US 20200113454A1

(19) **United States**

(12) **Patent Application Publication**

Wu et al.

(10) **Pub. No.: US 2020/0113454 A1**

(43) **Pub. Date: Apr. 16, 2020**

(54) **VIBRATION SENSING DEVICE**

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(21) Appl. No.: **16/417,650**

(22) Filed: **May 21, 2019**

(30) **Foreign Application Priority Data**

Oct. 12, 2018 (TW) 107135985

Publication Classification

(51) **Int. Cl.**

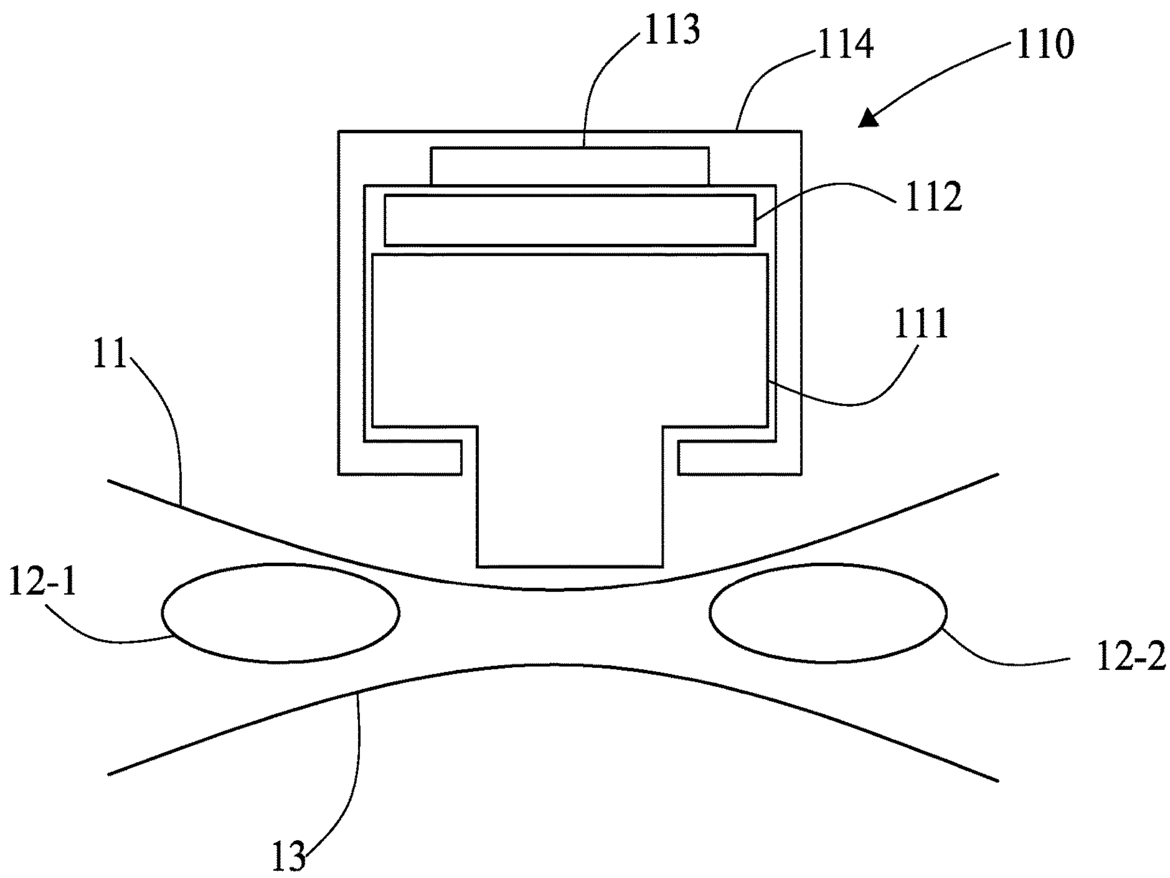
A61B 5/021 (2006.01)
A61B 5/00 (2006.01)
A61B 5/024 (2006.01)
A61B 5/0404 (2006.01)
A61B 5/0408 (2006.01)

(52) **U.S. Cl.**

CPC ***A61B 5/02108*** (2013.01); ***A61B 5/681*** (2013.01); ***A61B 5/02438*** (2013.01); ***A61B 5/0404*** (2013.01); ***A61B 5/0408*** (2013.01); ***A61B 5/02433*** (2013.01)

(57) **ABSTRACT**

A vibration sensing device includes a piezoelectric element, a static force meter, a vibration conduction element and a casing. The piezoelectric element is provided for converting vibration into an electronic signal. The static force meter is provided for converting static force into an electronic signal. The vibration conduction element is provided for vibration to the piezoelectric element. The piezoelectric element, the static force meter, and the vibration conduction element are covered by the casing.



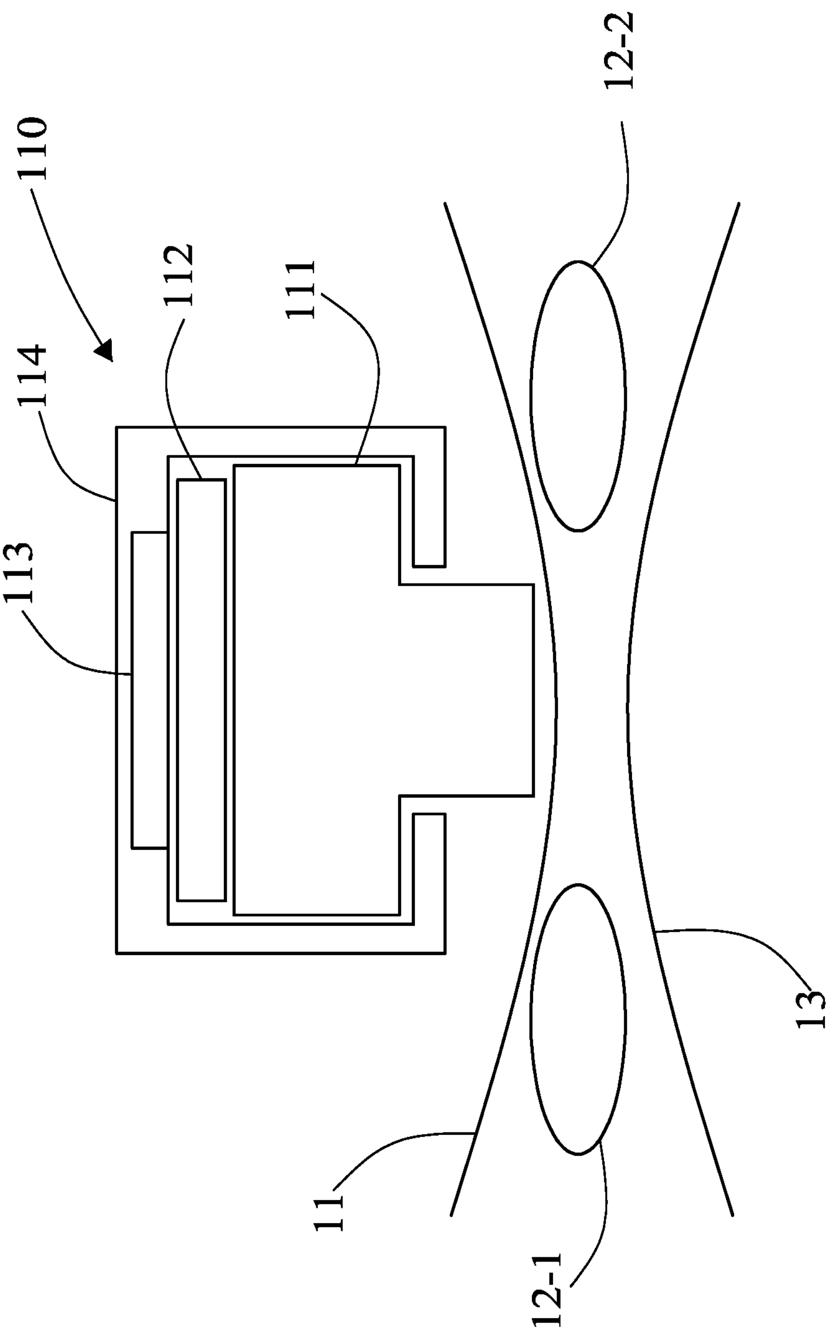


FIG.1

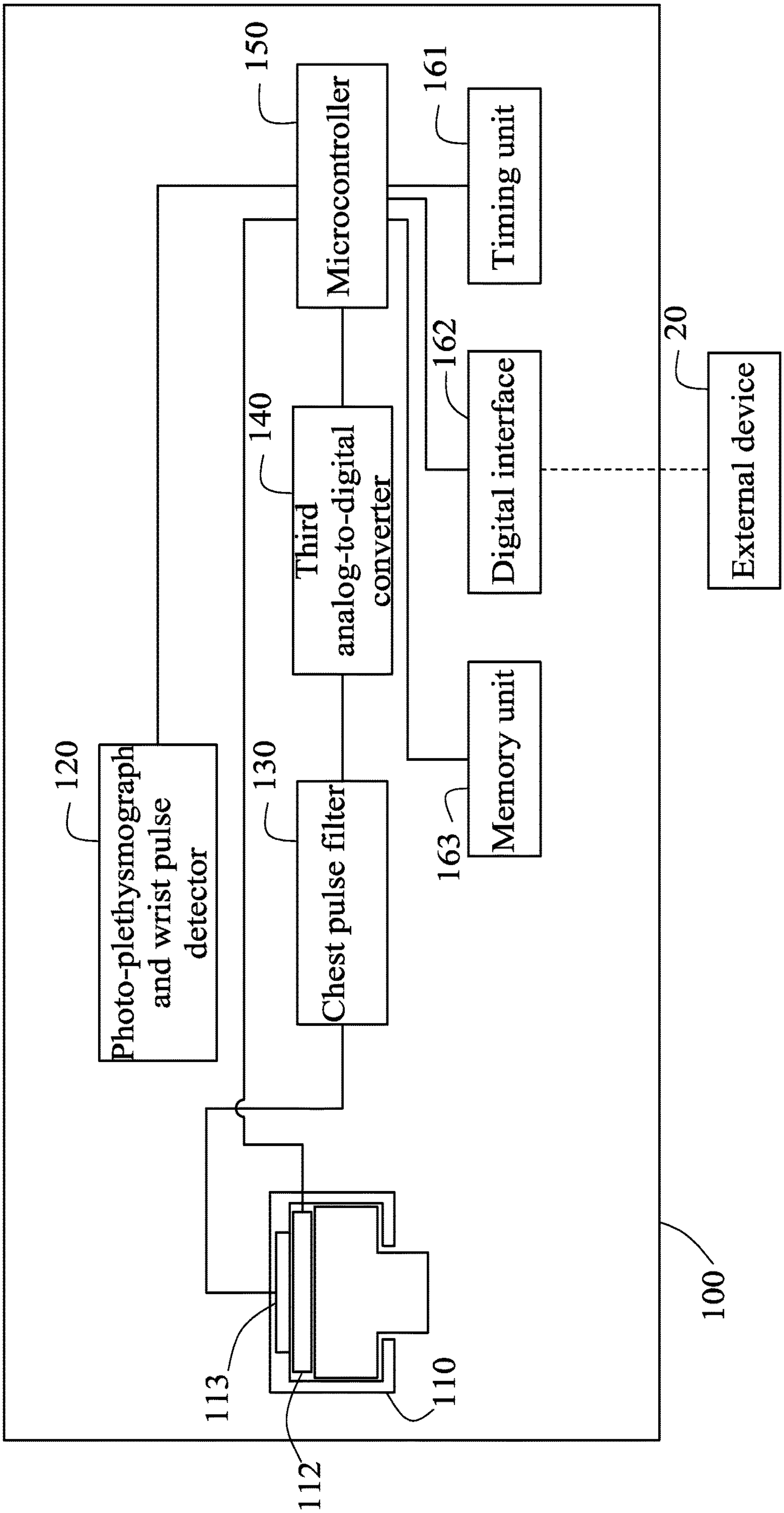

150
Microcontroller
161
Timing unit
162
Digital interface
20
External device
140
Third analog-to-digital converter
163
Memory unit
120
Photo-plethysmograph and wrist pulse detector
130
Chest pulse filter
100
110
112
113

FIG.2

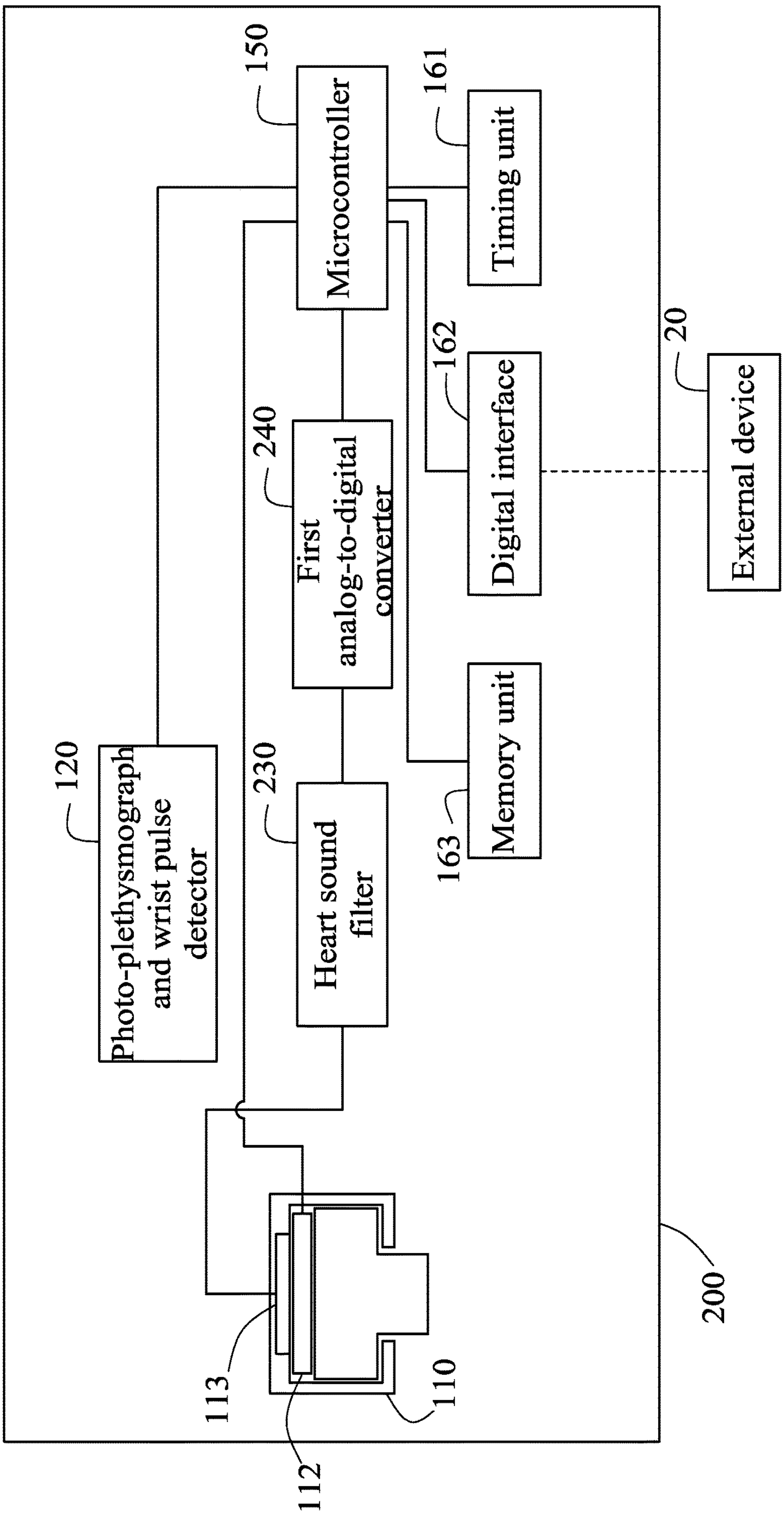

Microcontroller
150
Timing unit
161
Digital interface
162
External device
20
First analog-to-digital converter
240
Memory unit
163
Photo-plethysmograph and wrist pulse detector
120
Heart sound filter
230
113
112
110
200

FIG.3

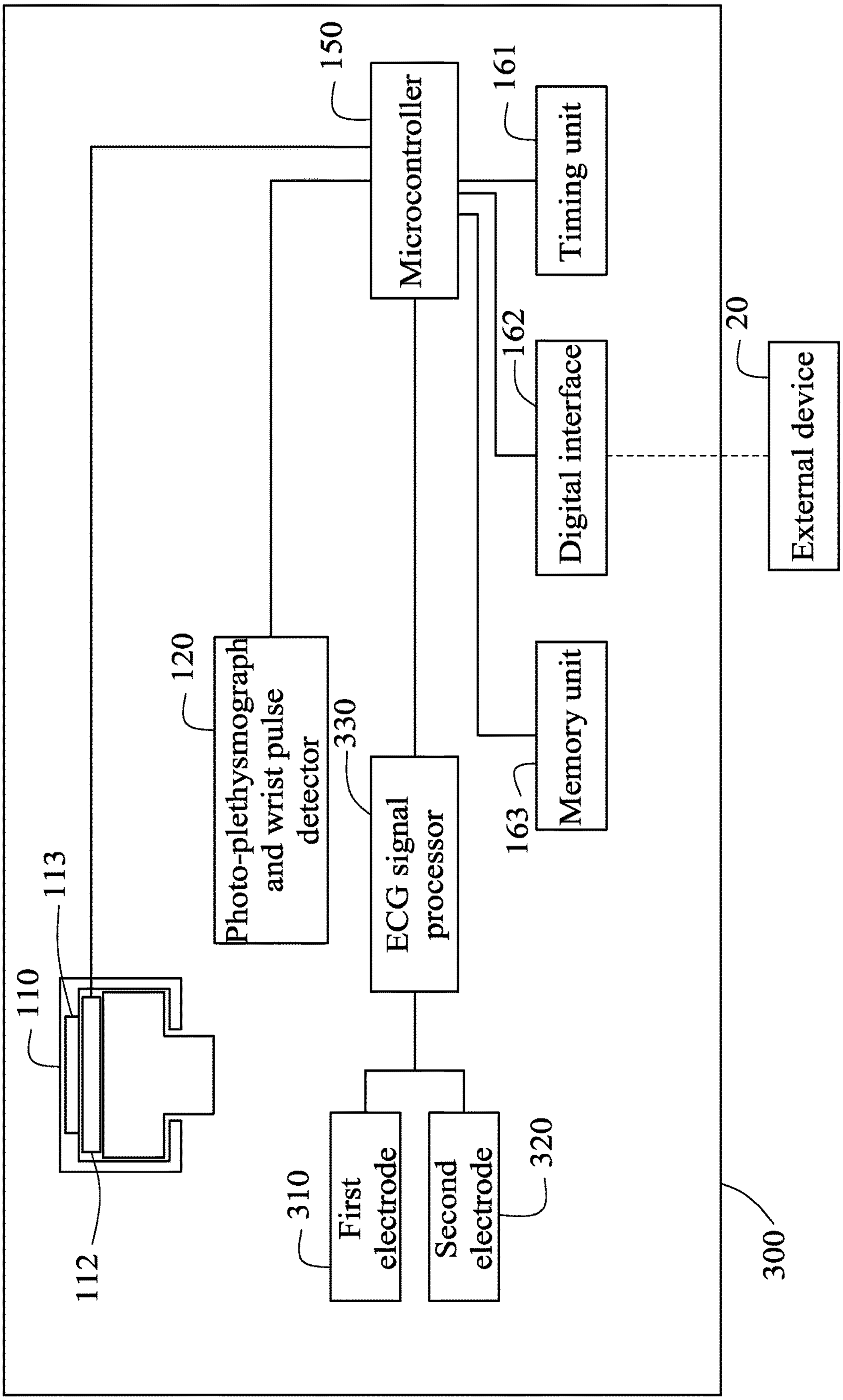

150
Microcontroller
161
Timing unit
162
Digital interface
20
External device
120
Photo-plethysmograph and wrist pulse detector
330
ECG signal processor
163
Memory unit
110
113
112
310
First electrode
Second electrode
320
300

FIG.4

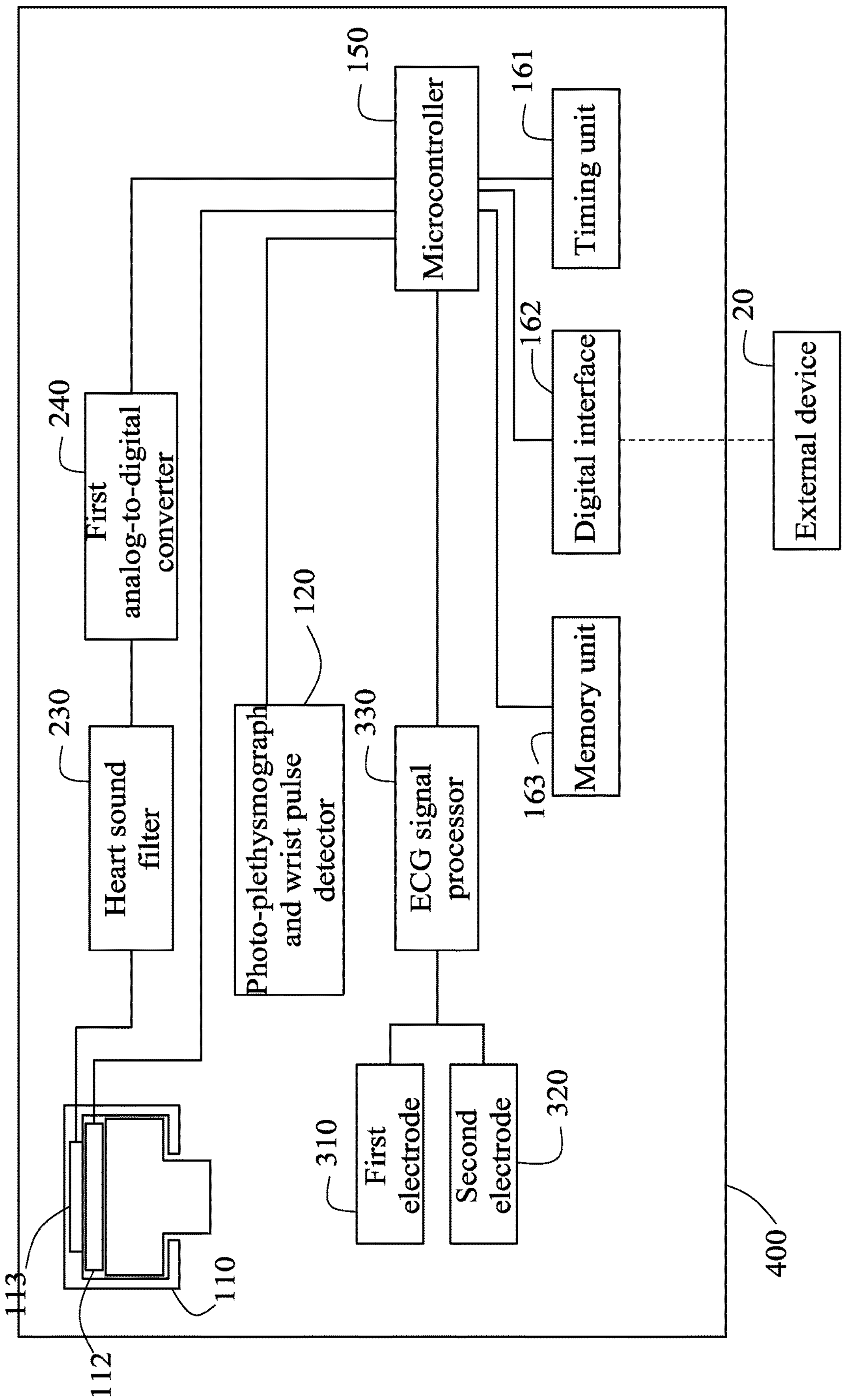
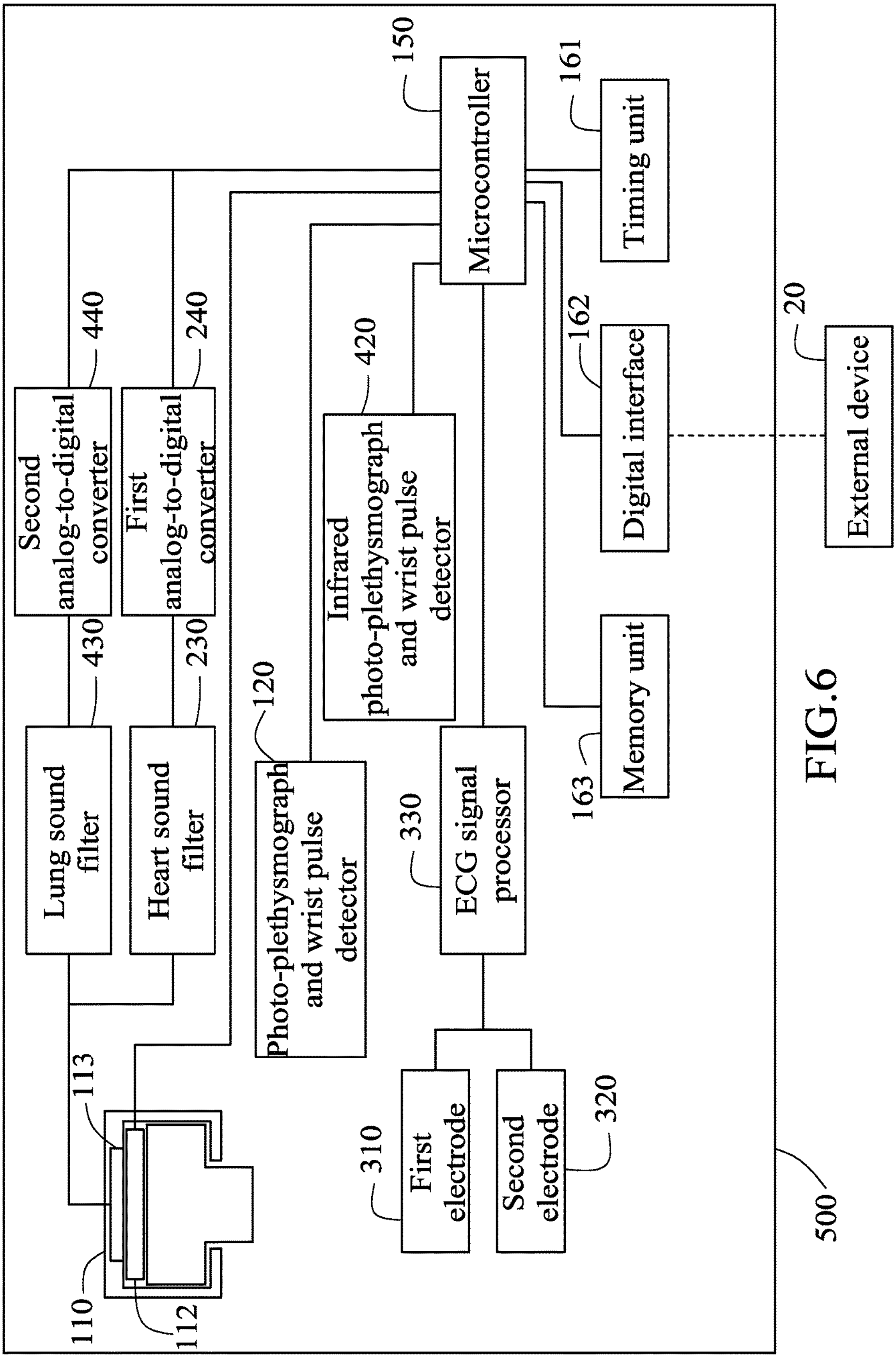

150
Microcontroller
161
Timing unit
240
First analog-to-digital converter
162
Digital interface
20
External device
120
Photo-plethysmograph and wrist pulse detector
230
Heart sound filter
330
ECG signal processor
163
Memory unit
310
First electrode
320
Second electrode
113
112
110
400

FIG.5



150
Microcontroller
161
Timing unit
440
Second analog-to-digital converter
240
First analog-to-digital converter
420
Infrared photo-plethysmograph and wrist pulse detector
162
Digital interface
20
External device
430
230
Lung sound filter
Heart sound filter
120
Photo-plethysmograph and wrist pulse detector
330
ECG signal processor
163
Memory unit
113
110
112
310
First electrode
320
Second electrode
500

FIG.6

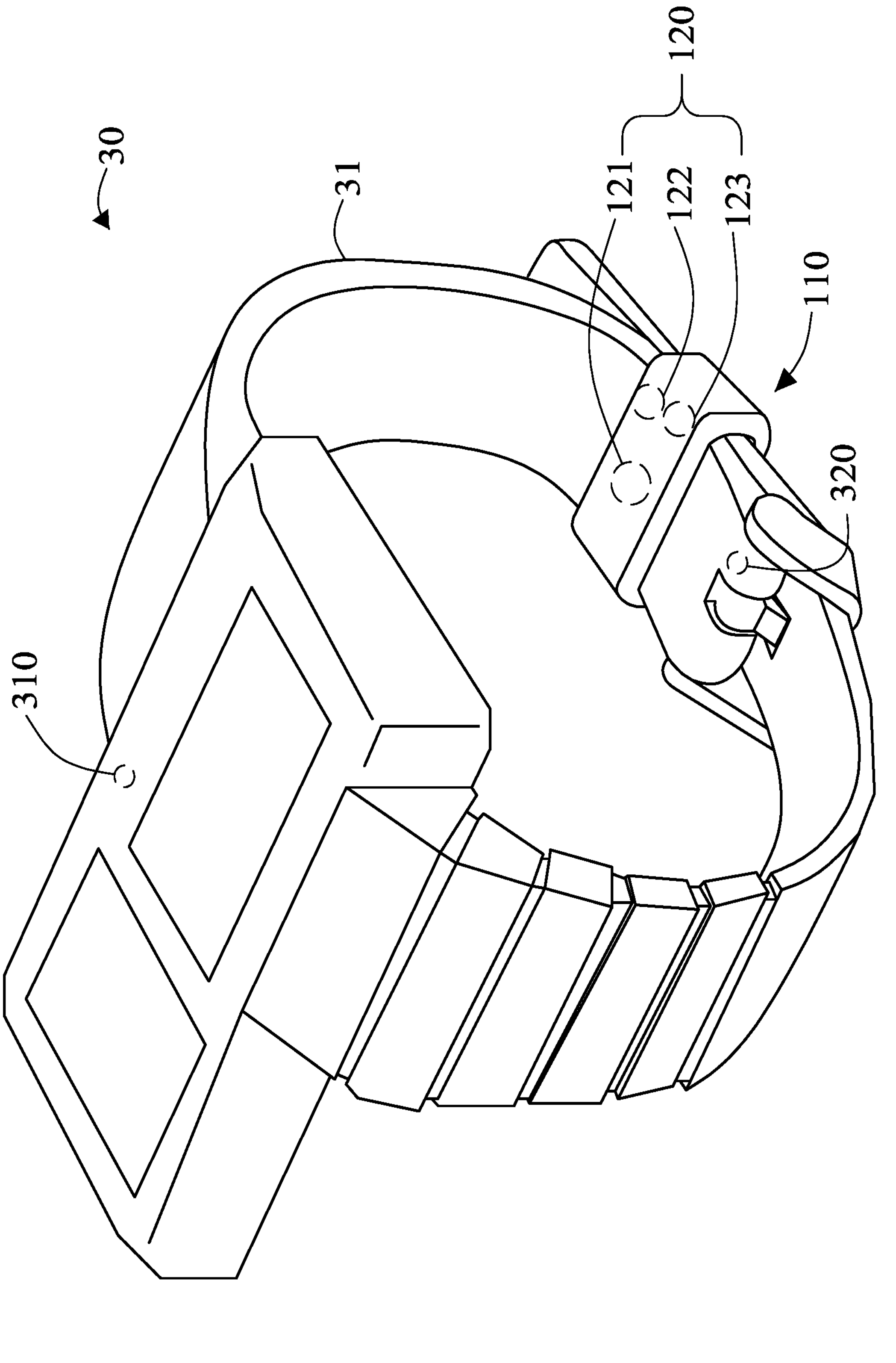


FIG.7A

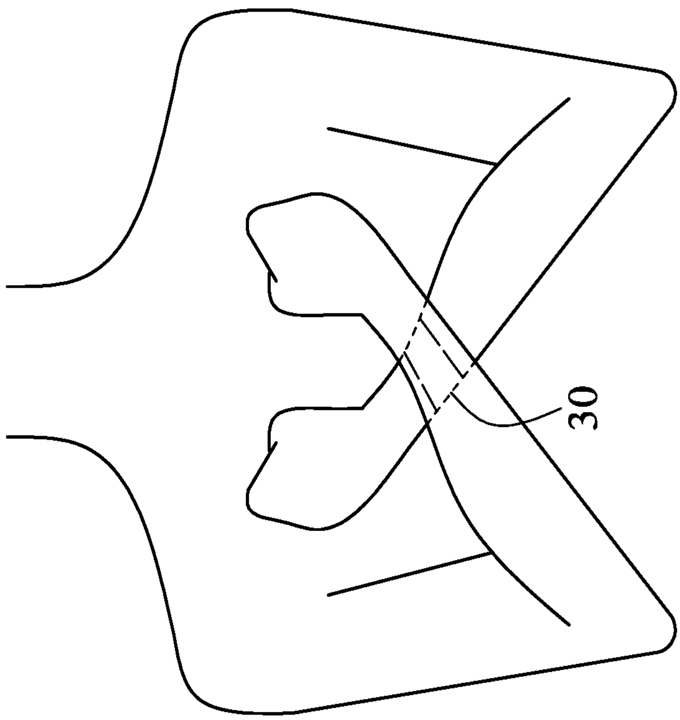


FIG.7B

VIBRATION SENSING DEVICE

FIELD OF THE INVENTION

[0001] The present invention relates to a physiological signal monitoring device, and more particularly to a portable cardiopulmonary efficacy monitoring device.

BACKGROUND OF THE INVENTION

[0002] Heart disease is the leading cause of death in the United States and the third largest killer in Taiwan. If the heart disease can be diagnosed at an early stage, the survival rate will be increased, and the medical expenditure will be reduced greatly. Most of the early heart diseases have abnormal electrocardiography (ECG) or heart sound symptoms. If a user has easily accessible ECG and heart sound recorders, the user will be able to obtain an ECG and a heart sound immediately to assist doctors' diagnosis when the user feels unwell. Taiwan Pat. Nos. 1555509 and 1623298 (or their foreign counterparts: U.S. Pat. Nos. US20170127966A1 and US20170273574A1 respectively) have disclosed a wearable electrode structure and an ECG recorder for obtaining ECG signals easily. However, there are few recorders capable of recording the heart sound continuously for a long time. The reason is that a sensor (such as a conventional stethoscope) that picks up the heart sound must be pressed slightly at a specific position of a patient's chest. For example, the Holter ECG recorder is uncomfortable to wear for a long time, so that there are few sensors that can record the heart sound continuously for a long time or few heart sound sensors (similar to an ECG event recorder) for obtaining the heart sound when the user feels unwell. As disclosed in U.S. Pat. No. 9,492,138, two electrodes are added to a conventional stethoscope, so that both heart sound and the ECG signal can be measured simultaneously to facilitate the calculation of a myocardial performance index (MPI) and a systolic performance index (SPI), and these indexes may be used for evaluating a patient's heart function. However, the patient must wear clothing to obtain the heart sound and ECG signal. Obviously, the conventional stethoscope is in applicable for recording incidental abnormal heart sounds and ECG signals in our daily life.

[0003] Therefore, it is an important subject for the related field to provide a feasible solution to the aforementioned problem.

SUMMARY OF THE INVENTION

[0004] To overcome the aforementioned problem, the present invention provides a vibration sensing device, a portable continuous blood pressure measuring device and a portable cardiopulmonary efficacy monitoring device which can be used conveniently without the need of taking off the patient's clothes.

[0005] To achieve the aforementioned objective, the present invention provides a vibration sensing device comprising a piezoelectric element, a static force meter, a vibration conduction element and a casing. The piezoelectric element is provided for converting vibration into an electronic signal. The static force meter is provided for converting static force into an electronic signal. The vibration conduction element is provided for conducting vibration to the piezoelectric element. The casing is provided for covering the piezoelectric element, the static force meter and the vibration conduction element.

[0006] The present invention further provides a portable continuous blood pressure measuring device comprising a photo-plethysmograph (PPG)wrist pulse detector, one of the aforementioned vibration sensing devices, a chest pulse filter, a third analog-to-digital converter and a microcontroller. The chest pulse filter is coupled to the vibration sensing device. The third analog-to-digital converter is coupled to the chest pulse filter. The microcontroller is coupled to the photo-plethysmograph (PPG) wrist pulse detector and the third analog-to-digital converter.

[0007] The portable continuous blood pressure measuring device further comprises a digital interface coupled to the microcontroller.

[0008] The portable continuous blood pressure measuring device further comprises a memory unit coupled to the microcontroller.

[0009] The portable continuous blood pressure measuring device further comprises a timing unit coupled to the microcontroller.

[0010] In the portable continuous blood pressure measuring device, the digital interface is a cable or wireless signal transmission device.

[0011] The present invention further provides a portable continuous blood pressure measuring device comprising the aforementioned vibration sensing device, a heart sound filter, a first analog-to-digital converter, a photo-plethysmograph (PPG) wrist pulse detector and a microcontroller. The heart sound filter is coupled to the vibration sensing device. The first analog-to-digital converter is coupled to the heart sound filter. The microcontroller is coupled to the photo-plethysmograph (PPG) wrist pulse detector and the analog-to-digital converter.

[0012] The portable continuous blood pressure measuring device further comprises a digital interface coupled to the microcontroller.

[0013] The portable continuous blood pressure measuring device further comprises a memory unit coupled to the microcontroller.

[0014] The portable continuous blood pressure measuring device further comprises a timing unit coupled to the microcontroller.

[0015] In the portable continuous blood pressure measuring device, the digital interface is a cable or wireless signal transmission device.

[0016] The present invention further provides a portable continuous blood pressure measuring device comprising a first electrode, a second electrode, an ECG signal processor, a photo-plethysmograph (PPG) wrist pulse detector, a static force meter and a microcontroller. The first electrode is provided for detecting an ECG signal. The second electrode is configured to be relative to the first electrode. The ECG signal processor is coupled to the first electrode and the second electrode. The static force meter is coupled to the photo-plethysmograph (PPG) wrist pulse detector. The microcontroller is coupled to the photo-plethysmograph (PPG) wrist pulse detector and the ECG signal processor.

[0017] The portable continuous blood pressure measuring device further comprises a digital interface coupled to the microcontroller.

[0018] The portable continuous blood pressure measuring device further comprises a memory unit coupled to the microcontroller.

[0019] The portable continuous blood pressure measuring device further comprises a timing unit coupled to the microcontroller.

[0020] In the portable continuous blood pressure measuring device, the digital interface is a cable or wireless signal transmission device.

[0021] The present invention further provides a portable continuous blood pressure measuring device comprising a first electrode, a second electrode, an ECG signal processor, the aforementioned vibration sensing device, a heart sound filter, a first analog-to-digital converter and a microcontroller. The first electrode is provided for detecting an ECG signal. The second electrode is configured to be relative to the first electrode. The ECG signal processor is coupled to the first electrode and the second electrode. The heart sound filter is coupled to the vibration sensing device. The first analog-to-digital converter is coupled to the heart sound filter. The microcontroller is coupled to the photo-plethysmograph (PPG) wrist pulse detector and the analog-to-digital converter.

[0022] The portable continuous blood pressure measuring device further comprises a digital interface coupled to the microcontroller.

[0023] The portable continuous blood pressure measuring device further comprises a memory unit coupled to the microcontroller.

[0024] The portable continuous blood pressure measuring device further comprises a timing unit coupled to the microcontroller.

[0025] In the portable continuous blood pressure measuring device, the digital interface is a cable or wireless signal transmission device.

[0026] The present invention further provides a portable cardiopulmonary efficacy monitoring device comprising a first electrode, a second electrode, an ECG signal processor, the aforementioned vibration sensing device, a heart sound filter, a first analog-to-digital converter, a lung sound filter, a second analog-to-digital converter, a photo-plethysmograph pulse detector and a microcontroller. The first electrode is provided for detecting an ECG signal. The second electrode is configured to be relative to the first electrode. The ECG signal processor is coupled to the first electrode and the second electrode. The heart sound filter is coupled to the vibration sensing device. The second analog-to-digital converter is coupled to the lung sound filter. The microcontroller is coupled to the ECG signal processor, the vibration sensing device, the heart sound filter, the lung sound filter, the red light photo-plethysmograph pulse detector and the infrared photo-plethysmograph pulse detector.

[0027] The portable cardiopulmonary efficacy monitoring device further comprises a digital interface coupled to the microcontroller.

[0028] The portable cardiopulmonary efficacy monitoring device further comprises a memory unit coupled to the microcontroller.

[0029] The portable cardiopulmonary efficacy monitoring device further comprises a timing unit coupled to the microcontroller.

[0030] In the portable cardiopulmonary efficacy monitoring device, the digital interface is a cable or wireless signal transmission device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031] FIG. **1** is a schematic view of a vibration sensing device of the present invention;

[0032] FIG. **2** is a schematic block diagram of a portable continuous blood pressure measuring device in accordance with a first embodiment of the present invention;

[0033] FIG. **3** is a schematic block diagram of a portable continuous blood pressure measuring device in accordance with a second embodiment of the present invention;

[0034] FIG. **4** is a schematic block diagram of a portable continuous blood pressure measuring device in accordance with a third embodiment of the present invention;

[0035] FIG. **5** is a schematic block diagram of a portable continuous blood pressure measuring device in accordance with a fourth embodiment of the present invention;

[0036] FIG. **6** is a schematic block diagram of a portable cardiopulmonary efficacy monitoring device in accordance with a fifth embodiment of the present invention;

[0037] FIG. **7**A is a perspective view of a portable cardiopulmonary efficacy monitoring device of the present invention; and

[0038] FIG. **7**B is a schematic view showing a way of using a wrist watch.

DESCRIPTION OF THE INVENTION

[0039] The technical contents of the present invention will become apparent with the detailed description of preferred embodiments accompanied with the illustration of related drawings as follows. It is intended that the embodiments and figures disclosed herein are to be considered illustrative rather than restrictive.

[0040] The present invention is directed to a vibration sensing device operating together with a wristband and a filter to measure a wearer's cardiopulmonary efficacy through clothing without the need of wearing the device for a long time.

[0041] With reference to FIG. **1** for a vibration sensing device of the present invention, the vibration sensing device **110** comprises a piezoelectric element **113**, a static force meter **112**, a vibration conduction element **111** and a casing **114**. The piezoelectric element **113** is a piezo film capable of generating a voltage when the piezo film is pressed, so that the piezoelectric element **113** can convert vibration into an electronic signal. The static force meter **112** is provided for measuring a static force and converting the static force into an electronic signal.

[0042] The vibration conduction element **111** is a T-shaped hard conductor provided for conducing vibration and static force to the piezoelectric element **113** and the static force meter **112**. Since the piezoelectric element **113** is a film, it may be damaged or its signal may be distorted when the vibration sensing device **110** is applied with a strong force in contact with a user's skin **11** in order to measure the heart sound and lung sound. The vibration conduction element **111** acts as a middle conducting element to conduct the vibration of the heart sound and the lung sound to the piezoelectric element **113**, and the static force meter **112** is provided for measuring the applied pressure to prevent over-pressing the piezoelectric element **113**.

[0043] The static force meter **112** can compensate the deficiency of the piezoelectric element **113** that cannot measure the static force (in form of a DC signal). On the other hand, the piezoelectric element **113** can also compensate the deficiency of the static force meter **112** that cannot measure the vibration (in form of an AC signal). Therefore, the static force meter **112** and the piezoelectric element **113** allow the vibration sensing device **110** to measure both the signals of the static force and the vibration. The casing **114** is provided for covering the static force meter **112**, the piezoelectric element **113** and a part of the vibration conduction element **111**. The other part of the vibration conduction element **111** is protruded from the casing **114** and contacted with the user's skin **11**. In an embodiment as shown in FIG. **1**, the static force meter **112** is installed between the piezoelectric element **113** and the vibration conduction element **111**. In a preferred embodiment, the positional relation between the static force meter **112** and the piezoelectric element **113** is interchangeable, so that the position of the static force meter **112** and the position of the piezoelectric element **113** may be switched to play the original effect.

[0044] In a specific way of using the vibration sensing device **110**, an end point of the vibration conduction element **111** protruded out from the casing **114** is in contact with the user's skin **11**, so that the vibration sensing device **110** can receive the vibration of the heart or lung from a position between the two ribs **12-1**, **12-2** and further measure the heart sound or lung sound. The electronic signal obtained from a vibration measured by the vibration sensing device **110** can be calculated as different data by an external device in order to monitor the cardiopulmonary efficacy, and applications of different embodiments will be described below.

[0045] With reference to FIG. **2** for a portable continuous blood pressure measuring device in accordance with a first embodiment of the present invention, the portable continuous blood pressure measuring device **100** comprises the aforementioned vibration sensing device **110** (including the piezoelectric element **113** and the static force meter **112**), a photo-plethysmograph (PPG) wrist pulse detector **120**, a chest pulse filter **130**, a third analog-to-digital converter **140** and a microcontroller **150**. In a preferred embodiment, the portable continuous blood pressure measuring device **100** further comprises a digital interface **162**, a memory unit **163** and a timing unit **161** which will be described in detail below.

[0046] The photo-plethysmograph (PPG) wrist pulse detector **120** is coupled to the microcontroller **150**, and the photo-plethysmograph (PPG) wrist pulse detector **120** obtains a wrist pulse by a photo-plethysmograph method and transmits the wrist pulse to the microcontroller **150**.

[0047] The chest pulse filter **130** is coupled to the piezoelectric element **113** of the vibration sensing device **110**. In an embodiment, the chest pulse filter **130** can filter the signal measured by the piezoelectric element **113** to generate the chest pulse. The third analog-to-digital converter **140** is coupled to the chest pulse filter **130** and provided for receiving an electronic signal received by the chest pulse filter **130**. Further, the electronic signal is converted into a digital signal. The microcontroller **150** is provided for receiving the signals from the third analog-to-digital converter **140** and the photo-plethysmograph (PPG) wrist pulse detector **120**. In this embodiment, the microcontroller **150** obtains the chest pulse and the wrist pulse and then calculates the time between the chest pulse and the wrist pulse which is a pulse transit time (PTT), and a continuous blood pressure can be calculated by the PTT, so as to measure a continuous blood pressure.

[0048] The digital interface **162** is coupled to the microcontroller **150**, and the digital interface **162** is a cable or wireless signal transmission device provided for transmitting the information received by the digital interface **162** to an external device **20**. The memory unit **163** is coupled to the microcontroller **150** and provided for storing the information computed by the microcontroller **150**. The timing unit **161** is coupled to the microcontroller **150** for providing time information to the microcontroller **150**. The external device **20** includes but not limited to a smartphone or a personal computer, and the external device **20** is installed with software and coupled to the portable continuous blood pressure measuring device **100**. The external device **20** receives and then displays related data for the view of others.

[0049] In the first embodiment, the static force meter **112** is coupled to the microcontroller **150**, and the external device **20** to remind the user to apply an appropriate static force to obtain good-quality chest pulses and wrist pulses and prevent damaging the piezoelectric element.

[0050] With reference to FIG. **3** for a portable continuous blood pressure measuring device in accordance with a second embodiment of the present invention, the portable continuous blood pressure measuring device **200** of this embodiment comprises the aforementioned vibration sensing device **110** (including the piezoelectric element **113** and the static force meter **112**), a photo-plethysmograph (PPG) wrist pulse detector **120**, a heart sound filter **230**, a first analog-to-digital converter **240** and a microcontroller **150**. In a preferred embodiment, the portable continuous blood pressure measuring device **200** further comprises a digital interface **162**, a memory unit **163** and a timing unit **161**. Wherein, the functions of the vibration sensing device **110**, the photo-plethysmograph (PPG) wrist pulse detector **120**, the digital interface **162**, the memory unit **163** and the timing unit **161** are the same of the previous embodiment, and thus will not be repeated here.

[0051] The second embodiment is characterized in that the portable continuous blood pressure measuring device **200** further comprises a heart sound filter **230** and a first analog-to-digital converter **240**. The heart sound filter **230** is coupled to the piezoelectric element **113** of the vibration sensing device **110** and capable of filtering the electronic signal of the piezoelectric element **113** to generate a heart sound, and the first analog-to-digital converter **240** is coupled to the heart sound filter **230** and provided for converting the heart sound into a digital signal. The microcontroller **150** receives the heart sound and the wrist pulse and then computes the time between the heart sound and the wrist pulse which is the pulse transit time (PTT), and a continuous blood pressure can be calculated by the PTT, so as to measure the continuous blood pressure.

[0052] In the second embodiment, the portable continuous blood pressure measuring device **200** further comprises a static force meter **112** coupled to the microcontroller **150**, and an external device **20** is provided for reminding a user to apply an appropriate static force to obtain good-quality heart sounds and wrist pulses and prevent damaging the piezoelectric element.

[0053] With reference to FIG. **4** for a portable continuous blood pressure measuring device in accordance with a third embodiment of the present invention, the portable continuous blood pressure measuring device **300** of this embodiment comprises a first electrode **310**, a second electrode **320**, an ECG signal processor **330**, a static force meter **112**, a photo-plethysmograph (PPG) wrist pulse detector **120**, a microcontroller **150**, a digital interface **162**, a memory unit **163** and a timing unit **161**. Wherein, the functions of the photo-plethysmograph (PPG) wrist pulse detector **120**, the digital interface **162**, the memory unit **163**, and the timing unit **161** are the same as those of the previous embodiment, and thus will not be repeated here.

[0054] The third embodiment is characterized in that the portable continuous blood pressure measuring device **300** comprises a first electrode **310**, a second electrode **320**, an ECG signal processor **330** and a static force meter **112**. The first electrode **310** and the second electrode **320** are provided by measuring an ECG signal by contacting the first electrode **310** and the second electrode **320** with a wearer's skin. The ECG signal processor **330** is coupled to the first electrode **310** and the second electrode **320** for processing the ECG signal, and converting the ECG signal into a signal computable by the microcontroller **150**. The photo-plethysmograph (PPG) wrist pulse detector **120** is provided for measuring a wrist pulse. The microcontroller **150** is provided for receiving the ECG signal and the wrist pulse and computing the time of the ECG signal and the wrist pulse which is a pulse transit time (PTT), and a continuous blood pressure can be calculated by the PTT, so as to achieve the effect of measuring the continuous blood pressure.

[0055] The static force meter **112** is provided for measuring the force applied to the wrist vessel when the photo-plethysmograph (PPG) wrist pulse detector **120** detects a wrist pulse and transmitting the measured value of the force to the microcontroller **150**. The microcontroller **150** will recognize the measured value of the force and then display the value of the force on a digital interface **162**. If the value of the force is too large or too small, then a warning message will be displayed on the digital interface to remind the user to control the force applied, so as to improve the accuracy of measuring the continuous blood pressure.

[0056] With reference to FIG. **5** for a portable continuous blood pressure measuring device in accordance with a fourth embodiment of the present invention, the portable continuous blood pressure measuring device **400** of this embodiment comprises the aforementioned vibration sensing device **110**, a photo-plethysmograph (PPG) wrist pulse detector **120**, a heart sound filter **230**, a first analog-to-digital converter **240**, a first electrode **310**, a second electrode **320**, an ECG signal processor **330**, a static force meter **112**, a photo-plethysmograph (PPG) wrist pulse detector **120**, a microcontroller **150**, a digital interface **162**, a memory unit **163** and a timing unit **161**.

[0057] Specifically, the fourth embodiment combines the advantages of the third embodiment and the second embodiment. The first electrode **310** and second electrode **320** are provided for measuring an ECG signal, and the vibration sensing device **110** is provided measuring a heart sound signal, and the photo-plethysmograph (PPG) wrist pulse detector **120** is provided for measuring a wrist pulse and operating with a heart sound filter **230** and an ECG signal processor **330** for processing and providing appropriate ECG signals and heart sound signals. The microcontroller **150** receives the wrist pulse, ECG signal and heart sound signal and further calculates the pulse transmit time and estimates a continuous blood pressure to achieve the effect of measuring the continuous blood pressure. In the meantime, the vibration sensing device **110** further comprises a static force meter **112** capable of applying a force to the wrist vessel when the photo-plethysmograph (PPG) wrist pulse detector **120** detects a wrist pulse and uses the applied force as a reference for the user to ensure the accuracy of measuring the continuous blood pressure.

[0058] With reference to FIG. **6** for a portable continuous blood pressure measuring device in accordance with a fifth embodiment of the present invention, the portable cardiopulmonary efficacy monitoring device **500** of this embodiment comprises the aforementioned vibration sensing device **110** (including a piezoelectric element **113** and a static force meter **112**), a lung sound filter **430**, a second analog-to-digital converter **440**, an infrared photo-plethysmograph (PPG) wrist pulse detector **420**, a photo-plethysmograph (PPG) wrist pulse detector **120**, a heart sound filter **230**, a first analog-to-digital converter **240**, a first electrode **310**, a second electrode **320**, an ECG signal processor **330**, a photo-plethysmograph (PPG) wrist pulse detector **120**, a microcontroller **150**, a digital interface **162**, a memory unit **163**, and a timing unit **161**.

[0059] Wherein, the functions of the vibration sensing device **110**, the photo-plethysmograph (PPG) wrist pulse detector **120**, the heart sound filter **230**, the first analog-to-digital converter **240**, the first electrode **310**, the second electrode **320**, the ECG signal processor **330**, the microcontroller **150**, the digital interface **162**, the memory unit **163** and the timing unit **16** are the same as those of the previous embodiments, and thus will not be repeated here.

[0060] The portable cardiopulmonary efficacy monitoring device **500** further comprises a lung sound filter **430**, a second analog-to-digital converter **440** and an infrared photo-plethysmograph (PPG) wrist pulse detector **420**. The lung sound filter **430** is coupled to the vibration sensing device **110** and provided for receiving an electronic signal from the vibration sensing device **110**. The lung sound filter **430** filters an electronic signal transmitted from the vibration sensing device **110** to generate a lung sound signal. The second analog-to-digital converter **440** is coupled to the lung sound filter **430** and provided for converting the analog lung sound signal filtered by the lung sound filter **430** into a digital signal and then transmitting the digital signal to the microcontroller **150**. The infrared photo-plethysmograph (PPG) wrist pulse detector **420** detects a user's wrist pulse by infrared light and transmits the wrist pulse to the controller **150**.

[0061] In the fifth embodiment, the portable cardiopulmonary efficacy monitoring device **500** measures the wrist pulse, heart sound, lung sound and ECG signal. The microcontroller **150** integrates and receives these signals and compares the signals with each other to compute parameters such as a myocardial performance index (MPI) and a systolic performance index (SPI) to further analyze the user's human health status.

[0062] In the fifth embodiment, the static force meter **112** is coupled to the microcontroller **150**, and an external device **20** is provided for reminding a user to apply a static force appropriately to obtain good-quality heart sounds and lung sounds and prevent damaging the piezoelectric element **113**.

[0063] With reference to FIG. **7**A for a schematic view of a portable cardiopulmonary efficacy monitoring device in accordance with an embodiment of the present invention, the portable continuous blood pressure measuring device may be in form of a wrist watch **30** provided to be worn by users. The wrist watch **30** may be installed with a portable continuous blood pressure measuring device and contacted the wearer with a photo-plethysmograph wrist pulse detector **120**, the vibration sensing device **110**, the first electrode **310**, and the second electrode **320**. In this embodiment, the photo-plethysmograph wrist pulse detector **120** comprises an infrared light source **121**, a red light source **122** and a photoreceptor **123** installed on a watchband **31**, and the vibration sensing device **110** is installed on the other side of the photo-plethysmograph wrist pulse detector **120**. The first electrode **310** and second electrode **320** are installed at relative positions of the watchband **31** respectively. In addition, the first electrode **310** is disposed on an outer side of the wrist watch **30**, and the second electrode **320** is disposed on an inner side of the wrist watch **30**, so that the first electrode **310** and second electrode **320** can touch a wearer's hands to measure and obtain a signal.

[0064] With reference to FIG. **7**B for a way of using a wrist watch, a user wears the wrist watch **30** on one of the hands, and then places the wrist watch on his/her chest wall near the heart and covers the wrist watch **30** by the other hand. The user applies a pressure appropriately to keep the wrist watch in touch of the user's body. During use, it is not necessary to take off clothing. Such operation allows the wrist watch to obtain signals such as the wear's ECG, lung sound, heart sound, wrist pulse and chest pulse. The digital interface **162** is provided for reading the signal and transmitting the signal to an external device **30** for display.

[0065] The portable continuous blood pressure measuring device or portable cardiopulmonary efficacy monitoring device of the present invention comes with the vibration sensing device **110** having the static force meter **112** and operates with the vibration conduction element **111** to conduct vibration, so that the piezoelectric element **113** can read the numerical values more accurately. These devices may be designed in form of the wrist watch **30** to provide an easy operation and allows users to measure physiological signals through clothing. In addition, the digital interface **162** is provided for transmitting data to other external devices in order to control the physiological signals more easily.

[0066] While the present invention has been described by means of specific embodiments, numerous modifications and variations could be made thereto by those skilled in the art without departing from the scope and spirit of the present invention set forth in the claims.

What is claimed is:

1. A vibration sensing device, comprising:
- a piezoelectric element, for converting vibration into an electronic signal;
- a static force meter, for converting static force into an electronic signal;
- a vibration conduction element, for conducting vibration to the piezoelectric element; and
- a casing, for covering the piezoelectric element, the static force meter and the vibration conduction element.

2. A portable continuous blood pressure measuring device, comprising:
- a photo-plethysmograph (PPG) wrist pulse detector;
- a vibration sensing device according to claim **1**;
- a chest pulse filter, coupled to the vibration sensing device;
- a third analog-to-digital converter, coupled to the chest pulse filter; and
- a microcontroller, coupled to the photo-plethysmograph (PPG) wrist pulse detector and the third analog-to-digital converter.

3. The portable continuous blood pressure measuring device of claim **2**, further comprising a digital interface coupled to the microcontroller.

4. The portable continuous blood pressure measuring device of claim **2**, further comprising a timing unit coupled to the microcontroller.

5. The portable continuous blood pressure measuring device of claim **3**, wherein the digital interface is a cable or wireless signal transmission device.

6. A portable continuous blood pressure measuring device, comprising:
- a vibration sensing device according to claim **1**;
- a heart sound filter, coupled to the vibration sensing device;
- a first analog-to-digital converter, coupled to the heart sound filter;
- a photo-plethysmograph (PPG) wrist pulse detector; and
- a microcontroller, coupled to the photo-plethysmograph (PPG) wrist pulse detector and the analog-to-digital converter.

7. The portable continuous blood pressure measuring device of claim **6**, further comprising a digital interface coupled to the microcontroller.

8. The portable continuous blood pressure measuring device of claim **6**, further comprising a timing unit coupled to the microcontroller.

9. The portable continuous blood pressure measuring device of claim **6**, wherein the digital interface is a cable or wireless signal transmission device.

10. A portable continuous blood pressure measuring device, comprising:
- a first electrode, for detecting an ECG signal;
- a second electrode, configured relative to the first electrode;
- an ECG signal processor, coupled to the first electrode and the second electrode;
- a photo-plethysmograph (PPG) wrist pulse detector;
- a static force meter, coupled to the photo-plethysmograph (PPG) wrist pulse detector; and
- a microcontroller, coupled to the optical photo-plethysmograph (PPG) wrist pulse detector, and the ECG signal processor.

11. The portable continuous blood pressure measuring device of claim **10**, further comprising a digital interface coupled to the microcontroller.

12. The portable continuous blood pressure measuring device of claim **10**, further comprising a timing unit coupled to the microcontroller.

13. The portable continuous blood pressure measuring device of claim **11**, wherein the digital interface is a cable or wireless signal transmission device.

14. A portable continuous blood pressure measuring device, comprising:
- a first electrode, for detecting an ECG signal;
- a second electrode, configured to be relative to the first electrode;
- an ECG signal processor, coupled to the first electrode and the second electrode;
- a vibration sensing device according to claim **1**;
- a heart sound filter, coupled to the vibration sensing device;
- a first analog-to-digital converter, coupled to the heart sound filter; and

a microcontroller, coupled to the photo-plethysmograph (PPG) wrist pulse detector and the analog-to-digital converter.

15. The portable continuous blood pressure measuring device of claim **14**, further comprising a digital interface coupled to the microcontroller.

16. The portable continuous blood pressure measuring device of claim **14**, further comprising a timing unit coupled to the microcontroller.

17. The portable continuous blood pressure measuring device of claim **15**, wherein the digital interface is a cable or wireless signal transmission device.

18. A portable cardiopulmonary efficacy monitoring device, comprising:

a first electrode, for detecting an ECG signal;

a second electrode, configured to be relative to the first electrode;

an ECG signal processor, coupled to the first electrode and the second electrode;

a vibration sensing device according to claim **1**;

a heart sound filter, coupled to the vibration sensing device;

a first analog-to-digital converter, coupled to the heart sound filter;

a lung sound filter, coupled to the vibration sensing device;

a second analog-to-digital converter, coupled to the lung sound filter;

a photo-plethysmograph pulse detector;

an infrared photo-plethysmograph pulse detector; and

a microcontroller, coupled to the ECG signal processor, the vibration sensing device, the heart sound filter, the lung sound filter, the photo-plethysmograph pulse detector and the infrared photo-plethysmograph pulse detector.

19. The portable cardiopulmonary efficacy monitoring device of claim **18**, further comprising a digital interface coupled to the microcontroller.

20. The portable cardiopulmonary efficacy monitoring device of claim **18**, further comprising a timing unit coupled to the microcontroller.

21. The portable cardiopulmonary efficacy monitoring device of claim **19**, wherein the digital interface is a cable or wireless signal transmission device.

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专利名称(译)	振动感应装置

公开(公告)号	US20200113454A1	公开(公告)日	2020-04-16
申请号	US16/417650	申请日	2019-05-21

[标]申请(专利权)人(译)	鋐雩科技有限公司
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IPC分类号	A61B5/021 A61B5/00 A61B5/024 A61B5/0404 A61B5/0408
CPC分类号	A61B5/681 A61B5/0408 A61B5/02108 A61B5/0404 A61B5/02433 A61B5/02438 A61B5/0205 A61B5/021 A61B5/02416 A61B5/0402 A61B7/003 A61B7/04 A61B2562/0247
优先权	107135985 2018-10-12 TW
外部链接	Espacenet USPTO

摘要(译)

振动感测装置包括压电元件，静力计，振动传导元件和壳体。 压电元件被设置用于将振动转换成电子信号。 提供静力计用于将静力转换成电子信号。 设置振动传导元件以使压电元件振动。 压电元件，静力计和振动传导元件被壳体覆盖。