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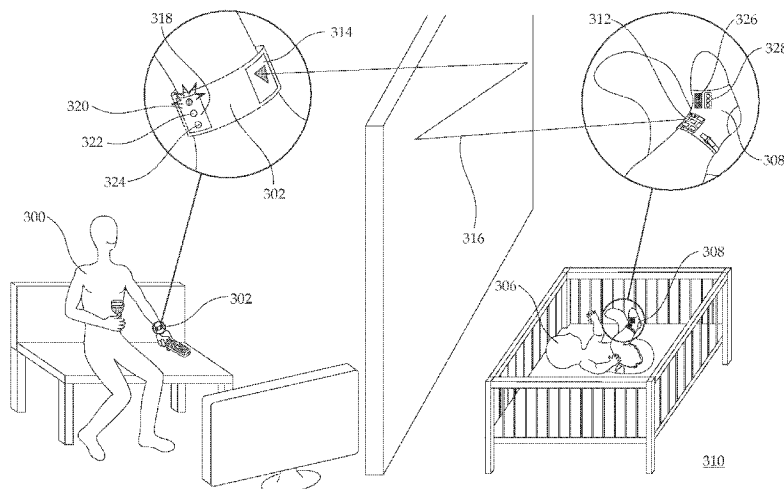


FIGURE 3A

(57) Abstract: Disclosed are methods and devices for monitoring and sensing stress situations of a human, such as a baby, and in some embodiments informing parents or other caretakers of such situations. 43

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DEVICE AND METHOD FOR PROVIDING INFORMATION INDICATIVE OF A STRESS SITUATION IN A HUMAN

RELATED APPLICATION

5 The present application gains priority from UK Patent Application GB 1213159.5 filed 24 July 2012, which is incorporated by reference as if fully set-forth herein.

FIELD AND BACKGROUND OF THE INVENTION

10 The invention, in some embodiments, relates to the field of sensors, and more particularly to methods and devices for providing information indicative of a stress situation in a baby, and in some embodiment, notifying a caregiver of such a situation.

 Electro-optical measurement of blood characteristics has been found to be useful in many areas of blood constituent diagnostics, such as glucose levels, oxygen saturation, hematocrit, bilirubin and others. This method is advantageous in that it can be performed in a
15 non-invasive fashion. In particular, much research has been done on oximetry, a way of measuring oxygen saturation in the blood, as an early indicator of respiratory distress.

 Pulse oximetry uses the difference in the absorption properties of oxyhemoglobin and deoxyhemoglobin to measure blood oxygen saturation in arterial blood. The oximeter passes light, usually red and infrared, through body tissue and uses a photodetector to sense the
20 absorption of light by the tissue. By measuring oxygen levels in the blood, one is able to detect respiratory distress at its onset.

 Various types of pulse oximetry are known. In transmission oximetry, two or more wavelengths of light are transmitted by one or more light sources on one side of an appendage where blood perfuses the tissue thereof (i.e. a finger or earlobe) through the
25 appendage towards a photodetector on the opposite side of the appendage, allowing to determine how much of what wavelengths of light are absorbed by blood in the appendage. The light source(s) and photodetector are typically mounted on a clip or on a band that attaches to the appendage and delivers data by cable to a processor. There are many problems with this type of pulse oximetry, including discomfort caused by the clips or bands,
30 geometrical limitations of the appendage to which a clip or band can be attached, and susceptibility to inaccurate reading due to movement of the light source(s) with respect to the photodetector.

In reflective, or backscattering, pulse oximetry, the light sources and photodetector are placed side by side on the same tissue surface, so reflective pulse oximeters may also be placed on a surface of a head, wrist or foot.

5 Electrodermal activity (EDA) sensors detect changes in the electrical properties of the skin in response to stress or anxiety. EDA sensors measure electrical properties of the skin by recording the electrical resistance of the skin following passing a low voltage current or by recording weak currents generated by the body. The electrodermal activity of a human may change in response to emotions and emotional states such as fear, anger, startle response, pain, and orienting response, which allows EDA sensing to be used in lie detection tests such
10 as the polygraph.

During the first year of life, human infants are susceptible to breathing disturbances and respiratory distress. Sudden Infant Death Syndrome (SIDS), also known as crib death or cot death, is a medical condition in which an infant enters respiratory distress and stops breathing, leading to the death of the infant. Although the cause and the warning signs of
15 SIDS are not clear, it has been shown that early detection of respiratory distress can provide the time to administer the aid necessary to prevent death.

Many types of baby-monitoring devices are available, from devices including simple motion detectors to complicated devices which stream oxygen enriched air into the infant's environment. Some of the more accepted baby-monitoring devices include chest motion
20 monitors, carbon dioxide level monitors and heart rate (pulse) monitors. Unfortunately such devices often do not give the advance warning necessary for a caregiver to administer aid. In addition, such baby-monitoring devices often require attaching straps and/or cords to the baby, which are cumbersome to use and present a strangulation risk.

The most commonly used baby-monitoring device is a chest motion monitor
25 configured to issue a warning when no chest motion is detected during a predetermined period (e.g., 1 minute) but gives no warning when the breathing patterns become irregular or when hyperventilation is occurring. Such a device typically detects respiratory distress only once chest motion has ceased, when it is usually too late to help the baby. In addition, chest-motion monitors have a high level of "false alarms" due to difficulty in distinguishing
30 between normal lapses in breathing (up to 20 seconds in infants) and respiratory distress.

Many infants, and particularly neonates, sleep for a large portion of the day, often as much of 20 hours. A baby-monitoring device must be battery-powered and comfortable to wear to be available for monitoring a baby during all sleep times and to be cable-free. These

requirements mean that a baby-monitoring device is preferably designed to operate in a manner to ensure that the batteries have long operation durations during the monitoring time.

SUMMARY OF THE INVENTION

5 The invention, in some embodiments, relates to the field of sensors, and more particularly to methods and devices for providing information indicative of a stress situation in a human, such as a human baby.

 The invention, in some embodiments, relates to the field of sensors, and more particularly to methods and devices for identifying a possible reason for a potential stress
10 situation, and in some embodiments notifying a caregiver such as a parent of the identified reason.

 According to an aspect of some embodiments of the invention, there is provided a method for providing information indicative of a stress situation in a human, comprising:

15 positioning a pulse oximeter and an electrodermal activity (EDA) sensor to monitor a human;

 at a processor functionally associated with the EDA sensor and the pulse oximeter, monitoring the human by receiving from the EDA sensor an EDA measurement signal at a EDA sensing rate;

20 at a processing rate, processing the received EDA measurement signals to identify an EDA indication of stress; and

 if an EDA indication of stress is identified:
 activating the pulse oximeter to determine a measure of at least one of pulse and blood oxygenation of the human;

25 at the processor, receiving from the pulse oximeter at least one pulse oximeter signal related to the determined measure of at least one of pulse and blood oxygenation;

 at the processor, processing the received pulse oximeter signal to identify a pulse oximeter indication of stress; and

30 if a pulse oximeter indication of stress is identified, the processor automatically providing an alarm signal.

 In some embodiments of the method, the providing an alarm signal comprises at least one of: providing a visual alarm from a visual indicator functionally associated with the processor; providing an audible alarm from an aural indicator functionally associated with the

processor; and automatically activating a wireless transmitter functionally associated with the processor to wirelessly transmit an alarm signal to a remote monitoring unit.

In some embodiments, the method also comprises at the remote monitoring unit, providing an alarm perceivable to a human.

5 In some embodiments, the remote monitoring unit includes at least one of: a component suitable to be worn by a person; a component configured to be clipped onto clothes of a person; and a component configured to be carried in a pocket of a person.

In some embodiments, the remote monitoring unit comprises a component not configured to be ordinarily worn by a person, and the method also comprising placing the
10 component not configured to be worn by a person in the vicinity of a person.

In some embodiments, the method also comprises, during the monitoring of the human, if no EDA indication of stress is identified, wirelessly transmitting an all-clear signal to the monitoring unit.

In some embodiments, the pulse oximeter operates with power from an energy storage
15 unit, and the method also comprises: during the monitoring of the human, monitoring a charge state of the energy storage unit; and if the charge state of the energy storage unit is below a charge threshold, the processor automatically activating the wireless transmitter to wirelessly transmit a low battery signal to the remote monitoring unit.

In some embodiments, the method also comprises: in the remote monitoring unit,
20 monitoring quality of signals received from the wireless transmitter; and if the quality of the signals is insufficient, providing an insufficient signal indication perceivable to a human.

In some embodiments, the measure of blood oxygenation comprises a blood oxygenation percentage.

In some embodiments, the pulse oximeter indication of stress comprises at least one
25 of: a blood oxygenation measure of the pulse oximeter signal being below a blood oxygenation threshold; a pulse rate measure of the pulse oximeter signal being below a low pulse rate threshold; and a pulse rate measure of the pulse oximeter signal being above a high pulse rate threshold.

In some embodiments, the method also comprises indicating whether the pulse
30 oximeter indication is indicative of stress stemming from a problem in blood oxygenation of the human or of stress stemming from a problem in pulse rate of the human.

In some embodiments, the method also comprises storing the EDA measurement signals and/or the measures of pulse and/or blood oxygenation in a memory.

In some embodiments, the method also comprises, during the monitoring of the human, if no EDA indication of stress is identified, keeping the pulse oximeter in an inactive energy-saving state.

According to an aspect of some embodiments of the invention, there is also provided
5 a device useful for providing information indicative of a situation in a human, comprising:

a pulse-oximeter configured for determining a measure of at least one of pulse and blood oxygenation of a human and producing a pulse oximeter signal related to the determined measure of at least one of pulse and blood oxygenation;

10 an electrodermal activity (EDA) sensor configured for determining electrodermal activity of a human at an EDA sensing rate and producing an EDA measurement signal related to the determined electrodermal activity;

a processor functionally associated with the pulse oximeter and with the EDA sensor;

and

a wireless transmitter functionally associated with the processor,

15 wherein the processor is configured to:

receive from the EDA sensor an EDA measurement signal at the EDA sensing rate,

at a processing rate, process the received EDA measurement signals to identify an EDA indication of stress,

20 if an EDA indication of stress is identified, activate the pulse oximeter to determine a measure of at least one of pulse and blood oxygenation of a human,

receive from the pulse oximeter at least one pulse oximeter signal related to the determined measure of at least one of pulse and blood oxygenation,

25 process the received the pulse oximeter signal to identify a pulse oximeter indication of stress, and

if a pulse oximeter indication of stress is identified, automatically provide an alarm signal.

In some embodiments, the device also comprises at least one indicator configured,
30 upon provision of the alarm signal, to provide at least one indication perceivable to a human.

In some such embodiments, at least one indicator is a visual indicator to provide a visual indication to the human. In some such embodiments, at least one indicator is an aural indicator to provide an audible indication to the human.

In some embodiments, the device also comprises a remote monitoring station, including:

a wireless receiver configured to receive transmissions from the wireless transmitter; and

5 an alarm indicator, configured to provide an alarm perceivable to a human upon receipt of an alarm signal by the wireless receiver.

In some embodiments, the human is a baby.

In some embodiments, the remote monitoring unit comprises at least one of: a component suitable to be worn by a person; a component configured to be clipped onto
10 clothes of a person; a component configured to be carried the pocket of a person; and a component not configured to be ordinarily worn by a person.

In some embodiments, the remote monitoring unit of the device comprises at least one of:

a visual indicator, wherein the alarm perceivable to a human comprises a visual alarm;

15 an aural indicator, wherein the alarm perceivable to a human comprises an audible alarm; and

a tactile indicator and the alarm perceivable to a human comprises a tactile alarm.

In some embodiments, the processor of the device is also configured to monitor a charge state of an energy storage unit of the device, and if the charge state of the energy
20 storage unit is below a charge threshold, to transmit a low battery signal, via the transmitter of the device.

In some embodiments, the processor of the device is also configured, if no EDA indication of stress is identified, to wirelessly transmit an all-clear signal, via the transmitter.

In some embodiments, the remote monitoring unit of the device is configured to
25 monitor quality of signals received from the wireless transmitter and to provide an insufficient signal indication perceivable to a human if the quality of signals is insufficient.

In some embodiments of the device, the pulse oximeter indication of stress comprises at least one of:

30 a blood oxygenation measure of the pulse oximeter signal being below a blood oxygenation threshold;

a pulse rate measure of the pulse oximeter signal being below a low pulse rate threshold; and

a pulse rate measure of the pulse oximeter signal being above a high pulse rate threshold.

In some embodiments of the device, the alarm signal indicates whether the pulse oximeter indication of stress is indicative of stress stemming from a problem in blood oxygenation of the human or of stress stemming from a problem in pulse rate of the human.

In some embodiments, the device also comprises a memory functionally associated with the processor, configured for storing the EDA measurement signals and/or the measures of pulse and/or blood oxygenation.

In some embodiments, the device also comprises an energy storage unit configured to power a group of components including at least one of the EDA sensor, the pulse oximeter, the processor, and the wireless transmitter.

In some embodiments, the energy storage unit is configured to provide sufficient power for continuous operation of the group of components for a period of time of not less than 24 hours of normal use. In some such embodiments, such an energy storage unit has a capacity of at least 130 ampere hours.

In some embodiments, the device is configured to keep the pulse oximeter in an inactive energy-saving state as long as no EDA indication of stress is identified.

In some embodiments, providing an alarm signal comprises providing a visual alarm indication perceivable to a human from a visual indicator functionally associated with the processor. In some embodiments, providing an alarm signal comprises providing an audible alarm signal from an aural indicator functionally associated with the processor.

In some embodiments, providing an alarm signal comprises automatically activating a wireless transmitter functionally associated with the processor to wirelessly transmit an alarm signal to a remote monitoring unit, and in the remote monitoring unit, providing an alarm perceivable to a human. In some such embodiments, the alarm at the remote monitoring unit comprises at least one of a visual alarm, an audible alarm and a tactile alarm.

The EDA sensor and the pulse oximeter may be positioned at any suitable location on the human. That said, in some embodiments, the EDA sensor is positioned to be touching the skin of the human. In some embodiments, the pulse oximeter is positioned to be touching the skin of the human.

The sensing rate may be any suitable EDA sensing rate. That said, in some embodiments, the EDA sensing rate is more frequently than every minute. In some embodiments the EDA sensing rate is more frequently than every 30 seconds, 10 seconds, 5 seconds, or even more frequently than every 1 second. In some embodiments, each EDA measurement has a set duration. In some embodiments, the duration is 15 seconds. In some embodiments, the duration is 30 seconds, 1 minute, or even up to five minutes.

The EDA indication of stress may be any suitable EDA indication. That said, in some embodiments, identifying an EDA indication of stress comprises processing a single EDA measurement signal to identify whether the single EDA measurement signal is above an EDA threshold. In some embodiments, identifying an EDA indication of stress comprises
5 processing multiple EDA measurement signals to identify whether a function of the multiple EDA measurement signals is above an EDA threshold. In some such embodiments, the function is an average of multiple EDA measurement signals. In some such embodiments, the function is a mean of multiple EDA measurement signals.

The EDA threshold may be any suitable threshold. That said, in some embodiments,
10 the EDA threshold is a 37% phasic change over the tonic level. In some embodiments, the EDA threshold is a 40% phasic change, a 45% phasic change, and even greater than a 50% phasic change over the tonic level. In some embodiments, the measurement signal is considered to be over the EDA threshold only if it remains over the EDA threshold for a duration of at least 15 seconds.

15 In some embodiments, during monitoring of the human, if no EDA indication of stress is identified, the pulse oximeter is kept in an inactive energy-saving state. In some embodiments, the pulse oximeter is activated periodically in order to obtain a measurement and make sure that all is well with the baby being monitored.

In some embodiments, the measure of blood oxygenation comprises a blood
20 oxygenation percentage.

In some embodiments, the pulse oximeter signal comprises a single pulse measurement by the pulse oximeter. In some embodiments, the pulse oximeter signal comprises a single blood oxygenation measurement by the pulse oximeter. In some
25 embodiments, the pulse oximeter signal comprises a pulse measurement and a blood oxygenation measurement by the pulse oximeter, obtained at the same time.

In some embodiments, the pulse oximeter signal comprises a function of multiple measurements by the pulse oximeter. In some such embodiments, the function is an average of the multiple measurements by the pulse oximeter. In some such embodiments, the function is a mean of the multiple measurements by the pulse oximeter. In some
30 pulse oximeter signal comprises multiple pulse oximeter signals, each representing a single measurement of pulse, blood oxygenation, or both, by the pulse oximeter.

The pulse oximeter indication of stress may be any suitable pulse oximeter indication. In some embodiments, the pulse oximeter indication comprises a blood oxygenation portion of the pulse oximeter signal being below a blood oxygenation threshold. In some

embodiments, the pulse oximeter indication comprises the blood oxygenation portion of at least two pulse oximeter signals being below the blood oxygenation threshold.

The blood oxygenation threshold can be any suitable threshold indicative of human stress. That said, in some embodiments, the blood oxygenation threshold is 60% saturation.

5 In some embodiments, the blood oxygenation threshold is 70% saturation, 80% saturation, or even below 92% saturation.

In some embodiments, the pulse oximeter indication comprises a pulse rate portion of the pulse oximeter signal being below a low pulse rate threshold. In some embodiments, the low pulse rate threshold is 50 beats per minute. In some embodiments the low pulse rate
10 threshold is 45 beats per minute.

In some embodiments, the pulse oximeter indication comprises a pulse rate portion of the pulse oximeter signal being above a high pulse rate threshold. In some embodiments, the high pulse rate threshold is 140 beats per minute. In some embodiments the high pulse rate threshold is 145, 150, or even 160 beats per minute.

15 In some embodiments, the method also comprises indicating whether the pulse oximeter indication is indicative of stress stemming from a problem in the blood oxygenation of the human or of stress stemming from a problem in the pulse rate of the human.

The wireless transmitter is configured to use any suitable wireless communication method or combination of methods. In some embodiments, the wireless transmitter is
20 configured to use at least one wireless communication method selected from the group consisting of ultrasonic communication, infrared communication, radio-frequency communication, Wi-Fi, GSM, and Bluetooth®.

Any suitable configuration or device may be used as the remote monitoring unit. That said, in some embodiments, the remote monitoring unit includes a component suitable to be
25 worn by a human, such as the human's parent or caregiver. For example, in some embodiments, the remote monitoring unit comprises a bracelet configured to be worn around a human's wrist. In some embodiments, the remote monitoring unit comprises a component which may be clipped onto a clothes of a person, for example formed in the style of a pager or pedometer. In some embodiments, the remote monitoring unit comprises a pendant to be
30 suspended from a human's neck. In some embodiments, the remote monitoring unit comprises a decorative piece of jewelry to be worn on a human's body, such as a ring or an earring. In some embodiments, the remote monitoring unit comprises a worn element to be worn on a human's body, such as an earpiece, eyeglasses, a wristwatch, or a pocket-watch.

In some embodiments, the remote monitoring unit comprises a component that is configured to be carried in a pocket of a person, for example, such as a component outwardly resembling a writing implement.

5 In some embodiments, the remote monitoring unit comprises a component not configured to be ordinarily worn by a person, which may be placed near a human. In some such embodiments, the method also comprises placing the component not configured to be worn by a person in the vicinity of a person.

10 In some embodiments, the remote monitoring unit comprises a known mobile communication device modified to function as a remote monitoring unit, to wirelessly receive alarm signals and to provide an alarm perceivable to a human, for example a mobile communication device selected from the group consisting of a mobile telephone, a smart phone, a PDA, a laptop, and a tablet computer.

In some embodiments, the alarm comprises a visual alarm. In some embodiments, the alarm comprises a tactile alarm. In some embodiments, the alarm comprises an audible alarm.

15 In some embodiments, the method also includes monitoring at least one additional parameter indicative of the human's condition with at least one suitably positioned additional sensor. In some embodiments, the at least one additional sensor is at least one sensor selected from a group consisting of a temperature sensor, a motion sensor, and a heart rate sensor.

20 In some embodiments, the at least one additional parameter is selected from a group consisting of body temperature monitored with a temperature sensor, body motion monitored with a motion sensor, and heart rate monitored with a heart rate sensor.

25 In some embodiments, measurements made by at the at least one additional sensor, and/or measurements made by the EDA sensor and/or measurements made by the pulse oximeter, are stored in a memory. In some embodiments, the memory is functionally associated with the wireless transmitter and the method further comprises wirelessly transmitting measurements stored in the memory to a remote location.

In some embodiments, the memory is functionally associated with a port for connection of an external device and the method further comprises:

30 connecting an external device to the memory through the port; and
retrieving measurements stored in the memory to the external device.

In some embodiments, in a device suitable for implementing the method of the teachings herein, the memory comprises a removable memory, configured to be removed for retrieval of information contained in the memory. In some embodiments, the removable memory is selected from the group consisting of a USB flash drive and a SD card.

In some embodiments, the method also includes providing an energy storage unit configured to power a group of components including at least one of the EDA sensor, the pulse oximeter, the processor, and the transmitter. In some embodiments, the energy storage unit is configured to power a group of components including all of the EDA sensor, the pulse
5 oximeter, the processor, and the transmitter. In some embodiments, the energy storage unit is configured to provide sufficient power for continuous operation of the group of components for a period of time of not less than 24 hours of normal use. In some embodiments, the energy storage unit is configured to provide sufficient power for continuous operation of the group of components for a period of time of not less than 30 hours, 36 hours, or even 48 hours under
10 normal conditions of use. In some embodiments, the energy storage unit is also configured to power at least one of the additional sensor and the memory. In some embodiments, the energy storage unit comprises at least one battery, such as at least one rechargeable battery. In some embodiments, the energy storage unit has a capacity of at least 130 ampere hours.

In some embodiments, in a device implementing the methods of the teachings herein,
15 at least some of the EDA sensor, pulse oximeter, processor, and transmitter, are housed in an assembly of a sensing unit, which assembly is placed on the body of a human. In some such embodiments, the EDA sensor, processor, and transmitter are housed in a first assembly of the sensing unit, and the pulse oximeter is housed in a second assembly of the sensing unit, separate from the first assembly, such that the first and second assemblies are placed on
20 different portions of the body of the human. In some embodiments, all of the EDA sensor, pulse oximeter, processor, and transmitter are housed in a single assembly of the sensing unit, which is placed on the body of the human.

In some such embodiments, the sensing unit also includes the memory. In some embodiments, the sensing unit also includes the at least one additional sensor. In some
25 embodiments, the sensing unit also includes the energy storage unit.

In some embodiments, the energy storage unit is removed from the sensing unit during recharging. In some embodiments, the energy storage unit is recharged while in the sensing unit, for example using a dedicated port.

In some embodiments, the sensing unit comprises a bracelet configured to be worn
30 around the human's wrist or ankle. In some embodiments, the sensing unit comprises a sock to be worn on the human's foot. In some embodiments, the sensing unit comprises a band to be attached around a portion of the human's body, such as the head or the torso. In some embodiments, a sensing unit comprises a band of fabric to be attached to a piece of clothing worn by the human or to a baby's diaper.

In some embodiments, the sensing unit includes a decorated external surface. In some embodiments, the decorations on the external surface comprise decorations configured to captivate a baby's gaze. In some such embodiments, the decorations are in colors configured to capture a neonate's attention such as black, white, or red. In some such embodiments, the decorations comprise images configured to attract a baby's attention.

In some embodiments, the method also includes during monitoring of the human, if no EDA indication of stress is identified, wirelessly transmitting to the monitoring station, via the transmitter, an all-clear control signal. In some such embodiments, the monitoring unit is configured to provide an all-clear indication perceivable by a human. In some embodiments, the all-clear indication comprises a visual indication. In some embodiments, the all-clear indication comprises a tactile indication. In some embodiments, the all-clear indication comprises an audible indication.

In some such embodiment, the all-clear control signal is transmitted periodically. In some embodiments, the all-clear signal is transmitted at a set rate, such as once an hour. In some embodiments, the all-clear signal is transmitted after a set number of the EDA measurements since transmission of a previous all-clear signal.

In some embodiments, the method also comprises during monitoring of the human, monitoring the charge state of the energy storage unit, and if a charge state of the energy storage unit is below a predetermined threshold, producing a low battery signal, wherein the low battery signal is wirelessly transmitted to the monitoring unit, via the transmitter.

In some such embodiments, the method also comprises in the remote monitoring unit, upon receipt of the low-battery signal, providing a low-battery indication perceivable by a human. In some embodiments, the low-battery indication comprises a visual indication. In some embodiments, the low-battery indication comprises a tactile indication. In some embodiments, the low-battery indication comprises an audible indication.

In some embodiments, the method also comprises in the monitoring unit, monitoring signal quality of signals received from the transmitter, and if the signal quality is insufficient, in the monitoring unit, producing an insufficient signal indication perceivable by a human.

In some embodiments, the method also includes providing an energy storage unit configured to power the remote monitoring unit, wherein the energy storage unit is configured to provide sufficient power for continuous operation of the remote monitoring unit for a period of time of not less than 24 hours under normal conditions of use. In some embodiments, the energy storage unit is configured to provide sufficient power for

continuous operation of the remote monitoring unit for a period of time of not less than 30 hours, 36 hours, or even 48 hours under normal conditions of use.

According to an aspect of some embodiments of the invention, there is also provided a method for providing information indicative of a reason for a stress situation in a human,
5 comprising:

positioning an electrodermal activity (EDA) sensor to monitor a human;
at a processor functionally associated with the EDA sensor, receiving from the EDA
sensor an EDA measurement signal at a EDA sensing rate;
at a processing rate, processing the received EDA measurement signals to identify an
10 EDA level category;

based on the identified EDA level category providing an appropriate signal, wherein:

if the received EDA measurement is identified to be in a first EDA level
category, providing an alarm indicating medical stress,

15 if the received EDA measurement is identified to be in a second EDA level
category, providing a signal indicating non-medical stress, and

if the received EDA measurement is identified to be in a third EDA level
category, providing a signal indicating that no stress is identified.

According to an aspect of some embodiments of the invention, there is also provided
a device useful for providing information indicative of a reason for a stress situation in a
20 human, comprising:

an electrodermal activity (EDA) sensor configured for determining electrodermal
activity of a human at an EDA sensing rate and producing an EDA measurement
signal related to the determined electrodermal activity; and

a processor functionally associated with the EDA sensor, configured to:

25 receive from the EDA sensor an EDA measurement signal at an EDA sensing
rate,

at a processing rate, process the received EDA measurement signals to identify
an EDA level category; and

based on the identified EDA level category, provide an appropriate signal,

30 wherein:

if the received EDA measurement is identified to be in a first EDA
level category, providing an alarm indicating medical stress,

if the received EDA measurement is identified to be in a second EDA
level category, providing a signal indicating non-medical stress, and

if the received EDA measurement is identified to be in a third EDA level category, providing a signal indicating that no stress is identified.

In some embodiments, the alarm indicating medical stress is indicative of a medical stress situation selected from the group consisting of blood oxygenation stress, pulse rate stress, stress triggered by heart disease, stress triggered by kidney disease, stress triggered by
5 improper processing of salts, and stress caused by epilepsy.

In some embodiments, the signal indicating non-medical stress is indicative of a non-medical stress situation selected from the group consisting of hunger, thirst, a dirty diaper, prolonged crying, gas in the digestive system, general discomfort, and pain.

10

Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which the invention pertains. In case of conflict, the specification, including definitions, will take precedence.

As used herein, the terms "comprising", "including", "having" and grammatical
15 variants thereof are to be taken as specifying the stated features, integers, steps or components but do not preclude the addition of one or more additional features, integers, steps, components or groups thereof. These terms encompass the terms "consisting of" and "consisting essentially of".

As used herein, the indefinite articles "a" and "an" mean "at least one" or "one or
20 more" unless the context clearly dictates otherwise.

As used herein, when a numerical value is preceded by the term "about", the term "about" is intended to indicate +/-10%.

Embodiments of methods and/or devices of the invention may involve performing or completing selected tasks manually, automatically, or a combination thereof. Some
25 embodiments of the invention are implemented with the use of components that comprise hardware, software, firmware or combinations thereof. In some embodiments, some components are general-purpose components such as general purpose computers or oscilloscopes. In some embodiments, some components are dedicated or custom components such as circuits, integrated circuits or software.

For example, in some embodiments, some of an embodiment is implemented as a
30 plurality of software instructions executed by a data processor, for example which is part of a general-purpose or custom computer. In some embodiments, the data processor or computer comprises volatile memory for storing instructions and/or data and/or a non-volatile storage, for example, a magnetic hard-disk and/or removable media, for storing instructions and/or

data. In some embodiments, implementation includes a network connection. In some embodiments, implementation includes a user interface, generally comprising one or more of input devices (e.g., allowing input of commands and/or parameters) and output devices (e.g., allowing reporting parameters of operation and results).

5

BRIEF DESCRIPTION OF THE FIGURES

Some embodiments of the invention are described herein with reference to the accompanying figures. The description, together with the figures, makes apparent to a person having ordinary skill in the art how some embodiments of the invention may be practiced. The figures are for the purpose of illustrative discussion and no attempt is made to show structural details of an embodiment in more detail than is necessary for a fundamental understanding of the invention. For the sake of clarity, some objects depicted in the figures are not to scale.

15 In the Figures:

FIG. 1 is a pictorial illustration of an embodiment of a sensing unit forming part of a human monitoring device according to an embodiment of the teachings herein;

FIG. 2 is a pictorial illustration of an embodiment of a monitoring unit forming part of a human monitoring device according to an embodiment of the teachings herein;

20 FIGS. 3A, 3B, 3C, and 3D are schematic representations of an embodiment of a human monitoring device as used in a home setting according to an embodiment of the teachings herein, in a regular situation, in an emergency situation, in a low-battery situation, and in an insufficient signal situation, respectively;

25 FIG. 4 is a schematic representation of an embodiment of a human monitoring device as used in a medical facility setting according to an embodiment of the teachings herein;

FIG. 5 is a flow chart of an embodiment of a method for monitoring the health of a human according to an embodiment of the teachings herein;

30 FIGS. 6A – 6C are pictorial illustrations of additional embodiments of a sensing unit forming part of a human monitoring device according to embodiments of the teachings herein; and

FIGS. 7A-7E are pictorial illustrations of additional embodiments of a monitoring unit forming part of a human monitoring device according to embodiments of the teachings herein.

DESCRIPTION OF SOME EMBODIMENTS OF THE INVENTION

The invention, in some embodiments, relates to the field of sensors, and more particularly to the field of methods and devices for providing information useful in identifying a stress situation of a human, such as a baby or a disabled human.

5 In accordance with some embodiments of the teachings herein, there are provided methods for providing information useful in determining stress of a human, comprising:

positioning a pulse oximeter and an electrodermal activity (EDA) sensor to monitor a human;

10 at a processor functionally associated with the EDA sensor and the pulse oximeter, monitoring the human by receiving from the EDA sensor an EDA measurement signal at a EDA sensing rate;

at a processing rate, processing the received EDA measurement signals to identify an EDA indication of stress;

if an EDA indication of stress is identified:

15 activating the pulse oximeter to determine a measure of at least one of pulse and blood oxygenation of the human;

at the processor, receiving from the pulse oximeter at least one pulse oximeter signal related to the determined measure of the at least one of pulse and blood oxygenation;

20 at the processor, processing the received pulse oximeter signal to identify a pulse oximeter indication of stress;

if a pulse oximeter indication of stress is identified, the processor automatically providing an alarm signal.

25 In accordance with some embodiments of the teachings herein, there are also provided devices for monitoring a human for stress signals, comprising:

a pulse-oximeter configured for determining a measure of at least one of pulse and blood oxygenation of a human and producing a pulse oximeter signal related to the determined measure of at least one of pulse and blood oxygenation;

30 an electrodermal activity (EDA) sensor configured for determining electrodermal activity of a human at an EDA sensing rate and producing an EDA measurement signal related to the determined electrodermal activity;

a processor functionally associated with the pulse oximeter and with the EDA sensor;
and

a wireless transmitter functionally associated with the processor,

wherein the processor is configured to:

- 5 receive from the EDA sensor an EDA measurement signal at the EDA sensing rate,
 at a processing rate, process the received EDA measurement signals to identify an EDA indication of stress,
 if an EDA indication of stress is identified, activate the pulse oximeter to
10 determine a measure of at least one of pulse and blood oxygenation of a human,
 receive from the pulse oximeter at least one pulse oximeter signal related to the determined measure of at least one of pulse and blood oxygenation,
 process the received the pulse oximeter signal to identify a pulse oximeter
15 indication of stress, and
 if a pulse oximeter indication of stress is identified, automatically provide an alarm signal.

20 The principles, uses and implementations of the teachings herein may be better understood with reference to the accompanying description and figures. Upon perusal of the description and figures present herein, one skilled in the art is able to implement the invention without undue effort or experimentation.

25 Before explaining at least one embodiment of the invention in detail, it is to be understood that the invention is not limited in its applications to the details of construction and the arrangement of the components and/or methods set forth in the following description and/or illustrated in the drawings and/or the Examples. The invention can be implemented with other embodiments and can be practiced or carried out in various ways. It is also understood that the phraseology and terminology employed herein is for descriptive purpose and should not be regarded as limiting.

30 As discussed in the introduction, there is need for baby monitoring system which does not provide false alarms to the baby's caretaker, which has no hazardous cables required for activation, and which can function effectively for extended periods of time, for example at least 24 hours, at least 36 hours, or even up to 48 hours. There is need for similar systems for

monitoring the health of elderly or disabled people, who are often not in a medical facility but require medical supervision.

In the exemplary embodiments described hereinbelow with reference to Figures 1-7E, the monitoring system is used to monitor a baby, and the monitoring person is the baby's caregiver, such as a parent.

Reference is now made to Figure 1, which is a pictorial illustration of an embodiment of a sensing unit forming part of a human monitoring device according to an embodiment of the teachings herein. As seen in Figure 1, a sock **10** is placed around the baby's foot **12**, such that an upper portion **14** of the sock **10** fits snugly around the baby's ankle **16** and cannot be moved by the baby.

In some embodiments, the upper portion **14** may be fitted to the size of ankle **16** by adjusting a width adjustor **18**. In some embodiments, the width adjustor **18** informed of Velcro®. In some embodiments, the width adjustor **18** comprises at least one hook and multiple eyes, spaced around upper portion **14**, and configured to receive the hook, in a similar structure to that of a bra strap. In some embodiments, the width adjustor **18** comprises a lever and multiple holes, spaced around upper portion **14**, and configured to receive the lever, in a similar structure to that of a watch strap or a belt.

Upper portion **14** includes an electronics portion **20**, located on an inner surface of the sock **10**. Electronics portion **20** comprises a processor **22**, such as an IC PIC MCU Flash processor commercially available from MicroChip Technology Inc. of Chandler, Arizona, USA, and a wireless transmitter **24**, such as a Linx RF 433MHz transmitter, commercially available from Linx Technologies of Merlin, Oregon, USA, functionally associated with a processor **22**. In some embodiments, electronics portion **20** is enclosed in a pocket, separating the electronics from the baby's skin. In some embodiments, transmitter **24** is configured to transmit information using at least one wireless communication method selected from a group consisting of radio-frequency communication, Wi-Fi, GSM, and Bluetooth®.

Functionally associated with processor **22** is an electrodermal activity (EDA) sensor **26**, such as an ag/agel E203 disc electrode, commercially available from Warner Instruments LLC of Hamden, Connecticut, USA. EDA sensor **26** is mounted on sock **10** such that a sensing portion of the sensor is in direct contact with the baby's skin, and the signal processing portion of the sensor forms part of electronics portion **20**. In some embodiments, the signal processing portion is located inside the electronics pocket, and the sensing portion is connected to the signal processing portion by a short wires (not shown) which are anchored to the sock **10**. The EDA sensor **26** is configured to measure the baby's skin conductance at

ankle **16** and to provide an EDA signal indicating the measured skin conductance to the processor **22** at a sensing rate. The sensing rate may be any suitable rate. That said, in some embodiments, the sensing rate is more frequently than every minute. In some embodiments the sensing rate is more frequently than every 30 seconds, 20 seconds, 10 seconds, or even
5 more frequently than every second. In some embodiments, each EDA measurement has a set duration. In some embodiments, the duration is 15 seconds. In some embodiments, the duration is 30 seconds, 1 minute, or even up to five minutes.

Functionally associated with processor **22** is a pulse oximeter **28**, such as a DCM02 or a DCM03, commercially available from APMKorea of Daejeon, KOREA. Pulse oximeter **28**
10 is mounted on sock **10** such that a sensing portion, comprising at least one light source **30** and a photodetector **32** is in direct contact with the baby's skin, and the signal processing portion of the sensor forms part of electronics portion **20**. In some embodiments, the pulse oximeter is enclosed in a protective enclosure (not shown), such as a silicon cushion, specifically designed to prevent sweat buildup on the pulse oximeter. In some embodiments, the signal
15 processing portion is located inside the electronics pocket, and the light emitter and light receiver are connected to the signal processing portion by a short wires (not shown) which are anchored to the sock **10**.

The pulse oximeter **28** is configured to measure the baby's pulse and blood oxygenation percentage at ankle **16** and to provide a pulse oximeter signal indicating at least
20 one of, and preferably both the measured pulse and blood oxygenation percentage to the processor **22**. The pulse oximeter **28** is also configured to be activated by a command from processor **22**.

Unless activated by processor **22**, pulse oximeter **28** is configured to remain in an inactive, energy-saving state. That said, in some embodiments, pulse oximeter **28** is
25 periodically activated to obtain a pulse oximeter measurement in order to ensure that all is well with the baby being monitored.

Processor **22**, transmitter **24**, EDA sensor **26**, and pulse oximeter **28**, are all powered by an energy storage unit such as a battery **34** located in electronics portion **20**. In some
30 embodiments, battery **34** is a rechargeable battery such as a Lithium-Polymer prismatic 3.6V battery cell, commercially available from PowerStream Technologies of Orem, Utah, USA. In some embodiments, electronics portion **20** includes a charger port **36** for connecting a charger to enable charging of battery **34** while the battery is located in electronics portion **20** of sock **10**. In some embodiments, battery **34** may be removed from sock **10**, for example for recharging the battery on a suitable recharger (not shown).

It is appreciated that when sock **10** is operated in accordance with the teachings herein, as described in further detail herein below with reference to Figure 5, battery **34** is configured to provide sufficient power for continuous operation of the components of the sock **10** for a period of time of not less than 24 hours. In some embodiments, battery **34** is
5 configured to provide sufficient power for continuous operation of the components of the sock **10** for a period of time of not less than 30 hours, 36 hours, or even up to 48 hours.

In some embodiments, at least one additional sensor **38**, which is functionally associated with processor **22**, is mounted on sock **10**. In some embodiments, the sensor **38** includes a sensing portion which is positioned to be in direct contact with the baby, and a
10 signal processing portion which forms part of electronics portion **20**. In some embodiments, the entirety of sensor **38** is included in electronics portion **20**. Additional sensor **38** may be any sensor suitable for monitoring the baby for a stress situation or for a health condition, such as, for example, a temperature sensor such as a SOT23 temperature probe commercially available from Texas Instruments Inc. of Dallas, Texas, USA, a motion sensor, a heart rate
15 sensor, and a pulse sensor. In some embodiments, additional sensor **38** is powered by battery **34**.

In some embodiments, electronics portion **20** includes a memory **40** functionally associated with EDA sensor **26** and/or with processor **22**, for storing EDA levels measured by EDA sensor **26**. The memory **40** may also store measurements provided by additional sensor
20 **38**. The memory **40** may store the EDA levels measured by EDA sensor **26** the sensing rate at which EDA sensor **26** receive the measurements, or at any other suitable rate, and may store the pulse and blood oxygenation measures measured by the pulse oximeter **28**.

In some embodiments, memory **40** is functionally associated with transmitter **24**, and is configured to wirelessly transmit stored information to a remote location, such as a nurse's
25 station, a doctor's office, or a caregiver's mobile device.

In some embodiments, electronics portion **20** includes a port **42**, such as a USB port, for connection of an external device or wire (not shown) to be functionally associated with processor **22** for downloading information from memory **40**.

In some embodiments, memory **40** comprises a removable memory, configured to be
30 removed from sock **10** for retrieval of the information contained in the memory. For example, the removable memory may be a USB flash drive or a SD card.

In some embodiments, sock **10** further comprises a visual indicator **44**, such as a source of visible light, for example a Bicolor SMT LED commercially available from Lite-On Inc. of Milpitas, California, USA, and/or an aural indicator **46**, such as a Buzzer SMD

speaker commercially available from Sanco Electronics Co. Ltd. of Ningbo, CHINA. Visual indicator **44** and aural indicator **46** may form part of electronics portion **20**, and are configured to provide an alarm indication perceivable to a human, such as a visual alarm or an audible alarm, if a stress situation is identified by processor **22**, as described in further
5 detail hereinbelow with reference to Figure 5.

In some embodiments, an external surface **48** of sock **10** include one or more decorative elements **50**. Decorative elements **50** may be any suitable decorative elements, and may have any suitable colors. In some embodiments, decorative elements **50** are geometrical shapes colored in black white and red, which are known to stimulate a neonate's eyesight. In
10 some embodiments, decorative elements **50** comprised images, such as images of the characters which would attract a child's attention.

In some embodiments, decorative elements **50** may comprise a rattle or a toy sewn on to sock **10** for the baby to play with while sock **10** is on his foot. However, for EDA sensor **26** and pulse oximeter **28** to function correctly, it is important that sock **10** remain properly
15 positioned on the baby's foot. Therefore it is important that the baby should not be able to move the sock **10** on his foot while playing the decorative elements **50**.

Reference is now made to Figure 2, which is a pictorial illustration of an embodiment of a monitoring unit forming part of a baby monitoring device according to an embodiment of the teachings herein. As seen in Figure 2, a monitoring unit **200** comprises a bracelet **210**
20 suitable to be worn around the wrist of a human, typically the baby's parent or caregiver. Bracelet **210** may be formed of any suitable material such as silicon, fabrics, leather, or any other suitable material. In some embodiments, bracelet **210** comprises a slip-on bracelet, configured to be slipped over a wearer's hand and onto the wearer's wrist. In some embodiments, bracelet **210** is openable, and comprises a size adjustor (not shown) for
25 adjusting the size of bracelet **210** to the size of the wearer's wrist. The size adjustor may be any suitable adjustor, such as a Velcro strap or a silicon strap.

Formed on an inner surface **212** of bracelet **210** is a receiver **214**, such as a Linx RF 433MHz receiver, commercially available from Linx Technologies of Merlin, Oregon, USA, configured to receive signals from a transmitter of a sensing unit, such as transmitter **24** of
30 the sock **10** of Figure 1. In some embodiments, receiver **214** is configured to receive the signal transmitted using at least one wireless communication method selected from a group consisting of radio-frequency communication, Wi-Fi, GSM, and Bluetooth®.

Functionally associated with receiver **214** is a processor **216**, such as an IC PIC MCU Flash processor commercially available from MicroChip Technology Inc. of Chandler, Arizona, configured to process signals received by receiver **214**.

Functionally associated with processor **216** are a visual indicator **218**, such as a
5 Bicolor SMT LED commercially available from Lite-On Inc. of Milpitas, California, USA, an aural indicator **220**, such as a Buzzer SMD speaker commercially available from Sanco Electronics Co. Ltd. of Ningbo, CHINA, and a tactile indicator **222**, such as a vibration motor
3, commercially available from Precision Microdrives Ltd. of London, UK.

Visual indicator **218** is formed on an outer surface **224** of bracelet **210** and may be
10 any suitable visual indicator emitting light perceivable by a human, such as the one or more LED lights. In some embodiments, visual indicator **218** comprises a red LED light **226** and a green LED light **228**. In some embodiments, the visual indicator **218** also comprises an orange LED light **230**. In some such embodiments, each of LED lights **226**, **228**, and **230** may be used to provide indication to a wearer of bracelet **210** in different situations as
15 described hereinbelow.

Aural indicator **220** may be any suitable aural indicator providing an indication perceivable by a human, such as a speaker, and may be formed on inner surface **212** or on outer surface **224** of bracelet **210**. In some embodiments, aural indicator **220** is configured to provide at least two different audible indications, which are perceivable by a human and
20 distinguishable by a human. For example, the different audible indications may have different amplitudes, different frequencies, or different patterns. In some such embodiments, each of the different audible indication may be used to provide indication to a wearer of bracelet **210** in different situations as described hereinbelow.

Tactile indicator **222** may be any suitable tactile indicator providing an indication
25 perceivable by a human, such as a small piezoelectric speaker as known in the art of cellular telephony, and it typically formed on inner surface **212** of bracelet **210**. In some embodiments, tactile indicator **222** is configured to provide at least two different tactile indications, which are perceivable by a human and distinguishable by a human. For example, the different tactile indications may have different frequencies or different amplitudes. In
30 some such embodiments, each of the different tactile indications may be used to provide indication to a wearer of bracelet **210** in different situations as described hereinbelow.

As will be described in further detail hereinbelow in reference to Figures 3A and 3B, in response to receipt of the signal from receiver **214**, processor **216** activates at least one of visual indicator **218**, aural indicator **220**, and tactile indicator **222**, in order to provide a

human-perceivable indication of the baby's health status and/or of system status to the wearer of bracelet **210**.

In some embodiments, processor **216** is configured to activate some or all of visual indicator **218**, aural indicator **220**, and tactile indicator **222** in response to a signal received by receiver **214**. For example, processor **216** activates visual indicator **218** to emit a red light from red LED light **226**, aural indicator **220** to sound alarm sounds, and tactile indicator **222** to vibrate, in response to an alarm signal received by receiver **214** from the sensing unit.

In some such embodiments, processor **216** is configured to distinguish between different signals received by receiver **214** by activating some or all of visual indicator **218**, aural indicator **220**, and tactile indicator **222** to provide different indications to the user in response to such different signals. For example, processor **216** may activate visual indicator **218** to emit a red light from red LED light **226** in response to an alarm signal received by receiver **214** and to emit a green light from green LED light **228** in response to an all-clear signal received by receiver **214**. As another example, processor **216** may activate visual indicator **218** to emit a flashing light in response to an alarm signal received by receiver **214** and to emit a continuous light in response to an all-clear signal received by receiver **214**. In a similar manner, processor **216** may activate aural indicator **220** and/or tactile indicator **222** to provide a high-frequency indication in response to an alarm signal received by receiver **214** and to provide low-frequency indication in response to an all-clear signal received by receiver **214**.

In some embodiments, processor **216** is configured to activate a different one or a different subset of visual indicator **218**, aural indicator **220**, and tactile indicator **222** in response to different signals received by receiver **214**. For example, processor **216** may activate visual indicator **218** in response to an all-clear signal received by receiver **214**, indicating that the baby is healthy and safe, and may activate all of visual indicator **218**, tactile indicator **222** and aural indicator **220** in response to an alarm signal received by receiver **214**.

In some embodiments, processor **216** is configured to activate at least one of the visual indicator **218**, aural indicator **220**, and tactile indicator **222**, in order to indicate a change in system status. For example, processor **216** may activate visual indicator **218** to flash an orange light from LED light **230** in response to a low-battery signal received by receiver **214**, or in response to receiving insufficient signals or to being out of range of the sensing unit of Figure 1.

Receiver **214**, processor **216**, visual indicator **218**, aural indicator **220**, and tactile indicator **222**, are all powered by a battery **232** formed on inner surface **212** of bracelet **210**.

In some embodiments, battery **232** is a rechargeable battery such as a Lithium-Polymer prismatic 3.6V battery cell, commercially available from PowerStream Technologies of Orem, Utah, USA. In some embodiments, bracelet **210** includes a charger port (not shown) for connecting a charger to enable charging of battery **232** while the battery is located in bracelet **210**. In some embodiments, battery **232** may be removed from bracelet **210**, for example for recharging the battery on a suitable recharger (not shown).

In some embodiments, battery **232** is configured to provide sufficient power for continuous operation of components of bracelet **210** for a period of time of not less than 24 hours. . In some embodiments, battery **232** is configured to provide sufficient power for continuous operation of the components of bracelet **210** for a period of time of not less than 26 hours, 36 hours, or even up to 48.

In some embodiments, processor **216** occasionally, periodically, or intermittently, checks the charge of battery **232**, and notifies the wearer of bracelet **210** if battery **232** needs to be recharged. Such notification may be achieved, for example, by activating one or more visual indicator **218**, aural indicator **220**, and tactile indicator **222** to provide a unique indication signal in a low battery in the monitoring unit. For example, processor **216** may activate orange LED light **230** of visual indicator **218** to flash as indication of low charge on battery **232**. As another example, processor **216** may activate all of LED light **226**, **228**, and **230** of the visual indicator **218** as indication of low charge on battery **232**.

In some embodiments, outer surface **224** of bracelet **210** has a decorative appearance, for example including a string of beads **234**, though any other decorative element is considered within the scope of the teachings herein. It is appreciated that in some situation the baby's caregiver's would want to be just more formally, such as at weddings, funerals, and other events. The decorative appearance of outer surface **232** of bracelet **210**, which may have the appearance of a piece of jewelry while maintaining its functionality, enables the caregiver to continue wearing bracelet **210** in such formal occasions and to continually be aware of the well-being of the baby.

Reference is now made to Figures 3A, 3B, 3C, and 3D, which are schematic representations of an embodiment of a baby monitoring device as used in a home setting according to an embodiment of the teachings herein, in a regular situation, in an emergency situation, in a low-battery situation, and in an out-of-range situation, respectively.

As seen in Figure 3A, a caregiver **300** wearing a monitoring unit **302**, such as bracelet **210** of Figure 2, is located in a first room **304**, such as a kitchen, living room, bedroom, or any other location. The caregiver may be involved in any activity, and is shown in figure 3A as relaxing while watching television and drinking a glass of wine. A baby **306** wearing a
5 sensing unit **308**, such as sock **10** of Figure 1, is located in a second room **310**, which is in wireless communication range of first room **304**.

As described herein below with reference to Figure 5, sensing unit **308** checks the electrodermal activity of baby **306** at an EDA sensing rate using an EDA sensor (not shown) such as EDA sensor **26** of Figure 1. As long as the electrodermal activity of baby **306** does
10 not indicate any stress condition, the sensing unit **308** does not check the baby's blood saturation level and does not provide an alarm signal to caregiver **300**.

Occasionally, transmitter **312** of sensing unit **308**, similar to transmitter **24** of Figure 1, wirelessly transmits an all-clear signal which is received by receiver **314** of monitoring unit **302**, similar to receiver **214** of Figure 2, as indicated by arrow **316**. In response to receipt
15 of an all-clear signal from sensing unit **308**, monitoring unit **302** provides an indication, perceivable by caregiver **300**, of the baby's well-being. In some embodiments, in response to transmission of an all-clear signal, sensing unit **308** provides an indication, perceivable to a human, of the baby's well-being, such as by providing a visual indication using visual indicator **326**, similar to visual indicator **44** of Figure 1, or by providing an audible indication
20 using aural indicator **328**, similar to aural indicator **46** of Figure 1.

In the illustrated example, monitoring unit **302** includes a visual indicator **318** comprising three LED lights: a green LED light **320**, a red LED light **322**, and orange LED light **324**. In response to receipt of the all clear signal, the processor (not shown) of monitoring unit **302** activates visual indicator **318** to flash a green light from LED light **320**,
25 thereby indicating that the caregiver **300** that all is well with the baby and there is no need to go check on baby **306**. However, any suitable indication, such as an aural indication, tactile indication, visual indication, or any combination thereof, may be provided to the baby's caregiver **300**, as long as the baby's caregiver can distinguish the indication from an alarm indication or system problem indication and can identify that the indication means that all is
30 well with the baby.

Transmitter **312** may transmit an all-clear signal to receiver **314** intermittently or periodically. In some embodiments, an all-clear signal is transmitted every set period of time, for example once, every 15 minutes, once every 30 minutes, once an hour, or even once in two hours. In some embodiments, an all-clear signal is transmitted after a set number of EDA

measurements since the transmission of the last all-clear signal or of an alarm signal, for example after 20 EDA measurements.

Turning to Figure 3B, the caregiver **300** is in first room **304**, while in second room **310** baby **306** is sleeping with a pillow **330** on his face. As described herein below with reference to Figure 5, sensing unit **308** checks the electrodermal activity of baby **306** at an EDA sensing rate using the EDA sensor and upon sensing an increase in the baby's electrodermal activity, a processor (not shown) of sensing unit **308** activates a pulse oximeter (not shown), similar to pulse oximeter **26** of Figure 1.

As explained hereinbelow with reference to Figure 5, if one or more measurements by the pulse oximeter are indicative of stress, such as the blood oxygenation portion of the measurement being below a predetermined blood oxygenation threshold and/or the pulse rate portion of the measurement being below a low pulse rate threshold or above a high pulse rate threshold, transmitter **312** of sensing unit **308** wirelessly transmits an alarm signal which is received by receiver **314** of monitoring unit **302** as indicated by arrow **332**. In some embodiments, the alarm signal transmitted by sensing unit **308** is indicative of the cause for alarm, such as a problem with blood oxygenation or a problem with the baby's pulse.

In response to receipt of an alarm signal from sensing unit **308**, monitoring unit **302** provides an alarm indication, perceivable by caregiver **300**.

In the illustrated example, monitoring unit **302** includes, in addition to visual indicator **318**, an aural indicator (not shown), and a tactile indicator (not shown). In response to receipt of the alarm signal, the processor of monitoring unit **302** activates visual indicator **318** to flash a red light from LED light **322**, sound an alarm from the aural indicator as shown at reference **334**, and cause the tactile indicator to vibrate as shown at reference **336**, thereby notifying the caregiver **300** of the emergency situation and alerting the caregiver to respond.

However, any suitable indication, such as an aural indication, tactile indication, visual indication, or any combination thereof, may be provided to the baby's caregiver **300**, as long as the baby's caregiver is alerted to respond to the baby's stress situation.

In the illustrated example, in addition to providing an alarm indication at monitoring unit **302**, an alarm indication perceivable to a human is also provided at sensing unit **308**. As seen, upon identifying a stress indicator, the processor of sensing unit **308** activates visual indicator **326** to flash a red light, and activates aural indicator **328** to sound an audible alarm, as indicated by reference numeral **338**.

As seen in Figure 3C, caregiver **300** wearing monitoring unit **302** is located in first room **304**, while baby **306** wearing a sensing unit **308** is located in a second room **310**, which is in wireless communication range of first room **304**.

Occasionally, a processor (not shown) of sensing unit **308** checks the charge of a battery (not shown) powering elements of sensing unit **308**, similar to battery **34** of Figure 1. If a low charge is detected in the battery of sensing unit **308**, transmitter **312** of sensing unit **308** wirelessly transmits a low-battery signal which is received by receiver **314** of monitoring unit **302**, as indicated by arrow **350**. In response to receipt of a low-battery signal from sensing unit **308**, monitoring unit **302** provides an indication, perceivable by caregiver **300**, of the status of the battery of sensing unit **308**.

In the illustrated example, in response to receipt of the low-battery signal, the processor of monitoring unit **302** activates visual indicator **318** to flash an orange light from LED light **324**, thereby indicating that the caregiver **300** that the battery of sensing unit **308** needs to be recharged. However, any suitable indication, such as an aural indication, tactile indication, visual indication, or any combination thereof, may be provided to the baby's caregiver **300**, as long as the baby's caregiver can distinguish the indication from other indications such as an alarm indication, and all-clear indication, and an out-of-range indication.

In the illustrated embodiment, caregiver **300** has a second sensing unit **352** being charged using the recharger **354** during use of sensing unit **308**. Thus, in response to noticing the low-battery indication, caregiver **300** may remove sensing unit **352** from recharger **354** and place it on the foot of baby **306** instead of sensing unit **308**. Subsequently, caregiver **300** may connect to sensing unit **308** to recharger **354** for recharging of the battery of sensing unit **308**. In this way, caregiver **300** can make sure that the EDA level, pulse, and blood oxygenation of baby **306** are constantly monitored, even during recharging of sensing unit **308**.

In some embodiments, the sensing unit, such as sensing unit **308** or sensing unit **352**, or the recharger, such as recharger **354**, provide an indication to the user, such as a visual indication or an audible indication, indicating that the sensing unit located in the recharger is currently being charged. In the illustrated example, a visual indicator **356**, similar to visual indicator **44** of Figure 1, emits a continuous orange light to indicate that the sensing unit **352** is fully charged. In some embodiments, during recharging of sensing unit **352**, and prior to it being fully charged, visual indicator **356** flashes an orange light to indicate current charging.

Turning to Figure 3D, it is seen that caregiver **300** wearing monitoring unit **302** is now located in a yard **370**, while baby **306** wearing sensing unit **308** remains in room **310**. However, yard **370** is not in wireless communication range of room **310**.

Occasionally, a processor (not shown) of monitoring unit **302** checks the signal quality of signals received from sensing unit **308**. If the processor of monitoring unit **300** detects that the signal quality is insufficient, monitoring unit **302** provides an indication, perceivable by caregiver **300**, that the monitoring unit **302** is receiving insufficient signals. Such insufficient signals may be received, for example, when the monitoring unit **302** is out of communication range from sensing unit **308**, as in the illustrated example.

In the illustrated example, in response to detection of insufficient signal quality, the processor of monitoring unit **302** activates visual indicator **318** to emit a continuous beam of orange light from LED light **324**, thereby indicating that the caregiver **300** that the monitoring unit is receiving signals of insufficient quality and is probably out of range, and will not receive an alarm signal if such is provided by sensing unit **308**. However, any suitable indication, such as an aural indication, tactile indication, visual indication, or any combination thereof, may be provided to the baby's caregiver **300**, as long as the baby's caregiver can distinguish the indication from other indications such as an alarm indication, and all-clear indication, and a low-battery indication.

Reference is now made to Figure 4, which is a schematic representation of an embodiment of a baby monitoring device as used in a medical facility setting according to an embodiment of the teachings herein.

As seen, a baby **400** wearing a sensing unit **402** is located in a medical facility such as a doctor's office **408**. A member of the medical staff **410**, such as a doctor or a nurse, retrieves the information stored in a memory (not shown) of sensing unit **402**, such as memory **40** of Figure 1.

In the illustrated embodiment, the data is retrieved by connecting sensing unit **402** to a computer **412**. Specifically, in the illustrated embodiment, a double sided USB wire **414** is connected to a suitable USB port in computer **412** and to a USB port **416**, similar to port **42** of Figure 1, in sensing unit **402**. The medical staff member **410** can thus transfer files and medical data collected in the memory of sensing unit **402** to the computer **412** for purposes of monitoring, diagnosis, or any other suitable medical needs.

It is appreciated that the medical data may be retrieved from the memory of sensing unit **402** in any suitable way. In some embodiments, the memory is removed from the sensing unit **402** and is connected to an appropriate device for accessing the data thereon, such as by

connecting a memory in the form of a USB flash drive memory to the computer **412** or by connecting the memory in the form of a SD card to a suitable card reader. In some embodiments, the data contained in the memory of sensing unit **402** is transmitted from sensing unit **402** directly to computer **412** via a transmitter (not shown) of sensing unit **402** and via a suitable network.

Reference is now made to Figure 5, which is a flow chart of an embodiment of a method for monitoring the health of a baby according to an embodiment of the teachings herein.

As seen in Figure 5, a sensing unit, such as sock **10** of Figure 1, employs an EDA sensor such as EDA sensor **26** of Figure 1, to obtain an EDA measurement signal at a sensing rate, as indicated at reference numeral **502**.

The sensing rate may be any suitable sensing rate. That said, in some embodiments, the sensing rate is more frequently than every minute. In some embodiments the sensing rate is more frequently than every 30 seconds, 10 seconds, 5 seconds, or even as frequently as every second. In some embodiments, each EDA measurement has a set duration. In some embodiments, the duration is 15 seconds. In some embodiments, the duration is 30 seconds, 1 minute, or even up to five minutes.

A processor of the sensing unit, similar to processor **22** of Figure 1, analyzes the EDA measurement signal to identify an EDA stress indication at reference numeral **504**. The EDA stress indication may be any suitable EDA indication. That said, in some embodiments, the indication comprises a single EDA measurement being above an EDA threshold.

In some embodiments, the indication comprises a function of multiple EDA measurements being above the EDA threshold. In some such embodiments, the function is an average of multiple EDA measurement. In some such embodiments, the function is a mean of multiple EDA measurements. The EDA threshold may be any suitable threshold. That said, in some embodiments, the EDA threshold is 37% of phasic change over the tonic level. In some embodiments, the EDA threshold is 40%, 45% or even greater than 50% change over the tonic level.

As seen in reference **506**, if the processor of the sensing unit did not identify an EDA stress indication, the processor determines whether it is time to provide an all-clear signal to the monitoring unit, as seen at reference **508**. If it is not time to provide an all-clear signal to the monitoring unit, the processor checks the charge of the battery powering the sensing unit, similar to battery **34** of Figure 1, as seen at reference **510**.

If the battery charge is sufficient, the processor continues to obtain EDA measurement signals as seen at reference **502**. If however, as seen at reference **512**, the battery charge is not sufficient, the processor of the sensing unit employs a transmitter of the sensing unit, similar to transmitter **24** of Figure 1, to transmit a low-battery signal to the monitoring unit.

5 Subsequently, the processor of the sensing unit continues to obtain EDA measurement signal as seen at reference numeral **502**. Concurrently, as seen at reference **514**, upon receipt of the low-battery signal from the sensing unit, the monitoring unit provides a low-battery indication to the user, as described hereinabove with reference to Figure 3C.

Returning to reference **508**, if it is time to provide an all-clear signal, the processor of the sensing unit employs the transmitter of the sensing unit to transmit an all-clear signal to the monitoring unit, as seen at reference **516**. Subsequently, the processor of the sensing unit continues to obtain EDA measurement signal as seen at reference numeral **502**. Concurrently, as seen at reference **518**, upon receipt of the all-clear signal from the sensing unit, the monitoring unit provides an all-clear indication to the user, as described hereinabove with

10 reference to Figure 3A.

15

Returning to reference **506**, if the processor identified an EDA stress indication, it proceeds to activate a pulse oximeter of the sensing unit, similar to pulse oximeter **28** of Figure 1, from an inactive, energy-saving state, to determine at least one of, preferably both a pulse of the baby and a blood oxygenation percentage of the baby, as seen at reference **520**.

20 The processor of the sensing unit obtains a pulse oximeter signal from the pulse oximeter, as seen in reference **522**, and analyzes the pulse oximeter signal to determine whether the blood oxygenation measure of the signal is indicative of stress and/or whether the pulse rate measure of the signal is indicative of stress, as seen at reference **524**.

In some embodiments, the pulse oximeter signal comprises a single pulse measurement by the pulse oximeter. In some embodiments, the pulse oximeter signal comprises a single blood oxygenation measurement by the pulse oximeter. In some embodiments, the pulse oximeter signal comprises a single measurement by the pulse oximeter including pulse measurement and blood oxygenation measurement.

25

In some embodiments, the pulse oximeter signal comprises a function of multiple measurements by the pulse oximeter. In some such embodiments, the function is an average of the multiple measurements by the pulse oximeter. In some such embodiments, the function is a mean of the multiple measurements by the pulse oximeter. In some embodiments, the pulse oximeter signal comprises multiple pulse oximeter signal, each representing a single measurement by the pulse oximeter.

30

The pulse oximeter indication of stress may be any suitable pulse oximeter indication. In some embodiments, the pulse oximeter indication comprises the blood oxygenation measure of the pulse oximeter signal being below a blood oxygenation threshold. In some embodiments, the pulse oximeter indication comprises the blood oxygenation measures of at least two pulse oximeter signals being below the blood oxygenation threshold.

The blood oxygenation threshold can be any suitable threshold indicative of baby stress. That said, in some embodiments, the blood oxygenation threshold is 60% saturation. In some embodiments, the blood oxygenation threshold is 70% saturation, 80% saturation, or even 92% saturation.

In some embodiments, the pulse oximeter indication comprises the pulse rate measure of the pulse oximeter signal being below a low pulse rate threshold. In some embodiments, the pulse oximeter indication comprises the pulse rate measures of at least two pulse oximeter signals being below the low pulse rate threshold.

The low pulse rate threshold can be any suitable threshold indicative of baby stress. That said, in some embodiments, the low pulse rate threshold is 50 beats per minute. In some embodiments the pulse rate threshold is 45 beats per minute.

In some embodiments, the pulse oximeter indication comprises a pulse rate portion of the pulse oximeter signal being above a high pulse rate threshold. In some embodiments, the pulse oximeter indication comprises the pulse rate measures of at least two pulse oximeter signals being above the high pulse rate threshold.

The high pulse rate threshold can be any suitable threshold indicative of baby stress. In some embodiments, the high pulse rate threshold is 140 beats per minute. In some embodiments the high pulse rate threshold is 145, 150, or even 160 beats per minute.

If the pulse oximeter signal is not indicative of stress, the processor of the sensing unit continues to obtain EDA measurement signals as seen at reference **502**. If however, as seen at reference **525**, an indication of stress is identified in the pulse oximeter signal, the processor of the sensing unit provides an alarm indication perceivable to a human, such as by activation of the visual indicator of the sensing unit, or by activation of the aural indicator of the sensing unit. As seen at reference **526**, the processor also employs the transmitter of the sensing unit to transmit an alarm signal to the monitoring unit. Upon receipt of the alarm signal from the sensing unit, the monitoring unit provides an alarm indication to the user, as described hereinabove with reference to Figure 3B, as seen at reference **528**.

It is appreciated that activation of the pulse oximeter only upon receipt of a stress indication from the EDA measurement signal greatly reduces the battery consumption of the

sensing unit, and facilitates the battery's ability to last for more than 24 hours nonstop. On the other hand, the regular EDA measurements have only a short time elapsing between one measurement and another, thereby making sure the baby stress signals don't go on identified.

Reference is now made to Figures 6A–6C, which are pictorial illustrations of
5 additional embodiments of a sensing unit forming part of a baby monitoring device according to embodiments of the teachings herein.

As seen in Figure 6A, a sensing unit **600** comprises a bracelet **602** having an inner surface **604**, is configured to be placed on a baby's wrist. Bracelet **602** may be formed of any suitable material such as silicon, fabrics, leather, or any other suitable material.

10 In some embodiments, bracelet **602** comprises an elasticated slip-on bracelet, configured to be slipped over a wearer's hand and onto the wearer's wrist and then to fit snugly around the wrist. In some embodiments, bracelet **602** is openable, and comprises a size adjustor (not shown) for adjusting the size of bracelet **602** to the size of the baby's wrist. The size adjustor may be any suitable adjustor, such as a Velcro strap, a watch strap, or a
15 spring based portion forming part of bracelet **602**.

Mounted onto inner surface **604** are a processor **622**, a transmitter **624**, an EDA sensor **626**, a pulse oximeter **628**, and the battery **634**, all configured and operative as described for equivalent parts hereinabove with reference to Figure 1. Bracelet **602** may also include one or more additional sensors **638** and a memory **640**, configured and operative
20 described hereinabove with reference to figure 1. In use, EDA sensor **626** and pulse oximeter **628** engage the baby's skin, and are formed such that they will not be reached by ambient light, for example by bracelet **602** being formed of an opaque material.

Turning to Figure 6B, it is seen that a sensing unit **700** comprises an opaque headband **702** having an inner surface **704**, and configured to be placed around a baby's head.
25 Headband **702** may be formed of any suitable material such as silicon, fabrics, leather, or any other suitable material.

In some embodiments, headband **702** comprises an elasticated slip-on headband, configured to be slipped over a baby's head and then to fit snugly around the baby's head touching the forehead. In some embodiments, headband **702** is openable, and comprises a
30 size adjustor (not shown) for adjusting the size of headband **702** to the size of the baby's head. The size adjustor may be any suitable adjustor, such as a Velcro strap, a watch strap, or a spring based portion forming part of headband **702**.

Mounted onto inner surface **704** are a processor **722**, a transmitter **724**, an EDA sensor **726**, a pulse oximeter **728**, and the battery **734**, all configured and operative as

described for equivalent parts hereinabove with reference to Figure 1. Headband **702** may also include one or more additional sensors **738** and a memory **740**, configured and operative described hereinabove with reference to figure 1.

In use, EDA sensor **726** and pulse oximeter **728** engage the baby's skin, and are
5 formed such that they will not be reached by ambient light, for example by headband **702** being formed of an opaque material. It is appreciated that a band, similar to headband **702**, may be placed at any suitable location around the baby's body, such as on the torso, thigh, or arm.

Turning to Figure 6C, it is seen that a sensing unit **800** comprises a diaper insert **802**
10 having an inner surface **804** and configured to be fitted onto, or clipped onto, a baby's diaper **806**, such that inner surface **804** engages the baby's skin.

Mounted onto inner surface **804** are a processor **822**, a transmitter **824**, an EDA sensor **826**, a pulse oximeter **828**, and a battery **834**, all configured and operative as described for equivalent parts hereinabove with reference to Figure 1. Diaper insert **802** may also
15 include one or more additional sensors **838** and a memory **840**, configured and operative described hereinabove with reference to Figure 1. In use, EDA sensor **826** and pulse oximeter **828** engage the baby's skin, and are formed such that they will not be reached by ambient light.

Reference is now made to Figures 7A-7E, which are pictorial illustrations of
20 additional embodiments of a monitoring unit forming part of a baby monitoring device according to embodiments of the teachings herein.

As seen in Figure 7A, a monitoring unit **900** comprises a pendant **902** configured to be worn on a necklace **904** around the user's neck. Formed on pendant **902** are a receiver **914**, a processor **916**, a visual indicator **918**, an aural indicator **920**, a tactile indicator **922**, and a
25 battery **932**, all configured and operative described for equivalent parts hereinabove with reference to Figure 2.

It is appreciated that visual indicator **918** is placed on a portion of pendant **902** visible by the wearer, and a tactile indicator **922** is formed on a portion of pendant **902** which engages the wearer's skin. It is further appreciated the external surface of pendant **902**, visible
30 by people looking at the wearer of pendant **902**, may have a decorative appearance, such as that of a piece of jewelry.

Turning to Figure 7B, it is seen that a monitoring unit **1000** comprises an intercom unit **1002** configured to be placed on the safe stable location, such as a table (not shown), for example on a desk or at the nurses' station. One part of intercom unit **1002** are a receiver

1014, a processor **1016**, a visual indicator **1018**, an aural indicator **1020**, and a battery **1032**, all configured and operative described for equivalent parts hereinabove with reference to Figure 2.

It is appreciated that in the context of an intercom unit **1002**, a tactile indicator, such a
5 tactile indicator **222** of Figure 2, would not be useful, since intercom unit **1002** is not to worn on a human's body and therefore vibration caused by a tactile indicator would not be felt by the baby's caretaker. That said, visual indicator **1018** and aural indicator **1020** would have the same functionality as described hereinabove with reference to Figure 2, and would be sufficient to alert the nurse's or caretaker's attention to an emergency situation. As described
10 hereinabove, visual indicator **1018** is placed on a portion intercom unit **1002** visible by the user.

It is further appreciated that battery **1032** of intercom unit **1002** may be replaced by an AC/DC connection for powering the components of intercom unit **1002** via an electrical socket.

15 Referring now to Figure 7C, a monitoring unit **1100** comprises a pen **1102** configured to be placed in a user's pocket. Forming part of pen **1102** are a receiver **1114**, a processor **1116**, a visual indicator **1118**, an aural indicator **1120**, a tactile indicator **1122**, and a battery **1132**, all configured and operative described for equivalent parts hereinabove with reference to Figure 2.

20 It is appreciated that visual indicator **1118** is placed on a portion of pen **1102** visible by the wearer, for example on clip **1140** used for clipping the pen onto the user's pocket, and tactile indicator **1122** is formed on a portion of pen **1102** which engages the wearer's skin, typically via a shirt, such as on a surface **1142** of pen **1102** which is opposite clip **1140**.

Turning to Figure 7D, a monitoring unit **1200** comprises a pager **1202** configured to
25 be clipped onto a user's clothing item using a clip **1204**. Forming part of pager **1202** are a receiver **1214**, a processor **1216**, a visual indicator **1218**, an aural indicator **1220**, a tactile indicator **1222**, and a battery **1232**, all configured and operative described for equivalent parts hereinabove with reference to Figure 2.

It is appreciated that visual indicator **1218** is placed on a portion of pager **1202** visible
30 by the wearer, and tactile indicator **1222** is formed on a portion of pager **1202** which engages the wearer's skin, typically via the user's clothing.

Referring now to Figure 7E, it is seen that a mobile device **1300** includes a monitoring unit application **1302** thereby functioning as the monitoring unit of Figure 2. A receiver **1304** of mobile device **1300** functions as receiver **214** of Figure 2, a processor **1306** of mobile

device **1300** functions as processor **216** of Figure 2, a display **1308** of mobile device **1300** functions as visual indicator **218** of Figure 2, a speaker **1310** of mobile device **1300** functions as an aural indicator **220** of Figure 2, a vibrating element **1312** of mobile device **1300** functions as tactile indicator **222** of Figure 2, and a battery **1314** of mobile device **1300**
5 functions of battery **232** of Figure 2.

It is appreciated that any suitable visual indication may be provided on display **1308**, including a change in lighting, change in coloring, display of text, display of an image, or any other suitable visual indication.

It is appreciated that certain features of the invention, which are, for clarity, described
10 in the context of separate embodiments, may also be provided in combination in a single embodiment. Conversely, various features of the invention, which are, for brevity, described in the context of a single embodiment, may also be provided separately or in any suitable subcombination or as suitable in any other described embodiment of the invention. Certain features described in the context of various embodiments are not to be considered essential
15 features of those embodiments, unless the embodiment is inoperative without those elements.

Although the invention has been described in conjunction with specific embodiments thereof, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art. Accordingly, it is intended to embrace all such alternatives, modifications and variations that fall within the scope of the appended claims.

20 Citation or identification of any reference in this application shall not be construed as an admission that such reference is available as prior art to the invention.

Section headings are used herein to ease understanding of the specification and should not be construed as necessarily limiting.

25

CLAIMS:

1. A method for providing information indicative of a stress situation in a human, comprising:
 - positioning a pulse oximeter and an electrodermal activity (EDA) sensor to monitor a human;
 - at a processor functionally associated with said EDA sensor and said pulse oximeter, monitoring said human by receiving from said EDA sensor an EDA measurement signal at an EDA sensing rate;
 - at a processing rate, processing said received EDA measurement signals to identify an EDA indication of stress; and
 - if an EDA indication of stress is identified:
 - activating said pulse oximeter to determine a measure of at least one of pulse and blood oxygenation of the human;
 - at said processor, receiving from said pulse oximeter at least one pulse oximeter signal related to said determined measure of at least one of pulse and blood oxygenation;
 - at said processor, processing said received pulse oximeter signal to identify a pulse oximeter indication of stress; and
 - if a pulse oximeter indication of stress is identified, said processor providing an alarm signal.
2. The method of claim 1, wherein said providing an alarm signal comprises at least one of:
 - providing a visual alarm from a visual indicator functionally associated with said processor;
 - providing an audible alarm from an aural indicator functionally associated with said processor; and
 - automatically activating a wireless transmitter functionally associated with said processor to wirelessly transmit an alarm signal to a remote monitoring unit.
3. The method of claim 2, also comprising in said remote monitoring unit, providing an alarm perceivable to a human.

4. The method of any one of claims 2 to 3, wherein said remote monitoring unit includes at least one of:
 - a component suitable to be worn by a person;
 - a component configured to be clipped onto clothes of a person; and
 - a component configured to be carried in a pocket of a person.
5. The method of any one of claims 2 to 4, wherein said remote monitoring unit comprises a component not configured to be ordinarily worn by a person, the method also comprising placing said component not configured to be worn by a person in the vicinity of a person.
6. The method of any one of claims 2 to 5, also comprising, during said monitoring of said human, if no EDA indication of stress is identified, wirelessly transmitting an all-clear signal to said monitoring unit.
7. The method of any one of claims 2 to 6, wherein said pulse oximeter operates with power from an energy storage unit, the method also comprising:
 - during said monitoring of said human, monitoring a charge state of said energy storage unit; and
 - if said charge state of said energy storage unit is below a charge threshold, said processor automatically activating said wireless transmitter to wirelessly transmit a low battery signal to said remote monitoring unit.
8. The method of any of claims 2 to 7, also comprising:
 - in said remote monitoring unit, monitoring quality of signals received from said wireless transmitter; and
 - if said quality of said signals is insufficient, providing an insufficient signal indication perceivable to a human.
9. The method of any one of the preceding claims, wherein said measure of blood oxygenation comprises a blood oxygenation percentage.
10. The method of any one of the preceding claims, wherein said pulse oximeter indication of stress comprises at least one of:

a blood oxygenation measure of said pulse oximeter signal being below a blood oxygenation threshold;

a pulse rate measure of said pulse oximeter signal being below a low pulse rate threshold; and

a pulse rate measure of said pulse oximeter signal being above a high pulse rate threshold.

11. The method of any one of the preceding claims, also comprising indicating whether said pulse oximeter indication is indicative of stress stemming from a problem in blood oxygenation of said human or of stress stemming from a problem in pulse rate of said human.

12. The method of any one of the preceding claims, also comprising storing said EDA measurement signals and/or said measures of pulse and/or blood oxygenation in a memory.

13. The method of any one of the preceding claims, also comprising, during said monitoring of said human, if no EDA indication of stress is identified, keeping said pulse oximeter in an inactive energy-saving state.

14. A device useful for providing information indicative of a stress situation in a human human, comprising:

a pulse-oximeter configured for determining a measure of at least one of pulse and blood oxygenation of a human and producing a pulse oximeter signal related to a said determined measure of at least one of pulse and blood oxygenation;

an electrodermal activity (EDA) sensor configured for determining electrodermal activity of a human at an EDA sensing rate and producing an EDA measurement signal related to said determined electrodermal activity;

a processor functionally associated with said pulse oximeter and with said EDA sensor; and

a wireless transmitter functionally associated with said processor,

wherein said processor is configured to:

receive from said EDA sensor an EDA measurement signal at said EDA sensing rate, at a processing rate, process said received EDA measurement signals to identify an EDA indication of stress,

if an EDA indication of stress is identified, activate said pulse oximeter to determine a measure of at least one of pulse and blood oxygenation of the human,
receive from said pulse oximeter at least one pulse oximeter signal related to said determined measure of at least one of pulse and blood oxygenation,
process said received pulse oximeter signal to identify a pulse oximeter indication of stress, and
if a pulse oximeter indication of stress is identified, automatically provide an alarm signal.

15. The device of claim 14, also comprising:
an indicator configured, upon provision of said alarm signal, to provide an indication perceivable to a human.
16. The device of any one of claims 14 to 15, also comprising a remote monitoring unit, including:
a wireless receiver configured to receive transmissions from said wireless transmitter;
and
an alarm indicator, configured to provide an alarm perceivable to a human upon receipt of a said alarm signal by said wireless receiver.
17. The device of claim 16, wherein said remote monitoring unit comprises at least one of:
a component suitable to be worn by a person;
a component configured to be clipped onto clothes of a person;
a component configured to be carried the pocket of a person; and
a component not configured to be ordinarily worn by a person.
18. The device of any one of claims 16 to 17, wherein said remote monitoring unit comprises at least one of:
a visual indicator, wherein said alarm perceivable to a human comprises a visual alarm;
an aural indicator, wherein said alarm perceivable to a human comprises an audible alarm; and
a tactile indicator and said alarm perceivable to a human comprises a tactile alarm.

19. The device of any one of claims 16 to 18, wherein said processor is also configured to monitor a charge state of an energy storage unit, and if said charge state of said energy storage unit is below a charge threshold, to transmit a low battery signal, via said transmitter.
20. The device of any one of claims 16 to 19, wherein said processor is also configured, if no EDA indication of stress is identified, to wirelessly transmit an all-clear signal, via said transmitter.
21. The device of any one of claims 16 to 20, wherein said remote monitoring unit is configured to monitor quality of signals received from said wireless transmitter and to provide an insufficient signal indication perceivable to a human if said quality of signals is insufficient.
22. The device of any of claims 14 to 21, wherein said pulse oximeter indication of stress comprises at least one of:
- a blood oxygenation measure of said pulse oximeter signal being below a blood oxygenation threshold;
 - a pulse rate measure of said pulse oximeter signal being below a low pulse rate threshold; and
 - a pulse rate measure of said pulse oximeter signal being above a high pulse rate threshold.
23. The device of any one of claims 14 to 22, wherein said alarm signal indicates whether said pulse oximeter indication is indicative of stress stemming from a problem in blood oxygenation of said human or of stress stemming from a problem in pulse rate of said human.
24. The device of any one of claims 14 to 23, also comprising a memory functionally associated with said processor, configured for storing said EDA measurement signals and/or said measures of pulse and/or blood oxygenation.
25. The device of any one of claims 14 to 24, also comprising an energy storage unit configured to power a group of components including at least one of said EDA sensor, said pulse oximeter, said processor, and said wireless transmitter.

26. The device of claim 25, wherein said energy storage unit is configured to provide sufficient power for continuous operation of said group of components for a period of time of not less than 24 hours of normal use.

27. The device of any one of claims 25 to 26, wherein said energy storage unit has a capacity of at least 130 ampere hours.

28. The device of any one of claims 14 to 27, configured to keep said pulse oximeter in an inactive energy-saving state as long as no EDA indication of stress is identified.

29. A method for providing information indicative of a reason for a stress situation in a human, comprising:

positioning an electrodermal activity (EDA) sensor to monitor a human;

at a processor functionally associated with said EDA sensor, receiving from said EDA sensor an EDA measurement signal at a EDA sensing rate;

at a processing rate, processing said received EDA measurement signals to identify an EDA level category;

based on said identified EDA level category providing an appropriate signal, wherein:

if said received EDA measurement is identified to be in a first EDA level category, providing an alarm indicating medical stress,

if said received EDA measurement is identified to be in a second EDA level category, providing a signal indicating non-medical stress, and

if said received EDA measurement is identified to be in a third EDA level category, providing a signal indicating that no stress is identified.

30. A device useful for providing information indicative of a reason for a stress situation in a human, comprising:

an electrodermal activity (EDA) sensor configured for determining electrodermal activity of a human at an EDA sensing rate and producing an EDA measurement signal related to said determined electrodermal activity; and

a processor functionally associated with said EDA sensor, configured to:

receive from said EDA sensor an EDA measurement signal at an EDA sensing rate,

at a processing rate, process said received EDA measurement signals to identify an EDA level category; and
based on said identified EDA level category, provide an appropriate signal, wherein:

if said received EDA measurement is identified to be in a first EDA level category, providing an alarm indicating medical stress,
if said received EDA measurement is identified to be in a second EDA level category, providing a signal indicating non-medical stress, and
if said received EDA measurement is identified to be in a third EDA level category, providing a signal indicating that no stress is identified.

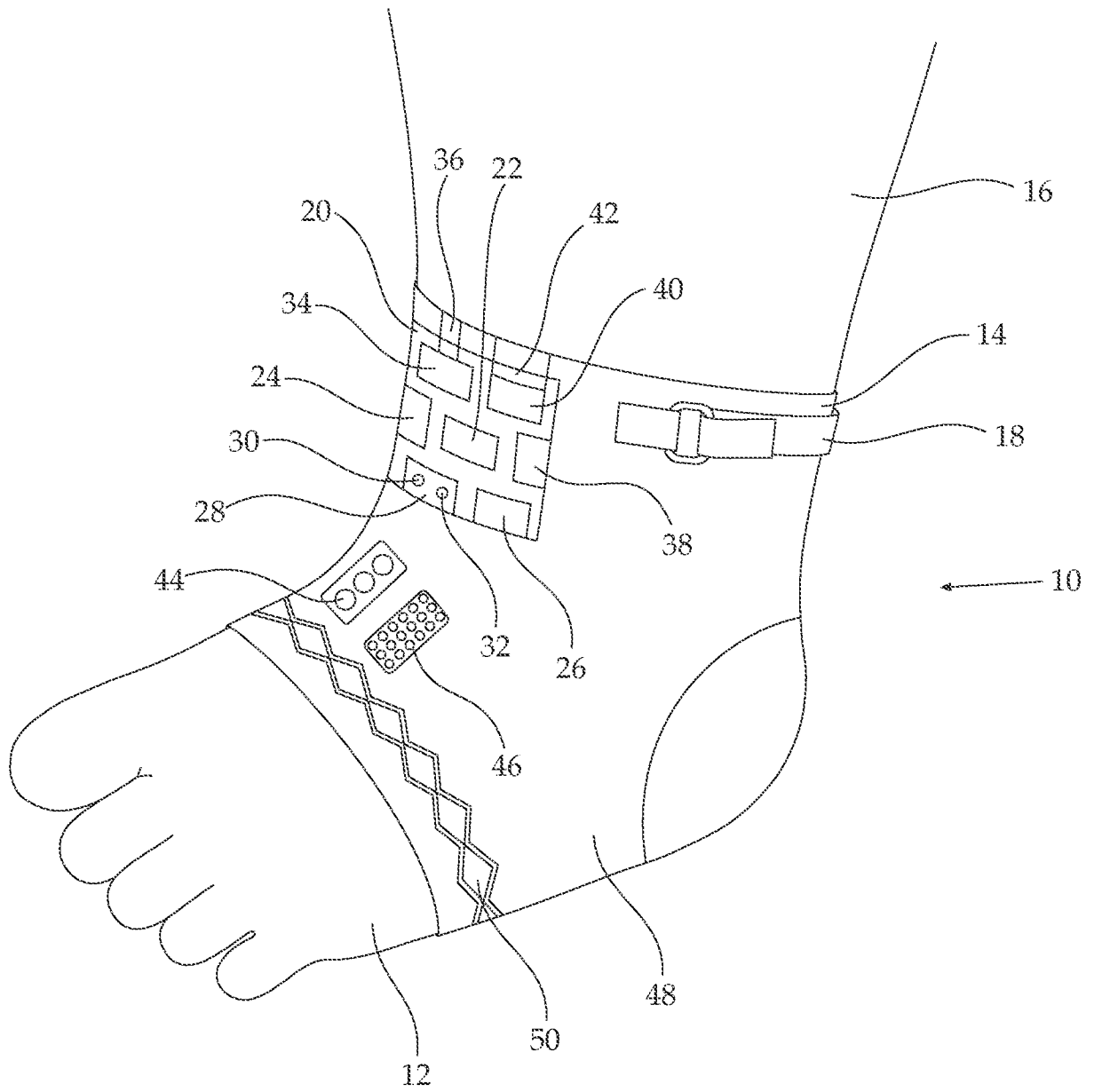


FIGURE 1

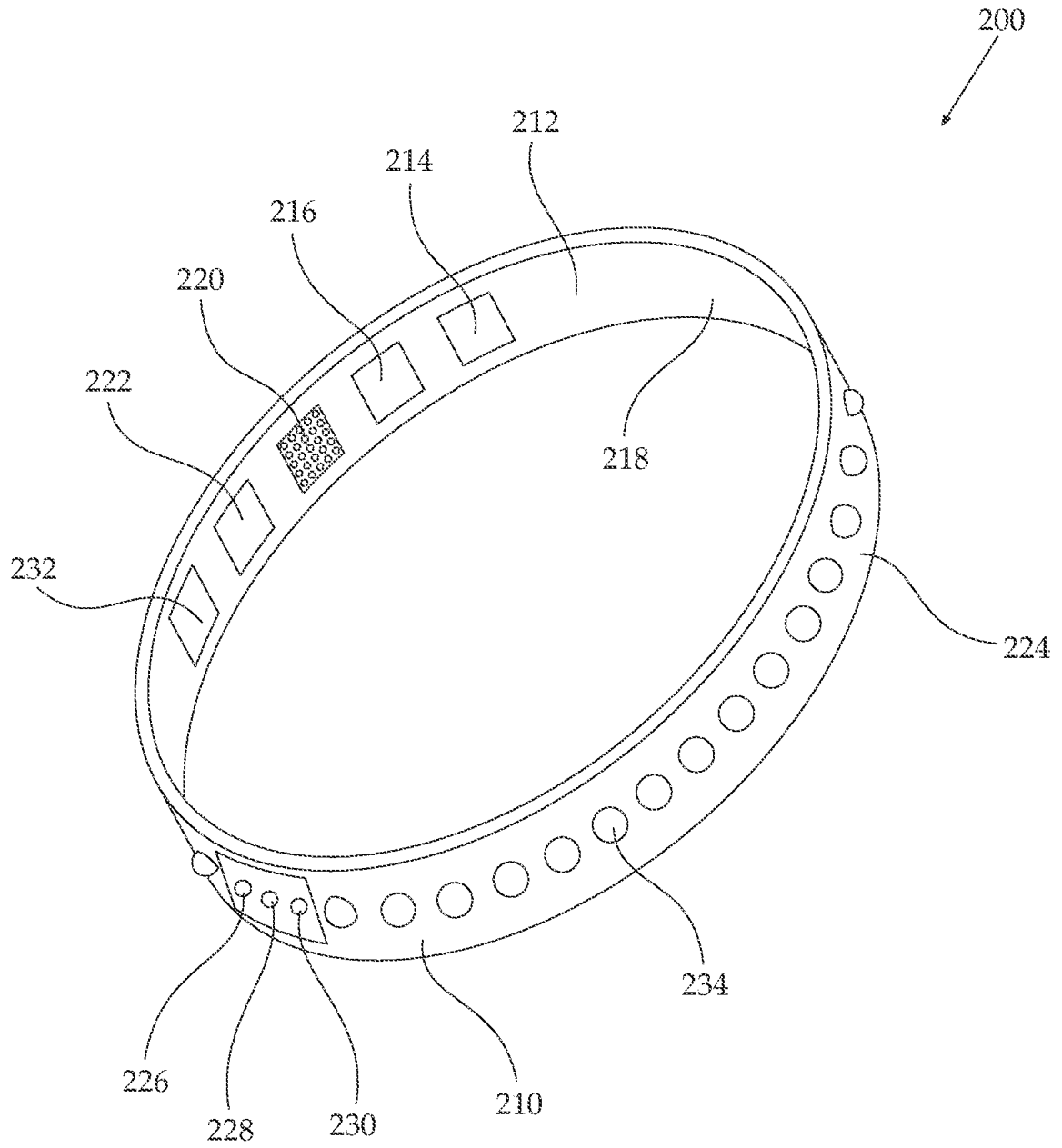


FIGURE 2

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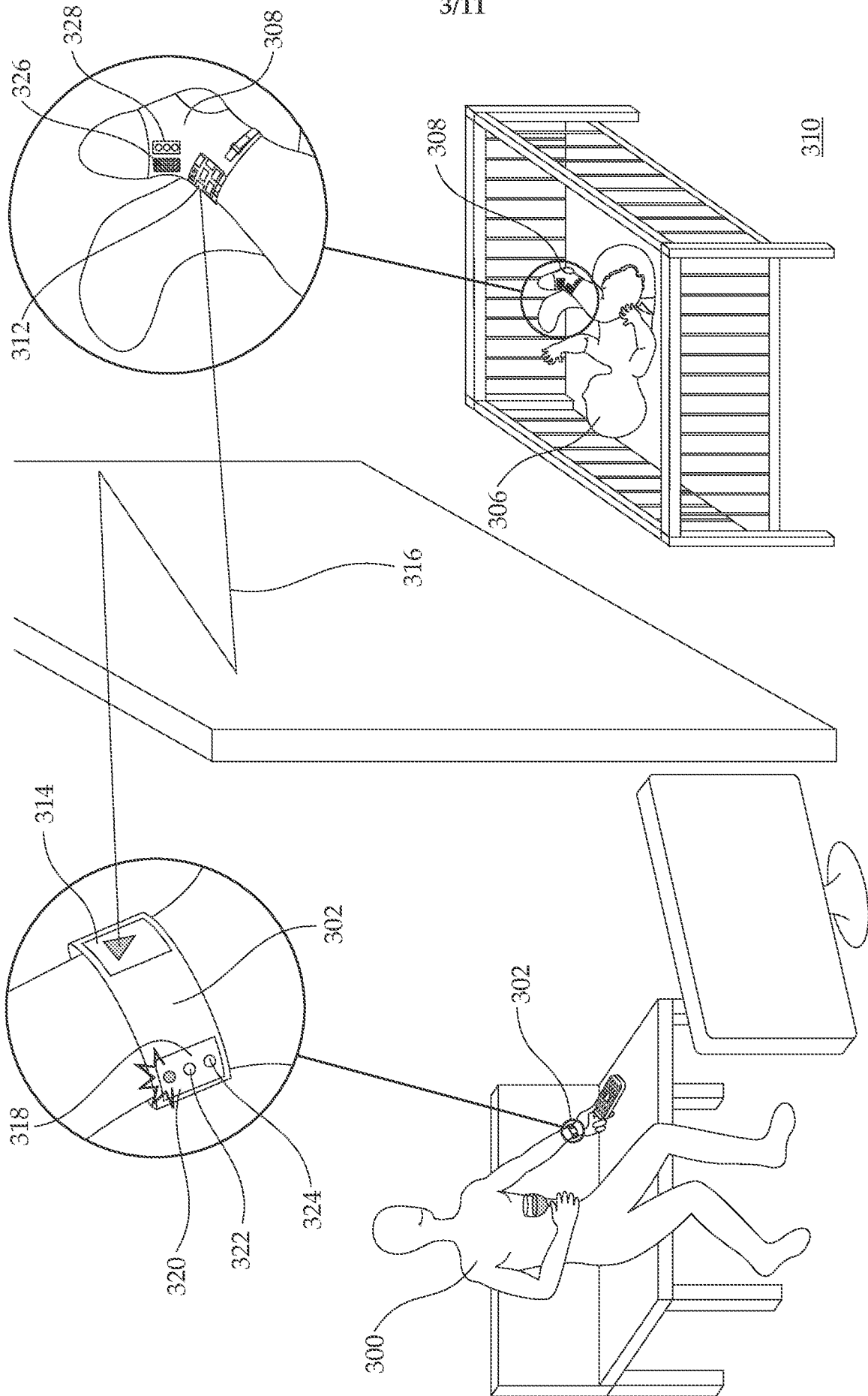


FIGURE 3A

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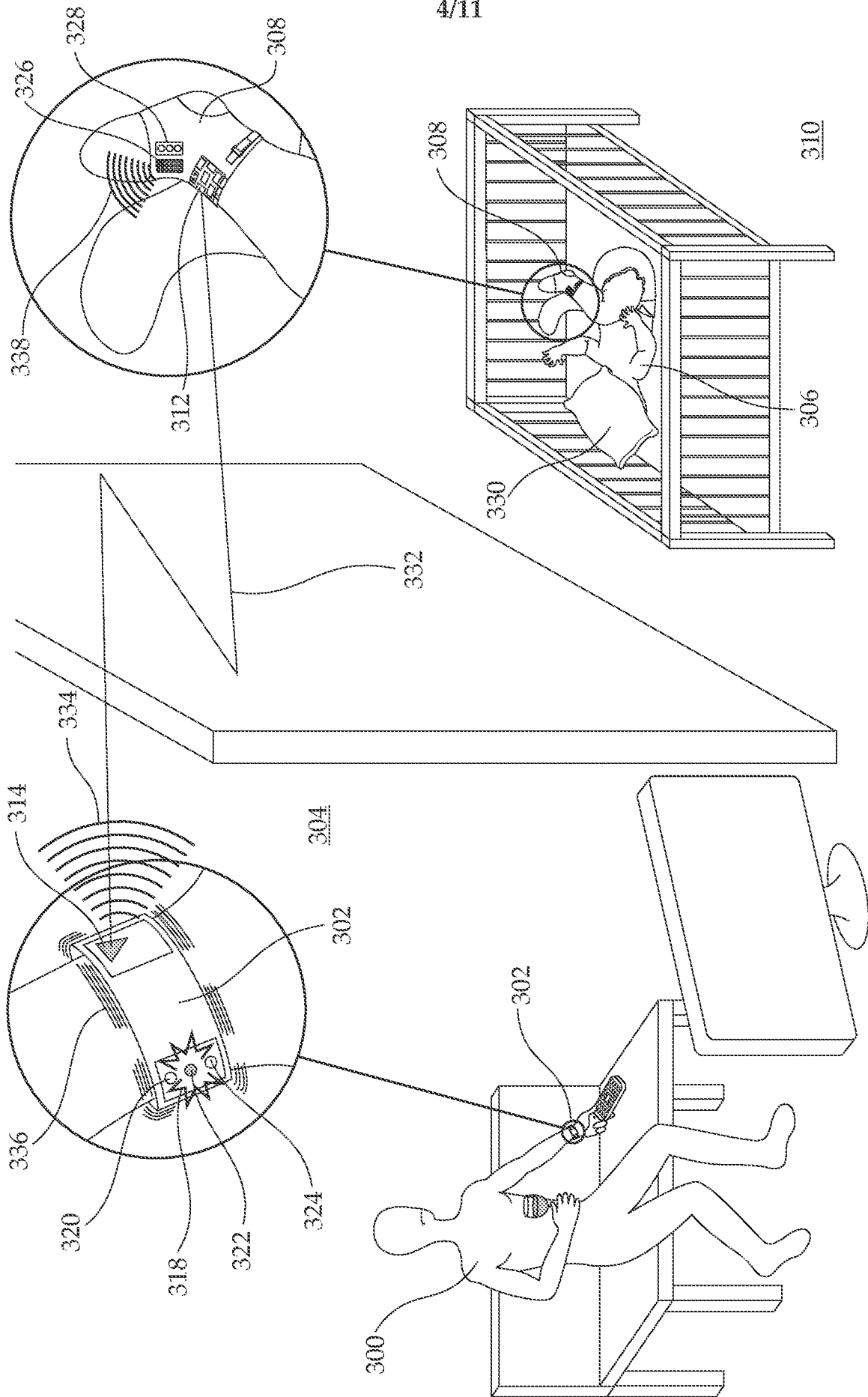


FIGURE 3B

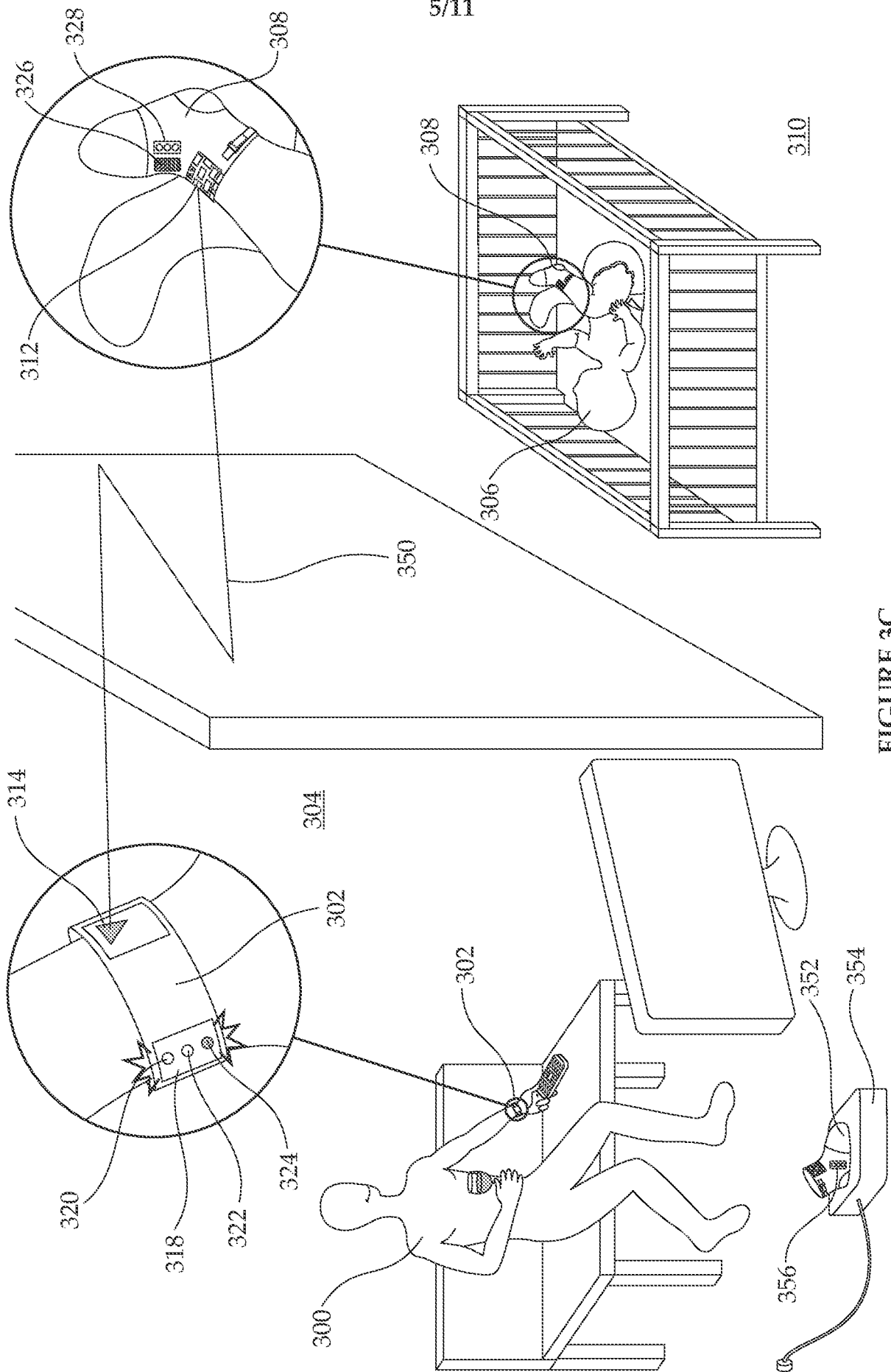


FIGURE 3C

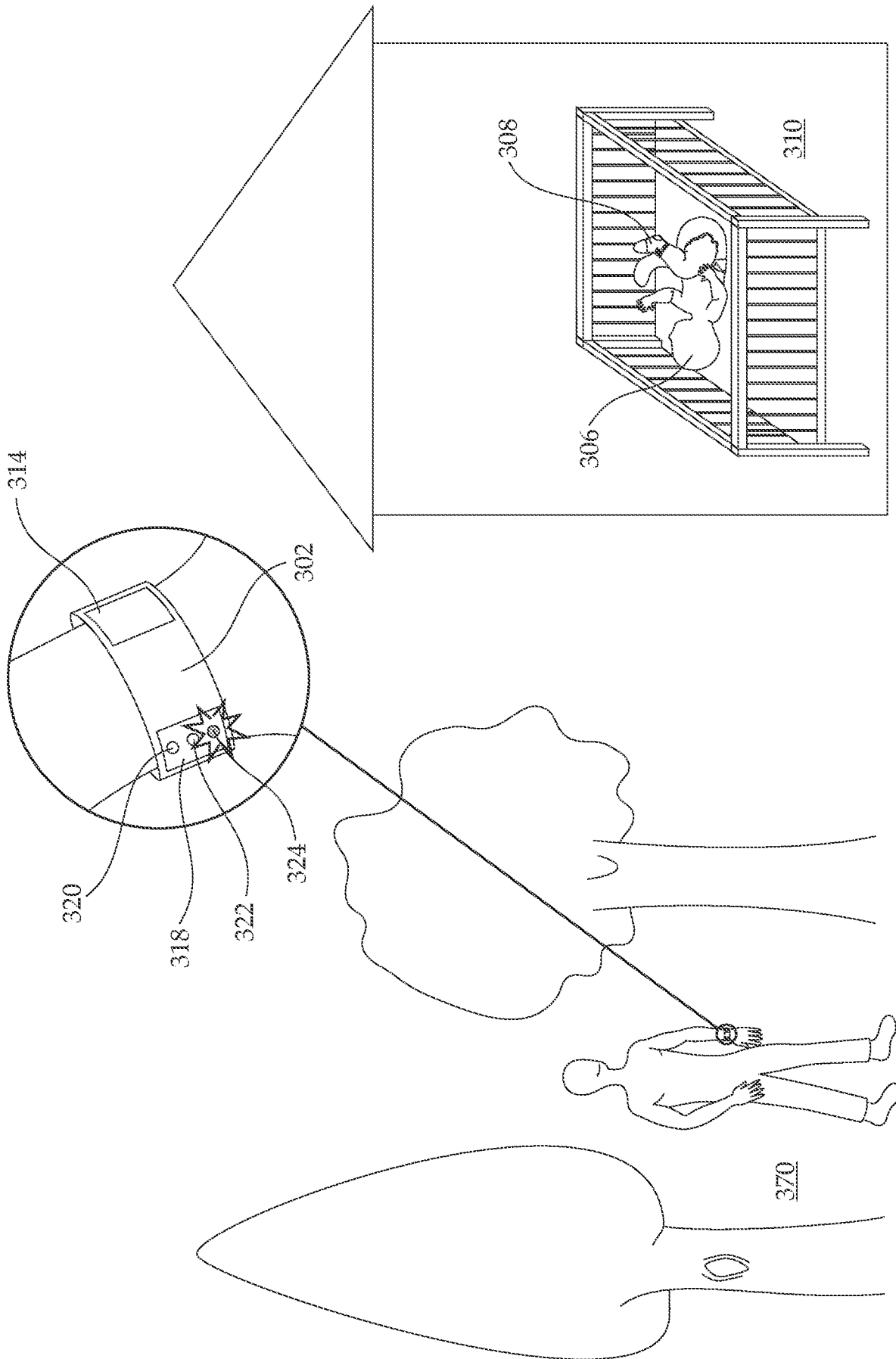


FIGURE 3D

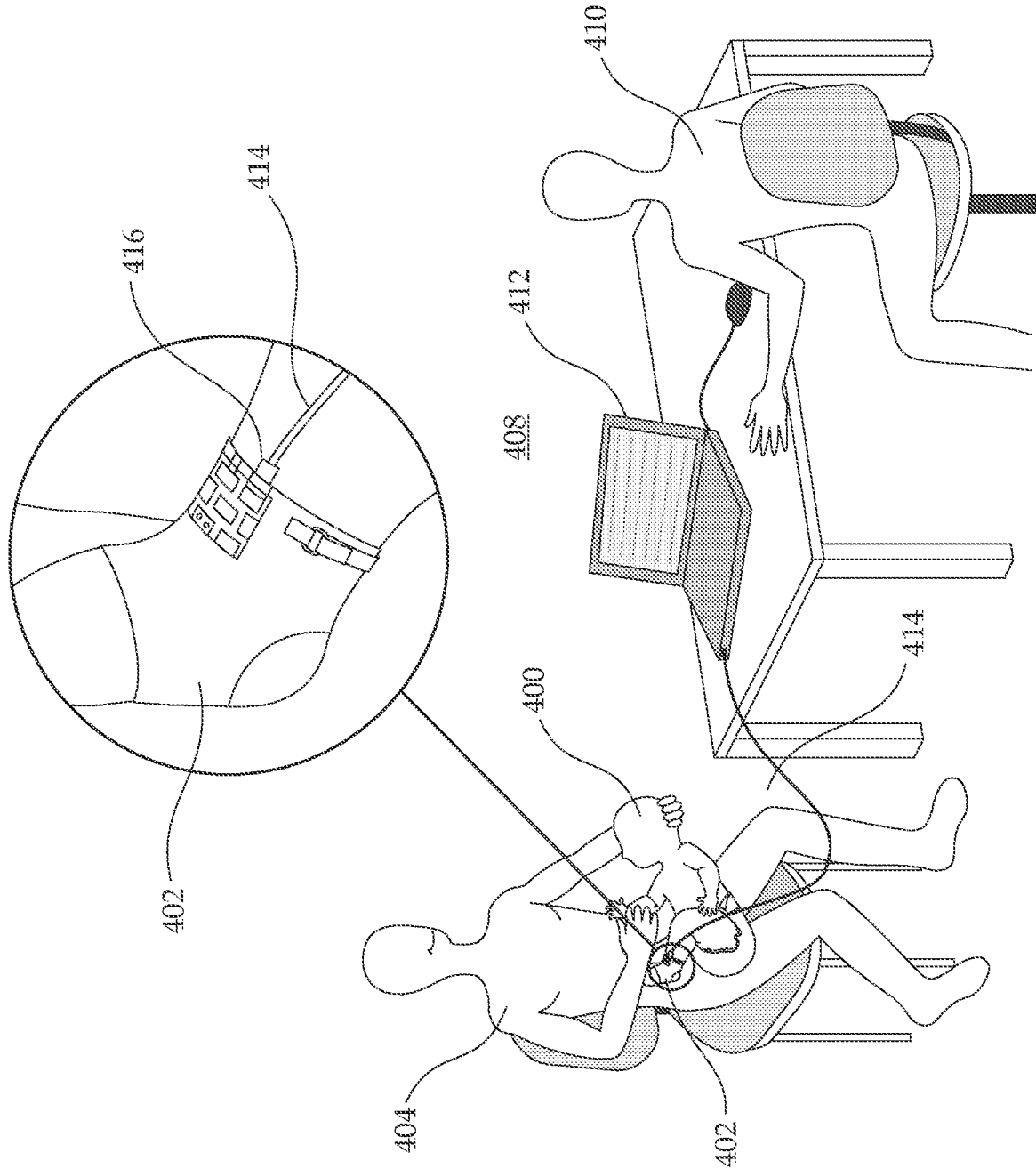


FIGURE 4

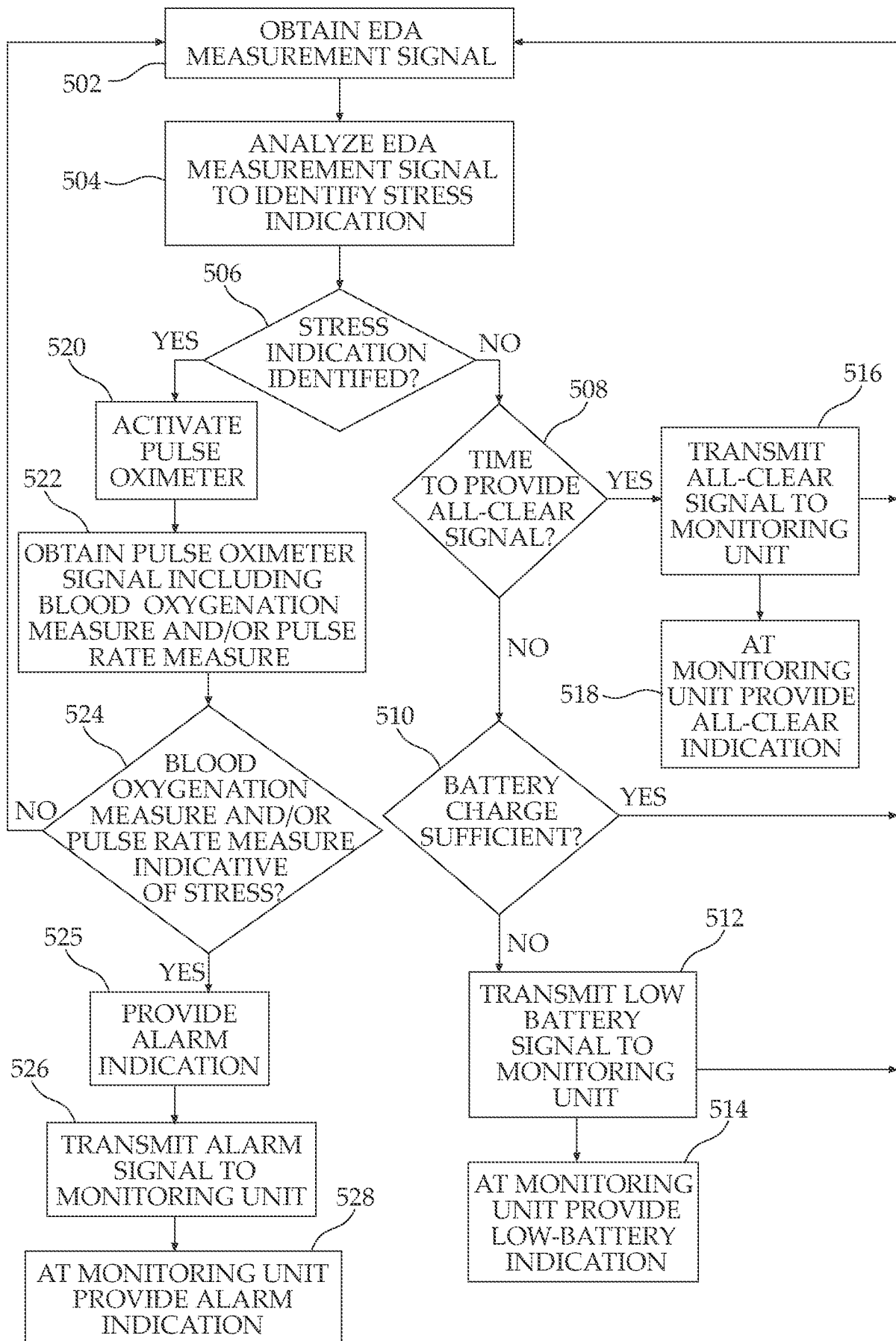


FIGURE 5

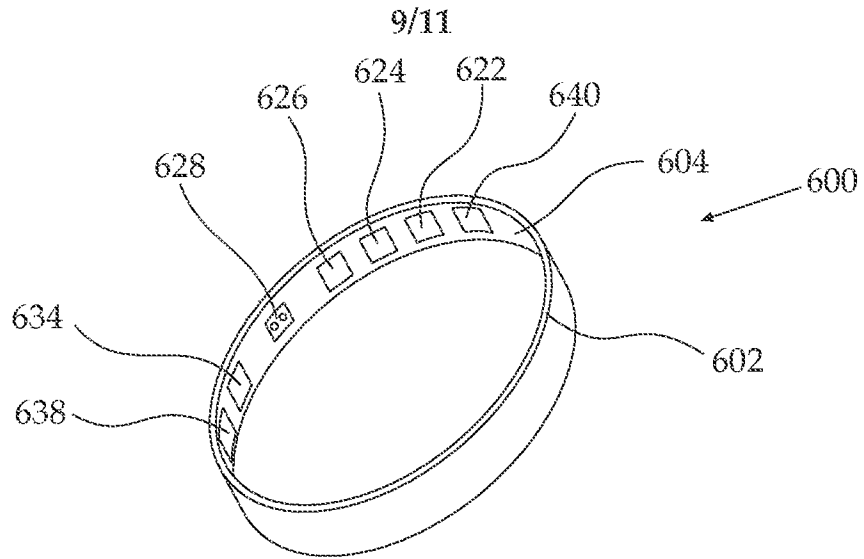


FIGURE 6A

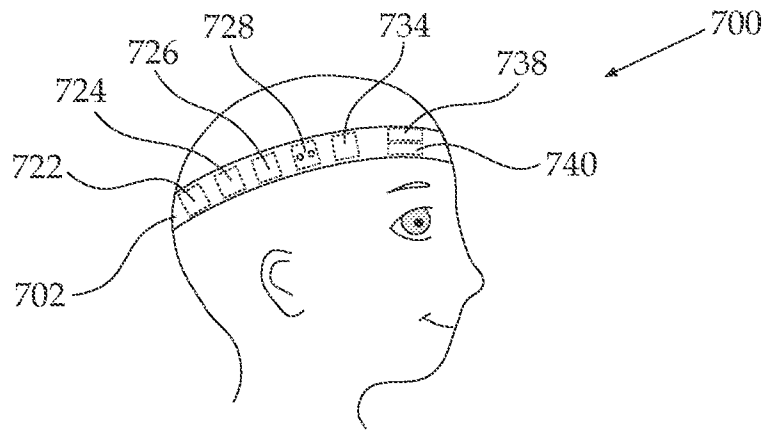


FIGURE 6B

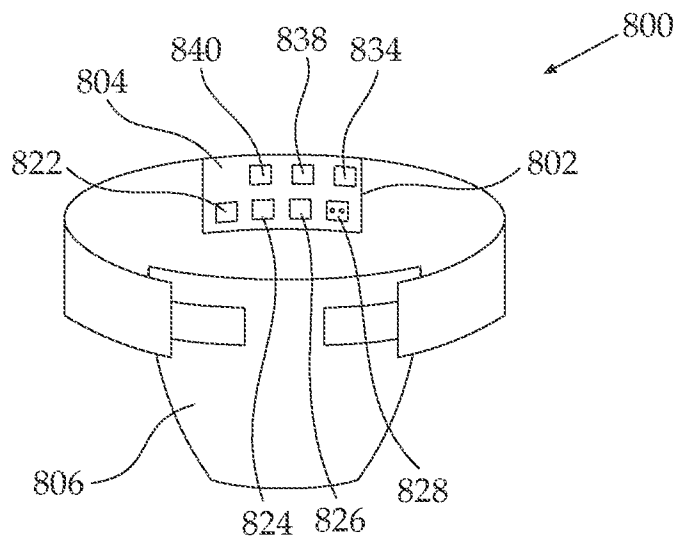


FIGURE 6C

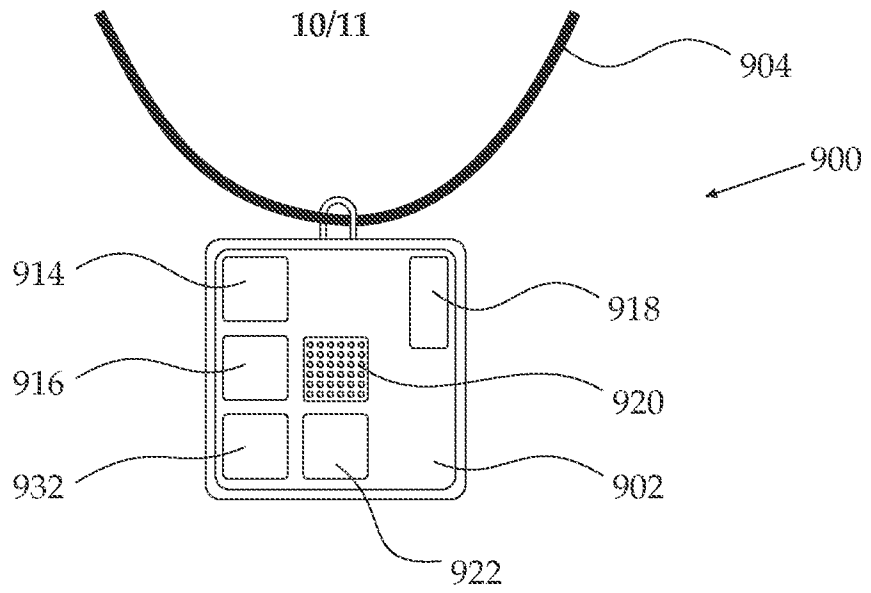


FIGURE 7A

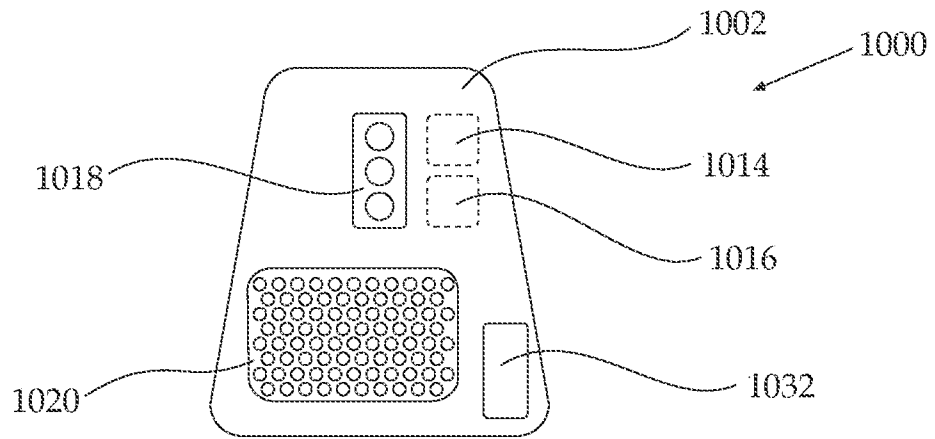


FIGURE 7B

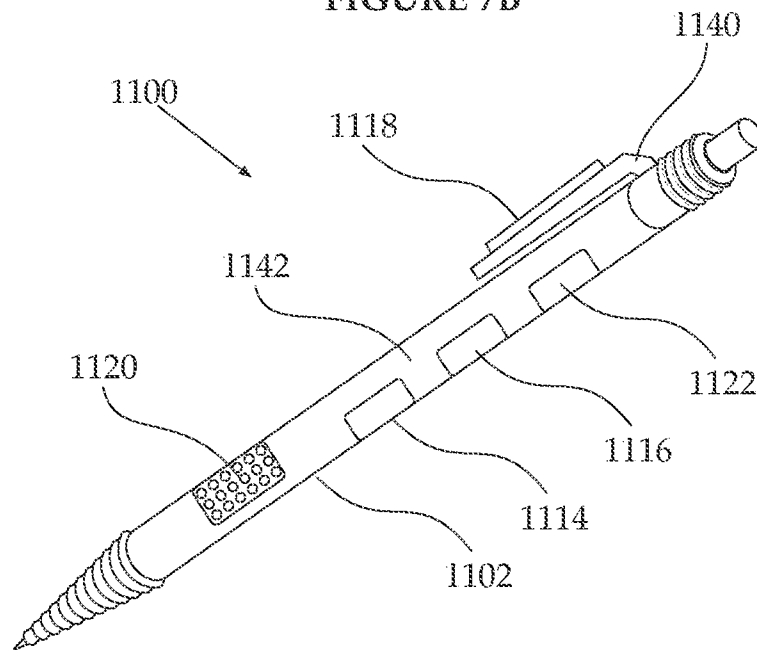


FIGURE 7C

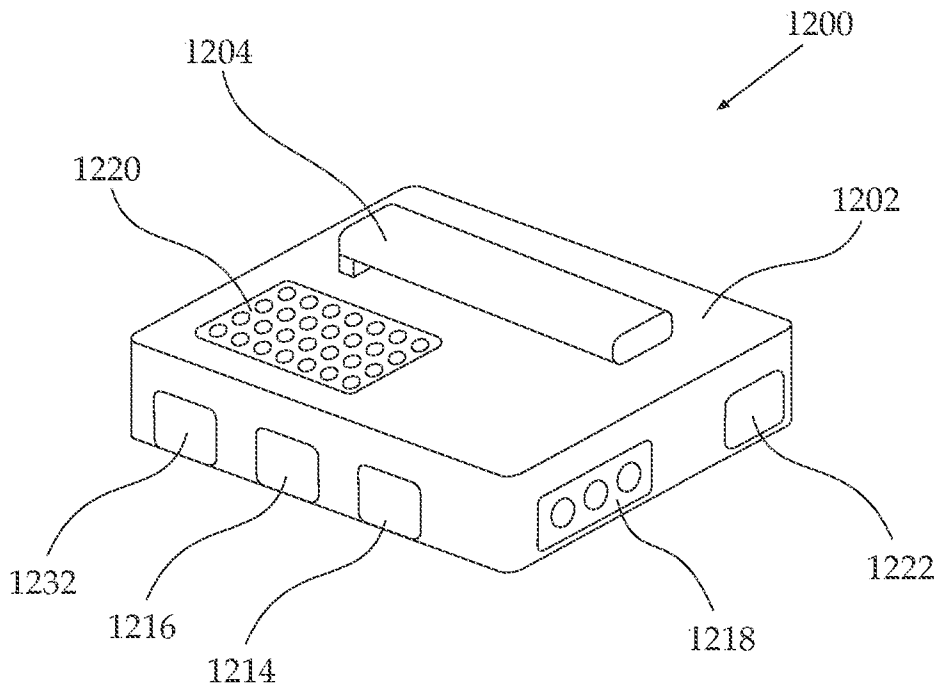


FIGURE 7D

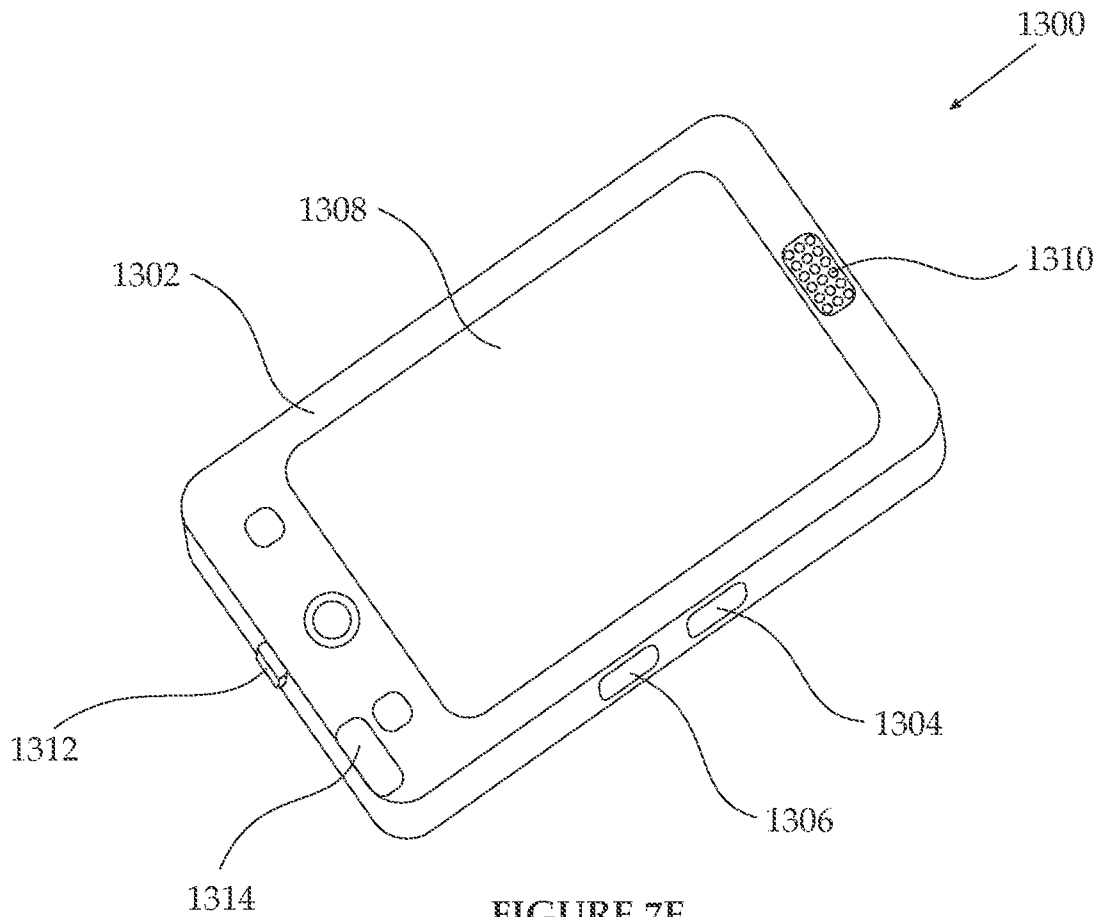


FIGURE 7E

INTERNATIONAL SEARCH REPORT

International application No.

PCT/IB2013/056013

A. CLASSIFICATION OF SUBJECT MATTER

IPC (2013.01) A61B 1/00, A61B 8/02, A61B 5/145500, G06F 19/00, A61B 5/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC (2013.01) A61B 5/00, G06F 19/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Databases consulted: THOMSON INNOVATION, Esp@cenet, FamPat database

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 6571124 B1 STORM HANNE 27 May 2003 (2003/05/27) The whole document	1-30
Y	WO 2011106773 A1 NELLCOR PURITAN BENNETT LLC; MCKENNA, EDWARD; LISOGURSKI, DANIEL 01 Sep 2011 (2011/09/01) The whole document	1-30
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A	US 2007208235 A1 BESSON MARCUS; VON CZETTRIZ GOTTHART; BAX RALPH 06 Sep 2007 (2007/09/06) The whole document	1-30
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Further documents are listed in the continuation of Box C.

See patent family annex.

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Date of the actual completion of the international search

03 Nov 2013

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/IB2013/056013

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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A	WO 2007040645 A1 ALLEZ PHYSIONIX LTD; UNIVERSITY OF WASHINGTON; KLIOT, MICHEL; FREDERICKSON, ROBERT, C., A; FORGHANI, KAMRAN; MOURAD, PIERRE, D 12 Apr 2007 (2007/04/12) The whole document	1-30

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International application No.

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专利名称(译)	用于提供指示人体中的压力情况的信息的装置和方法		
公开(公告)号	EP2877078A1	公开(公告)日	2015-06-03
申请号	EP2013822979	申请日	2013-07-22
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当前申请(专利权)人(译)	MED-BRIGHT MEDICAL SOLUTIONS LTD.		
[标]发明人	MAIERSHON DAVID AKSTEIN ORI		
发明人	MAIERSHON, DAVID AKSTEIN, ORI		
IPC分类号	A61B1/00 A61B8/02 A61B5/1455 G06F19/00 A61B5/00 A61B5/0205 A61B5/024 A61B5/053 G01N33/49 G08B21/02		
CPC分类号	A61B5/0004 A61B5/0059 A61B5/1455 A61B5/6802 A61B5/6804 A61B5/746 G06F19/34 A61B5/0205 A61B5/02416 A61B5/0531 A61B5/14551 A61B5/6803 A61B5/6807 A61B5/6808 A61B5/74 A61B2503/04 A61B2560/0209 G01N33/4925 G06F19/3418 G08B21/0211 G16H40/67 A61B5/02438 A61B5/04 A61B5/0826 A61B5/14542 A61B5/165 A61B5/4818 G08B19/00 G08B21/0453 A61B5/0022 A61B5/024 A61B5/0533 A61B5/7285 A61B5/742		
优先权	2012013159 2012-07-24 GB		
其他公开文献	EP2877078A4		
外部链接	Espacenet		

摘要(译)

公开了用于监测和感测人(例如婴儿)的压力情况的方法和装置,并且在一些实施例中公开了向父母或其他看护人通知这种情况。 43