



US 20020188210A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2002/0188210 A1**

**Aizawa**

(43) **Pub. Date: Dec. 12, 2002**

(54) **PULSE WAVE SENSOR AND PULSE RATE DETECTOR**

**Publication Classification**

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(51) **Int. Cl.<sup>7</sup> ..... A61B 5/02**

(52) **U.S. Cl. .... 600/503; 600/502**

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(57) **ABSTRACT**

(21) Appl. No.: **10/152,818**

A pulse wave sensor for detecting a pulse wave by detecting light output from a light emitting diode and reflected from the artery of a wrist of a subject, the sensor comprising four photodetectors disposed around the light emitting diode symmetrically on a circle concentric to the light emitting diode, and a pulse rate detector comprising the pulse wave sensor and means of computing the pulse rate of a subject based on the output of the pulse wave sensor.

(22) Filed: **May 23, 2002**

(30) **Foreign Application Priority Data**

Jun. 11, 2001 (JP) ..... 2001-175909

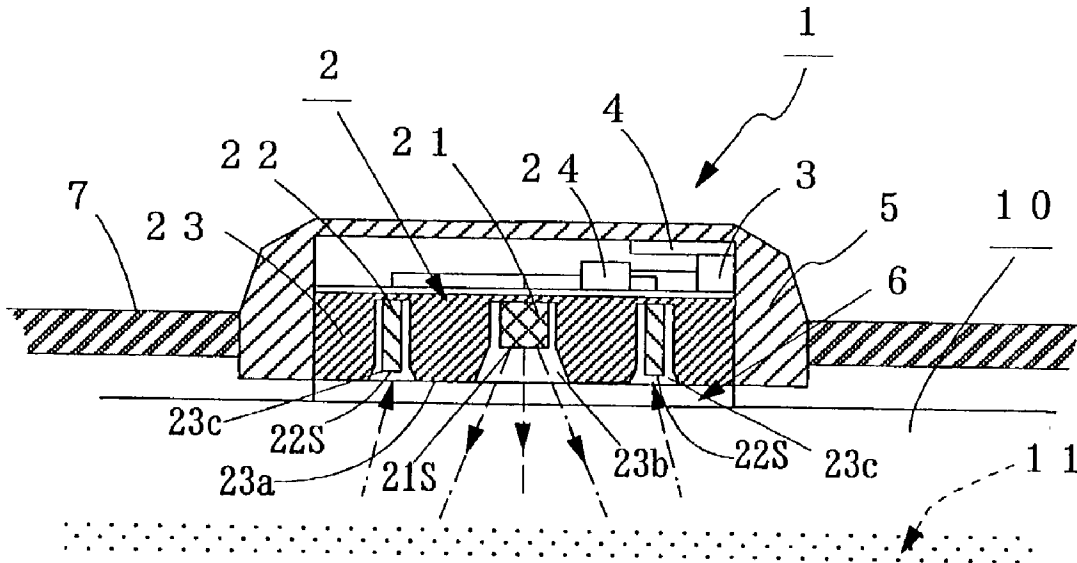


FIG. 1 (a)

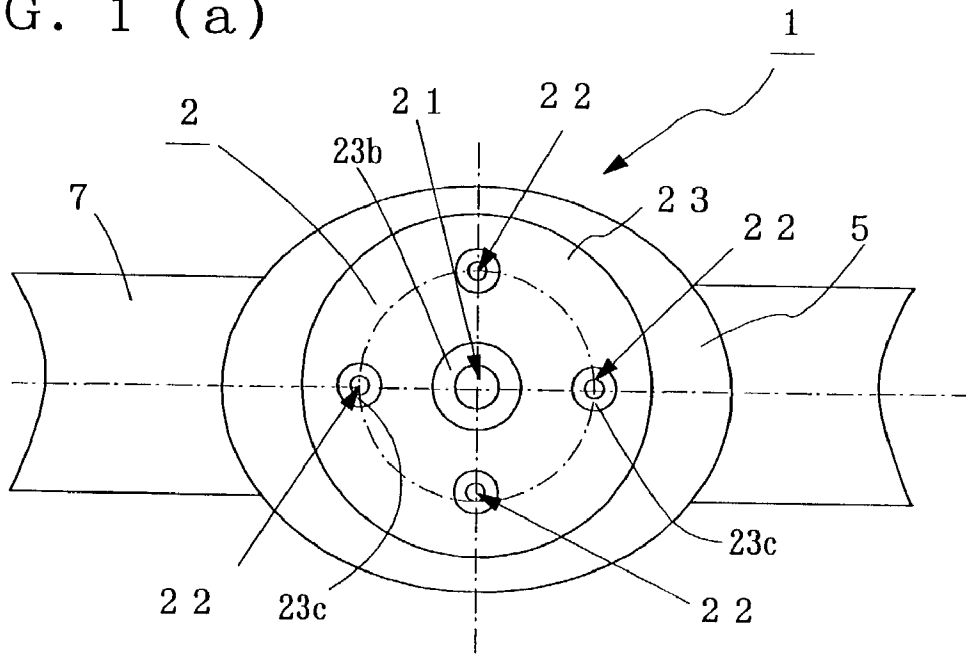


FIG. 1 (b)

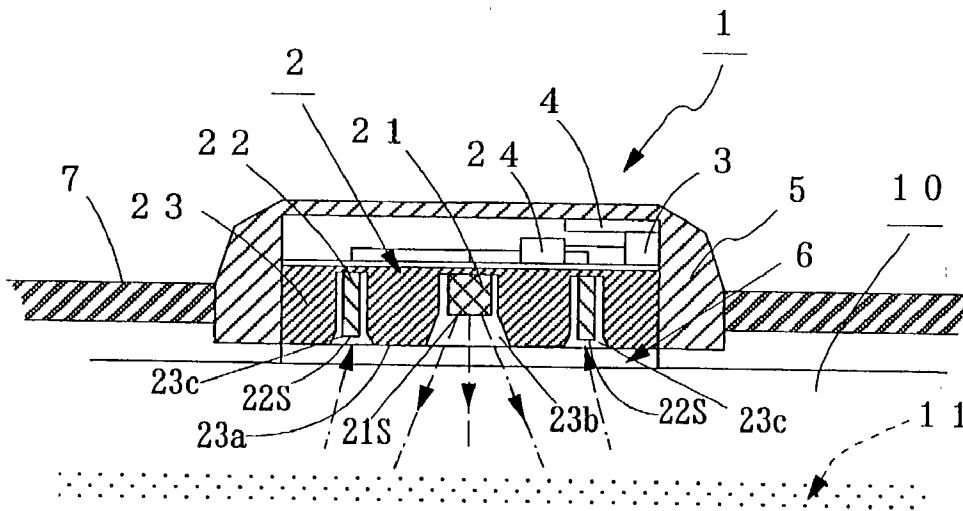


FIG. 2

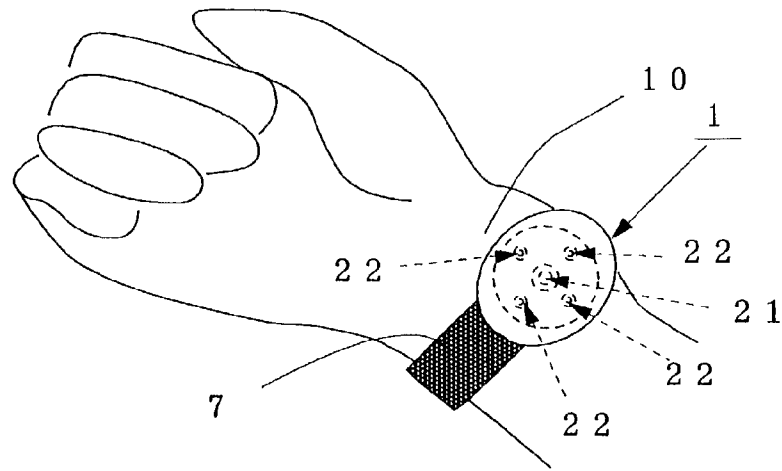


FIG. 3

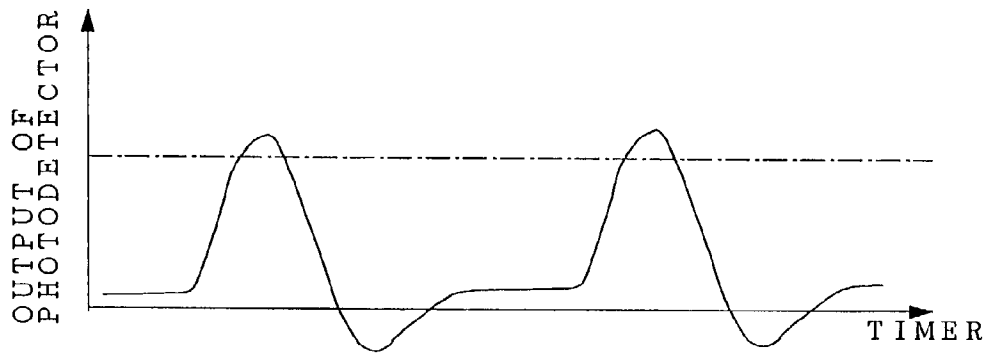


FIG. 4 (a)

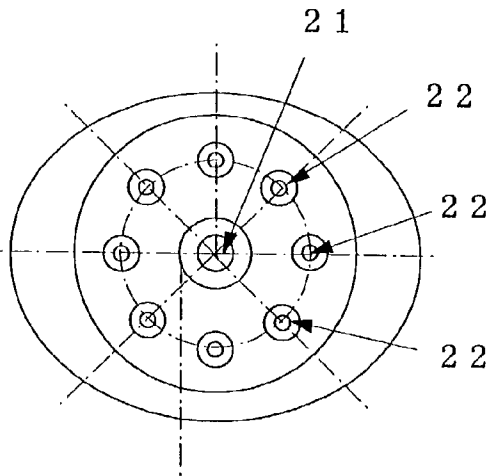


FIG. 4 (b)

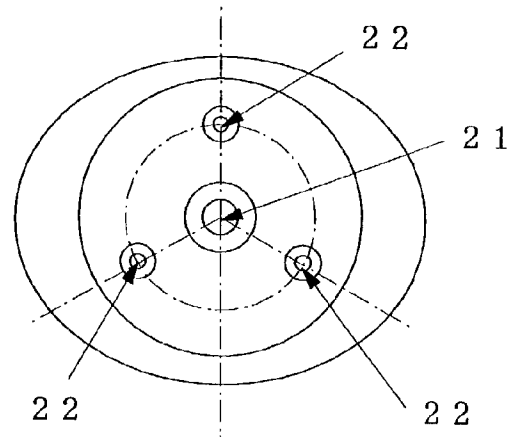
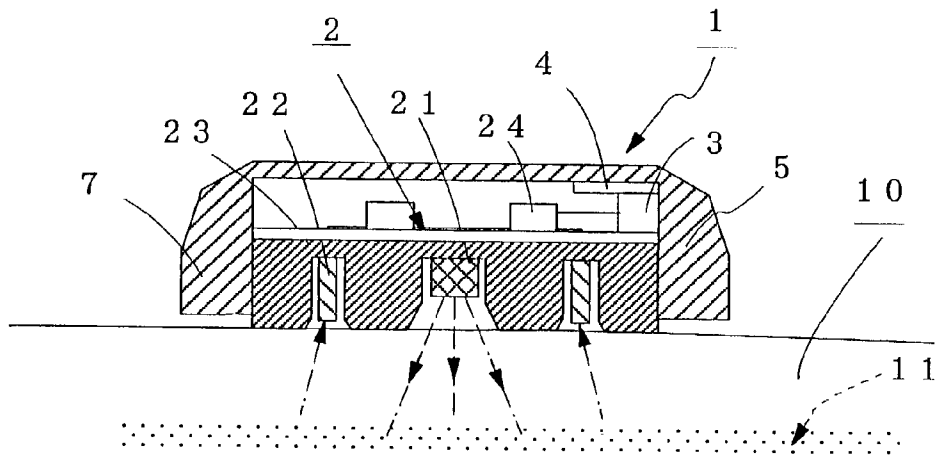


FIG. 5



## PULSE WAVE SENSOR AND PULSE RATE DETECTOR

### BACKGROUND OF THE INVENTION

#### [0001] 1. Field of the Invention

[0002] The present invention relates to a pulse wave sensor for detecting the pulse wave of a subject from light reflected from a red corpuscle in the artery of a wrist of the subject by irradiating the artery of the wrist with light having a wavelength of an infrared range and to a pulse rate detector for detecting the pulse rate of the subject from the above pulse wave data.

#### [0003] 2. Description of the Prior Art

[0004] In recent years, along with shift to the aging society and westernized eating habits, an increase in the number of diseases caused by life habits, such as hyperpiesia, diabetes mellitus, heart diseases and cerebrovascular diseases of the brain is becoming a big social problem. As means of preventing these diseases or treating the diseases, a personal exercise cure such as walking is widely adopted. In this exercise cure, a pedometer or kinetic calorimeter is carried to know the quantity of motion. There has recently been proposed a method of estimating a burden on the heart of a person who takes exercise by real-time measuring his/her heart rate at the time of exercise.

[0005] For the measurement of the above heart rate, an optical pulse wave sensor for detecting the pulse wave of a subject from reflected light or transmitted light by irradiating the site of a blood vessel with light having an infrared or near infrared range is widely used. Stated more specifically, a pulse wave sensor which comprises a pair of an LED (light emitting diode) and a phototransistor (photodetector) is attached to a finger or ear to measure the heart rate by calculating the cycle (frequency) of pulse waves from the waveform of reflected light or transmitted light detected by the above photodetector.

[0006] However, although the conventional pulse wave sensor to be attached to the finger or ear is small in size, a signal from the sensor is weak because it detects the motion of a red corpuscle in the capillary and is easily affected by noise caused by the shaking of the body of the subject. Also, as some pressure is applied to the measurement site at the time of detection, the subject cannot carry the detector for a long time when walking or the like.

[0007] Meanwhile, since a strong signal is obtained when the motion of a red corpuscle in the artery is detected, a detector to be attached to a wrist or arm is conceivable. As understood when the pulse of the wrist is actually taken, it is difficult to attach the sensor to a predetermined position. When the attachment position is dislocated, no output can be obtained, thereby making it difficult to implement the detector.

### SUMMARY OF THE INVENTION

[0008] It is an object of the present invention which has been made in view of the above problem to provide a pulse wave sensor which is easily attached and is capable of

[0009] According to a first aspect of the present invention, there is provided a pulse wave sensor for detecting a pulse wave by detecting light output from a light emitting diode and reflected from the artery of a wrist of a subject, the sensor comprising at least three photodetectors disposed around the light emitting diode and not linearly. Even when the attachment position of the sensor is dislocated, a pulse wave can be detected accurately.

[0010] According to a second aspect of the present invention, there is provided a pulse sensor, wherein a near infrared LED which is a general-purpose product is used as the light emitting diode. This makes it possible to produce an inexpensive sensor.

[0011] According to a third aspect of the present invention, there is provided a pulse sensor, wherein the photodetectors are disposed at an equal distance from the light emitting diode.

[0012] According to a fourth aspect of the present invention, there is provided a pulse sensor, wherein cavities are formed in a contact face between a holder for holding the light emitting diode and the photodetectors and the wrist, the light emitting face of the light emitting diode and the light receiving faces of the photodetectors are disposed at respective predetermined distances from the contact face, and the sectional forms of the cavities are tapered such that their widths increase toward the contact face. Since this makes it possible to expand the light emitting area and the light receiving area, a pulse wave can be easily detected even when the attachment position of the sensor is dislocated.

[0013] According to a fifth aspect of the present invention, there is provided a pulse sensor, wherein a transparent plate-like member is provided on a portion including at least the light emitting face and the light receiving faces of the contact face. This makes it possible to improve adhesion between the sensor and the wrist and thereby further improve the detection efficiency of pulse waves.

[0014] According to a sixth aspect of the present invention, there is provided a pulse rate detector comprising the pulse wave sensor of claim 1 and means of computing the pulse rate of a subject based on the output of the pulse wave sensor.

[0015] According to a seventh aspect of the present invention, there is provided a pulse rate detector which comprises a transmitter for transmitting the measured pulse rate data to a display for displaying the pulse rate data and a device for computing the amount of motion load from the pulse rate.

[0016] The above and other objects, advantages and features of the present invention will become apparent from the following description when taken in conjunction with the accompanying drawings.

### BRIEF DESCRIPTION OF THE DRAWINGS

[0017] FIGS. 1 are schematic diagrams of a pulse rate detector according to an embodiment of the present invention;

[0018] FIG. 2 is a diagram showing that the pulse rate detector is attached.

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