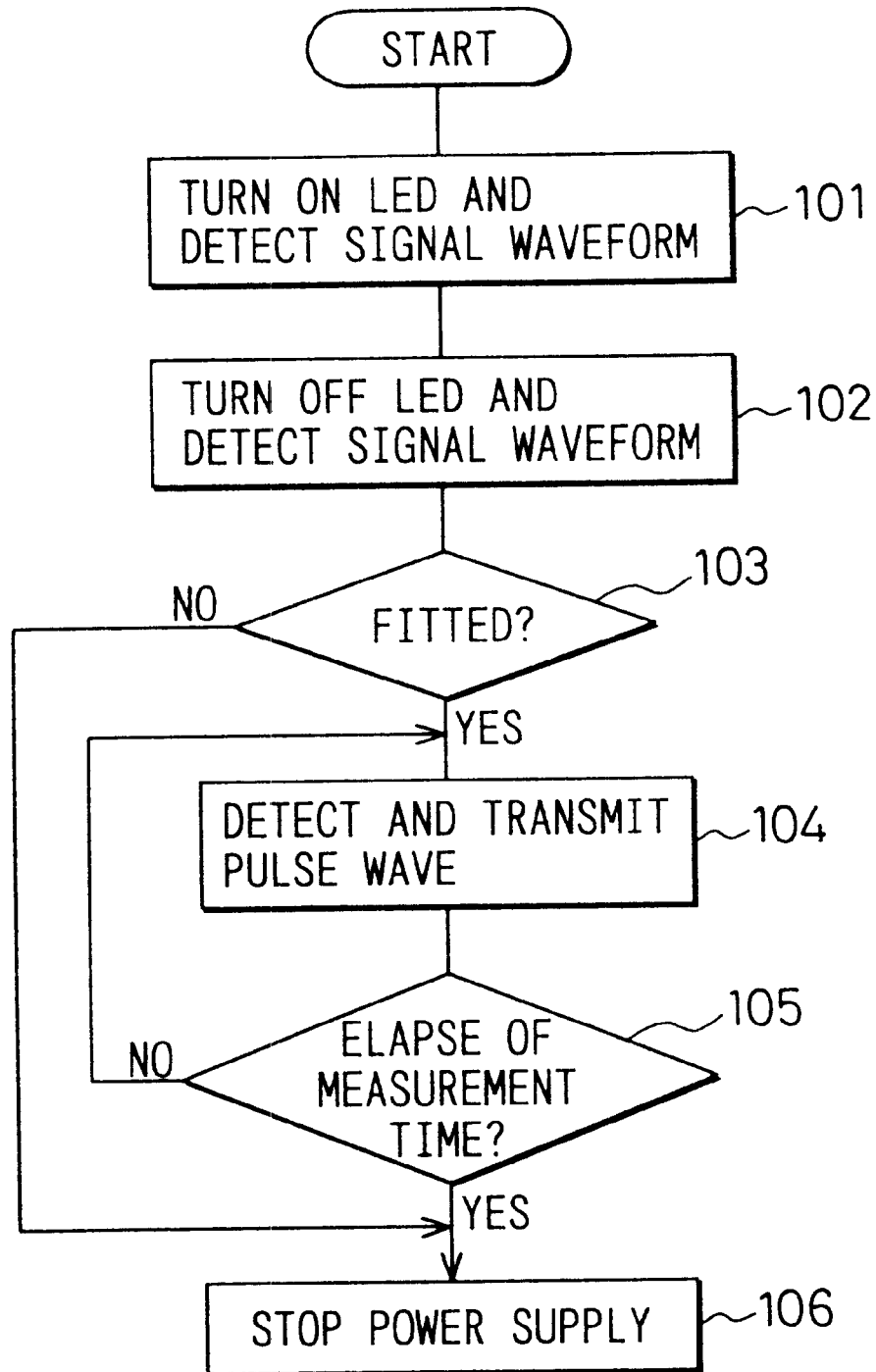


FIG. 3D2



# FIG. 4



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