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(54) **OXYGEN SATURATION MEASUREMENTS**

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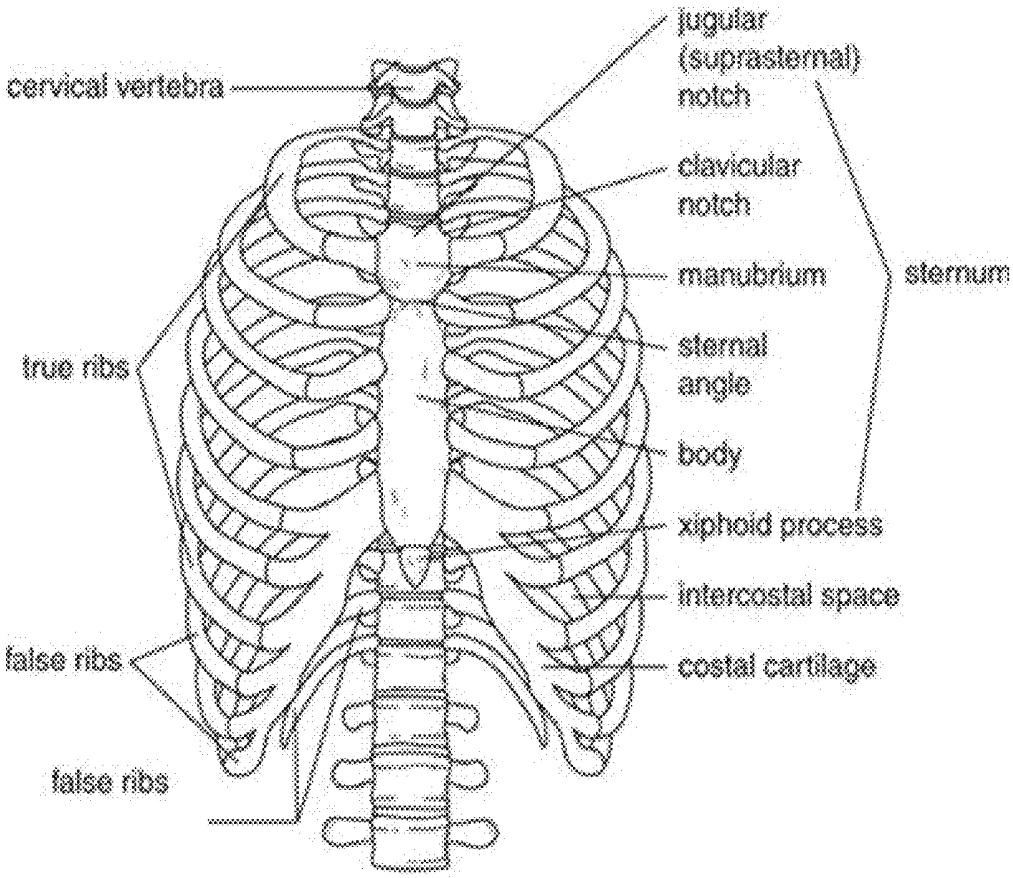
(57) **ABSTRACT**

A method for measuring oxygen saturation of a user, the method includes illuminating a sternal angle of the user by electromagnetic radiation; and sensing, by an oxygen saturation sensor included in a device that is removably attached to a user, radiation emitted from the sternal angle of the user as a result of the illuminating, wherein the sensing occurs while the oxygen saturation sensor faces the sternal angle of the user; and generating detection signals by the oxygen saturation sensor in response to the sensing of the radiation, wherein the detection signals are indicative of an oxygen saturation characteristic of the user.



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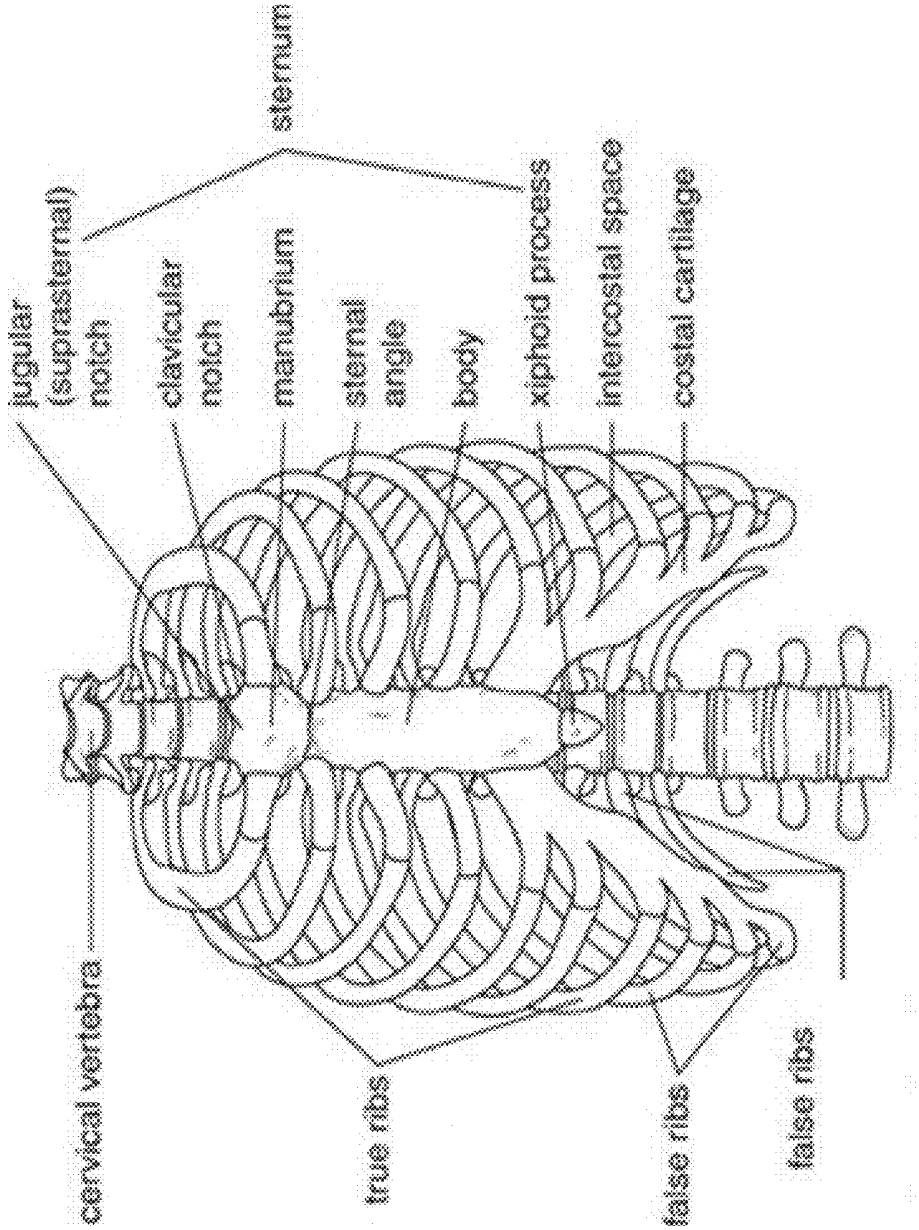
jugular (suprasternal) notch
clavicular notch
manubrium
sternal angle
body
xiphoid process
intercostal space
costal cartilage
sternum
cervical vertebra
true ribs
false ribs
false ribs
10

FIG. 1

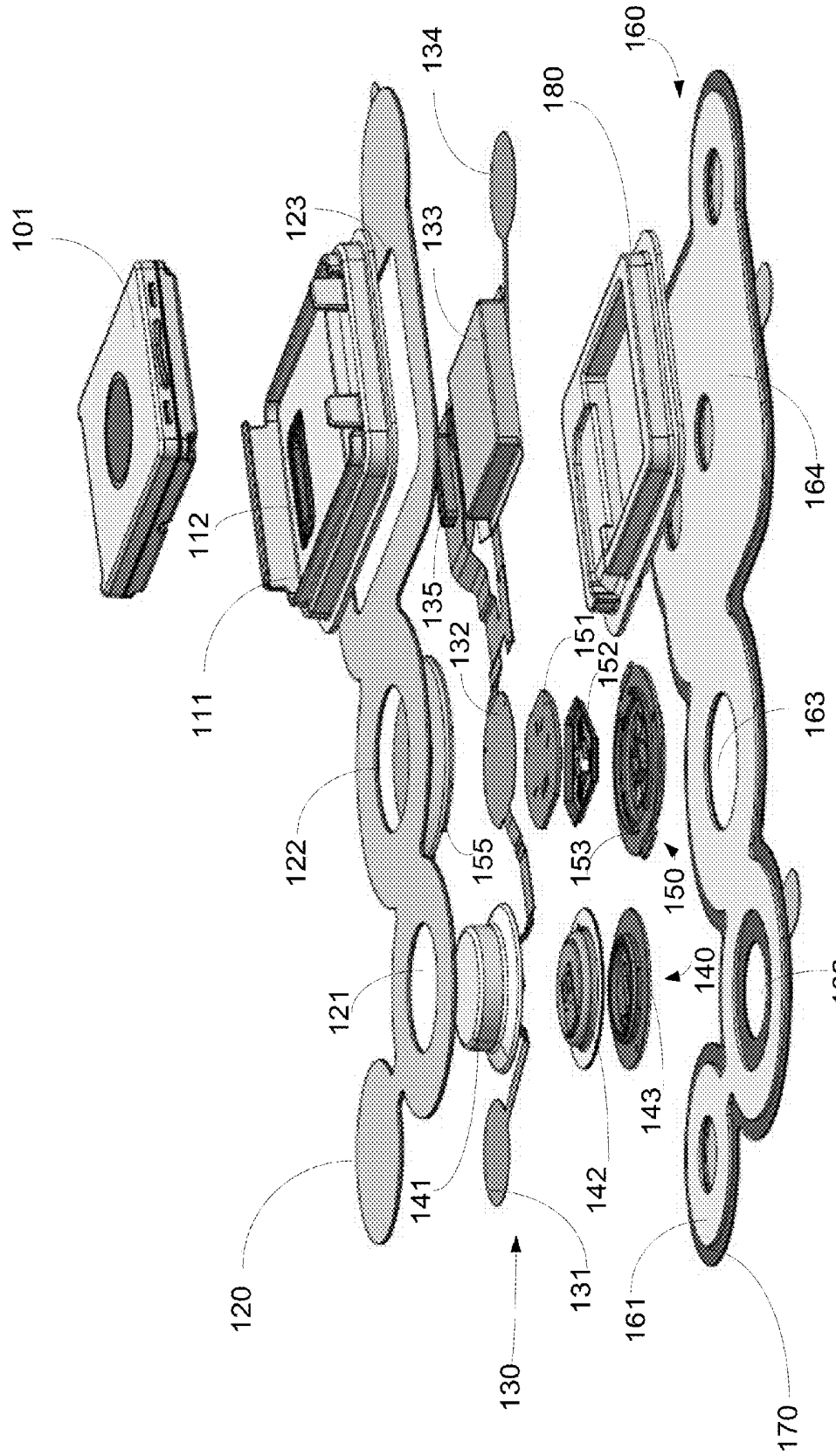
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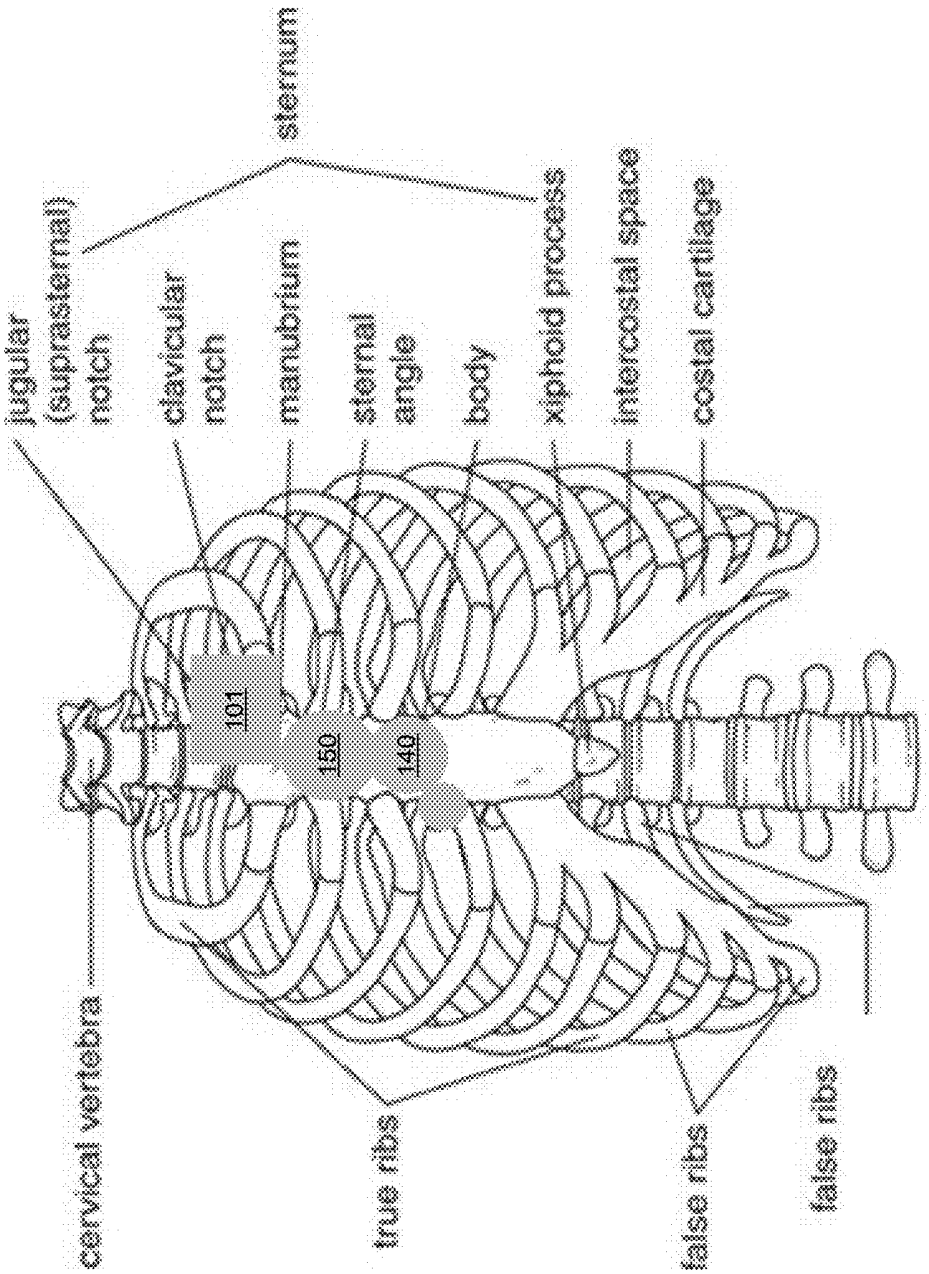
FIG. 2


jugular (suprasternal) notch
clavicular notch
manubrium
sternal angle
body
xiphoid process
intercostal space
costal cartilage
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101
150
140
cervical vertebra
true ribs
false ribs
false ribs

FIG. 3

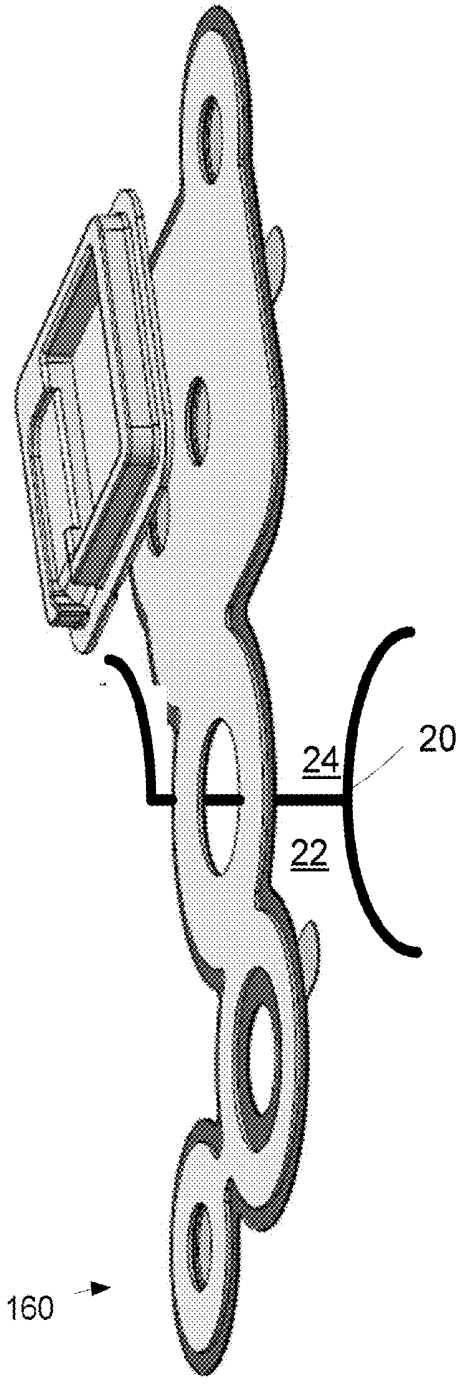


FIG. 4

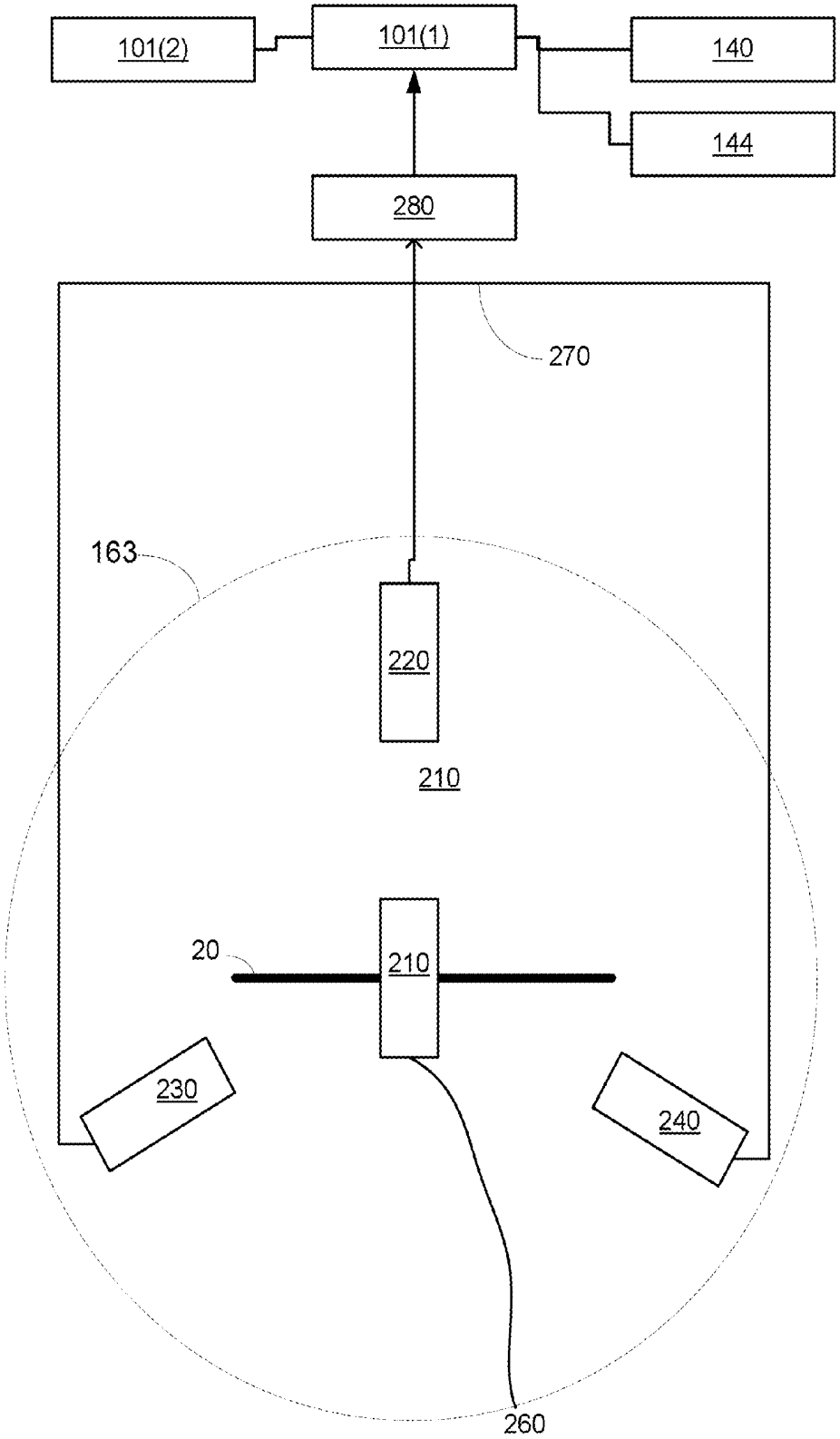


FIG. 5

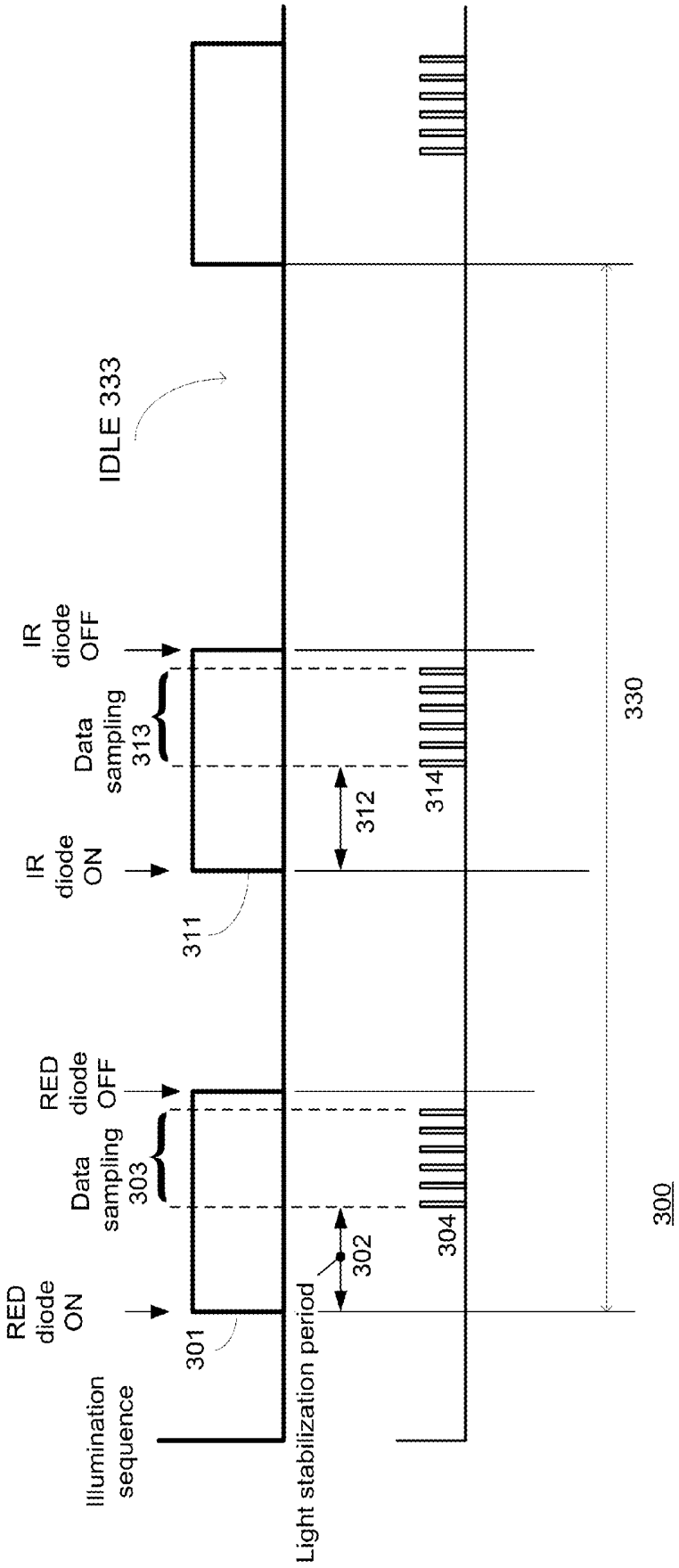

IDLE 333
IR diode OFF
Data sampling 313
IR diode ON
311
312
314
330
RED diode OFF
Data sampling 303
RED diode ON
301
302
304
300
Illumination sequence
Light stabilization period

FIG. 6

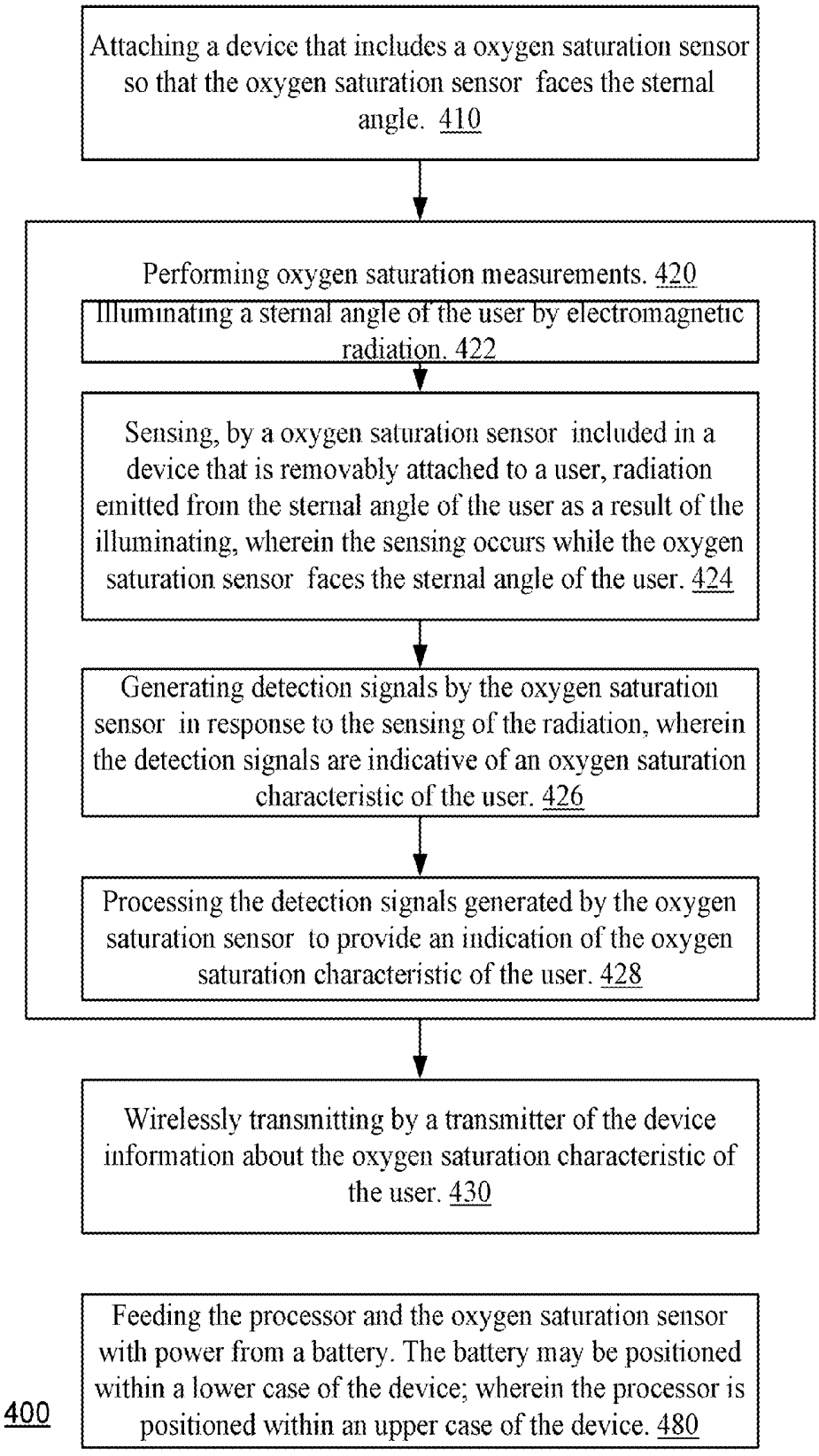
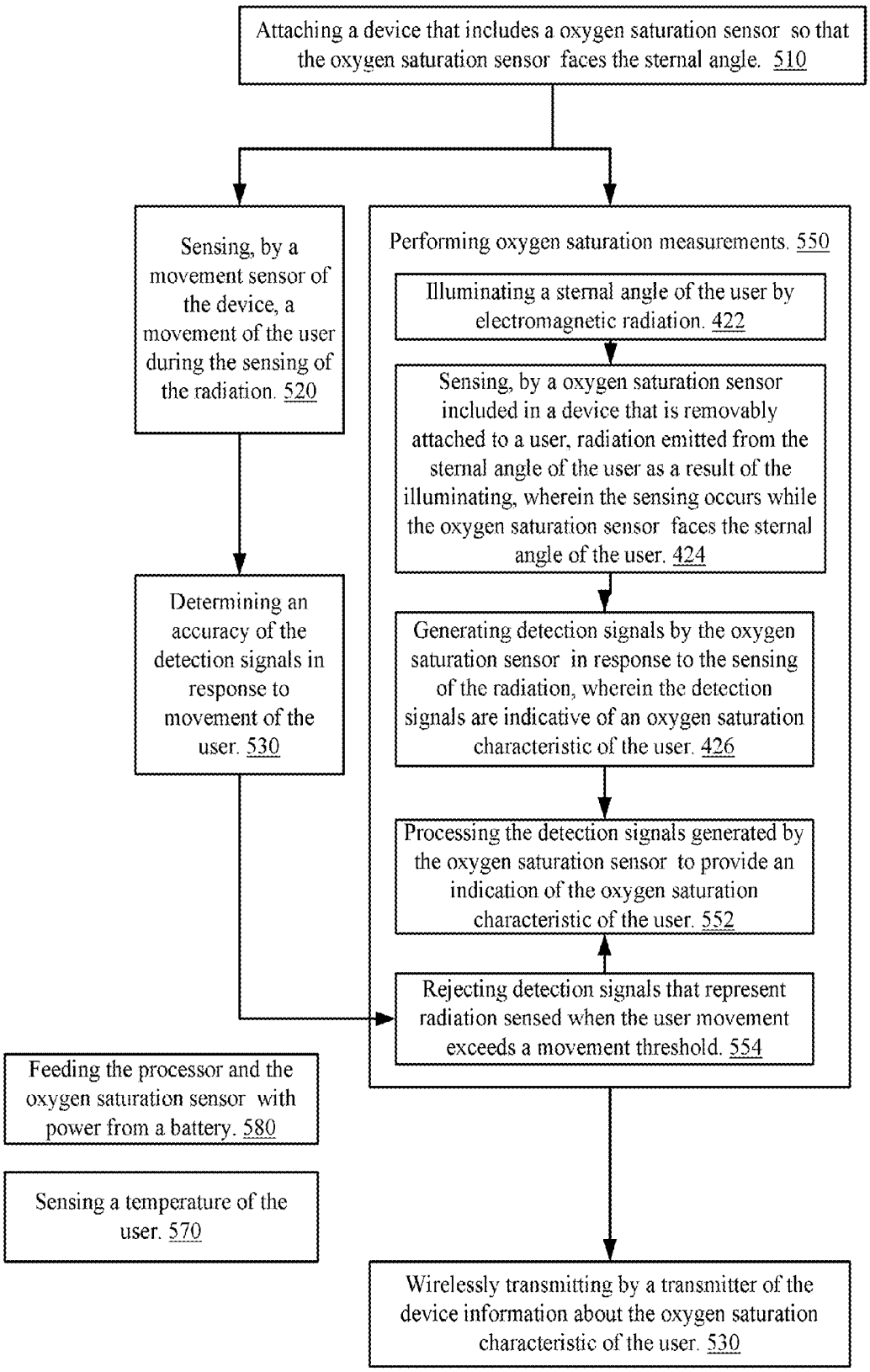
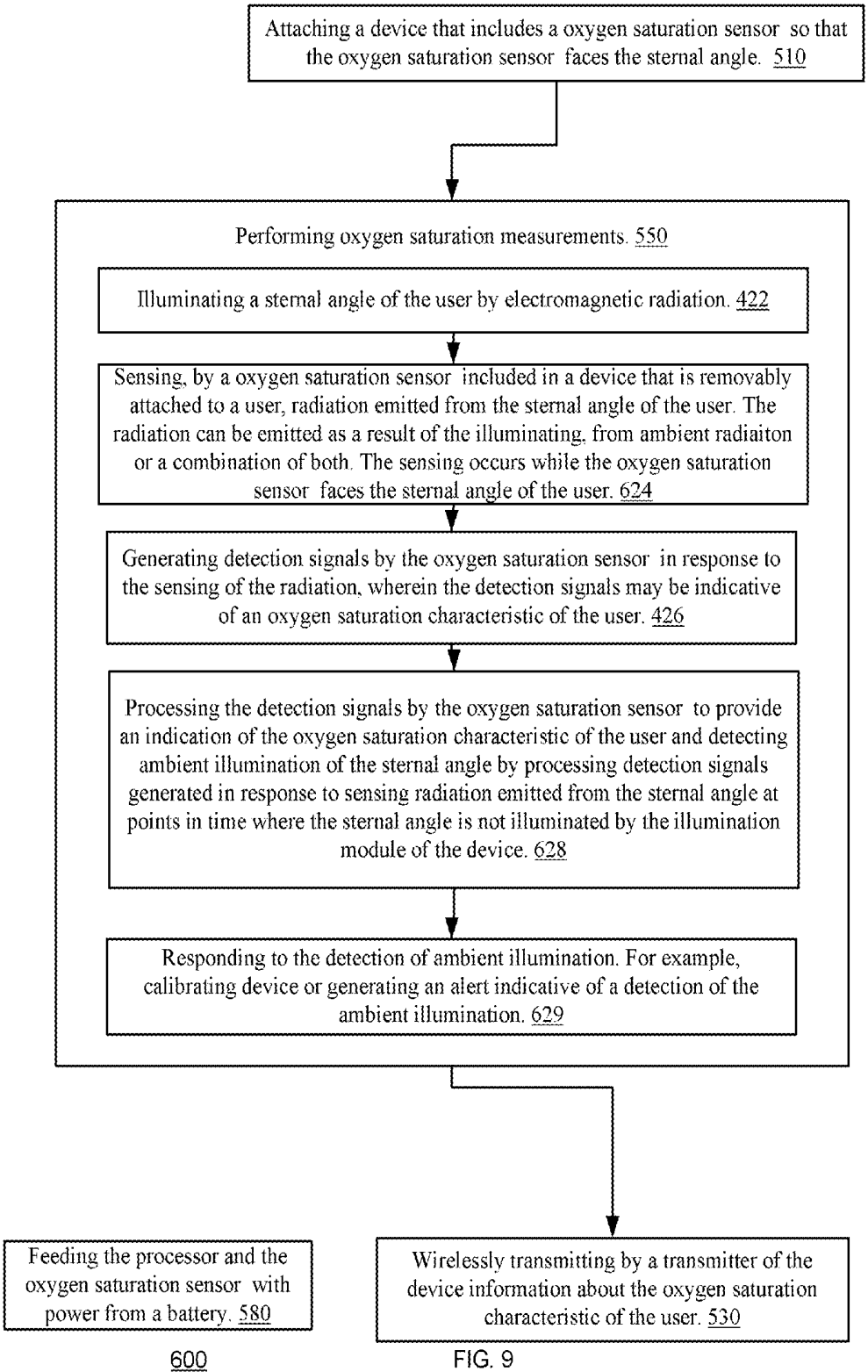

Attaching a device that includes a oxygen saturation sensor so that the oxygen saturation sensor faces the sternal angle. 410
Performing oxygen saturation measurements. 420
Illuminating a sternal angle of the user by electromagnetic radiation. 422
Sensing, by a oxygen saturation sensor included in a device that is removably attached to a user, radiation emitted from the sternal angle of the user as a result of the illuminating, wherein the sensing occurs while the oxygen saturation sensor faces the sternal angle of the user. 424
Generating detection signals by the oxygen saturation sensor in response to the sensing of the radiation, wherein the detection signals are indicative of an oxygen saturation characteristic of the user. 426
Processing the detection signals generated by the oxygen saturation sensor to provide an indication of the oxygen saturation characteristic of the user. 428
Wirelessly transmitting by a transmitter of the device information about the oxygen saturation characteristic of the user. 430
Feeding the processor and the oxygen saturation sensor with power from a battery. The battery may be positioned within a lower case of the device; wherein the processor is positioned within an upper case of the device. 480
400

FIG. 7


Attaching a device that includes a oxygen saturation sensor so that the oxygen saturation sensor faces the sternal angle. 510
Sensing, by a movement sensor of the device, a movement of the user during the sensing of the radiation. 520
Determining an accuracy of the detection signals in response to movement of the user. 530
Performing oxygen saturation measurements. 550
Illuminating a sternal angle of the user by electromagnetic radiation. 422
Sensing, by a oxygen saturation sensor included in a device that is removably attached to a user, radiation emitted from the sternal angle of the user as a result of the illuminating, wherein the sensing occurs while the oxygen saturation sensor faces the sternal angle of the user. 424
Generating detection signals by the oxygen saturation sensor in response to the sensing of the radiation, wherein the detection signals are indicative of an oxygen saturation characteristic of the user. 426
Processing the detection signals generated by the oxygen saturation sensor to provide an indication of the oxygen saturation characteristic of the user. 552
Rejecting detection signals that represent radiation sensed when the user movement exceeds a movement threshold. 554
Feeding the processor and the oxygen saturation sensor with power from a battery. 580
Sensing a temperature of the user. 570
Wirelessly transmitting by a transmitter of the device information about the oxygen saturation characteristic of the user. 530

500

FIG. 8


Attaching a device that includes a oxygen saturation sensor so that the oxygen saturation sensor faces the sternal angle. 510
Performing oxygen saturation measurements. 550
Illuminating a sternal angle of the user by electromagnetic radiation. 422
Sensing, by a oxygen saturation sensor included in a device that is removably attached to a user, radiation emitted from the sternal angle of the user. The radiation can be emitted as a result of the illuminating, from ambient radiaiton or a combination of both. The sensing occurs while the oxygen saturation sensor faces the sternal angle of the user. 624
Generating detection signals by the oxygen saturation sensor in response to the sensing of the radiation, wherein the detection signals may be indicative of an oxygen saturation characteristic of the user. 426
Processing the detection signals by the oxygen saturation sensor to provide an indication of the oxygen saturation characteristic of the user and detecting ambient illumination of the sternal angle by processing detection signals generated in response to sensing radiation emitted from the sternal angle at points in time where the sternal angle is not illuminated by the illumination module of the device. 628
Responding to the detection of ambient illumination. For example, calibrating device or generating an alert indicative of a detection of the ambient illumination. 629
Feeding the processor and the oxygen saturation sensor with power from a battery. 580
Wirelessly transmitting by a transmitter of the device information about the oxygen saturation characteristic of the user. 530

600

FIG. 9

OXYGEN SATURATION MEASUREMENTS

BACKGROUND OF THE INVENTION

[0001] Oxygen saturation measurements provide highly valuable information about the state of a user. Results of oxygen saturation measurements depend upon the location of measurement and may be required to be taken over relatively long periods.

[0002] There is a growing need to provide methods for accurate oxygen saturation measurements that can be easily taken over long periods of time.

SUMMARY OF THE INVENTION

[0003] According to an embodiment of the invention there may be provided a method that may include illuminating a sternal angle of the user by electromagnetic radiation; and sensing, by an oxygen saturation sensor included in a device that is removably attached to a user, radiation emitted from the sternal angle of the user as a result of the illuminating, wherein the sensing occurs while the oxygen saturation sensor faces the sternal angle of the user; and generating detection signals by the oxygen saturation sensor in response to the sensing of the radiation, wherein the detection signals are indicative of an oxygen saturation characteristic of the user.

[0004] The method may include processing the detection signals by the oxygen saturation sensor to provide an indication of the oxygen saturation characteristic of the user. The device may include a sheet having an underside provided with a self-adhesive.

[0005] The method may include sensing, by a movement sensor of the device, a movement of the user during the sensing of the radiation; and determining an accuracy of the detection signals in response to movement of the user.

[0006] The method may include rejecting detection signals that represent radiation sensed when the user movement exceeds a movement threshold.

[0007] The method may include sensing the radiation by a plurality of photodiodes that are coupled in parallel to each other.

[0008] The method may include sensing a temperature of the user by a temperature sensor of the device.

[0009] The illuminating may include illuminating the sternal angle of the user by a diode that emits visible light pulses and infrared pulses in an interleaved manner.

[0010] The illumination may be executed by an illumination module of the device.

[0011] The method may include detecting ambient illumination of the sternal angle by processing detection signals generated in response to sensing radiation emitted from the sternal angle at points in time where the sternal angle is not illuminated by the illumination module of the device.

[0012] The method may include generating an alert indicative of a detection of the ambient illumination.

[0013] The method may include sensing the radiation by a plurality of photodiodes that are arranged in a radially symmetrical manner.

[0014] The method may include sending the detection signals to a processor of the device and processing the detection signals by the processor to provide a result indicative of the oxygen saturation characteristic of the user.

[0015] The method may include feeding the processor and the oxygen saturation sensor with power from a battery positioned within a lower case of the device; wherein the processor is positioned within an upper case of the device.

[0016] The method may include wirelessly transmitting by a transmitter of the device information about the oxygen saturation characteristic of the user.

[0017] According to an embodiment of the invention there may be provided a device that is removably attached to a user and may include an oxygen saturation sensor, wherein the oxygen saturation sensor may be configured to: (a) sense radiation emitted from a sternal angle of a user as a result of an illuminating of the sternal angle of the user, wherein the sensing occurs while the oxygen saturation sensor faces the sternal angle of the user; and (b) generate detection signals in response to the sensing of the radiation, wherein the detection signals are indicative of an oxygen saturation characteristic of the user.

[0018] The device may be configured to process the detection signals by the oxygen saturation sensor to provide an indication of the oxygen saturation characteristic of the user.

[0019] The device may include a sheet having an underside provided with a self-adhesive.

[0020] The device may include a movement sensor that may be configured to sense a movement of the user during the sensing of the radiation; and wherein the device may be configured to determine an accuracy of the detection signals in response to movement of the user.

[0021] The device may be configured to reject detection signals that represent radiation sensed when the user movement exceeds a movement threshold.

[0022] The oxygen saturation sensor may include a plurality of photodiodes that are coupled in parallel to each other.

[0023] The device may include a temperature sensor that may be configured to sense a temperature of the user.

[0024] The device may be configured to illuminate the sternal angle of the user by a diode that emits visible light pulses and infrared pulses in an interleaved manner.

[0025] The device may include an illumination module that may be configured to illuminate the sternum angle of the user.

[0026] The device may be configured to detect ambient illumination of the sternal angle by processing detection signals generated in response to sensing radiation emitted from the sternal angle at points in time where the sternal angle is not illuminated by the illumination module of the device.

[0027] The device may be configured to generate an alert indicative of a detection of the ambient illumination.

[0028] The device may include a plurality of photodiodes that are configured in a radially symmetrical manner.

[0029] The device may include a processor that may be configured to receive the detection signals and to process the detection signals by the processor to provide a result indicative of the oxygen saturation characteristic of the user.

[0030] The device may include a battery that may be configured to feed the processor and the oxygen saturation sensor with power, wherein the battery is positioned within a lower case of the device; wherein the processor is positioned within an upper case of the device.

[0031] The device may include a transmitter that may be configured to wirelessly transmit information about the oxygen saturation characteristic of the user.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032] The subject matter regarded as the invention is particularly pointed out and distinctly claimed in the concluding portion of the specification. The invention, however, both as

to organization and method of operation, together with objects, features, and advantages thereof may best be understood by reference to the following detailed description when read with the accompanying drawings in which:

[0033] FIG. **1** illustrates the sternum and the ribs of a person;

[0034] FIG. **2** is an exploded view of a device according to an embodiment of the invention;

[0035] FIG. **3** illustrates a placement of the device of FIG. **2** on a chest of a user according to an embodiment of the invention;

[0036] FIG. **4** illustrates a placement of the device of FIG. **2** on a chest of a user according to an embodiment of the invention;

[0037] FIG. **5** is a schematic diagram of various components of the device of FIG. **2** according to an embodiment of the invention;

[0038] FIG. **6** is a timing diagram according to an embodiment of the invention;

[0039] FIG. **7** illustrates a method according to an embodiment of the invention;

[0040] FIG. **8** illustrates a method according to an embodiment of the invention; and

[0041] FIG. **9** illustrates a method according to an embodiment of the invention.

[0042] It will be appreciated that for simplicity and clarity of illustration, elements shown in the figures have not necessarily been drawn to scale. For example, the dimensions of some of the elements may be exaggerated relative to other elements for clarity. Further, where considered appropriate, reference numerals may be repeated among the figures to indicate corresponding or analogous elements.

DETAILED DESCRIPTION OF THE DRAWINGS

[0043] The subject matter regarded as the invention is particularly pointed out and distinctly claimed in the concluding portion of the specification. The invention, however, both as to organization and method of operation, together with objects, features, and advantages thereof, may best be understood by reference to the following detailed description when read with the accompanying drawings.

[0044] In the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of the invention. However, it will be understood by those skilled in the art that the present invention may be practiced without these specific details. In other instances, well-known methods, procedures, and components have not been described in detail so as not to obscure the present invention.

[0045] It has been surprisingly found that measuring oxygen saturation by illuminating the sternal angle of a user provides reliable results. The sternal angle is easy to find by the user (or third parties) so that users can easily and accurately position the sensor to face sternal angle. This greatly increases the repetitiveness of the oxygen saturation results. Furthermore—placing the device in this position reduces the breath induced movements that the device experiences and further increases the accuracy of this measurement. In addition—placing the device at that position is relatively easy as the sternum is relatively flat.

[0046] FIG. **1** illustrates the sternum and the ribs of a person **10**. The sternum angle is located between the manubrium bone and the body of the sternum.

[0047] FIG. **2** is an exploded view of a device **100** according to an embodiment of the invention.

[0048] Device **100** includes:

[0049] 1. Processor and transceiver (collectively denoted **101**).

[0050] 2. An upper elastic layer **120** that include first, second and third openings **121**, **122** and **123**.

[0051] 3. Intermediate layer **130** that includes conductors **131**, **132** and **134** and socket **135** for conveying power from battery **133**.

[0052] 4. Temperature sensor **140** that includes temperature sensor cover **141**, temperature sensor electrical board **142** and temperature sensor case **143**.

[0053] 5. Oxygen saturation sensor **150** that includes oxygen saturation sensor electrical board **151**, **151**, oxygen saturation sensor shield **152** and oxygen saturation sensor case **153**.

[0054] 6. A lower elastic layer **160** that include first, second and third openings **161**, **162** and **163** and an addition portion **164** to be contacted by lower case **180**. The lower elastic layer **160** has an underside provided with a self-adhesive. Removable cover **170** shields the self-adhesive and is removed before attaching the device **100** to a user.

[0055] 7. Upper case **111** having socket **112**.

[0056] 8. Lower case **180**.

[0057] The temperature sensor cover **141** is shaped and positioned to pass through the first opening **121** of the upper elastic layer **120**. Cover **155** is arranged to seal the second opening **122** of the upper elastic layer **120**. Cover **155** is positioned between the upper elastic layer **120** and conductor **132** of the intermediate layer **120**. Conductor **132** is positioned above the oxygen saturation sensor electrical board **151**.

[0058] The temperature sensor case **143** is positioned directly above the first opening **162** of the lower elastic layer **160**.

[0059] The oxygen saturation sensor **150** is positioned directly above the second opening **163** of the lower elastic layer **160**. It may contact the sternum angle during measurements but may be positioned slightly (few millimeters) above the sternum angle without contacting the sternum angle.

[0060] Battery **133** is placed within lower case **180** and its upper facet supports a lower facet of upper case **111** that is connected to the processor and transceiver **101**.

[0061] Device **100** is illustrated as including a temperature sensor **140** and oxygen saturation sensor **150**. It is noted that other sensor (or sensors) can be provided instead (or in addition) to the temperature sensor **140**. Alternatively, the only sensor included in device **100** may be the oxygen saturation sensor **150**. For an example (illustrated in FIG. **6**), the device **100** may include a movement sensor **144**, a temperature sensor **140** and the oxygen saturation sensor **150**.

[0062] The device **100** may be very compact and light weight. Its transceiver (denoted **101(2)** in FIG. **6**) may be arranged to perform short range and/or long range transmissions.

[0063] FIG. **3** illustrates device **100** as being positioned on a user wherein the oxygen saturation sensor **150** is positioned directly above the sternum angle, the temperature sensor **140** is positioned below the sternum angle and the processor/transceiver **101** is positioned above the sternum angle.

[0064] FIG. **4** illustrates the lower elastic layer **160** of device **100** as being positioned on a user wherein the third

opening **163** (that the oxygen saturation sensor **150** is positioned directly above) is positioned directly above the sternum angle **22**, the temperature sensor **140** is positioned directly above the body **24** of the sternum and the lower case **180** faces the manubrium bone **24**.

[0065] FIG. **5** is a schematic diagram of various components of the device **100** of FIG. **2** according to an embodiment of the invention.

[0066] FIG. **5** illustrates the oxygen saturation sensor **150** as including three radiation sensing elements **220**, **230** and **240**, illumination module **210** (illustrated as being positioned directly above the sternum angle **20** and within third opening **163** of the lower elastic layer **160**), intermediate module **260** (that may include an analog amplifier, an analog to digital converter or a combination of both), processor **101**(**1**) of processor/transducer **101**, transducer **101**(**2**), temperature sensor **140** and movement sensor **144**.

[0067] The illumination module **210** may be arranged to illuminate the sternum angle with infrared pulses and visible light pulses. The radiation sensing elements **220**, **230** and **240** may sense radiation reflected and/or scattered from the sternum angle in the infrared and visible light ranges and send detection signals towards intermediate module **260**.

[0068] Pulses of energy are provided to the illumination module **210** via conductor **210**.

[0069] Radiation sensing elements **220**, **230** and **240** are coupled in parallel to each other via conductors **270** but may be coupled in a serial manner to each other.

[0070] Processor **101**(**1**) may receive detection signals from temperature sensor **140** and movement sensor **144**. It may be arranged to disregard detection signals obtained when the user moves in a manner that may reduce the reliability of the detection signals below a predefined threshold.

[0071] FIG. **6** is a timing diagram **300** according to an embodiment of the invention. It illustrates a cyclic illumination pattern having a period of **330**. Each cycle includes an activation window **301** of a red diode (delimited between RED diode ON and RED diode OFF) and an activation window **313** of an infrared diode (delimited between IR diode ON and IR diode OFF) that are followed by an idle period **333**. Each activation window includes a stabilization period (**302** and **312** respectively) in which the emitted light (red or infrared) is stabilized that is followed by a measurement period (**303** and **313**) in which the light pulses (**304** and **314** respectively) can be used for oxygen saturation measurements. The activation windows may be of the same length (for example 0.5 millisecond) or of different lengths. The cyclic illumination pattern may have a cycle **330** that is longer and even much longer than the duration of the activation windows (for example—13 millisecond).

[0072] Detection signals generated during idle period **333** may be indicative of unwanted ambient light.

[0073] FIG. **7** illustrates method **400** according to an embodiment of the invention.

[0074] Method **400** may start by stage **410** of attaching a device that includes an oxygen saturation sensor so that the oxygen saturation sensor faces the sternal angle. This may, for example, positioning device **100** (or any other device that has an oxygen saturation sensor for sensing oxygen saturation characteristics) on a user. The device can be attached using a self-adhesive material, using a belt and the like.

[0075] Stage **410** may be followed by stage **420** of performing oxygen saturation measurements. Multiple oxygen saturation measurements can be performed over short or long periods of time—minutes, hours, days and even more.

[0076] An oxygen saturation measurement may include a detection signal acquisition phase and a processing phase. The detection signal acquisition phase is executed by the device attached to the client. The processing stage can be executed in full by the device, can be partially executed by the device or can be executed by another device or system not attached to the device.

[0077] The detection signal acquisition stage includes:

[0078] 1. Illuminating (stage **422**) a sternal angle of the user by electromagnetic radiation.

[0079] 2. Sensing (stage **424**) by an oxygen saturation sensor included in a device that is removably attached to a user, radiation emitted from the sternal angle of the user. The radiation detected can result from the illuminating of the sternal angle. The sensing occurs while the oxygen saturation sensor faces the sternal angle of the user.

[0080] 3. Generating detection signals (stage **426**) by the oxygen saturation sensor in response to the sensing of the radiation, wherein the detection signals are indicative of an oxygen saturation characteristic of the user.

[0081] Stage **422** may include illuminating the sternal angle of the user by a diode that emits visible light pulses and infrared pulses in an interleaved manner.

[0082] Stage **422** may be executed by an illumination module of the device.

[0083] Stage **424** may include sensing the radiation by one or more sensing elements such as photodiodes. If there are multiple sensing elements the sensing elements may be coupled to each other in parallel, in serial or a combination thereof.

[0084] Stage **424** may include sensing the radiation by a plurality of photodiodes that are arranged in a radially symmetrical manner.

[0085] The processing phase includes processing (stage **428**) the detection signals generated by the oxygen saturation sensor to provide an indication of the oxygen saturation characteristic of the user.

[0086] If the processing is performed by a processor of the device then stage **428** is preceded (or includes) sending the detection signals to the processor of the device. If the processing is executed by a processor that does not belong to the device then the method includes transmitting the detection signals towards that processor.

[0087] Stage **420** may be followed by stage **430** of wirelessly transmitting by a transmitter of the device information about the oxygen saturation characteristic of the user.

[0088] Method **400** may also include stage **480** of feeding the processor and the oxygen saturation sensor with power from a battery. The battery may be positioned within a lower case of the device. The processor may be positioned within an upper case of the device.

[0089] FIG. **8** illustrates method **500** according to an embodiment of the invention.

[0090] Method **500** starts by stage **510** of attaching a device that includes an oxygen saturation sensor so that the oxygen saturation sensor faces the sternal angle.

[0091] Stage **510** may be followed by stages **520** and **550**.

[0092] Stage **520** may include sensing, by a movement sensor of the device, a movement of the user during the sensing of the radiation.

[0093] Stage **520** may be followed by stage **530** of determining an accuracy of the detection signals in response to movement of the user.

[0094] Stage **550** may include of performing oxygen saturation measurements. Multiple oxygen saturation measurements can be performed over short or long periods of time-minutes, hours, days and even more.

[0095] Stage **550** may include stages **422**, **424** and **426**. Stage **550** may also include stage **552** of processing the detection signals by the oxygen saturation sensor to provide an indication of the oxygen saturation characteristic of the user and stage **554** of rejecting detection signals that represent radiation sensed when the user movement exceeds a movement threshold.

[0096] If the processing is performed by a processor of the device then stage **552** is preceded (or includes) sending the detection signals to the processor of the device. If the processing is executed by a processor that does not belong to the device then the method includes transmitting the detection signals towards that processor.

[0097] Stage **550** may be followed by stage **560** of wirelessly transmitting by a transmitter of the device information about the oxygen saturation characteristic of the user.

[0098] Method **500** may also include stage **580** of feeding the processor and the oxygen saturation sensor with power from a battery. The battery may be positioned within a lower case of the device. The processor may be positioned within an upper case of the device.

[0099] FIG. **8** also illustrates method **500** as sensing (**570**) a temperature of the user by a temperature sensor of the device. It is noted that this stage can include performing any further sensing operation by any other type of sensor.

[0100] FIG. **9** illustrates method **600** according to an embodiment of the invention.

[0101] Method **600** may start by stage **610** of attaching a device that includes an oxygen saturation sensor so that the oxygen saturation sensor faces the sternal angle.

[0102] Stage **610** may be followed by stage **620** of performing oxygen saturation measurements.

[0103] An oxygen saturation measurement may include a detection signal acquisition phase and a processing phase. The detection signal acquisition phase is executed by the device attached to the client. The processing stage can be executed in full by the device, can be partially executed by the device or can be executed by another device or system not attached to the device.

[0104] The detection signal acquisition stage includes:

[0105] 1. Illuminating (stage **422**) a sternal angle of the user by electromagnetic radiation.

[0106] 2. Sensing (stage **624**), by an oxygen saturation sensor included in a device that is removably attached to a user, radiation emitted from the sternal angle of the user. The radiation detected can result of the illuminating of the sternal angle, from ambient illumination of from a combination thereof. The sensing occurs while the oxygen saturation sensor faces the sternal angle of the user.

[0107] 3. Generating detection signals (stage **426**) by the oxygen saturation sensor in response to the sensing of the radiation, wherein the detection signals are indicative of an oxygen saturation characteristic of the user.

[0108] Stage **424** may include sensing the radiation by one or more sensing elements such as photodiodes. If there are multiple sensing elements the sensing elements may be coupled to each other in parallel, in serial or a combination thereof.

[0109] The processing phase includes processing (stage **628**) the detection signals by the oxygen saturation sensor to provide an indication of the oxygen saturation characteristic of the user.

[0110] Stage **628** may include detecting ambient illumination of the sternal angle by processing detection signals generated (during stage **426**) in response to sensing radiation emitted from the sternal angle at points in time where the sternal angle is not illuminated by the illumination module of the device. See, for example, generation of detection signals that sense ambient radiation sensed during idle period **330** of FIG. **5**.

[0111] Stage **628** may be followed by stage **629** of responding to the detection of ambient illumination.

[0112] For example, calibrating device or generating an alert indicative of a detection of the ambient illumination. The calibrating may include estimating the ambient light and compensating the oxygen saturation measurements in response to the ambient light. For example- reducing from detected radiation (detected when illuminating the sternum angle by IR or light pulse) the estimated value of the ambient light (IR component or light component respectively).

[0113] The alert may signal the user that he should re-attach the device in order to reduce or eliminate ambient radiation from reaching the sternum angle.

[0114] If the processing is performed by a processor of the device then stage **628** is preceded (or includes) sending the detection signals to the processor of the device. If the processing is executed by a processor that does not belong to the device then the method includes transmitting the detection signals towards that processor.

[0115] Stage **620** may be followed by stage **630** of wirelessly transmitting by a transmitter of the device information about the oxygen saturation characteristic of the user.

[0116] Method **600** may also include stage **680** of feeding the processor and the oxygen saturation sensor with power from a battery. The battery may be positioned within a lower case of the device. The processor may be positioned within an upper case of the device.

[0117] While certain features of the invention have been illustrated and described herein, many modifications, substitutions, changes, and equivalents will now occur to those of ordinary skill in the art. It is, therefore, to be understood that the appended claims are intended to cover all such modifications and changes as fall within the true spirit of the invention.

1. A method for measuring oxygen saturation of a user, the method comprises:

illuminating a sternal angle of the user by electromagnetic radiation; and

sensing, by an oxygen saturation sensor included in a device that is removably attached to a user, radiation emitted from the sternal angle of the user as a result of the illuminating, wherein the sensing occurs while the oxygen saturation sensor faces the sternal angle of the user; and

generating detection signals by the oxygen saturation sensor in response to the sensing of the radiation, wherein the detection signals are indicative of an oxygen saturation characteristic of the user.

2. The method according to claim 1 comprises processing the detection signals by the oxygen saturation sensor to provide an indication of the oxygen saturation characteristic of the user.

3. The method according to claim 1 wherein the device comprises a sheet having an underside provided with a self-adhesive.

4. The method according to claim 1, comprising sensing, by a movement sensor of the device, a movement of the user during the sensing of the radiation; and determining an accuracy of the detection signals in response to movement of the user.

5. The method according to claim 4 comprising rejecting detection signals that represent radiation sensed when the user movement exceeds a movement threshold.

6. The method according to claim 1 comprising sensing the radiation by a plurality of photodiodes that are coupled in parallel to each other.

7. The method according to claim 1 further comprising sensing a temperature of the user by a temperature sensor of the device.

8. The method according to claim 1 wherein the illuminating comprises illuminating the sternal angle of the user by a diode that emits visible light pulses and infrared pulses in an interleaved manner.

9. The method according to claim 1 wherein the illumination is executed by an illumination module of the device.

10. The method according to claim 9 comprising detecting ambient illumination of the sternal angle by processing detection signals generated in response to sensing radiation emitted from the sternal angle at points in time where the sternal angle is not illuminated by the illumination module of the device.

11. The method according to claim 10 comprising generating an alert indicative of a detection of the ambient illumination.

12. The method according to claim 1 comprising sensing the radiation by a plurality of photodiodes that are arranged in a radially symmetrical manner.

13. The method according to claim 1 further comprising sending the detection signals to a processor of the device and processing the detection signals by the processor to provide a result indicative of the oxygen saturation characteristic of the user.

14. The method according to claim 13 comprising feeding the processor and the oxygen saturation sensor with power from a battery positioned within a lower case of the device; wherein the processor is positioned within an upper case of the device.

15. The method according to claim 13 further comprising wirelessly transmitting by a transmitter of the device information about the oxygen saturation characteristic of the user.

16. A device that is removably attached to a user and comprises an oxygen saturation sensor, wherein the oxygen saturation sensor is configured to: (a) sense radiation emitted from a sternal angle of a user as a result of an illuminating of the sternal angle of the user, wherein the sensing occurs while the oxygen saturation sensor faces the sternal angle of the user; and (b) generate detection signals in response to the sensing of the radiation, wherein the detection signals are indicative of an oxygen saturation characteristic of the user.

17. The device according to claim 16 wherein the device is configured to process the detection signals by the oxygen saturation sensor to provide an indication of the oxygen saturation characteristic of the user.

18. The device according to claim 16 wherein the device comprises a sheet having an underside provided with a self-adhesive.

19. The device according to claim 1, comprising a movement sensor that is configured to sense a movement of the user during the sensing of the radiation; and wherein the device is configured to determine an accuracy of the detection signals in response to movement of the user.

20. The device according to claim 19 wherein the device is configured to reject detection signals that represent radiation sensed when the user movement exceeds a movement threshold.

21. The device according to claim 16 wherein the oxygen saturation sensor comprises a plurality of photodiodes that are coupled in parallel to each other.

22. The device according to claim 16 comprising a temperature sensor that is configured to sense a temperature of the user.

23. The device according to claim 16 wherein the device is configured to illuminate the sternal angle of the user by a diode that emits visible light pulses and infrared pulses in an interleaved manner.

24. The device according to claim 16 wherein the device comprises an illumination module that is configured to illuminate the sternum angle of the user.

25. The device according to claim 24 wherein the device is configured to detect ambient illumination of the sternal angle by processing detection signals generated in response to sensing radiation emitted from the sternal angle at points in time where the sternal angle is not illuminated by the illumination module of the device.

26. The device according to claim 25 wherein the device is configured to generate an alert indicative of a detection of the ambient illumination.

27. The device according to claim 16 comprising a plurality of photodiodes that are configured in a radially symmetrical manner.

28. The device according to claim 16 comprising a processor that is configured to receive the detection signals and to process the detection signals by the processor to provide a result indicative of the oxygen saturation characteristic of the user.

29. The device according to claim 28 comprising a battery that is configured to feed the processor and the oxygen saturation sensor with power, wherein the battery is positioned within a lower case of the device; wherein the processor is positioned within an upper case of the device.

30. The device according to claim 28 comprising a transmitter that is configured to wirelessly transmit information about the oxygen saturation characteristic of the user.

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专利名称(译)	氧饱和度测量		
公开(公告)号	US20160192883A1	公开(公告)日	2016-07-07
申请号	US14/590149	申请日	2015-01-06
申请(专利权)人(译)	LIFEWATCH TECHNOLOGIES，LTD.		
当前申请(专利权)人(译)	LIFEWATCH TECHNOLOGIES，LTD.		
[标]发明人	PASTERNAK MICHAEL LOVTON YOSSI		
发明人	PASTERNAK, MICHAEL LOVTON, YOSSI		
IPC分类号	A61B5/00 A61B5/11 A61B5/01 A61B5/1455		
CPC分类号	A61B5/6823 A61B5/14551 A61B5/7278 A61B5/6832 A61B5/11 A61B2560/0214 A61B5/01 A61B5/0004 A61B5/746 A61B2562/04 A61B5/721 A61B5/14552 A61B5/6833		
外部链接	Espacenet USPTO		

摘要(译)

一种用于测量用户的氧饱和度的方法，该方法包括通过电磁辐射照射用户的胸骨角;通过包括在可拆卸地连接到用户的装置中的氧饱和度传感器，感测由于照射而从用户的胸骨角发射的辐射，其中在氧饱和度传感器面向胸骨角的情况下进行感测。用户;响应于辐射的感测，由氧饱和度传感器产生检测信号，其中检测信号指示用户的氧饱和度特性。