(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
4 February 2010 (04.02.2010)

PCT

(10) International Publication Number
WO 2010/014743 A1

(51) International Patent Classification:
A61B 5/00 (2006.01) *G08B 21/00* (2006.01)
G08B 19/00 (2006.01) *G08B 23/00* (2006.01)

(21) International Application Number:
PCT/US2009/052146

(22) International Filing Date:
29 July 2009 (29.07.2009)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/084,615 29 July 2008 (29.07.2008) US

(71) Applicant *(for all designated States except US)*: **MASIMO CORPORATION** [US/US]; 40 Parker, Irvine, CA 92618 (US).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **KIANI, Massi Joe, E.** [US/US]; 40 Parker, Laguna Niguel, CA (US). **CEBADA, Steve** [US/US]; 40 Parker, Mission Viejo, CA (US). **OLSON, Greg** [US/US]; 40 Parker, Irvine, CA (US).

(74) Agent: **ALTMAN, Daniel, E.**; Knobbe Martens Olson & Bear, LLP, 2040 Main Street, Fourteenth Floor, Irvine, CA 92614 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

(54) **Title**: ALARM SUSPEND SYSTEM

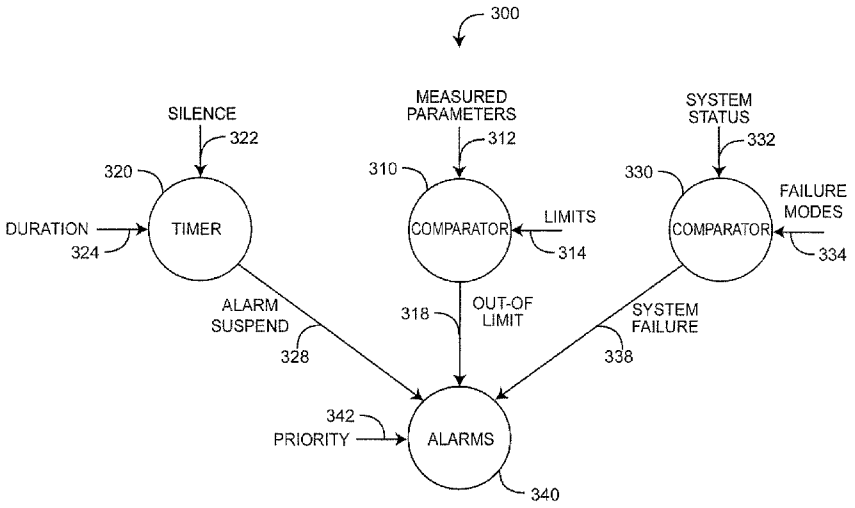

FIG. 3

(57) **Abstract**: An alarm suspend system utilizes an alarm trigger (318) responsive to physiological parameters (312) and corresponding limits (314) on those parameters. The parameters are associated with both fast and slow treatment times (324) corresponding to length of time it takes for a person to respond to medical treatment for out-of-limit parameter measurements (312). Audible and visual alarms (340) respond to the alarm trigger. An alarm silence button (322) is pressed to silence the audible alarm for a predetermined suspend time. The audible alarm is activated after the suspend time (328) has lapsed. Longer suspend times are associated with slow treatment parameters and shorter suspend times are associated with fast treatment parameters.

WO 2010/014743 A1

ALARM SUSPEND SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims priority benefit under 35 U.S.C. § 119(e) to U.S. Provisional Patent Application Serial No. 61/084,615, filed July 29, 2008, titled *Alarm Management System*, hereby incorporated by reference herein.

BACKGROUND OF THE INVENTION

[0002] Pulse oximetry for measuring constituents of circulating blood has achieved acceptance in a wide variety of medical applications, including surgical wards, intensive care and neonatal units, general wards, home care, physical training, and virtually all types of monitoring scenarios. A pulse oximeter generally includes a two-wavelength optical sensor applied to a patient, a monitor for processing sensor signals and displaying results and a patient cable electrically interconnecting the sensor and the monitor. The monitor typically provides a numerical readout of physiological parameters such as oxygen saturation (SpO_2) and pulse rate (PR). Advanced physiological monitors utilize multiple wavelength sensors and enhanced measurement capabilities to provide readouts of additional parameters, such as carboxyhemoglobin (HbCO), methemoglobin (HbMet) and total hemoglobin (Hbt).

[0003] Pulse oximeters capable of reading through motion induced noise are disclosed in at least U.S. Pat. Nos. 6,770,028, 6,658,276, 6,650,917, 6,157,850, 6,002,952, 5,769,785 and 5,758,644; low noise pulse oximetry sensors are disclosed in at least U.S. Patent 6,088,607 and 5,782,757; all of which are assigned to Masimo Corporation, Irvine, California ("Masimo") and are incorporated by reference herein.

[0004] Physiological monitors and corresponding multiple wavelength optical sensors are described in at least U.S. Pat. App. No. 11/367,013, filed March 1, 2006 and titled *Multiple Wavelength Sensor Emitters* and U.S. Pat. App. No. 11/366,208, filed March 1, 2006 and titled *Noninvasive Multi-Parameter Patient Monitor,* both

assigned to Masimo Laboratories, Irvine, CA (Masimo Labs) and both incorporated by reference herein.

[0005] Further, physiological monitoring systems that include low noise optical sensors and pulse oximetry monitors, such as any of LNOP® adhesive or reusable sensors, SofTouch™ sensors, Hi-Fi Trauma™ or Blue™ sensors; and any of Radical®, SatShare™, Rad-9™, Rad-5™, Rad-5v™ or PPO+™ Masimo SET® pulse oximeters, are all available from Masimo. Physiological monitoring systems including multiple wavelength sensors and corresponding noninvasive blood parameter monitors, such as Rainbow™ adhesive and reusable sensors and RAD-57™ and Radical-7™ monitors for measuring SpO_2, pulse rate (PR), perfusion index (PI), pleth variability index (PVI), signal quality, HbCO and HbMet among other parameters are also available from Masimo.

SUMMARY OF THE INVENTION

[0006] Monitor alarms are triggered by out-of-limit parameters and system failures, the latter including monitor or sensor failures or improper sensor placement, to name a few. Alarms can be visual, audible or both. Alarms can also have different levels of priority, which are reflected in the type of visual and audible alarms. In an embodiment, parameters exceeding limits such as low SpO_2, high HbCO, high HbMet and low and high BPM trigger high priority alarms. System failures due to sensor off, no sensor or defective sensor also trigger high priority alarms. Parameters exceeding limits such as high SpO_2, low and high PI, low and high PVI, for example, trigger medium priority alarms. Parameters exceeding limits such as low HbCO and low HbMet along with a system low battery indication are examples of low priority alarms.

[0007] An audible alarm may be temporarily suspended by pressing an alarm silence button so as to prevent unnecessary disturbance to the patient and distraction of the caregiver. During alarm suspension, visual alarms remain active. If an alarm condition persists after a predetermined alarm suspend period, the audible alarm resumes. The alarm suspend period is typically long enough to give a caregiver sufficient time to intervene with appropriate patient treatment yet short

enough to ensure that patient health is not endangered if intervention is ineffective. For conventional pulse oximetry, an alarm suspend may be, for example, a maximum of 120 seconds.

[0008] Alarm suspension on advanced blood parameter monitors is problematic. With conventional pulse oximetry, treatment for abnormal parameter measurements can be quickly applied and a patient response is typically fast. For example, a treatment for low oxygen saturation is the application of an oxygen mask or an increase in oxygen flow. By contrast, the duration of treatment for parameters measured by advanced monitors is highly dependent on the alarm-triggering parameter. For example, the treatment for high methemoglobin is the injection of methylene blue, and the patient response to such an injection is slow. When patient treatment time exceeds the maximum alarm suspend period, an audible alarm will constantly reactivate. Thus, a single alarm suspend duration for all parameters is inadequate to cope with the many different types of parameters measured by advanced monitors.

[0009] One aspect of an alarm suspend system for silencing the alarms is an alarm trigger responsive to any of various parameters and predetermined limits corresponding to the parameters, where the parameters are partitioned according to treatment time, i.e. the relative length of time it takes for a person to respond to medical treatment for a parameter measurement outside of the predetermined limits. An audible alarm is responsive to the alarm trigger. An alarm silence button is actuated so as to suspend the audible alarm. A timer tracks the duration of the suspended alarm and is initiated by actuation of an alarm silence button. The timer retriggers the audible alarm after the timed duration has lapsed/expired. In an embodiment, a long duration suspend time is associated with slow treatment parameters and a short duration suspend time is associated with fast treatment parameters. Fast treatment parameters may include, for example, parameters relating to normal blood hemoglobin constituents and slow treatment parameters may include parameters relating to abnormal blood hemoglobin constituents.

[0010] In various embodiments, a long duration suspend time is less than or equal to about two minutes and a short duration suspended time is greater than

about two minutes. A default duration associated with the fast treatment parameters is about two minutes and a default duration associated with the slow treatment parameters is about fifteen minutes. The alarm suspend system may also have an alarm suspend override responsive to a predetermined unit change in the parameter triggering a suspended alarm. The override results in reactivation of the suspended alarm. A physiological monitor having an alarm suspend system may also have a pop-up window that appears on the monitor display in response to actuation of the silence button, where the pop-up window presents a choice of alarm suspend durations.

[0011] Another aspect of an alarm suspend system is a partition of measured parameters into at least a first group and a second group. An audible alarm is triggered if at least one parameter is outside of predetermined limits. The audible alarm is suspended in response to a silence request. A first duration is associated with the first group and a second duration is associated with the second group. The audible alarm is reactivated after at least one of the first duration and the second duration. The first duration may be set so as to generally correspond to a first range of treatment times for the first group of parameters. Likewise, the second duration may be set so as to generally correspond to a second range of treatment times for the second group of parameters, where the first range of treatment times and the second range of treatment times are non-overlapping.

[0012] In various embodiments, suspended audible alarms are overridden if the triggering parameter has greater than a predetermined unit change before the suspended alarm expires according to either the first duration or the second duration. The first and second groups are defined in relation to normal hemoglobin measurements abnormal hemoglobin measurements, respectively. The first duration is set to be less than or equal to two minutes and the second duration is set to be greater than two minutes, with default durations of about two minutes corresponding to the first group and about fifteen minutes corresponding to the second group. In an embodiment, a pop-up window for a monitor display is constructed and the first duration and the second duration are selected from a range of durations presented within the pop-up window.

[0013] A further aspect of an alarm suspend system deactivates an audible alarm for one of a short duration and a long duration according to the alarm-triggering parameter. A first group of parameters is associated with the short duration and a second group of parameters is associated with the long duration. The first group and the second group are partitioned according to a fast treatment time and a short treatment time associated with the parameters. An override reactivates the audible alarm if the trigger parameter changes more than a predetermine amount during the corresponding duration. In various embodiments, the first group comprises parameters related to the measurement of normal hemoglobin and the second group comprises parameters related to the measurement of abnormal hemoglobin. The long duration is greater than about 120 seconds and the short duration is less than or equal to about 120 seconds. A pop-up window for the display allows selection of the long duration and the short duration in response to the silence button.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] **FIG. 1** is a perspective view of a physiological measurement system utilizing an alarm suspend system;

[0015] **FIG. 2** is a detailed block diagram of a physiological measurement system utilizing an alarm suspend system;

[0016] **FIG. 3** is a flow diagram of an alarm suspend system embodiment;

[0017] **FIG. 4** is a state diagram of an alarm suspend system embodiment; and

[0018] **FIG. 5** is an illustration of an alarm suspend pop-up window.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0019] **FIG. 1** illustrates a physiological measurement system **100** that utilizes an alarm suspend system. The physiological measurement system **100** has a noninvasive sensor **105** attached to a tissue site **10**, a physiological monitor **101**, and an interface cable **109** interconnecting the monitor **101** and the sensor **105**. The physiological measurement system **100** may incorporate pulse oximetry in addition to advanced features, such as a multiple wavelength sensor and advanced processes for determining physiological parameters other than or in addition to those of pulse oximetry, such as carboxyhemoglobin, methemoglobin and total hemoglobin, as a few examples.

[0020] The monitor **101** has a front panel **110** providing a display **120**, touch keys **130**, controls **140**, a speaker **150**, a sensor port **160** and status indicators **170**. The display **120** shows parameter readouts, limits and waveforms among other items. The display **120** also has touch key icons **122** that indicate touch key **130** functions. The speaker **150** provides an audible alarm in response to physiological measurements that violate preset conditions, such as an out-of-limit parameter, as well as system failures, such as a low battery condition. The controls **140** include an alarm silence button **144** that is pressed to temporarily suspend out-of-limit parameter alarms and system alarms, such as low battery. The display **120** provides visual alarms, which include a bell-shaped alarm status indicator **124** that illuminates during an alarm condition and parameter readouts **210** and limits **220** that flash when parameters are out-of-limit. Status indicators **170** also provide visual alarms. When there are multiple alarm conditions, the parameter displays **202** indicate parameters with the highest alarm priority. Touch keys **130** and corresponding icons **122** include an alarm menu access button for setting alarm conditions, such as high or low alarm limits for SpO_2, HbCO, HbMet, PR and PI. The alarm silence button **144** is pressed to temporarily suspend audible alarms. Advantageously, an alarm suspend system provides a parameter-dependent variation in the alarm suspend duration, as described below, utilizing a common silence button or other suspend initiator.

[0021] **FIG. 2** illustrates a physiological measurement system **200** including a physiological monitor **201**, a sensor **205** and an interface cable **209**. The sensor **205** is attached to a tissue site, such as a finger **10**, and includes a plurality of emitters **206** irradiating the tissue site **10** with multiple wavelengths of light. The sensor **205** also includes one or more detectors **208** capable of detecting the light after attenuation by the tissue site **10**. The sensor **205** transmits optical radiation at wavelengths other than or including the red and infrared wavelengths utilized in pulse oximeters. The monitor **201** inputs a corresponding sensor signal **211** and determines the relative concentrations of blood constituents other than or in addition to the "normal" blood hemoglobin constituents HbO_2 and Hb, including "abnormal" blood hemoglobin constituents HbCO, HbMet and blood related parameters such as fractional oxygen saturation, total hemoglobin and blood glucose to name a few.

[0022] As shown in **FIG. 2**, the monitor **201** has a front-end signal conditioner **210**, an A/D converter **220**, emitter drivers **230**, D/A converters **240** and a digital signal processor ("DSP") **250**. In general, the emitter drivers **230** convert digital control signals, via the D/A converters **240**, into analog drive signals capable of driving the sensor emitters **206**. The front-end signal conditioner **210** converts, via the A/D converter **220**, composite analog intensity signal(s) from light sensitive detector(s) **208** into digital data input to the DSP **250**. The emitter drivers **230** and front-end signal conditioner **210** communicate with the sensor **205** via the interface cable **209**.

[0023] Also shown in **FIG. 2**, the monitor **201** has an instrument manager **260** and a user interface **280**. The user interface **280** includes one or more displays **282**, alarms **284** and user input/output (I/O) **286**. The instrument manager **260** communicates with the DSP **250** to receive parameter data and to present that data on the display **282**. The instrument manager **260** may also store and display historical or trending data related to one or more of the measured parameters or combinations of the measured parameters. The instrument manager **260** also controls audible and visual alarms and indicators **284**. The instrument manager **260** responds to user-actuated keys and communicates with external devices via various I/O ports **286**. Further, the instrument manager **260** executes alarm suspend

firmware **270** so as to respond to an alarm silence button press **288**, as described in detail with respect to **FIGS. 3-4**.

[0024] **FIG. 3** generally illustrates an alarm suspend system **300**. Alarm triggers include system failures **338** and out-of-limit parameters **318**. Triggered alarms **340** may be audible, visual or both, and may vary according to priority **342**. Audible alarms may be generated by a monitor front-panel-mounted speaker **150** (**FIG. 1**) and may vary in loudness, pitch and sound pattern. Visual alarms may include parameter labels, parameter numerics, symbols and status lights, which can flash and vary in color.

[0025] As shown in **FIG. 3**, measured parameters **312** are compared **310** to default or user-specified limits **314**. An out-of-limit condition **318** triggers an alarm **340**. An alarm suspend **328** is user-initiated by a silence request **322**. This may be a press of a silence button **144** (**FIG. 1**) on a monitor front panel **110** (**FIG. 1**). In an embodiment, the alarm suspend **328** silences audible alarms and modifies the display of visual alarms. The alarm suspend **328** is based on a timer **320**, which ends the alarm suspend **328** after a predetermined duration **324**. The duration **324** may be a function of the out-of-limit parameter **312**. In an advantageous embodiment, the duration **324** relates to, or is a function of, the treatment time for the alarm-triggering parameter so as to avoid nuisance alarms while maintaining alarm integrity.

[0026] **FIG. 4** illustrates an alarm suspend embodiment **400** that operates independently for each measured parameter that can trigger an alarm. An alarm is initially off **410**. The alarm remains off as long as the parameter is within its set limits **412**. If a parameter is measured outside of its set limits **414**, an alarm is triggered **420**. The alarm may audible, visual or both audible and visual. A user can request to silence the alarm by pressing an alarm silence button **144** (**FIG. 1**), for example. The silence request **422** suspends the alarm **430** which turns off audible alarms but, in an embodiment, does not deactivate visual alarms. The audible alarm remains suspended **430** for a predetermined duration **432**. When the suspend duration has passed, the alarm suspend expires **434** and audible alarms are once again activated **420**. The alarm remains on **428** until the triggering

parameter is within limits **424** or a user once again requests silence **422**. The alarm suspend **430** deactivates if the measured parameter becomes within limits **438**, such as when the patient condition improves, or if no physiological data is detected **439**, such as no sensor, sensor off, no cable or malfunctioning sensor situations, to name a few. Also, if the measured parameter changes during the alarm suspend **430** by a sufficient out-of-limit amount, an override **436** reactivates the audible alarms **420**.

[0027] In an alarm suspend system embodiment, parameters are classified according to the typical time it takes for medical treatment to transition an out-of-limit measurement to a within-limit measurement. Suspend durations **324** (**FIG. 3**) are set accordingly. For example, in a two-tier embodiment, relatively slow treatment parameters, such as HbMet, HbCO, Hbt and PVI, are assigned relatively long suspend durations. Similarly, relatively fast treatment parameters, such as SpO_2 and PR, are assigned relatively short suspend durations. In an embodiment, the alarm suspend duration is adjustable for each individual parameter, including 2, 5, 10, 15, 20, 25 and 30 minutes for slow treatment parameters, with a default of 15 minutes; and 30, 60, 90 and 120 seconds for fast treatment parameters, with a default of 120 seconds. These alarm features are only active when alarm limits have been set . Other alarm features apply to both slow treatment and fast treatment parameters. For example, an alarm delay of 0, 5, 10 or 15 seconds applies to all enabled parameters.

[0028] In an embodiment, an override **436** occurs if slow treatment parameters such as HbCO, HbMet or PVI increase or Hbt decreases by a certain unit change during the alarm suspend duration. The unit change is adjustable for each parameter, such as from 1-15 in increments of 1. **TABLE 1** shows a default embodiment of override unit changes for these parameters.

Parameter	Unit Change	Direction
HbCO	5	Increase
HbMet	2	Increase
Hbt	2	Decrease
PVI	OFF	Increase

TABLE 1: Override Unit Changes for Selected Parameters

[0029] **FIG. 5** illustrates an alarm suspend window **500** that provides a "pop-up" display so that a monitor user may manually enter an alarm suspend duration. The alarm suspend window **500** appears as a portion of a monitor display **501**, such as the front panel display **120** (**FIG. 1**) described above. The pop-up window **500** responds to a suspend request, such as a silence button **144** (**FIG. 1**) press. The alarm suspend window **500** has a window identifier **502** and one or more parameter subsections **510**, **520**. Each parameter subsection **510**, **520** has a parameter identifier **512**, **522** and corresponding suspend duration options **514**, **524**. In an embodiment, specific suspend times are selected via monitor touch keys **130** (**FIG. 1**) as guided by corresponding touch key icons **560**. Selected suspend times are highlighted or otherwise identified and entered, also via a touch key **130** (**FIG. 1**). In an alternative embodiment, the monitor display is a touch screen and alarm suspend times are directly entered by a finger press on a specific duration "virtual button" **514**, **524**. Once one or more suspend durations are entered, the pop-up window **500** disappears from the display **501**. The alarm suspend window **500** advantageously allows a user to quickly choose an appropriate alarm suspend duration for the situation at hand, rather than relying on a predetermined or default duration.

[0030] An alarm suspend system is described above with respect to alarms triggered by measured parameters and limits associated with those measured parameters. Limits may correspond to levels of a measured parameter, such as a percentage oxygen saturation to name but one example. Limits may also correspond to trends of a measured parameter, such as a rate-of-change of oxygen saturation, for example. Limits may also correspond to patterns in a measured

parameter or a comparison of one measured parameter with another measured parameter, as further examples.

[0031] An alarm suspend system is described above with respect to a two-tier grouping of parameters, such as slow treatment and fast treatment parameters and alarm suspend durations associated with those groups. Groupings of parameters with respect to alarm suspend durations may be multi-tier, such as slow, medium and fast treatment parameters, to name but one example.

[0032] An alarm suspend system has been disclosed in detail in connection with various embodiments. These embodiments are disclosed by way of examples only and are not to limit the scope of the claims that follow. One of ordinary skill in the art will appreciate many variations and modifications.

WHAT IS CLAIMED IS:

1. A monitor having a sensor configured to attach to a person so as to transmit optical radiation into a tissue site and generate a sensor signal responsive to the optical radiation after attenuation by pulsatile blood flow within the tissue site, the monitor configured to measure and display a plurality of physiological parameters responsive to the sensor signal and to generate alarms when those parameter measurements are outside of predetermined limits, the monitor having an alarm suspend system for silencing the alarms, the alarm suspend system comprising:

an alarm trigger responsive to any of a plurality of parameters and to predetermined limits corresponding to the parameters;

the parameters partitioned into a plurality of fast treatment parameters and a plurality of slow treatment parameters according to the relative length of time it takes for a person to respond to medical treatment for a parameter measurement outside of the predetermined limits;

an audible alarm responsive to the alarm trigger;

an alarm silence button actuated so as to suspend the audible alarm;

a timer for timing the duration of the suspended alarm;

the timer initiated by actuation of the alarm silence button;

the timer retriggering the audible alarm after the timed duration has lapsed;

a long duration suspend time associated with the slow treatment parameters; and

a short duration suspend time associated with the fast treatment parameters.

2. The alarm suspend system according to claim 1 wherein:

fast treatment parameters include parameters relating to normal blood hemoglobin constituents; and

slow treatment parameters include parameters relating to abnormal blood hemoglobin constituents.

3. The alarm suspend system according to claim 2 wherein:

the long duration suspend time is less than or equal to about two minutes; and

the short duration suspended time is greater than about two minutes.

4. The alarm suspend system according to claim 3 further comprising:

a default duration associated with the fast treatment parameters of about two minutes; and

a default duration associated with the slow treatment parameters of about fifteen minutes.

5. The alarm suspend system according to claim 4 further comprising an alarm suspend override;

the override responsive to a predetermined unit change in a parameter triggering a suspended alarm; and

the override resulting in reactivation of the suspended alarm.

6. The alarm suspend system according to claim 5 further comprising:

a monitor configured to measure the physiological parameters;

a monitor display for displaying the measured parameters;

a pop-up window that appears on the display in response to actuation of the silence button; and

the pop-up window presenting a choice of alarm suspend durations.

7. An alarm suspend method comprising the steps of:

measuring a plurality of physiological parameters;

partitioning the parameters into at least a first group and a second group;

triggering an audible alarm if at least one parameter is outside of predetermined limits;

suspending the audible alarm in response to a silence request;

associating a first duration with the first group and a second duration with the second group; and

reactivating the audible alarm after at least one of the first duration and the second duration.

8. The alarm suspend method according to claim 7 comprising the further steps of:

setting the first duration so as to generally correspond to a first range of treatment times for the first group of parameters;

setting the second duration so as to generally correspond to a second range of treatment times for the second group of parameters;

the first range of treatment times and the second range of treatment times being non-overlapping.

9. The alarm suspend method according to claim 8 comprising the further step of overriding the suspended audible alarm if the triggering parameter has greater than a predetermined unit change before the suspended alarm expires according to the at least one first duration and second duration.

10. The alarm suspend method according to claim 9 comprising the further steps of:

defining the first group in relation to normal hemoglobin measurements; and

defining the second group in relation to abnormal hemoglobin measurements.

11. The alarm suspend method according to claim 10 comprising the further steps of:

setting the first duration to be less than or equal to two minutes; and

setting the second duration to be greater than two minutes.

12. The alarm suspend method according to claim 11 comprising the further steps of:

defining a default duration of about two minutes corresponding to the first group; and

defining a default duration of about fifteen minutes corresponding to the second group.

13. The alarm suspend method according to claim 12 comprising the further steps of:

constructing a pop-up window for a monitor display; and

selecting the first duration and the second duration from a range of durations presented within the pop-up window.

14. A physiological measurement system comprising:

a sensor configured to attach to a person so as to transmit optical radiation into a tissue site and generate a sensor signal responsive to the optical radiation after attenuation by pulsatile blood flow within the tissue site;

a monitor in communications with the sensor so as to measure a plurality of physiological parameters responsive to the sensor signal;

a display mounted on the monitor that displays the measured parameters along with visual alarms associated with the measured parameters;

a speaker mounted on the monitor that generates an audible alarm triggered by at least one of the parameters;

a silence button mounted on the monitor that, when actuated, initiates a silence request for the monitor to suspend the audible alarm; and

an alarm suspend system that deactivates the audible alarm for one of a short duration and a long duration according to the alarm-triggering parameter.

15. The physiological measurement system according to claim 14 wherein the alarm suspend system comprises:

a first group of parameters associated with the short duration;

a second group of parameters associated with the long duration;

the first group and the second group partitioned according to a fast treatment time and a short treatment time associated with the parameters

16. The physiological measurement system according to claim 15 further comprising an override that reactivates the audible alarm if the trigger parameter changes more than a predetermine amount during the corresponding duration.

17. The physiological measurement system according to claim 16 wherein the first group comprises parameters related to the measurement of normal hemoglobin and the second group comprises parameters related to the measurement of abnormal hemoglobin.

18. The physiological measurement system according to claim 17 wherein the long duration is greater than about 120 seconds.

19. The physiological measurement system according to claim 18 wherein the short duration is less than or equal to about 120 seconds.

20. The physiological measurement system according to claim 19 further comprising a pop-up window for the display that allows selection of the long duration and the short duration in response to the silence button.

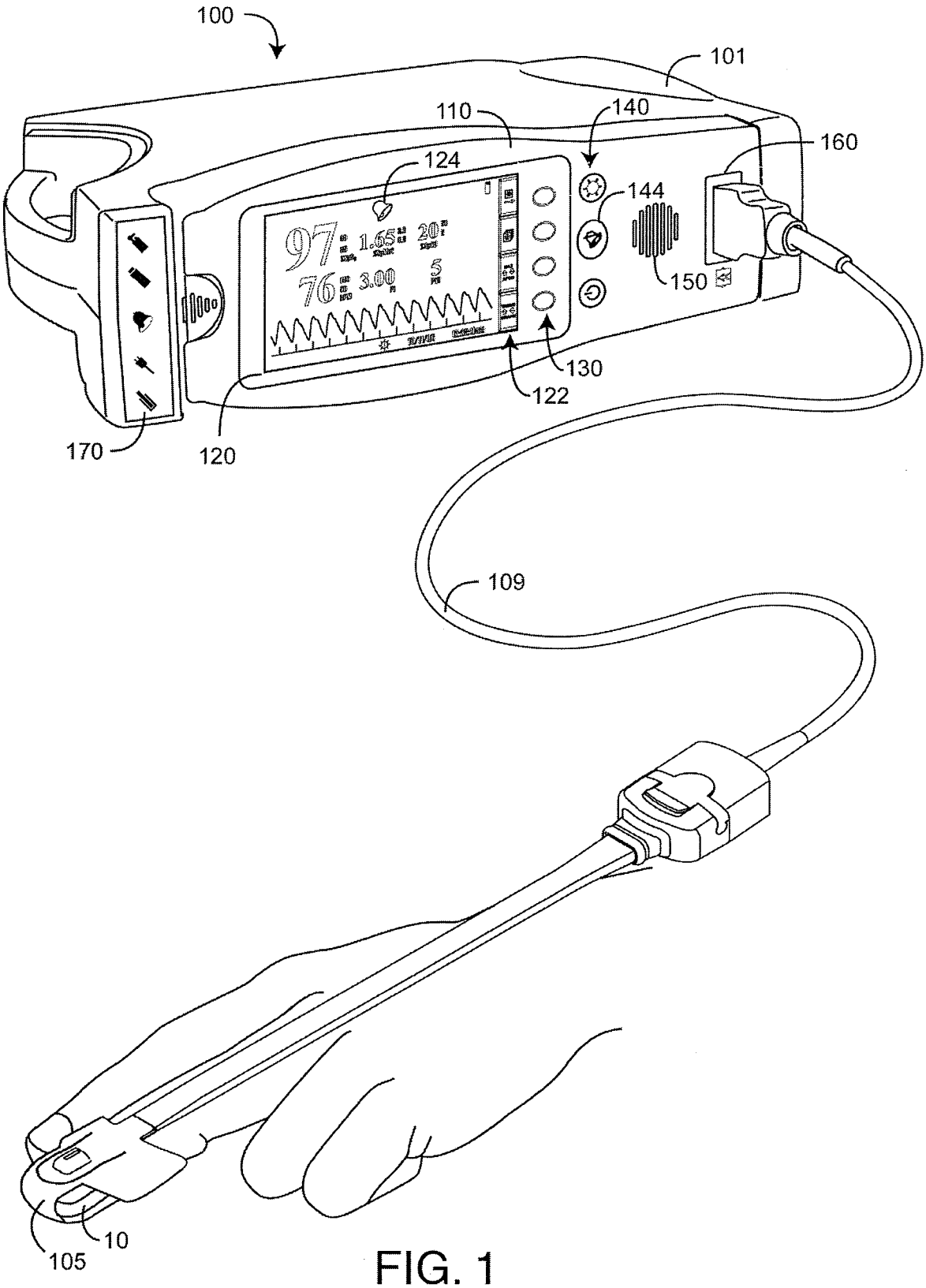

FIG. 1

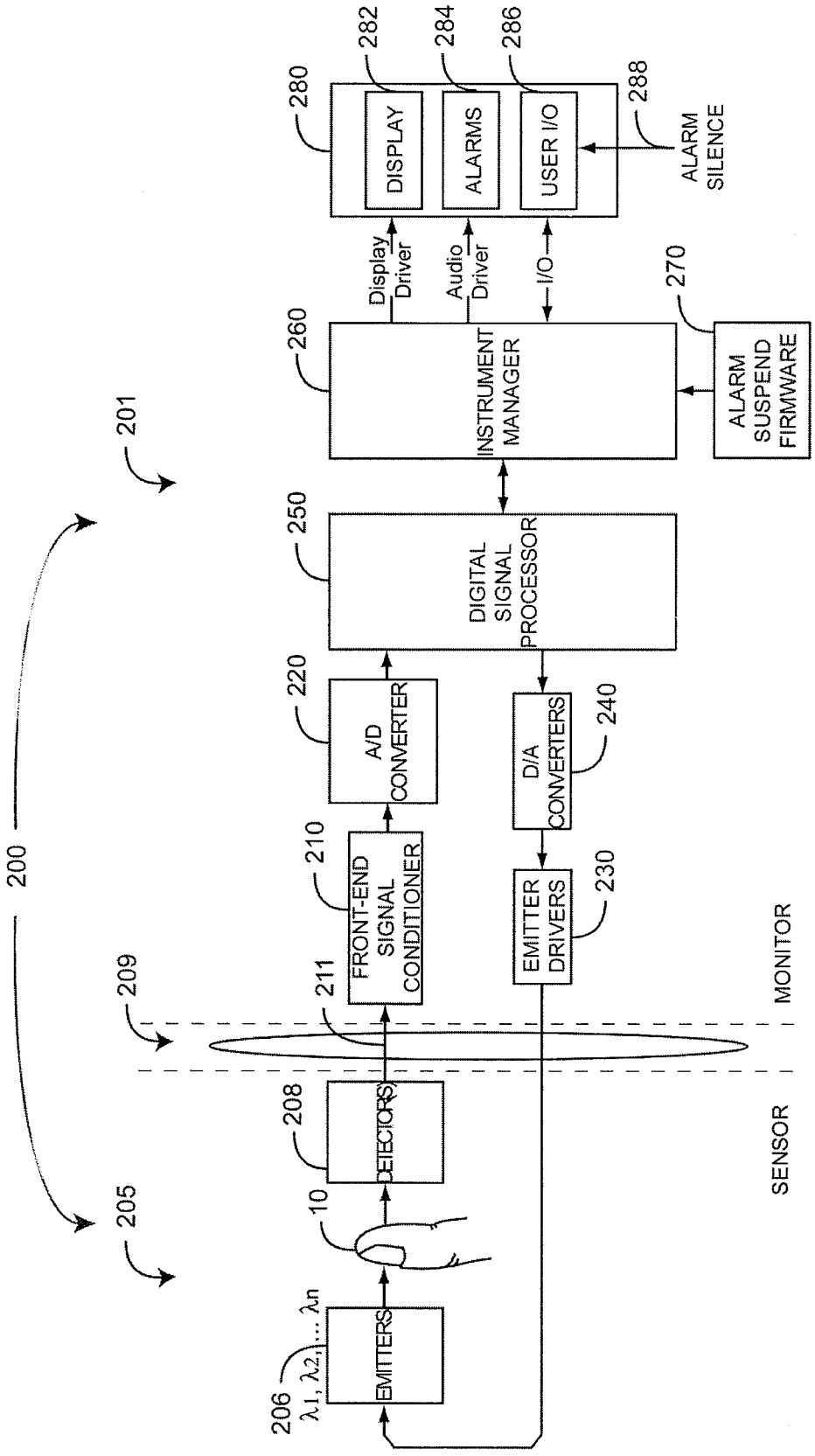
200
201
205
206
λ1, λ2, ... λn
EMITTERS
10
208
DETECTORS
209
211
SENSOR
MONITOR
210
FRONT-END SIGNAL CONDITIONER
220
A/D CONVERTER
230
EMITTER DRIVERS
240
D/A CONVERTERS
250
DIGITAL SIGNAL PROCESSOR
260
INSTRUMENT MANAGER
270
ALARM SUSPEND FIRMWARE
Display Driver
Audio Driver
I/O
280
282
DISPLAY
284
ALARMS
286
USER I/O
288
ALARM SILENCE

FIG. 2

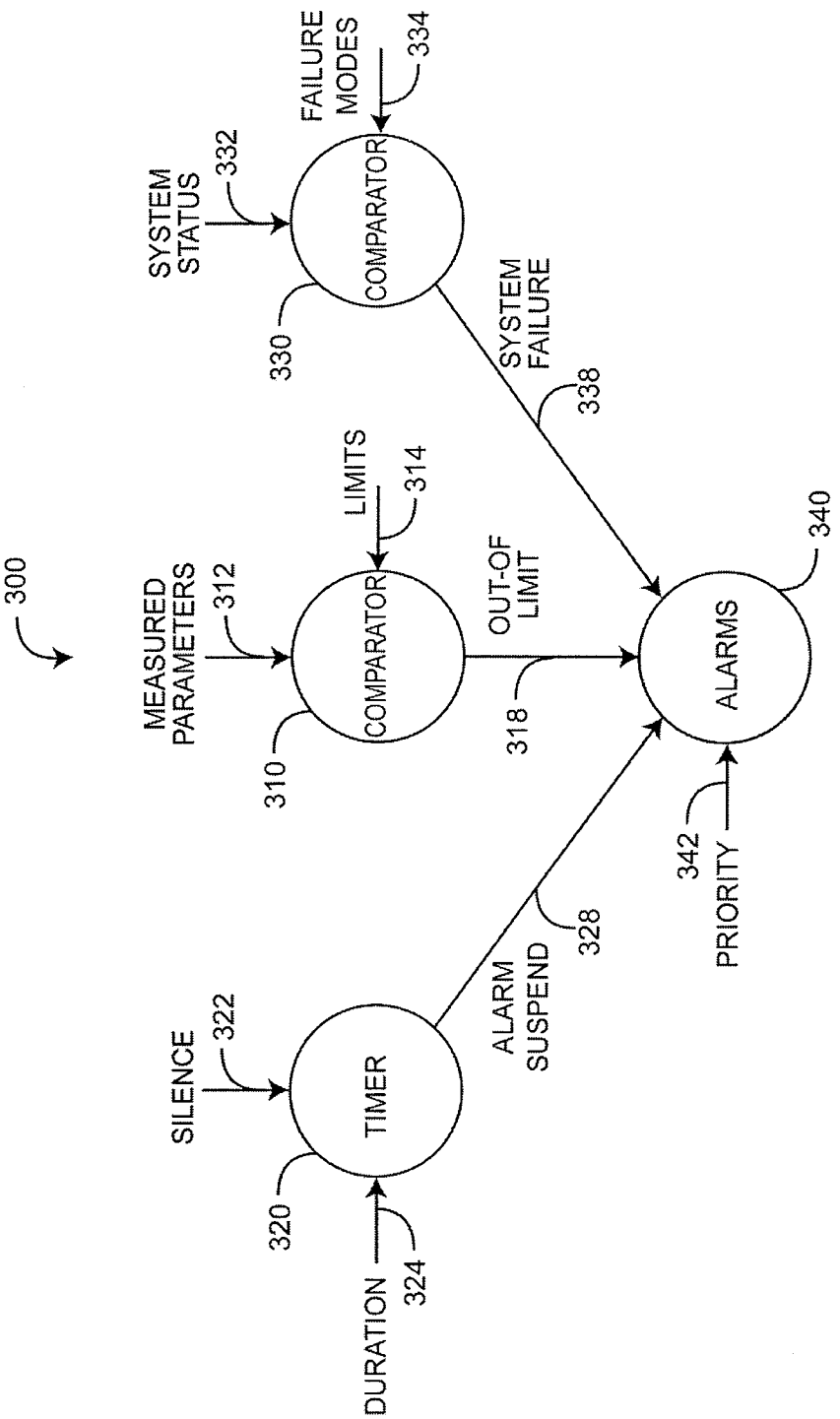
300
MEASURED PARAMETERS
312
SYSTEM STATUS
332
FAILURE MODES
334
LIMITS
314
COMPARATOR
310
COMPARATOR
330
OUT-OF LIMIT
318
SYSTEM FAILURE
338
ALARMS
340
SILENCE
322
TIMER
320
DURATION
324
ALARM SUSPEND
328
PRIORITY
342

FIG. 3

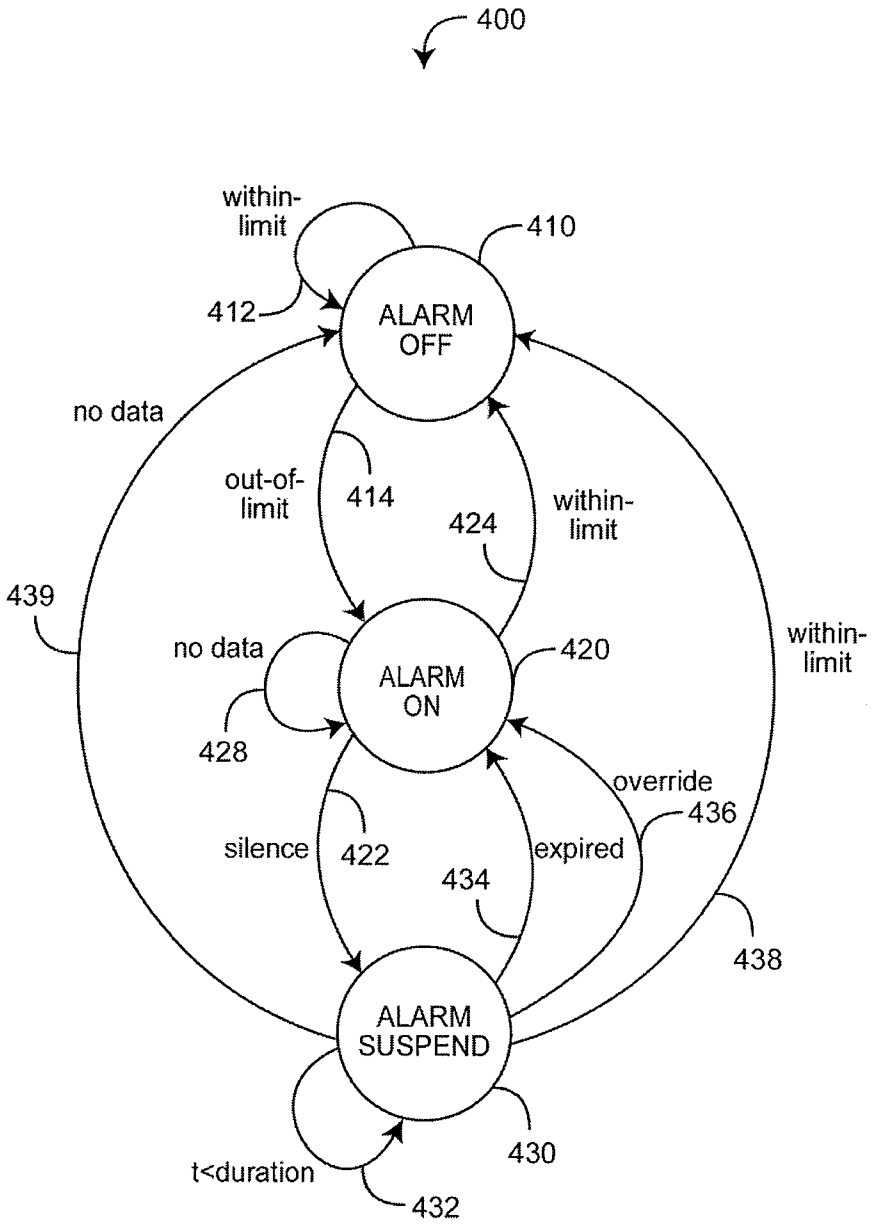
400
within-limit
410
412
ALARM OFF
no data
out-of-limit
414
424
within-limit
439
no data
ALARM ON
420
within-limit
428
override
436
silence
422
expired
434
438
ALARM SUSPEND
430
t<duration
432

FIG. 4

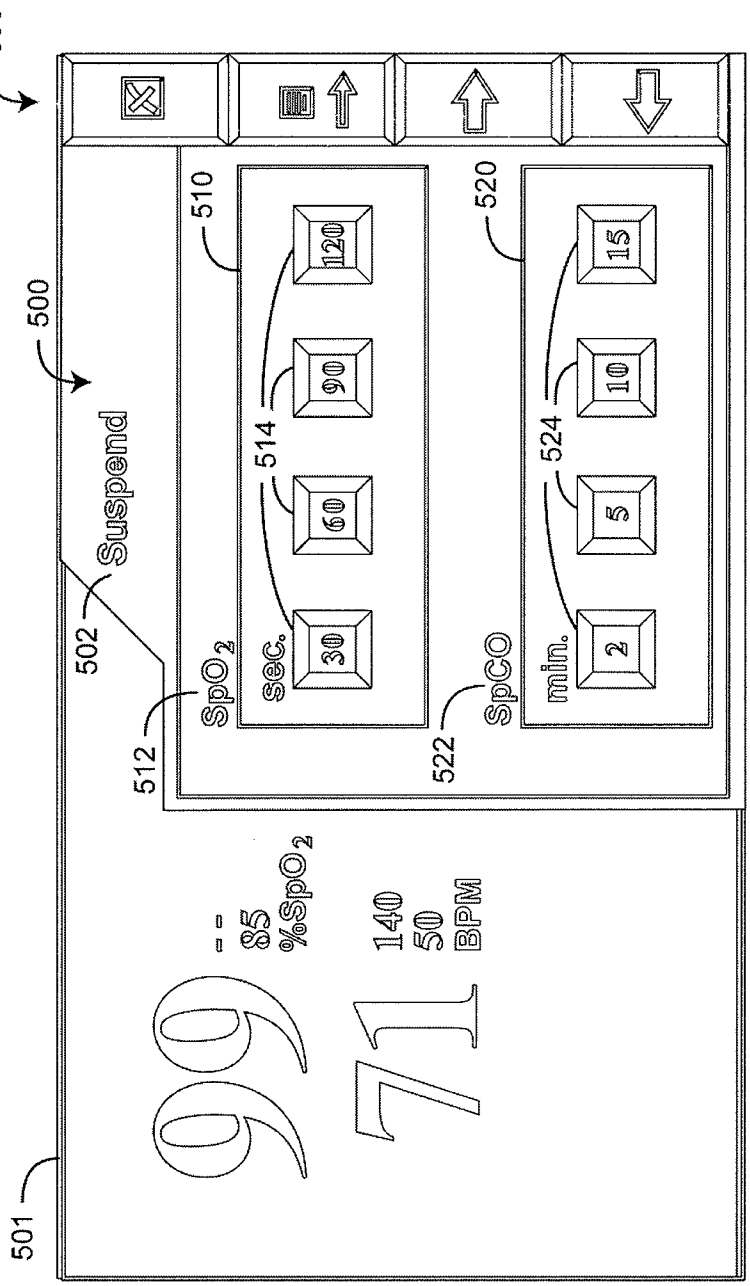
560
500
Suspend
502
510
520
514
524
512
522
SpO2
sec.
SpCO
min.
120
90
60
30
15
10
5
2
501
99
- -
85
%SpO2
140
50
BPM
71

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2009/052146

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B5/00 G08B19/00 G08B21/00 G08B23/00

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)
A61B G08B

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 practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2002/161291 A1 (KIANL MASSI E [US] ET AL) 31 October 2002 (2002-10-31) paragraph [0090] - paragraph [0095]; figures 11A-B	1-20
A	WO 2005/087097 A (MASIMO CORP [US]; AL-ALI AMMAR [US]; GRAYBEAL JOHN; KIANI MASSI E [US]) 22 September 2005 (2005-09-22) paragraph [0017] - paragraph [0020]	1-20
A	US 2003/137423 A1 (AL-ALI AMMAR [US]) 24 July 2003 (2003-07-24) paragraph [0016] - paragraph [0020]	1-20
A	US 2008/103375 A1 (KIANI MASSI E [US]) 1 May 2008 (2008-05-01) paragraph [0089] - paragraph [0091]	1-20

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
2 December 2009	15/12/2009

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Schindler, Martin

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2009/052146

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2002161291 A1	31-10-2002	NONE	
WO 2005087097 A	22-09-2005	EP 1722676 A1	22-11-2006
		JP 2007527776 T	04-10-2007
		US 2005203352 A1	15-09-2005
		US 2008300471 A1	04-12-2008
US 2003137423 A1	24-07-2003	US 2008228052 A1	18-09-2008
		US 2005083193 A1	21-04-2005
US 2008103375 A1	01-05-2008	NONE	