US009775561B2

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

(10) **Patent No.: US 9,775,561 B2**
(45) **Date of Patent: Oct. 3, 2017**

(54) **SYSTEM METHOD AND DEVICE FOR MONITORING PHYSIOLOGICAL PARAMETERS OF A PERSON**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 750 days.

(21) Appl. No.: **13/331,544**

(22) Filed: **Dec. 20, 2011**

(65) **Prior Publication Data**

US 2012/0165645 A1 Jun. 28, 2012

Related U.S. Application Data

(60) Provisional application No. 61/426,836, filed on Dec. 23, 2010.

(51) **Int. Cl.**

A61B 5/0408	(2006.01)
A61B 5/00	(2006.01)
A61B 5/024	(2006.01)
A61B 5/08	(2006.01)
A61B 5/11	(2006.01)

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

CPC ***A61B 5/6804*** (2013.01); ***A61B 5/0024*** (2013.01); ***A61B 5/6823*** (2013.01); *A61B 5/024* (2013.01); *A61B 5/0408* (2013.01); *A61B 5/0816* (2013.01); *A61B 5/1116* (2013.01); *A61B 5/1118* (2013.01); *A61B 2562/16* (2013.01); *A61B 2562/227* (2013.01)

(58) **Field of Classification Search**

CPC A61B 5/04; A61B 5/0402; A61B 5/0416; A61B 5/0478; A61B 5/6802; A61B 5/6804–5/6806; A61B 5/6814; A61B 5/6823; A61B 5/6831; A61B 2562/16; A61B 5/0408

USPC 600/372, 386, 509, 382, 388–390, 383; 439/909, 37, 153, 261, 282, 310, 439/312–321, 550, 569; 174/559–564

See application file for complete search history.

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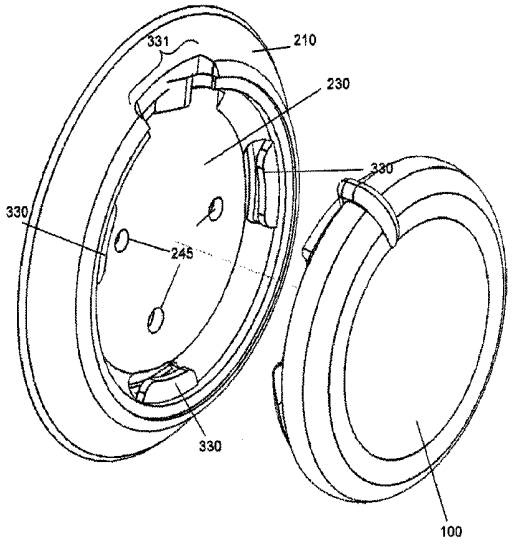
Primary Examiner — Lee S Cohen
Assistant Examiner — Erin M Cardinal

(57) **ABSTRACT**

Provided is a system, method and portable device for monitoring physiological parameters of a person in the field.

6 Claims, 12 Drawing Sheets



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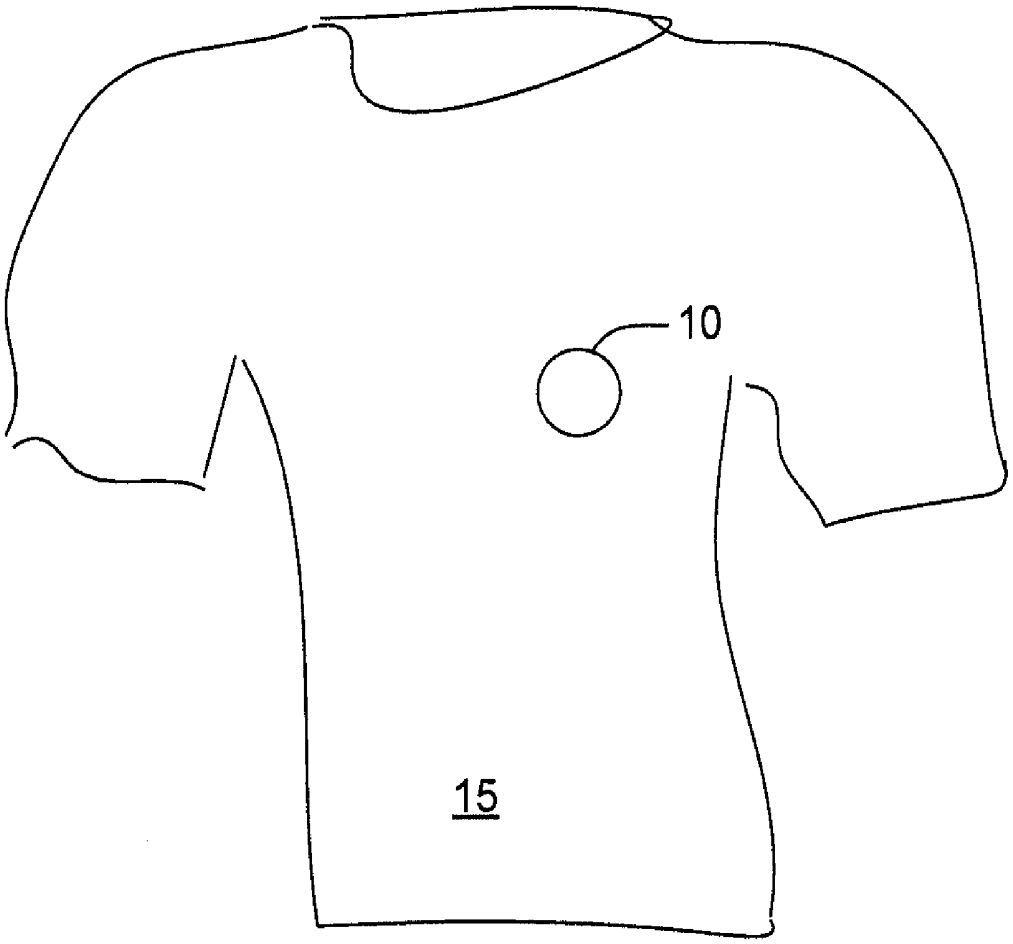

FIG. 1

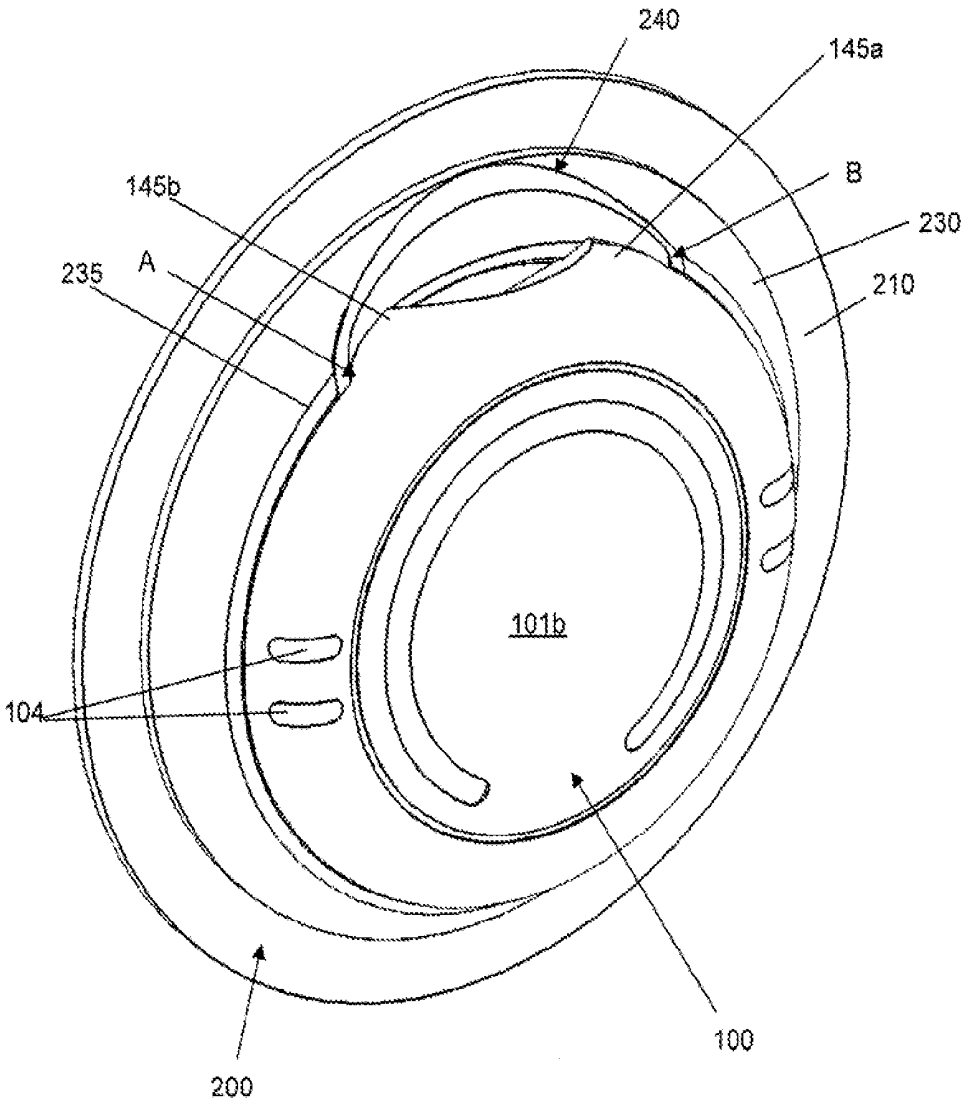

FIG. 2

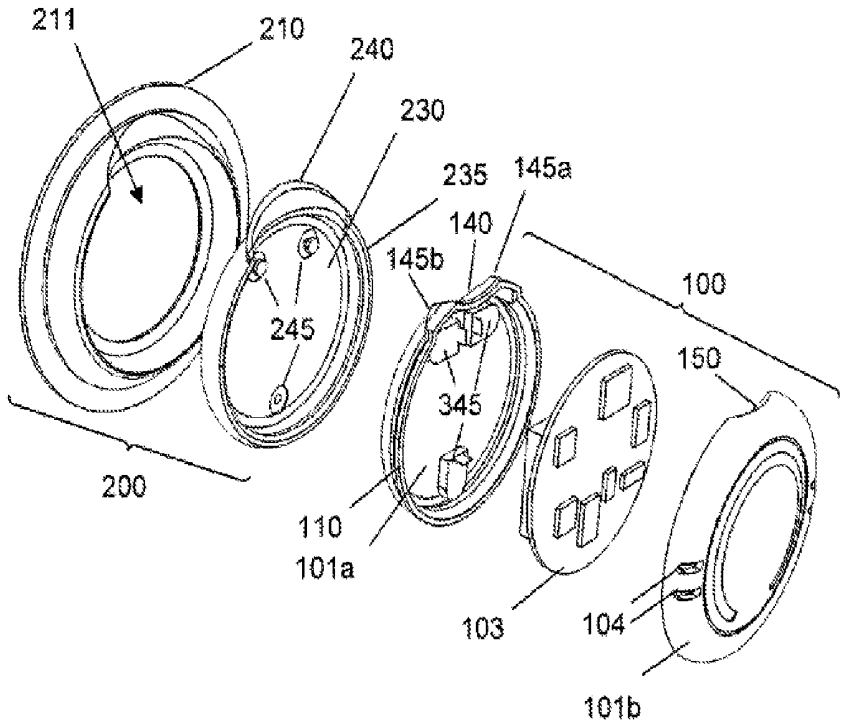
211
210
240
230
235
145a
140
145b
100
245
150
345
200
110
101a
103
104
101b

FIG. 3

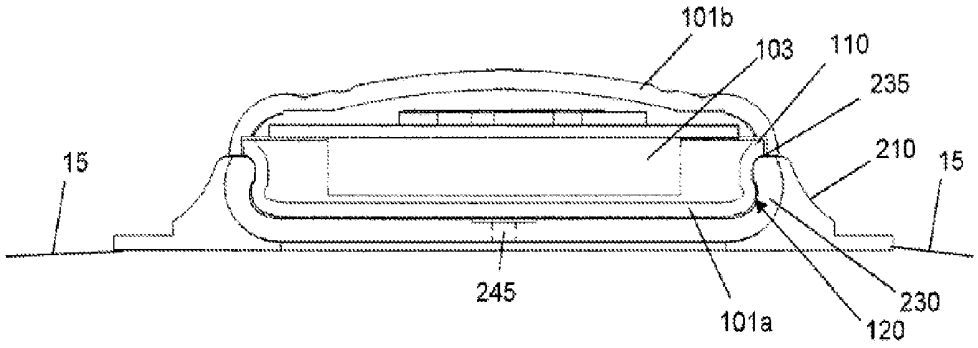
101b
103
110
235
210
15
15
245
230
101a
120

FIG. 4

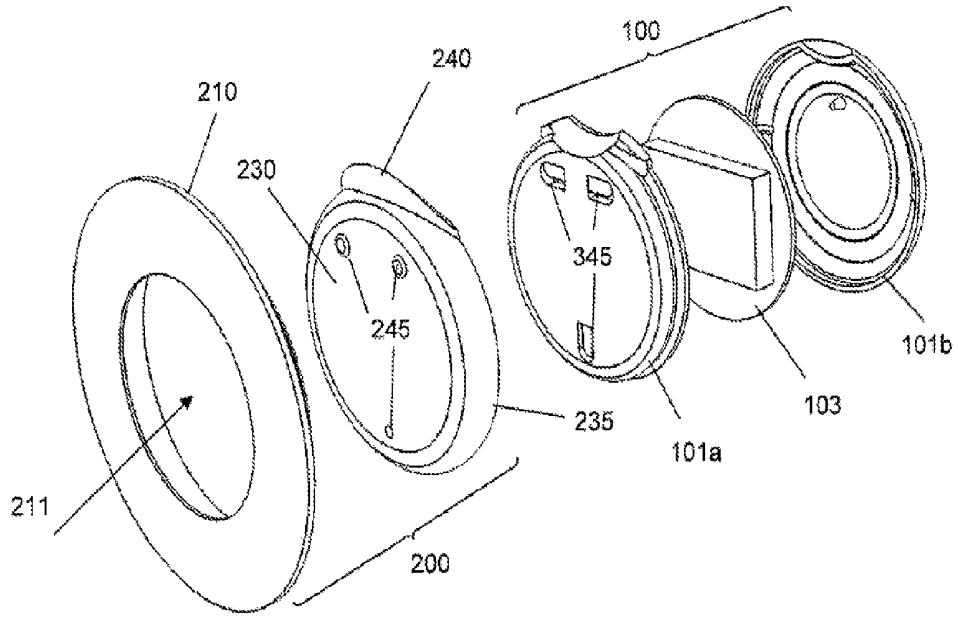

FIG. 5

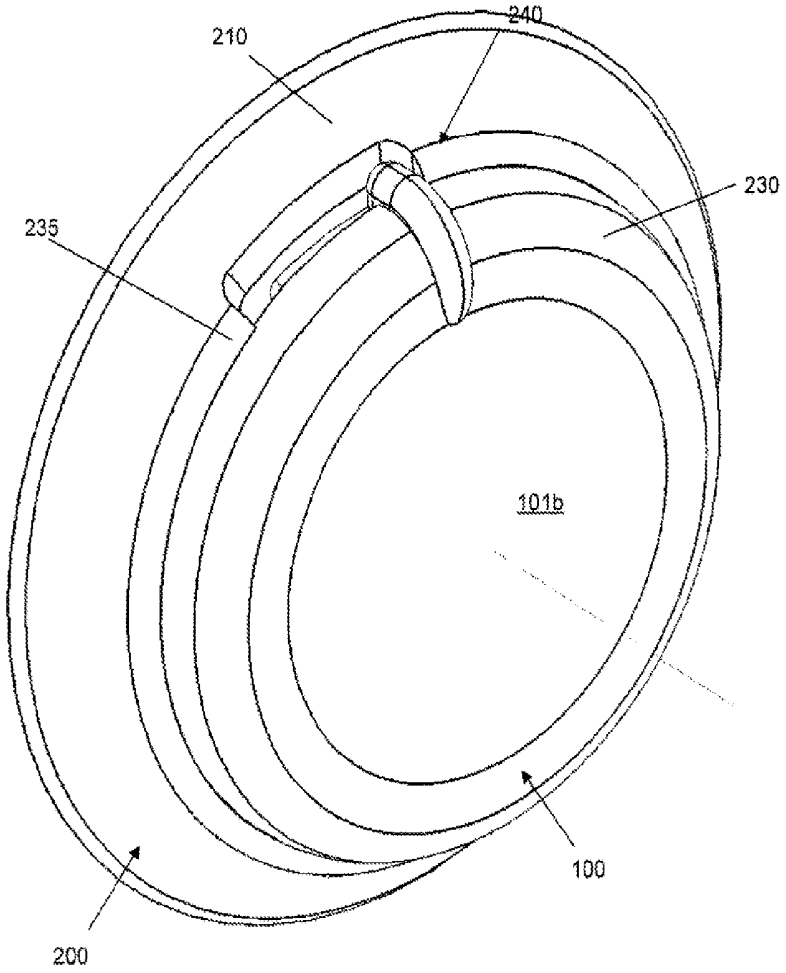

FIG. 6

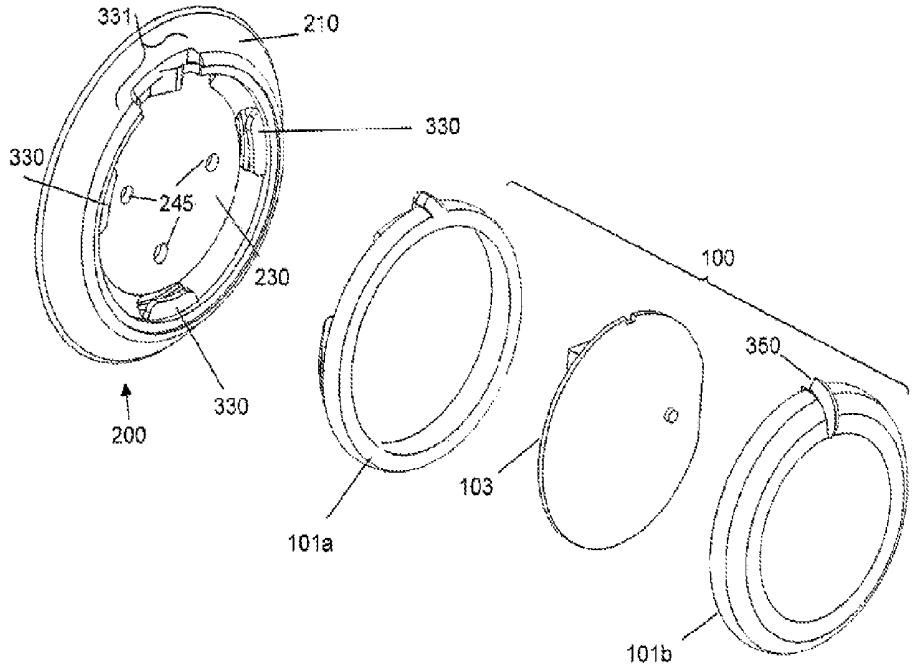
331
210
330
330
245
230
330
200
100
350
103
101a
101b

FIG. 7

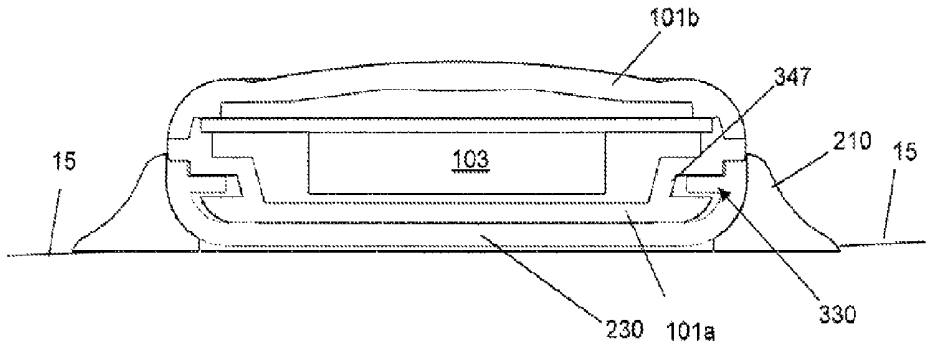
101b
347
210
15
15
103
230
101a
330

FIG. 8

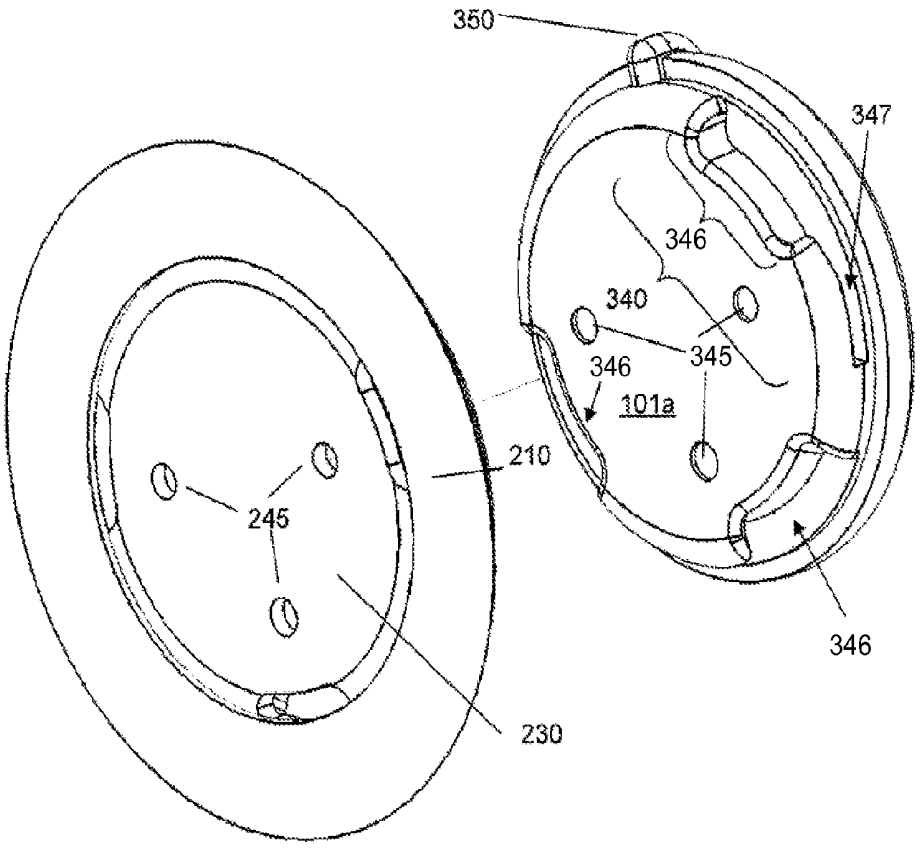

FIG. 9

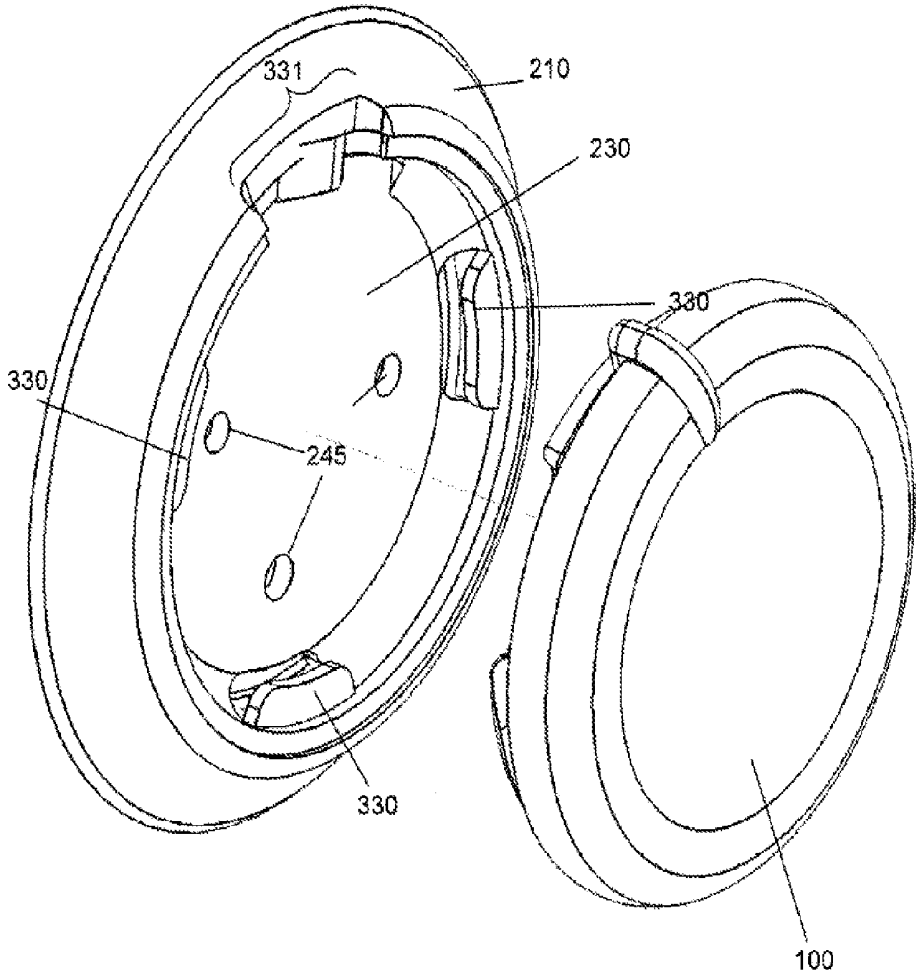

FIG. 10

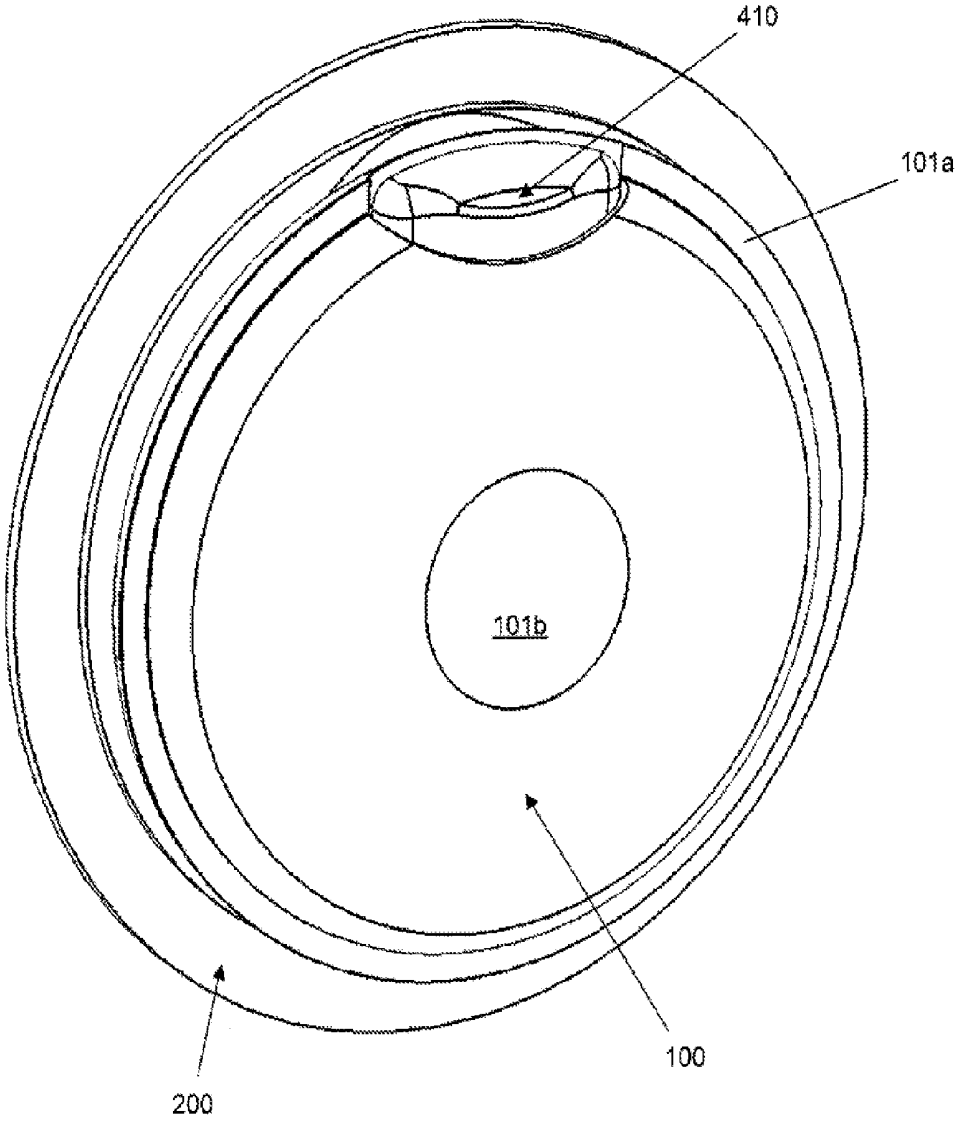

FIG. 11

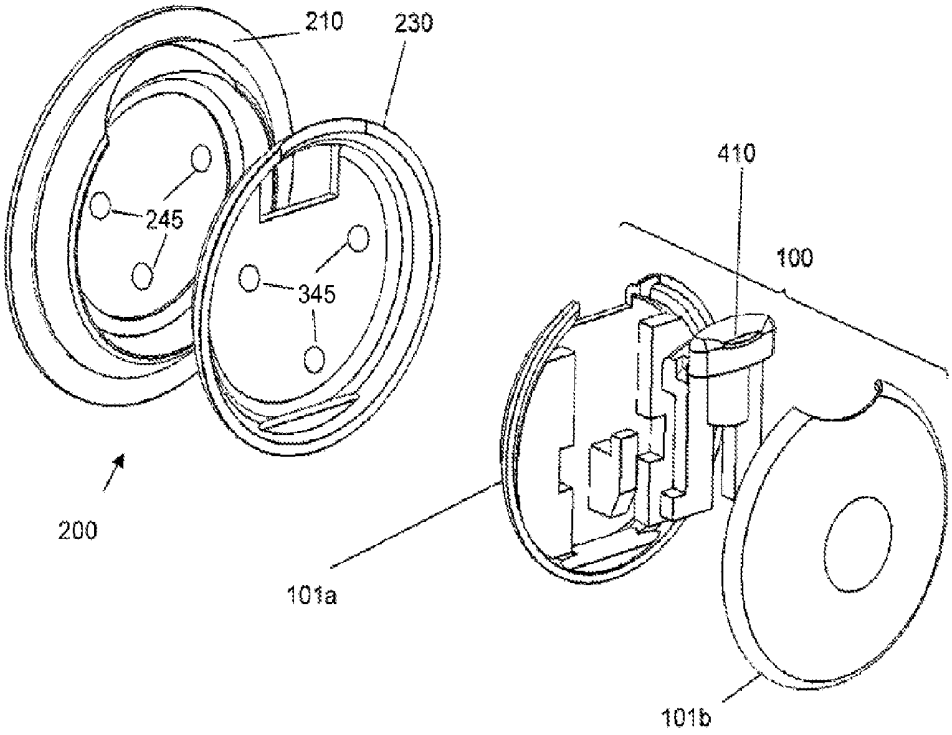

FIG. 12

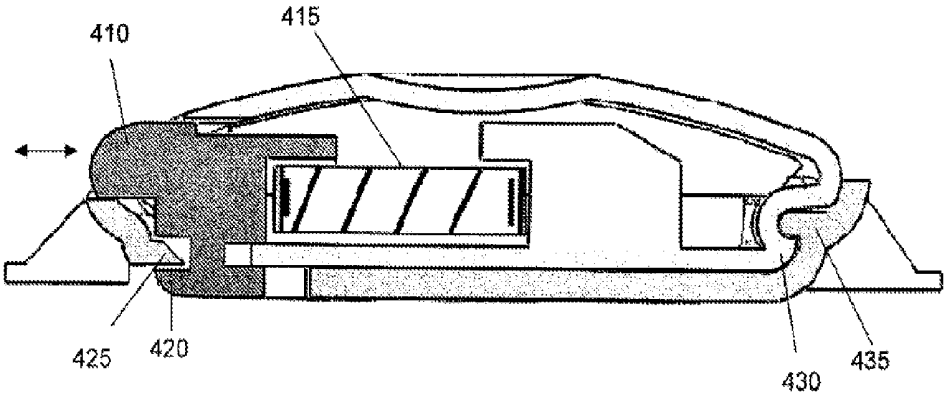

FIG. 13

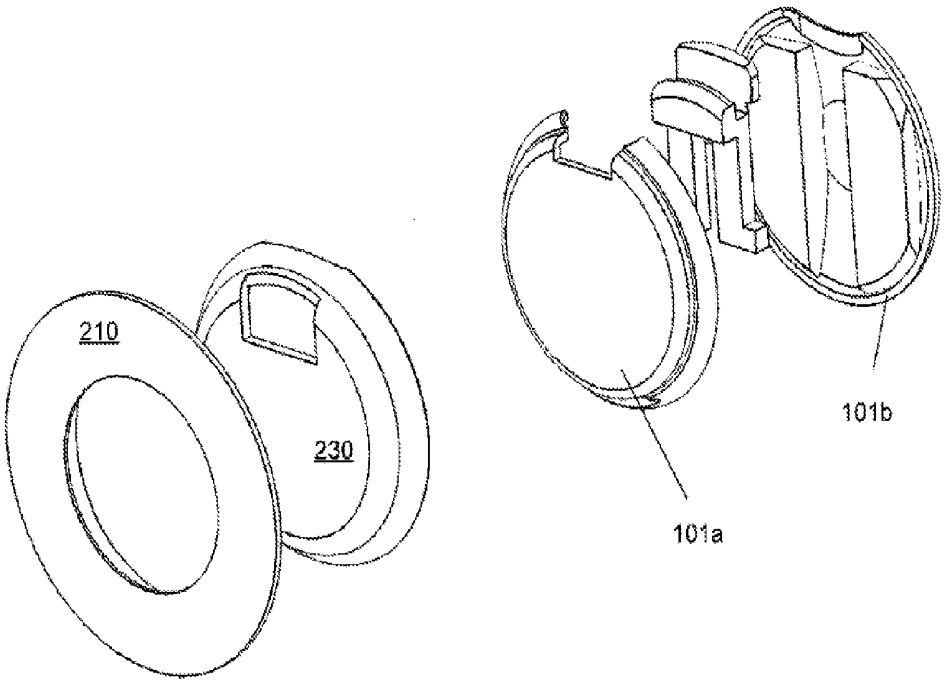

FIG. 14

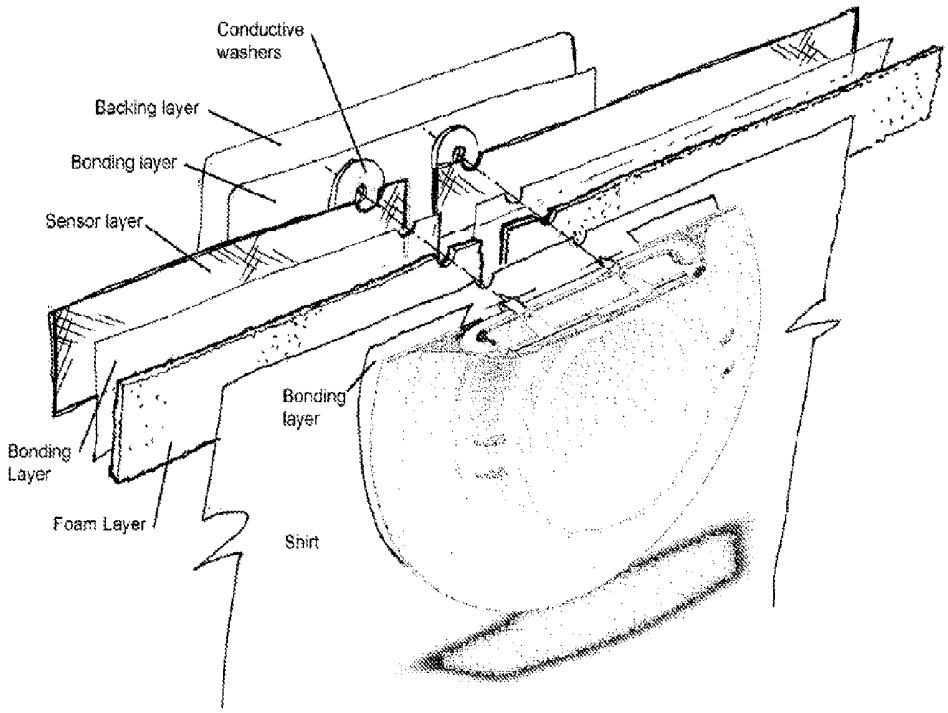
Conductive washers
Backing layer
Bonding layer
Sensor layer
Bonding layer
Bonding Layer
Foam Layer
Shirt

FIG. 15

SYSTEM METHOD AND DEVICE FOR MONITORING PHYSIOLOGICAL PARAMETERS OF A PERSON

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to U.S. Provisional Patent Application Ser. No. 61/426,836, filed 23 Dec. 2010, the complete disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

The present invention generally relates to physiological data processing and more particularly, to a system, method and portable device for monitoring physiological parameters of a person in the field.

A person's physiological parameters are traditionally monitored in clinical setting. However, field based monitoring has advantages of being able to monitor the physiological parameters over an extended period of time (e.g., hours or days versus minutes), in a person's typical environment, and during activities of that person. For example, it may be desirable to monitor the vital signals of an athlete (e.g., a professional, collegiate, or high school football, basketball, or baseball player) during a game or during practice for a game and in the athlete's environment (e.g., on the (hot or cold) football field, basketball court, etc.). Similarly, it may be desirable to monitor a patient's vital signs over an extended period of time in the patient's home and/or work place. In addition, monitoring vital signs over extended time periods (in the field) provides more useful information to allow an understanding of a person's physiological state.

It may be desirable for a biosensor sensor system that includes one or more sensors that are integrated or attached to the garment and wherein the biosensor monitoring device is removably attached to the garment.

There are various challenges to removably attaching a monitoring device to a garment. Specifically, the monitoring device must be easily connected to the garment by the user, but in a secure manner so that it does not inadvertently get dislodged. Second, the connections system must satisfy various manufacturability, performance, and usability requirements. Third, it is desirable to reduce or minimize the interference caused by the monitoring device with the user's activities.

These and other advantages may be provided by one or more embodiments of the present invention.

SUMMARY OF THE INVENTION

The above objectives and other objectives are obtained by a device for attaching an electronics portion to a garment, comprising:

- a housing enclosing at least a portion of the electronics portion;
- an interface configured to be fixedly attached to the garment;
- said housing having a plurality of housing sensor pads;
- said housing configured to be removably attached to said interface; and
- said interface having a plurality of sensor pads positioned to contact the plurality of housing sensor pads when said housing is attached to said interface.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates a monitoring device attached to a garment;

FIG. **2** illustrates a monitoring device;
FIG. **3** illustrates a monitoring device;
FIG. **4** illustrates a monitoring device;
FIG. **5** illustrates a monitoring device;
FIG. **6** illustrates a monitoring device and interface;
FIG. **7** illustrates a monitoring device and interface;
FIG. **8** illustrates a monitoring device and interface;
FIG. **9** illustrates a monitoring device and interface;
FIG. **10** illustrates a monitoring device and interface;
FIG. **11** illustrates a monitoring device and interface;
FIG. **12** illustrates a monitoring device and interface;
FIG. **13** illustrates a monitoring device and interface; and
FIG. **14** illustrates a monitoring device and interface;

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

In the following description, for purposes of explanation and not limitation, specific details are set forth, such as particular networks, communication systems, computers, terminals, devices, components, techniques, data and network protocols, software products and systems, operating systems, development interfaces, hardware, etc. in order to provide a thorough understanding of the present invention.

However, it will be apparent to one skilled in the art that the present invention may be practiced in other embodiments that depart from these specific details. Detailed descriptions of well-known networks, communication systems, computers, terminals, devices, components, techniques, data and network protocols, software products and systems, operating systems, development interfaces, and hardware are omitted so as not to obscure the description.

The present invention provides a system, device and method of connecting a monitoring device of a biosensor system to a garment and where one or more sensors are attached or integrated into the garment.

Example embodiments of the present invention may be used to connect a monitoring device to sensors that are attached to or integrated into a garment and have that has the functionality of the BioHarness®, which is commercially available and manufactured by Zephyr Technology of Annapolis, Md. As illustrated in FIG. **1**, the monitoring device **10** is attached to the garment **15** (a shirt) in the chest area. In other embodiments, the monitoring device may be connected to the garment on the upper arm or on the side (under the arm). Example embodiments of the monitoring device **10** may measure heart rate, breathing rate, temperature, activity and/or posture. The monitoring device **10** may include a battery and have a Bluetooth wireless transceiver (and/or one or more other transceivers such as ZigBee (IEEE 8902.154 under Zigbee), ANT, etc.), a processor, and internal memory. Where multiple transceivers are included, two, three or more transceivers may be operational (and operate) concurrently to allow simultaneous communications with different remote devices. The person may wear the device at home and/or work (or in a clinic environment). The data from the biomechanical and physiological sensors (and in some embodiments environmental sensors that measure ambient temperature, humidity, altitude, etc.) is regularly collected and stored in memory. Processing of collected data may be performed by an algorithm executed on the monitoring device **10** or a computer that receives the data from the collection device.

FIGS. **2-5** illustrate a monitoring device **100** and interface **200** according to an example embodiment of the present invention. The monitoring device **100** comprises a bottom portion **101***a* and top portion **101***b* that mate together to

house an internal portion **103** that comprises a processor, electronics, one or more transceivers, one or more light emitting LEDs (that are arranged to be visible through apertures **104** in the top portion **101***b*). The bottom portion **101***a* may include leaf springs **345** (or other sensor pads) that conduct data from a plurality of sensors in or attached to the garment to the electronics (e.g., an ADC, DSP, or processor) of the internal portion **103**.

The interface **200** comprises a receptacle portion **230** that is fixedly attached to mounting member **210**. In this example, member **210** comprises an elastomeric ring having an aperture **211** therethrough. Receptacle portion **230** includes rim **235** that extends around the perimeter of the receptacle portion except for a lip portion **240**. In addition, receptacle portion **230** includes three sensor pads **245**, which may comprise rivets that extend through the garment. Each sensor pad is electrically connected to one or more sensors attached to or integrated into the garment **15**. In this example, one of the sensor pads connects to a sensor ground, one connects to an ECG sensor, and one sensor pad connects to a breathing rate sensor. Member **210** is fixedly attached to the garment **15** such as by being heat bonded or sewn on, although other methods may be used. Thus, the sensor pads **245** may be connected to sensors in the garment via rivets (or conductors) that extend through the aperture **211** of the member **210** to other locations on the garment (which may be outside the circumference of the ring).

Bottom portion **101***a* includes an indentation **140** and similarly top portion **101***b* includes an indentation **150**. When top portion **101***b* and bottom portion **101***a* are mated together the indentation in the monitoring device **100** is designed to align with the lip **240** in the receptacle portion **230** of the interface **200**. To ensure that alignment, some embodiments of the invention may include a key system. Specifically, in this embodiment the bottom portion **101***a* includes a first protrusion **145***a* and a second protrusion **145***b* that protrude slightly downward and radially outward (further than the rim **110** of bottom portion **101***a*). Each protrusion **145** is positioned to protrude into the space adjacent the lip portion **240** and to abut against the rim portion **235** at points A and B.

The assembled monitoring device **100** is designed to "snap" into the receptacle portion of the interface **200**. The protrusions **145***a-b* ensure that the monitoring portion **100** is correctly oriented with respect to the interface **200** to ensure that leaf springs **345** of the monitoring device **100** align with and contact the sensor pads **245** (which may comprise rivets that protrude from the garment through member **210**) of the receptacle portion **230** when inserted.

Referring to FIG. **4**, the sides of the receptacle portion **230** are slightly concave and terminate in rim **235**. The external lower rim edge **120** of the bottom portion **101***a* may have a diameter that is greater than (or that extends radially outward further than) the internal edge of the rim **235** of the receptacle portion **230**. Thus, the receptacle portion **230** may be made of plastic or other deformable material that temporarily deforms outward to allow the external lower rim edge **120** to pass through the opening defined by the rim **235** of the receptacle portion **230** (or vice versa). Once in place, the internal edge of the rim **235** of the receptacle portion **230** pinches the external lower rim edge **120** to (1) prevent the monitoring device from being inadvertently dislodged; and (2) to urge the monitoring device **100** toward the receptacle portion. It is worth noting that the outside of the bottom portion **101** is slightly curved at **120** to more easily urge the rim **235** outward when pressure is applied by the user.

During use, the user would press the monitoring device **100** into the interface **200** until the external lower rim edge **120** of the bottom portion **101***a* passes through the opening defined by the rim **235** of the receptacle portion **230** and "snaps" into place. To remove the monitoring device **100**, the user inserts a finger or thumb under the edge of the monitoring device **100** at the lip portion **240** (and as permitted due to the indentations **140** and **150**) and pulls (or leverages) the monitoring device **100** out of the interface **200**.

FIGS. **6-10** depict a monitoring device **100** and interface **200** according to a second example embodiment of the present invention. The monitoring device **100** comprises a bottom portion **101***a* and top portion **101***b* that mate together to house an internal portion **103** that comprises a processor, electronics, one or more transceivers, one or more light emitting LEDs (not shown (that are arranged to be visible through apertures (not shown) in the top portion **101***b*). The bottom portion **101***a* may include leaf springs **345** that conduct data from a plurality of sensors in or attached to the garment to the electronics (e.g., ADC, DSP, or processor) of the internal portion **103**.

The interface **200** comprises a receptacle portion **230** that is fixedly attached to member **210**. In this example, mounting member **210** comprises an elastomeric ring having an aperture therethrough. In addition, receptacle portion **230** includes three sensor pads **245** (which may comprise rivets that are riveted to the garment and provide a conductive path through the garment). Each sensor pad or rivet is electrically connected to one or more sensors attached to or integrated into the garment **15** such as via three respective conductors. In this example, one of the sensor pads connects to a sensor ground, one connects to an ECG sensor, and one sensor pad connects to a breathing rate sensor. Member **210** is fixedly attached to the garment **15** such as by heat bonding or sewn on, although other methods may be used. Thus, the sensor pads **245** may be connected to sensors in the garment via conductors that extend through the aperture **211** of the member **210** to other locations on the garment (outside the circumference of the ring).

In this embodiment, the receptacle portion **230** includes three inwardly protruding edges **330** and an opening **331** along the perimeter of the receptacle portion **230**. In addition, the bottom portion **101***a* of the monitoring device **100** may include three edge engaging portions **340** that each include an opening **346** and a groove **347**. The top portion **101***b* of the monitoring portion has a handle **350** to allow the user to urge the monitoring device **100** clockwise or counterclockwise. To removably attach the monitor **100** to the interface **200**, the user inserts the monitor device **100** into the interface **200** so that the handle **350** enters into the opening **331** along the perimeter of the receptacle portion **230**. When inserted so that the handle **350** enters into the opening **331** along the perimeter of the receptacle portion **230**, the three protruding edges **330** of the receptacle portion **230** will be aligned with (in registration with) the three openings **346** of the monitoring device **100**, to thereby allow the bottom portion **101***a* of the monitoring device **100** to abut the bottom center of the receptacle portion **230**. The user may then rotate the monitoring device **100** approximately thirty degrees clockwise, which causes the three protruding edges **330** to slide into the three grooves **347** of the engaging portions **340**. When fully rotated so that the protruding edges **330** are abutted against the end of the grooves **37**, the leaf springs **345** of the monitoring device **100** will be in contact with the sensor pads **245** of the bottom receptacle portion **230**. The grooves **347** may have a slightly

narrowing opening so that the monitoring device **100** is held in place with a friction fit. In addition, the grooves **347** may be spaced away from the back surface of the bottom portion **101***a* so that, when the monitoring device **100** is fully inserted, the leaf springs **345** of the monitoring device **100** are urged toward the pads **245** (e.g., rivets) of the receptacle portion **230**. Furthermore, the edge protrusions **330** may have an indentation (or vertical protrusion)—not shown—that engages a protrusion (or indentation) on the grooves **347** to keep the monitoring device **100** securely attached. The remaining aspects of this embodiment are substantially similar to the first embodiment.

FIGS. **11-14** depict a monitoring device **100** and interface **200** according to a third example embodiment of the present invention. The monitoring device **100** comprises a bottom portion **101***a* and a top portion **101***b* that mate together to house an internal portion that comprises a processor, electronics, one or more transceivers, one or more light emitting LEDs (not shown). The bottom portion **101***a* may include leaf springs **345** (or other sensor pads) that conduct data from a plurality of sensors in or attached to the garment to the electronics (e.g., DSP, ADC<processor) of the internal portion. The device **100** may include a user actuated member **410** which the user may actuate (e.g., press with a finger or thumb) that moves (e.g., toward the center of the device **100**) to release the monitoring device **100** from the interface **200** to thereby allow removal.

Referring to FIG. **13**, the user actuated member **410** moves laterally when depressed as indicated by the arrow. The user actuated member **410** is adjacent to (or connected to) a spring **415** (or other urging member) that urges the user actuated member **410** outward. When the user presses the user actuated member **410** against the spring (or other urging member), a latching member **420** of the user actuated member **410** moves inward beyond a lip **425** of the interface **200** allowing removal of the monitoring device **100** from the interface **200**. The opposite side of the monitoring device **100** includes a protrusion **430** that interfaces with a lip **435** to secure that side of the monitoring device **100** to the interface **200**. The remaining aspects of this embodiment are substantially similar to the first embodiment.

FIG. **15** illustrates an example embodiment of a monitoring device attached to a shirt in which the device/shirt assembly that includes the shirt, a first bonding layer, foam layer, a second bonding layer, a sensor layer (e.g., conductive fabric), a third bonding layer with conductive washers, and a backing layer.

In the above described embodiments, the receptacle (and monitoring device) may be formed from nylon or plastic. In addition, three conductive threads may be attached to the garment or woven therein to connect the three pads **245** of the receptacle to the sensors attached to or integrated into the garment. Alternately or additionally, plastic threads may be used to optically conduct the signals to and from the sensors.

It is to be understood that the foregoing illustrative embodiments have been provided merely for the purpose of explanation and are in no way to be construed as limiting of the invention. Words used herein are words of description and illustration, rather than words of limitation. In addition, the advantages and objectives described herein may not be realized by each and every embodiment practicing the present invention. Further, although the invention has been described herein with reference to particular structure, materials and/or embodiments, the invention is not intended to be limited to the particulars disclosed herein. Rather, the invention extends to all functionally equivalent structures, methods and uses, such as are within the scope of the appended claims. Those skilled in the art, having the benefit of the teachings of this specification, may affect numerous modifications thereto and changes may be made without departing from the scope and spirit of the invention.

What is claimed is:

1. An apparatus, comprising:

an electronics portion;

a housing enclosing at least a portion of said electronics portion and comprising a plurality of housing sensor pads, each of the plurality of housing sensor pads comprising a leaf spring;

a garment, at least a portion of said garment having a plurality of stacked layers, one of said plurality of stacked layers being an electrically conductive sensor layer, said sensor layer

configured to measure at least a first physiological signal of a user wearing said garment;

an interface comprising a receptacle portion and a plurality of interface sensor pads, the interface configured to be fixedly attached to said garment in a chest area, each of the plurality of interface sensor pads comprising a protrusion;

said housing configured to be removably attached to said interface by snapping into the receptacle portion of the interface, wherein the plurality of protrusions are configured to orient the housing in an attached state with respect to the interface to ensure that each leaf spring of the plurality of housing sensor pads aligns with and contacts the protrusion of the plurality interface sensor pads when the housing is snapped into the interface,

the plurality of interface sensor pads including a first interface sensor pad coupled to a sensor ground, a second interface sensor pad coupled to an ECG sensor, and a third interface sensor pad coupled to a breathing rate sensor;

at least one of said interface sensor pads being electrically coupled to said sensor layer.

2. The apparatus of claim **1**, wherein said housing includes a user actuated member having a first state in which said user actuated member engages said interface and a second state in which said user actuated member does not engage said interface and wherein said user actuated member is configured to transition from said first state to said second state by actuation of the user.

3. The apparatus of claim **1**, wherein said interface is fixedly attached to said garment by any of heat bonding or sewing, or a combination thereof.

4. The apparatus of claim **1**, wherein said electronics portion comprises:

a battery,

at least one wireless transceiver,

a processor,

at least one light emitting LED, and

an internal memory.

5. The apparatus of claim **4**, wherein said at least one wireless transceiver comprises:

at least two wireless transceivers, each operable to communicate simultaneously with at least one remote device.

6. The apparatus of claim **1**, wherein said apparatus is configured to measure at least one of heart rate, temperature, activity, ECG data, breathing rate, or posture.

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专利名称(译)	用于监测人的生理参数的系统方法和设备		
公开(公告)号	US9775561	公开(公告)日	2017-10-03
申请号	US13/331544	申请日	2011-12-20
[标]申请(专利权)人(译)	ZEPHYR科技股份有限公司		
申请(专利权)人(译)	ZEPHYR科技股份有限公司		
当前申请(专利权)人(译)	COVIDIEN LP		
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IPC分类号	A61B5/0408 A61B5/00 A61B5/024 A61B5/08 A61B5/11		
CPC分类号	A61B5/6804 A61B5/0024 A61B5/6823 A61B5/024 A61B5/0408 A61B5/0816 A61B5/1116 A61B5/1118 A61B2562/16 A61B2562/227		
优先权	61/426836 2010-12-23 US		
其他公开文献	US20120165645A1		
外部链接	Espacenet USPTO		

摘要(译)

提供了一种用于监视现场人员的生理参数的系统，方法和便携式设备。