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(54) **MOTION ENERGY HARVESTING WITH WIRELESS SENSORS**

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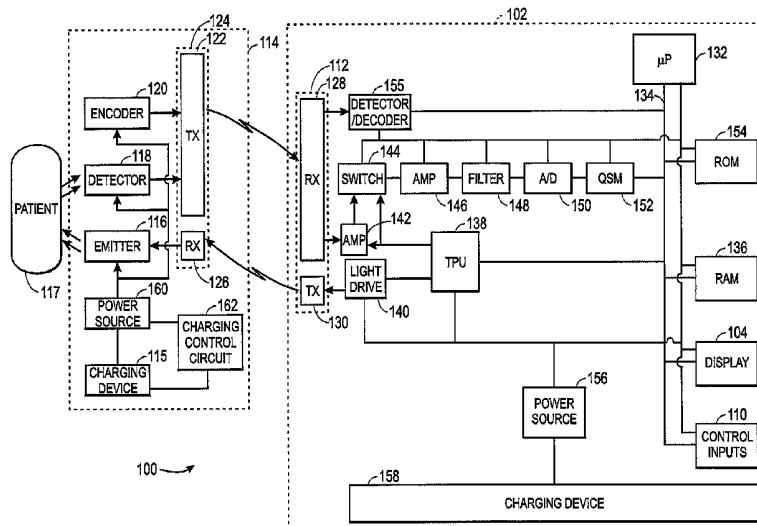
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(57) **ABSTRACT**

A system and method for generating power when one or more motion sensitive structures are moved. The system may include one or more sensing components which, acting alone or in combination, are capable of generating data related to one or more physiological parameters. The system may also include wireless communication circuitry capable of wirelessly transmitting the data related to the one or more physiological parameters. Furthermore, at least one of the one or more sensing components or the wireless communication circuitry may be at least partially powered, directly or indirectly, by the one or more motion sensitive structures.

**22 Claims, 6 Drawing Sheets**



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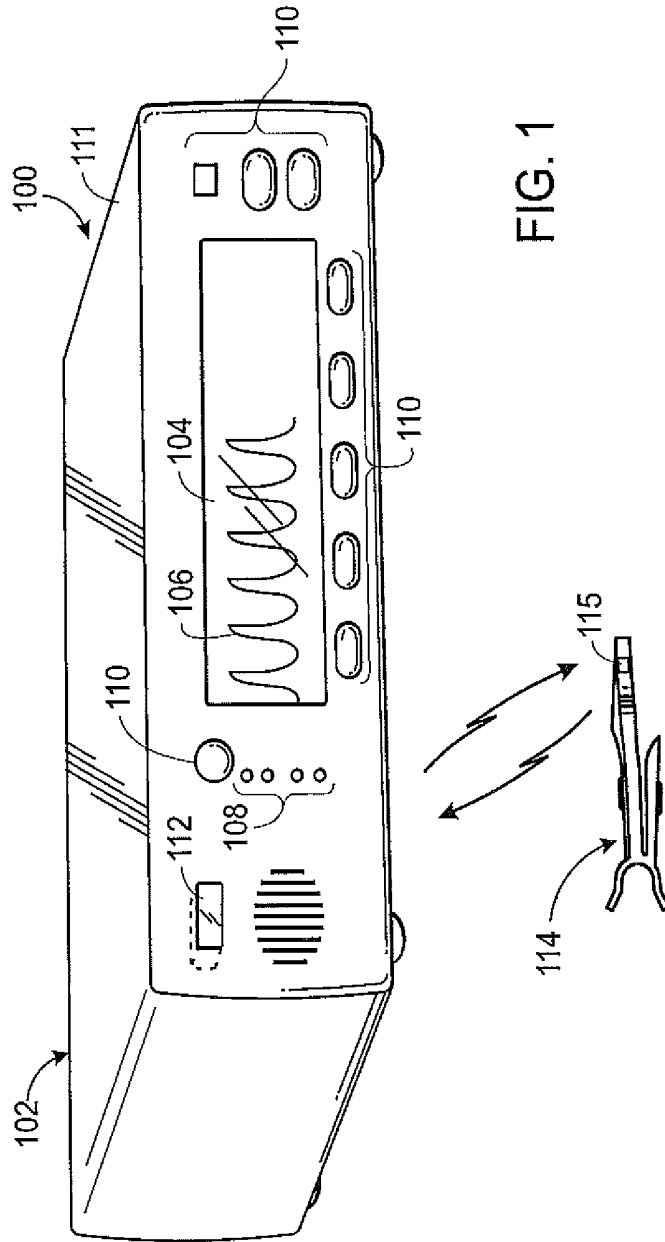


FIG. 1

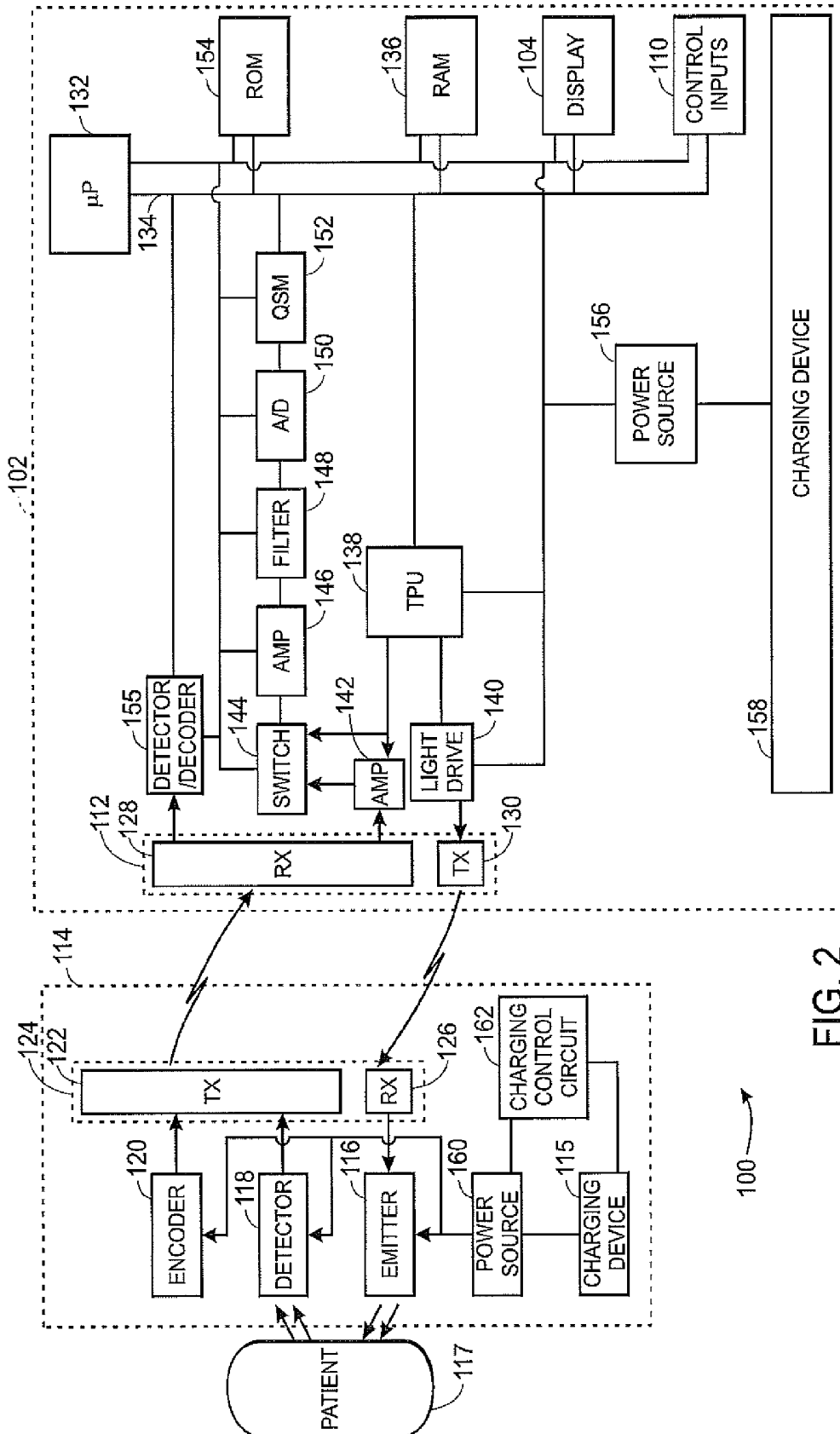


FIG. 2

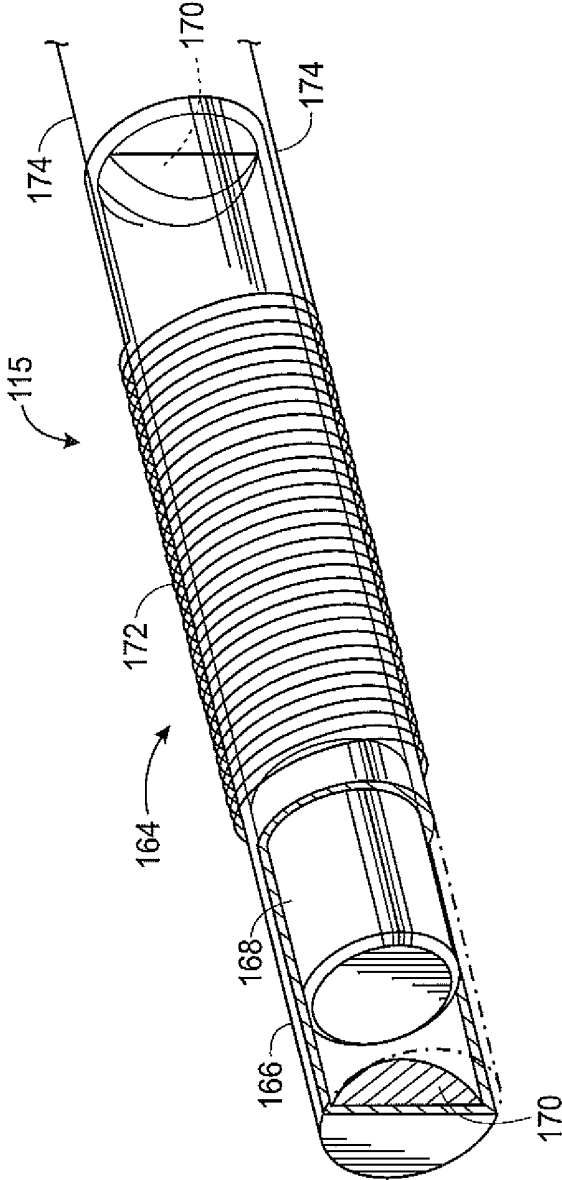


FIG. 3

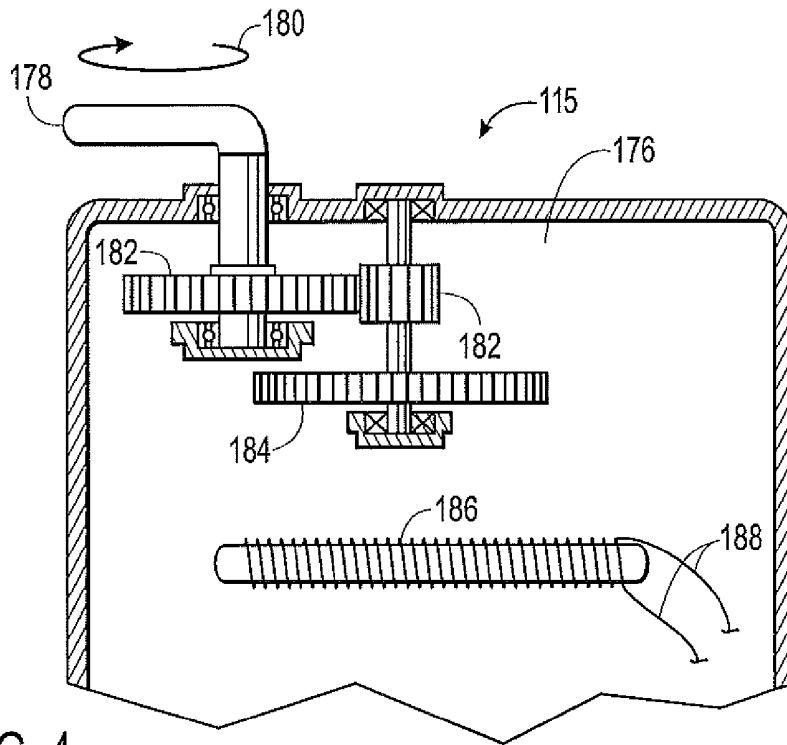


FIG. 4

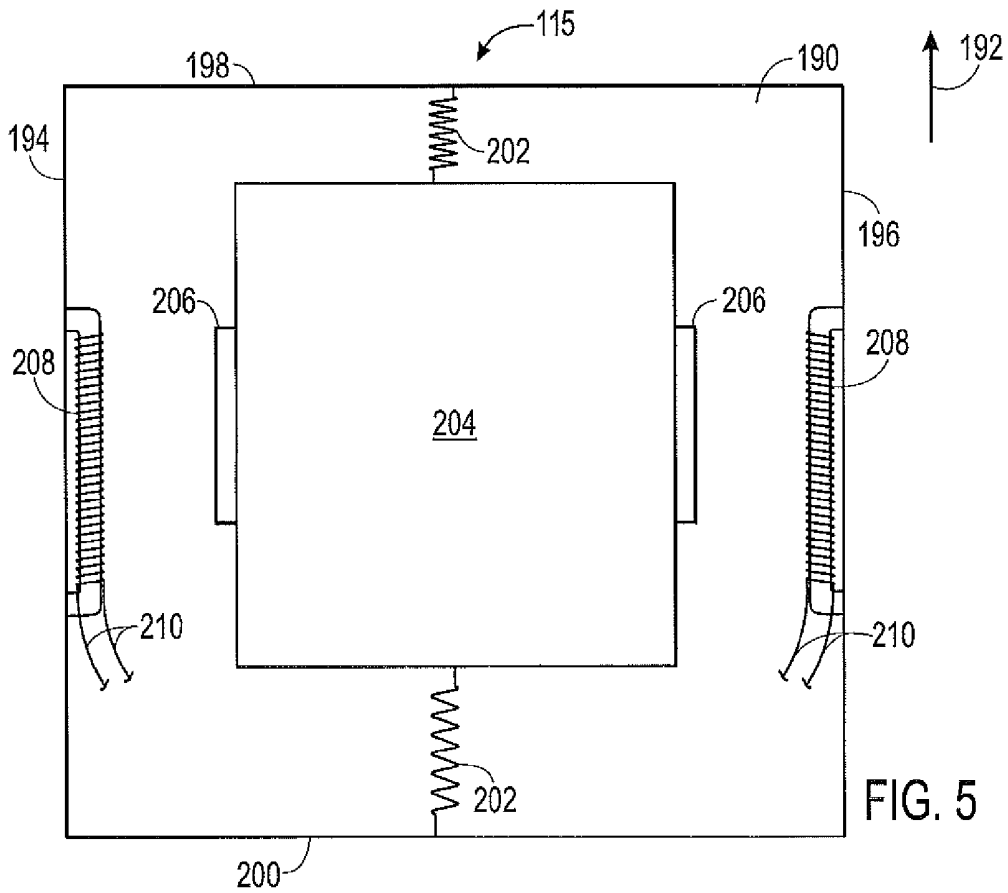


FIG. 5

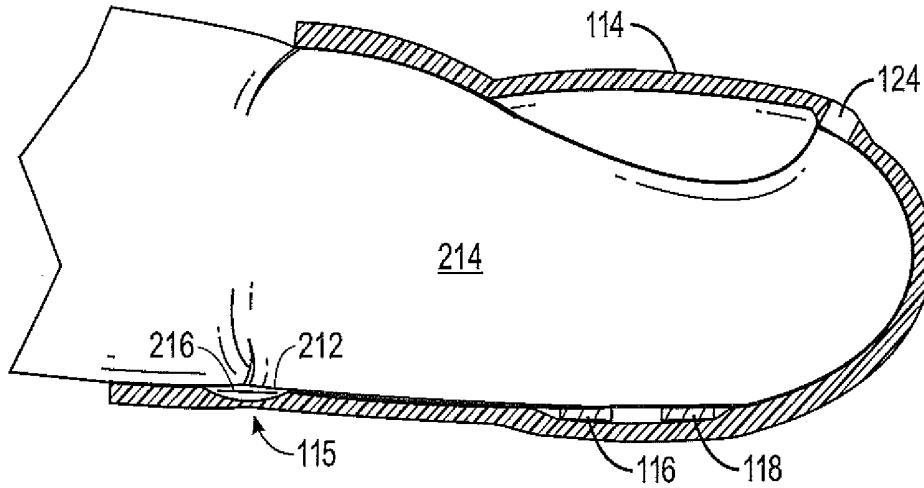


FIG. 6A

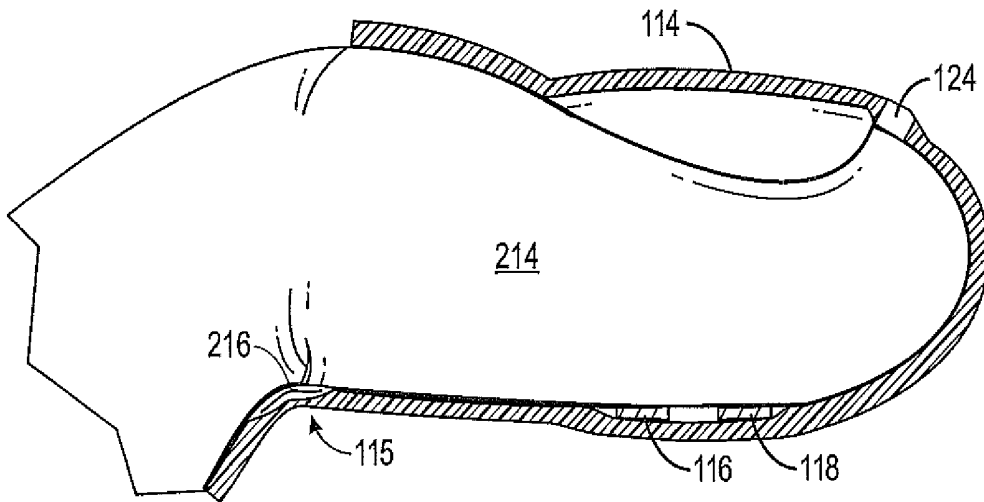
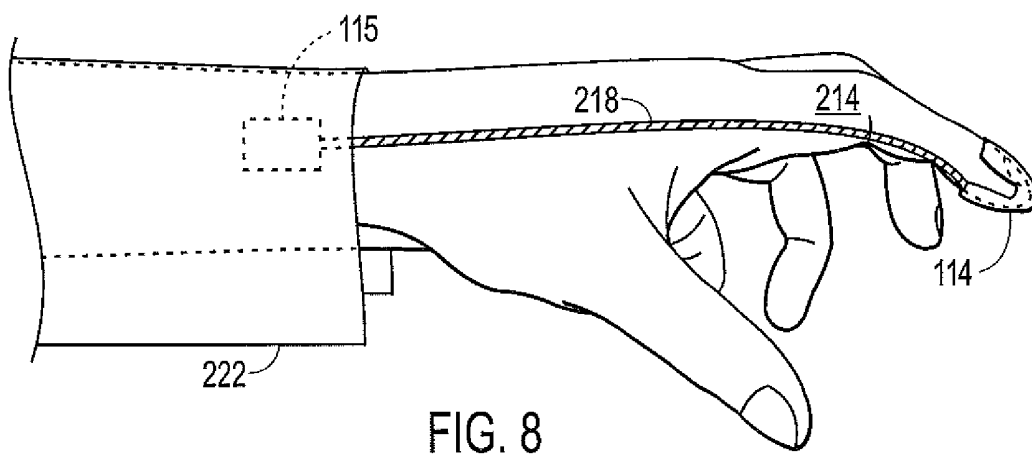
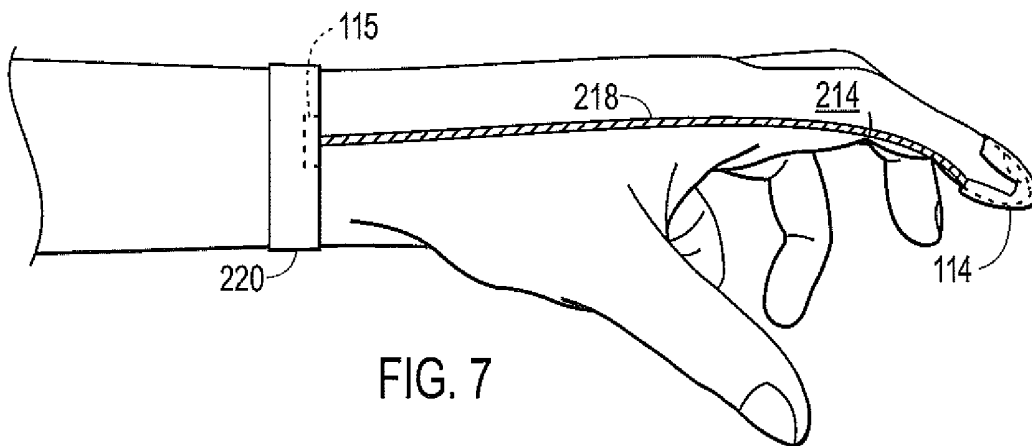


FIG. 6B



## MOTION ENERGY HARVESTING WITH WIRELESS SENSORS

### BACKGROUND

The present disclosure relates generally to medical devices and, more particularly, to sensors used for sensing physiological parameters of a patient.

This section is intended to introduce the reader to various aspects of art that may be related to various aspects of the present disclosure, which are described and/or claimed below. This discussion is believed to be helpful in providing the reader with background information to facilitate a better understanding of the various aspects of the present disclosure. Accordingly, it should be understood that these statements are to be read in this light, and not as admissions of prior art.

In the field of medicine, doctors often desire to monitor certain physiological characteristics of their patients. Accordingly, a wide variety of devices have been developed for monitoring many such physiological characteristics. Such devices provide doctors and other healthcare personnel with the information they need to provide the best possible healthcare for their patients. As a result, such monitoring devices have become an indispensable part of modern medicine.

One technique for monitoring certain physiological characteristics of a patient is commonly referred to as pulse oximetry, and the devices built based upon pulse oximetry techniques are commonly referred to as pulse oximeters. Pulse oximetry may be used to measure various blood flow characteristics, such as the blood-oxygen saturation of hemoglobin in arterial blood, the volume of individual blood pulsations supplying the tissue, and/or the rate of blood pulsations corresponding to each heartbeat of a patient. In fact, the "pulse" in pulse oximetry refers to the time varying amount of arterial blood in the tissue during each cardiac cycle.

Pulse oximeters typically utilize a non-invasive sensor that transmits light through a patient's tissue and that photoelectrically detects the absorption and/or scattering of the transmitted light in such tissue. One or more of the above physiological characteristics may then be calculated based upon the amount of light absorbed or scattered. More specifically, the light passed through the tissue is typically selected to be of one or more wavelengths that may be absorbed or scattered by the blood in an amount correlative to the amount of the blood constituent present in the blood. The amount of light absorbed and/or scattered may then be used to estimate the amount of blood constituent in the tissue using various algorithms.

Wireless sensors have been developed for use in measuring physiological parameters of a patient. Powering of these devices may present a challenge as there may be no wires connected to the sensor available to provide power to the sensors. While internal power sources such as batteries may be utilized, problems may exist in which the internal power source is drained, yielding an undesirable operational lifetime. Accordingly, alternate powering methods may be useful.

### BRIEF DESCRIPTION OF THE DRAWINGS

Advantages of the disclosed techniques may become apparent upon reading the following detailed description and upon reference to the drawings in which:

FIG. 1 illustrates a perspective view of a wireless power system including an electronic device, such as a pulse oximeter, in accordance with an embodiment;

FIG. 2 illustrates a simplified block diagram of the pulse oximeter in FIG. 1, according to an embodiment;

FIG. 3 illustrates the charging device of FIG. 1, in accordance with an embodiment;

FIG. 4 illustrates the charging device of FIG. 1, in accordance with a second embodiment;

FIG. 5 illustrates the charging device of FIG. 1, in accordance with a third embodiment;

FIG. 6A illustrates the charging device of FIG. 1 in a first position, in accordance with a fourth embodiment;

FIG. 6B illustrates the charging device of FIG. 1 in a second position, in accordance with a fourth embodiment;

FIG. 7 illustrates the sensor and the charging device of FIG. 1, in accordance with a fifth embodiment; and

FIG. 8 illustrates the sensor and the charging device of FIG. 1, in accordance with a sixth embodiment.

### DETAILED DESCRIPTION OF SPECIFIC EMBODIMENTS

One or more specific embodiments of the present techniques will be described below. In an effort to provide a concise description of these embodiments, not all features of an actual implementation are described in the specification. It should be appreciated that in the development of any such actual implementation, as in any engineering or design project, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which may vary from one implementation to another. Moreover, it should be appreciated that such a development effort might be complex and time consuming, but would nevertheless be a routine undertaking of design, fabrication, and manufacture for those of ordinary skill having the benefit of this disclosure.

Present embodiments relate to a system and method for converting movement into power for powering electronic devices. The system may include one or more motion sensitive structures that, when moved, may generate electromagnetic charging signals. The system may further include one or more elements that may receive the generated electromagnetic charging signals and may utilize the electromagnetic charging signals to charge a power source, such as a rechargeable battery, of a device. Additionally and/or alternatively, the electromagnetic charging signals may be utilized to power the device directly. The device may include, but is not limited to, pulse oximetry sensors, pulse oximetry monitors, portable pulse oximeters, and/or medical implants. That is, the system may include a device with one or more sensing components which, acting alone or in combination, are capable of generating data related to one or more physiological parameters. The system may also include wireless communication circuitry capable of wirelessly transmitting the data related to the one or more physiological parameters. In one embodiment, at least one of the one or more sensing components or the wireless communication circuitry of the device may be at least partially powered, directly or indirectly, by energy harvested through movement by one or more of the motion sensitive structures.

Turning to FIG. 1, a perspective view of a medical device is illustrated in accordance with an embodiment. The medical device may be a pulse oximeter **100**. The pulse oximeter **100** may include a monitor **102**, such as those available from Nellcor Puritan Bennett LLC. The monitor **102** may be configured to display calculated parameters on a display **104**. As illustrated in FIG. 1, the display **104** may be integrated into the monitor **102**. However, the monitor **102** may be configured to provide data via a port to a display (not shown) that is not integrated with the monitor **102**. The display **104** may be

configured to display computed physiological data including, for example, an oxygen saturation percentage, a pulse rate, and/or a plethysmographic waveform **106**. As is known in the art, the oxygen saturation percentage may be a functional arterial hemoglobin oxygen saturation measurement in units of percentage SpO<sub>2</sub>, while the pulse rate may indicate a patient's pulse rate in beats per minute. The monitor **102** may also display information related to alarms, monitor settings, and/or signal quality via indicator lights **108**.

To facilitate user input, the monitor **102** may include a plurality of control inputs **110**. The control inputs **110** may include fixed function keys, programmable function keys, and soft keys. Specifically, the control inputs **110** may correspond to soft key icons in the display **104**. Pressing control inputs **110** associated with, or adjacent to, an icon in the display may select a corresponding option. The monitor **102** may also include a casing **111**. The casing **111** may aid in the protection of the internal elements of the monitor **102** from damage.

The monitor **102** may further include a transceiver **112**. The transceiver **112** may allow for wireless operation signals to be transmitted to and received from an external sensor **114**. In this manner, the monitor **102** and the sensor **114** may communicate wirelessly. The sensor **114** may be of a disposable or a non-disposable type. Furthermore, the sensor **114** may obtain readings from a patient that can be used by the monitor **102** to calculate certain physiological characteristics such as the blood-oxygen saturation of hemoglobin in arterial blood, the volume of individual blood pulsations supplying the tissue, and/or the rate of blood pulsations corresponding to each heartbeat of a patient. As will be discussed in greater detail below, the sensor **114** may include a charging device **115**, respectively, for harnessing of energy for use by the sensor **114**.

Turning to FIG. 2, a simplified block diagram of the pulse oximeter **100** is illustrated in accordance with an embodiment. Specifically, certain components of the sensor **114** and the monitor **102** are illustrated in FIG. 2. As previously noted, the sensor **114** may include a charging device **115**. The sensor **114** may also include an emitter **116**, a detector **118**, and an encoder **120**. It should be noted that the emitter **116** may be capable of emitting at least two wavelengths of light, e.g., RED and infrared (IR) light, into the tissue of a patient **117** to calculate the patient's **117** physiological characteristics, where the RED wavelength may be between about 600 nanometers (nm) and about 700 nm, and the IR wavelength may be between about 800 nm and about 1000 nm. Alternative light sources may be used in other embodiments. For example, a single wide-spectrum light source may be used, and the detector **118** may be capable of detecting certain wavelengths of light. In another example, the detector **118** may detect a wide spectrum of wavelengths of light, and the monitor **102** may process only those wavelengths which are of interest for use in measuring, for example, water fractions, hematocrit, or other physiologic parameters of the patient **117**. It should be understood that, as used herein, the term "light" may refer to one or more of ultrasound, radio, microwave, millimeter wave, infrared, visible, ultraviolet, gamma ray or X-ray electromagnetic radiation, and may also include any wavelength within the radio, microwave, infrared, visible, ultraviolet, or X-ray spectra, and that any suitable wavelength of light may be appropriate for use with the present disclosure.

Additionally the sensor **114** may include an encoder **120**, which may contain information about the sensor **114**, such as what type of sensor it is (e.g., whether the sensor is intended for placement on a forehead or digit) and the wavelengths of

light emitted by the emitter **116**. This information may allow the monitor **102** to select appropriate algorithms and/or calibration coefficients for calculating the patient's **117** physiological characteristics. Additionally, the encoder **120** may include information relating to the proper charging of the sensor **112**. The encoder **120** may, for instance, be a memory on which one or more of the following information may be stored for communication to the monitor **102**; the type of the sensor **114**; the wavelengths of light emitted by the emitter **116**; the proper calibration coefficients and/or algorithms to be used for calculating the patient's **117** physiological characteristics; and/or information regarding a charging device for the sensor **114**. The sensor **114** may be any suitable physiological sensor, such as those available from Nellcor Puritan Bennett LLC.

Signals from the detector **118** and the encoder **120** (if utilized) may be transmitted to the monitor **102** via a transmitter **122** that may be located in a transceiver **124**. The transceiver **124** may also include a receiver **126** that may be used to receive signals from the monitor **102**. As may be seen, the receiver **126** may transmit received signals to the emitter **116** for transmission to a patient **117**. The transmitter **122** may receive signals from both the detector **118** and the encoder **120** for transmission to the monitor **102**. As previously described, the signals used in conjunction with the emitter **116** and the detector **118** may be utilized for the monitoring of physiologic parameters of the patient **117** while the signals from the encoder may contain information about the sensor **114** to allow the monitor **102** to select appropriate algorithms and/or calibration coefficients for calculating the patient's **117** physiological characteristics.

As previously discussed, the monitor **102** may include a transceiver **112**. The transceiver **112** may include a receiver **128** and a transmitter **130**. The receiver **128** may receive transmitted signals from the transmitter **122** of the sensor **114** while the transmitter **130** of the monitor **102** may operate to transmit signals to the receiver **126** of the sensor **114**. In this manner, the sensor **114** may wirelessly communicate with the monitor **102** (i.e., the sensor **114** may be a wireless sensor **114**). The monitor **102** may further include one or more processors **132** coupled to an internal bus **134**. Also connected to the bus may be a RAM memory **136** and the display **104**. A time processing unit (TPU) **138** may provide timing control signals to light drive circuitry **140**, which controls (e.g., via the transmitter **130**), when the emitter **116** is activated, and if multiple light sources are used, the multiplexed timing for the different light sources. TPU **138** may also control the gating-in of signals from detector **118** through an amplifier **142** and a switching circuit **134**. The amplifier **142** may amplify, for example, the signals from the detector **118** received at the receiver **128**. The TPU **138** may control the gating-in of signals from detector **118** through an amplifier **142** to insure that the signals are sampled at the proper time, which may depend at least in part upon which of multiple light sources is activated, if multiple light sources are used. The received signal from the detector **118** may be passed through an (optional) amplifier **146**, a low pass filter **148**, and an analog-to-digital converter **150** for amplifying, filtering, and digitizing the electrical signals from the sensor **114**. The digital data may then be stored in a queued serial module (QSM) **152**, for later downloading to RAM **136** as QSM **152** fills up. In an embodiment, there may be multiple parallel paths of separate amplifier, filter, and A/D converters for multiple light wavelengths or spectra received.

In an embodiment, based at least in part upon the received signals corresponding to the light received by detector **118**, processor **122** may calculate the oxygen saturation using

various algorithms. These algorithms may use coefficients, which may be empirically determined, and may correspond to the wavelengths of light used. The algorithms may be stored in a ROM 154 and accessed and operated according to processor 122 instructions. The monitor 102 may also include a detector/decoder 155 that may receive signals (via the receiver 128) from the encoder 120. The detector/decoder 155 may, for instance, decode the signals from the encoder 120 and may provide the decoded information to the processor 132. The decoded signals may provide information to the processor such as the type of the sensor 114 and the wavelengths of light emitted by the emitter 116 so that proper calibration coefficients and/or algorithms to be used for calculating the patient's 117 physiological characteristics may be selected and utilized by the processor 132.

The monitor 102 may also include a power source 156 that may be used to transmit power to the components located in the monitor 102. In one embodiment, the power source 156 may be one or more batteries, such as a rechargeable battery. The battery may be user-removable or may be secured within the housing of the monitor 102. Use of a battery may, for example, allow the oximeter 100 to be highly portable, thus allowing a user to carry and use the oximeter 100 in a variety of situations and locations. Additionally, the power source 156 may include AC power, such as provided by an electrical outlet, and the power source 156 may be connected to the AC power via a power adapter through a power cord (not shown). This power adapter may also be used to directly recharge one or more batteries of the power source 156 and/or to power the pulse oximeter 100. In this manner, the power adapter may operate as a charging device 158.

The sensor 114 may also include a charging control circuit 162, which may, for example, allow for the adaptive control of wireless energy harvested from the charging device 115 for use in the power source 160 of the sensor 114. In one embodiment, the power source 160 may be one or more batteries, such as a rechargeable battery that may be user-removable or may be secured within the housing of the sensor 114. Alternatively, the power source 160 may be one or more capacitors for storage of charge. The charging control circuit 162 may, for example, include a processing circuit that may determine the current level of charge remaining in the power source 160, as well as the current amount of power being harvested by the charging device. For example, the charging control circuit 162 may determine if the charging device 115 is generating too little power to charge the power source 160. In response to determining that the charging device 115 is generating too little power to charge the power source 160 and that the power source 160 is low on power, the charging control circuit 162 may generate an error signal that may be transmitted to the monitor 102 for generation of a corresponding error message for display on the display 104 of the monitor 102 by, for example, the processor 132. The error message may indicate to a user that the sensor 102 is low on power and may also direct the user to take action, such as changing the power source 160 (i.e., installing new batteries), charging the power source 160 (i.e. by plugging the sensor 102 into a charging unit or into an electrical outlet via a power adapter). Alternatively, the error message may indicate to a user that the recharging system of the sensor is potentially malfunctioning, and may direct the user, for example, to replace the sensor 114. In one embodiment, the error message may be generated when the charging control circuit 162 determines that the power source 160 has reached a certain charge level, for example 20% of the total charge remains in the power source 160. Additionally, as described below in greater detail, the charging control circuit 162 may also include conversion

translation circuitry, such as a rectifier circuit, for conversion of alternating current generated via the charging device 115 into direct current.

Furthermore, the charging device 115 may be one of a multitude of energy harvesting components that utilize, for example, inductive energy generation techniques and/or piezoelectric energy generation techniques. Through use of these techniques, power may be harvested, for example, through motion of a patient 117, and utilized to directly recharge one or more batteries (or capacitors) of the power source 160 and/or to power the sensor 114. FIG. 3 illustrates a first embodiment of a charging device 115.

The charging device 115 may include an energy harvester 164 that includes a case 166, a magnet 168, one or more buffers 170, a coil 172, and one or more leads 174. It should be noted that one or more energy harvesters 164 may be utilized in conjunction with one another and that the energy harvester 164 may be sized to be imbedded in the sensor 114 or attached thereto. For example, the energy harvester 164, as well as the components that make up the energy harvester 164, may be, for example, microelectromechanical systems (MEMS) and/or nano electromechanical systems (NEMS) made up of components sized between 1 to 100 micrometers. However, the energy harvester 164, as well as the components that make up the energy harvester 164, may also be larger than MEMS and NEMS, as long as they may be integrated into or attached to a given sensor 114.

Returning to the components of the energy harvester 164, the case 166 may be composed of plastic or any other non-conducting material. The case 166 may enclose the magnet 168 and the buffers 170. The case 166 may also be sized to allow lateral movement of magnet 168. In one embodiment, the case 166 is cylindrical in shape. The magnet 168 may be sized to fit within the case 166 and move laterally within the case 166. The magnet 168 may be a permanent magnet. The magnet 168 may be capable of sliding from one end of the case 166 to the other in response to an input of kinetic energy. In one embodiment, the kinetic energy may include patient 117 movement that causes the magnet 168 to move through the case 166 of the energy harvester 164. The movement of the magnet 168 through the case 166 causes the magnet to pass through the coil 172. The coil 172 may be made up of a conductive substance and may be wrapped around the case 166. In one embodiment, the coil 172 may be made from coiled aluminum. In another embodiment, the coil 172 may be made from coiled copper wire. The copper wire may be covered by thin insulation.

As the magnet 168 passes through the coil 172, electricity is generated via electromagnetic induction. This electricity may then be transmitted via the leads 174 to the charging control circuit 162 or directly to the power source 160. In one embodiment, the generated electricity may be passed through a rectifier circuit, which may be located in, for example, the charging control circuit 162, and may translate the alternating current generated via electromechanical induction into direct current. The rectifier circuit may, for example, be a full wave rectifier made up of, for example, diodes. The rectification of the electricity by the rectifier circuit may also include smoothing the output of the rectifier circuit. A filter, such as a reservoir capacitor, may be used to smooth the output of the rectifier circuit prior to its transmission to the power storage device 160. Additionally, it should be noted that the leads 174 may include a single wire, two wires, or three wires (or other conductors) for allowing the leads 174 to conduct one, two, or three phase power.

The magnet 168 also may contact buffers 170 as it passes through the case 166. The buffers 170 may be made of elastic

material such as rubber. In another embodiment, the buffers 170 may be springs. The buffers 170 are to help conserve the kinetic energy being focused into the sliding magnet 168 by redirecting the magnet 168 back through the case 166 when the buffer 170 is contacted by the magnet 168. In this manner, the buffers 170 aid in the conversion of kinetic energy into usable electricity.

Another embodiment for the charging device 115 is illustrated in FIG. 4. The charging device 115 may include an energy harvester 176 that includes a mass 178 that may be utilized to generate rotational torque. One or more energy harvesters 176 may be utilized in conjunction with one another and the energy harvester 176 may be sized to be imbedded in the sensor 114 or attached thereto as MEMS, NEMS, or as other systems.

In operation, the mass 178 in energy harvester 176 may be free to rotate circumferentially 180 in response to movements by the patient 117. The mass 178 may be attached to a gear train 182. As the mass 178 rotates circumferentially 180, the gear train 182 may operate to transfer the rotational torque from the mass 178 to a permanent magnet 184, causing circumferential 180 rotation of the magnet 184. In one embodiment, the gear train 182 is set to create increased rotations of the magnet 184 relative to rotations of the mass 178. The magnet 184 may be positioned adjacent to a coil 186. The rotational motion of the magnet 184 induces an electrical current in the coil 186 which may be transmitted via conductive leads 188 to the charging control circuit 162 or directly to the power source 160. As noted above, the current generated may pass through a rectifier circuit, a transformer, or a phase converter as, for example, part of the charging control circuit 162. Accordingly, the energy harvester 176 may convert inputted kinetic energy, for example, movement by a patient 117 causing rotational movement of a mass 178, into electricity useable by the pulse oximeter 100.

An additional embodiment for the charging device 115 is illustrated in FIG. 5. The charging device 115 may include an energy harvester 190 that may convert vibratory motion along an axis 192 into electrical energy. One or more energy harvesters 190 may be utilized in conjunction with one another and the energy harvester 190 may be sized to be imbedded in the sensor 114 or attached thereto as MEMS, NEMS, or as other systems. The energy harvester 190 may be enclosed by, for example, four partitions 194, 196, 198, and 200. As may be seen, partitions 194 and 196 may be opposite paired partitions while partitions 198 and 200 may also be opposite paired partitions. The energy harvester 190 may further include one or more attachment devices, such as springs 202, which may be utilized to suspend enclosure 204 from partitions 198 and 200. The springs 202 may allow for reciprocating movement of the enclosure 204 relative to partitions 194 and 196 only along the axis 192. This movement of the enclosure 204 may be in response to movement by the patient 117.

Additionally, the enclosure 204 of the energy harvester 190 may include one or more magnets 206 attached thereto. Accordingly, the enclosure 204, may allow for reciprocating movement of the magnets 206 relative to the partitions 194 and 196. Indeed, one or more coils 208 may be attached to the partitions 194 and 196 such that the reciprocating movement of the magnets 206 inductively generates a current in the coils 208. This induces current in coils 208 may be transmitted via conductive leads 210 to the charging control circuit 162 or directly to the power source 160. As noted above, the current generated may pass through a rectifier circuit, a transformer, or a phase converter as, for example, part of the charging control circuit 162. Accordingly, the energy harvester 190

may convert inputted kinetic energy, for example, movement by a patient 117 causing reciprocating movement of an enclosure 204 (and thus the magnets 206 attached thereto), into electricity useable by the pulse oximeter 100.

FIGS. 6A and 6B illustrate an embodiment of the charging device 115 that makes use of a piezoelectric energy harvester 212 in a first and a second position, respectively. One or more piezoelectric energy harvesters 212 may be utilized in conjunction with one another and the piezoelectric energy harvester 212 may be sized to be imbedded in the sensor 114 or attached thereto as MEMS, NEMS, or as other systems.

FIGS. 6A and 6B illustrate a sensor 114 that may be utilized in conjunction with a finger 214 of a patient 117. As may be seen, the emitter 116 and the detector 118, as well as the transceiver 124 are illustrated as elements of the sensor 114. As depicted, the emitter 116 and detector 118 may be arranged in a reflectance-type configuration in which the emitter 116 and detector 118 are typically placed on the same side of the sensor site. Reflectance type sensors may operate by emitting light into the tissue (e.g., finger 214) and detecting the reflected light that is transmitted and scattered by the tissue. That is, reflectance type sensors detect light photons that are scattered back to the detector 118. The sensor 114 may alternatively be configured as a transmittance type sensor whereby the emitter 116 and detector 118 are typically placed on differing sides of the sensor site. In this manner, the detector 118 may detect light that has passed through one side of a tissue site to an opposite side of the tissue site.

As illustrated in both FIGS. 6A and 6B, the sensor 114 may also include a piezoelectric energy harvester 212. The piezoelectric energy harvester 212 may, for example, include a piezoelectric wire 216 contacted at two ends by conductive materials, such as metal, and mounted on a flexible substrate. This piezoelectric wire 216 may be comprised of, for example, Zinc Oxide (ZnO), Arium titanate (BaTiO<sub>3</sub>), Lead titanate (PbTiO<sub>3</sub>), Lead zirconate titanate (commonly known as PZT), and/or potassium niobate (KNbO<sub>3</sub>). The piezoelectric wire 216 (as well as any piezoelectric material) has the ability to generate an electric potential in response to applied mechanical stress. Accordingly, piezoelectric wire 216 in the piezoelectric energy harvester 212 may operate to drive a current back and forth across the piezoelectric energy harvester 212 as the piezoelectric wire 216 is stretched, as may be seen in FIG. 6A, and compressed, as may be seen in FIG. 6B. This current may be transmitted to the charging control circuit 162 or directly to the power source 160 of the sensor 114. As noted above, the current generated may pass through a rectifier circuit, a transformer, or a phase converter as, for example, part of the charging control circuit 162. Accordingly, the piezoelectric energy harvester 212 may convert inputted kinetic energy, for example, movement by a patient 117 such as bending of a finger 214, into electricity useable by the pulse oximeter 100 via the piezoelectric wire 216.

FIG. 7 illustrates an embodiment whereby the charging device 115 may be located externally from the sensor 114. As illustrated, the charging device 115 may be attached to the sensor 114 via a lead 218. The lead 218 may be an electrical conductor, such as a power cable, that transmits harvested power to the sensor 114. The lead 218 may terminate with the charging device 115 which may be integrated into (or be attached to) a bracelet 220. The bracelet 220 may be, for example, a medical bracelet. Furthermore, the lead 218 may be connected to and separated from the charging device 115. That is, the lead 218 may be separable (i.e., releasable) from the charging device 115, the bracelet 220, and/or the sensor 114. Alternatively, the lead 218 may be permanently affixed to the charging device 115 and/or the bracelet 220. Regard-

less, by separating the charging device 115 from the sensor 114, more available area in the bracelet 220 may be available for harvesting of energy via patient 117 movement. That is, with greater area available for the charging device 115, a greater number of energy harvesters 164, 176, 190, and/or 212 may be utilized, thus increasing the overall amount of energy that may be harvested.

FIG. 8 illustrates a second embodiment whereby the charging device 115 may be located externally from the sensor 114. As illustrated, the charging device 115 may be attached to the sensor 114 via a lead 218. The lead 218 may be an electrical conductor, such as a power cable, that transmits power to the sensor 114 and may terminate with the charging device 115 which may be integrated into (or be attached to) a garment 222. Again, the lead 218 may be separable (i.e., releasable) from the charging device 115, the garment 222, and/or the sensor 114. The garment 222 may be, for example, a shirt or a sleeve of a shirt. The use of the a garment 222 to house the charging device 115 may allow for the charging device 115 to be expanded in size, or for more than one charging devices 115 to be utilized in conjunction, while still allowing for the garment 222 to be comfortably worn. Thus a greater number of energy harvesters 164, 176, 190, and/or 212 may be utilized, which may increase the overall amount of energy that may be harvested. Additionally, by utilizing a large area, such as the garment 222, movements of a patient 117 across a plurality of regions of the patient 117 may be utilized to harvest energy from. That is, movements in the chest, arms, etc. of the patient 117 may be translated into power for use by the sensor 114. In this manner, a greater number of movements of a patient 117 may be harvested into power for use with the sensor 114 relative to energy harvesters 164, 176, 190, and/or 212 located in the sensor 114.

While the disclosure may be susceptible to various modifications and alternative forms, specific embodiments have been shown by way of example in the drawings and have been described in detail herein. However, it should be understood that the embodiments provided herein are not intended to be limited to the particular forms disclosed. Indeed, the disclosed embodiments may not only be applied to measurements of blood oxygen saturation, but these techniques may also be utilized for the measurement and/or analysis of other blood constituents. For example, using the same, different, or additional wavelengths, the present techniques may be utilized for the measurement and/or analysis of carboxyhemoglobin, met-hemoglobin, total hemoglobin, fractional hemoglobin, intravascular dyes, and/or water content. Rather, the various embodiments may cover all modifications, equivalents, and alternatives falling within the spirit and scope of the disclosure as defined by the following appended claims.

What is claimed is:

1. A physiological sensor, comprising:

one or more motion sensitive structures disposed in a first housing of the physiological sensor and configured to generate power when moved, wherein the physiological sensor comprises a pulse oximetry sensor;

one or more sensing components which, acting alone or in combination, are capable of generating data related to one or more physiological parameters, wherein the one or more sensing components are disposed in a second housing of the physiological sensor, and wherein the second housing is separate from the first housing and configured to be placed adjacent to an external portion of tissue of a patient;

a memory element configured to store information specific to the physiological sensor; and

wireless communication circuitry capable of wirelessly transmitting the data related to the one or more physiological parameters;

wherein at least one of the one or more sensing components or the wireless communication circuitry are at least partially powered, directly or indirectly, by the one or more motion sensitive structures, wherein the information includes information regarding the one or more motion sensitive structures.

2. The physiological sensor of claim 1, comprising an energy storing structure that is at least partially charged by the one or more motion sensitive structures, wherein the one or more sensing components are at least partially powered by the energy storing structure.

3. The physiological sensor of claim 2, wherein the energy storing structure comprises a chargeable battery or a capacitor.

4. The physiological sensor of claim 1, wherein the one or more motion sensitive structures comprise an inductive energy harvester.

5. The physiological sensor of claim 1, wherein the one or more motion sensitive structures comprise a piezoelectric energy harvester.

6. A method for powering a wireless optical sensor, comprising the acts of:

generating power in a motion sensitive energy harvesting device disposed in a first housing of the wireless optical sensor in response to motion of a patient, wherein the wireless optical sensor comprises a pulse oximetry sensor, and wherein the wireless optical sensor comprises a memory element configured to store information specific to the wireless optical sensor, wherein the information includes information regarding the motion sensitive energy harvesting device; and

providing the power to one or more sensing components disposed in a second housing of the wireless optical sensor on the patient, wherein the second housing is separate from the first housing.

7. The method of claim 6, wherein the power is stored in a battery or capacitor prior to being provided to the one or more sensing components of the wireless optical sensor.

8. The method of claim 6, comprising utilizing the power by the wireless optical sensor to generate data related to one or more physiological parameters of the patient.

9. A monitoring system, comprising:

a wireless pulse oximetry sensor, comprising:

a light generating component;

a light detecting component capable of detecting light generated by the light generating component;

a wireless transmitter capable of wirelessly transmitting a signal based on the light detected by the light detecting component;

a power generating component that generates power in response to motion of the power generating component, wherein the generated power is provided to one or more of the light generating component, the light detecting component, or the wireless transmitter;

a charging control circuit configured to determine whether a level of charge generated by the power generating component is sufficient to charge an energy storage component of the wireless pulse oximetry sensor and to generate an error signal in response to determining that the level of charge is insufficient to charge the energy storage component; and

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a memory element configured to store information specific to the wireless pulse oximetry sensor, wherein the information includes information regarding the power generating component.

10. The monitoring system of claim 9, wherein the power generating component is incorporated into the wireless pulse oximetry sensor.

11. The monitoring system of claim 10, wherein the power generating component is separate from, but in communication with, the wireless pulse oximetry sensor.

12. The monitoring system of claim 10, comprising the energy storage component capable of storing the generated power prior to the power being provided to one or more of the light generating component, the light detecting component, or the wireless transmitter.

13. The monitoring system of claim 10, wherein the power generating component comprises a plurality of energy harvesting devices.

14. The monitoring system of claim 10, wherein the plurality of energy harvesting devices comprise inductive energy harvesting devices or piezoelectric energy harvesting devices.

15. The physiological sensor of claim 1, wherein the physiological sensor is configured to be disposed about a digit of the patient.

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16. The physiological sensor of claim 1, comprising a charging control circuit configured to determine a level of charge generated by the one or more motion sensitive structures and to generate an error signal in response to determining that the level of charge is below a threshold charge level.

17. The physiological sensor of claim 16, wherein the wireless communication circuitry is configured to transmit the error signal to a patient monitor.

18. The method of claim 6, wherein the motion sensitive energy harvesting device comprises an inductive energy harvester or a piezoelectric energy harvester.

19. The method of claim 8, comprising transmitting, via a wireless transmitter disposed in the second housing of the wireless optical sensor, the data related to the one or more physiological parameters of the patient to a patient monitor.

20. The monitoring system of claim 10, wherein the wireless transmitter is configured to wirelessly transmit the error signal.

21. The monitoring system of claim 10, comprising a monitor configured to receive the error signal and to display an error message on a display based at least in part on the received error signal.

22. The monitoring system of claim 11, wherein the power generating component is disposed in a bracelet or a garment worn by the patient.

\* \* \* \* \*

专利名称(译)	用无线传感器收集运动能量		
公开(公告)号	<a href="#">US9078610</a>	公开(公告)日	2015-07-14
申请号	US12/709696	申请日	2010-02-22
[标]申请(专利权)人(译)	内尔科尔普里坦贝内特公司		
申请(专利权)人(译)	NELLCOR PURITAN BENNETT LLC		
当前申请(专利权)人(译)	COVIDIEN LP		
[标]发明人	MCKENNA EDWARD		
发明人	MCKENNA, EDWARD		
IPC分类号	A61B5/00 F03G7/08 A61B5/1455 F03G5/06 A61B5/024		
CPC分类号	A61B5/14552 A61B5/14551 A61B5/6826 A61B5/6838 F03G5/06 A61B5/02438 A61B2560/0214 A61B5/6804 A61B5/681 H02K7/1892 H02N2/18		
其他公开文献	US20110208010A1		
外部链接	<a href="#">Espacenet</a>	<a href="#">USPTO</a>	

摘要(译)

一种用于在移动一个或多个运动敏感结构时产生功率的系统和方法。该系统可以包括一个或多个感测组件，其单独或组合起作用，能够产生与一个或多个生理参数相关的数据。该系统还可以包括能够无线传输与一个或多个生理参数有关的数据的无线通信电路。此外，一个或多个感测组件或无线通信电路中的至少一个可以由一个或多个运动敏感结构至少部分地直接或间接地供电。

