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(54) **ALARM SUSPEND SYSTEM**

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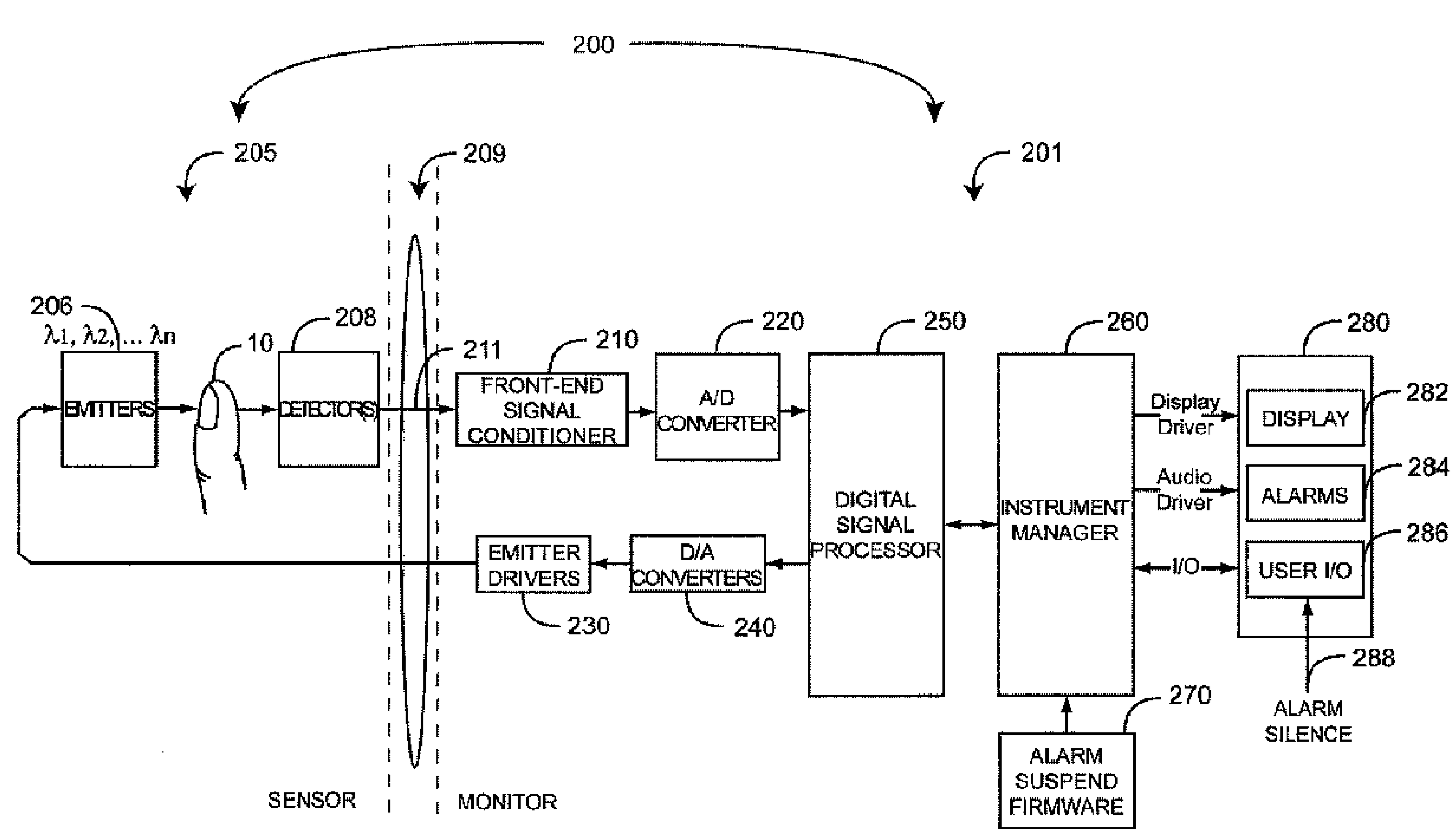
(57) **ABSTRACT**

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

25 Claims, 5 Drawing Sheets



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See application file for complete search history.

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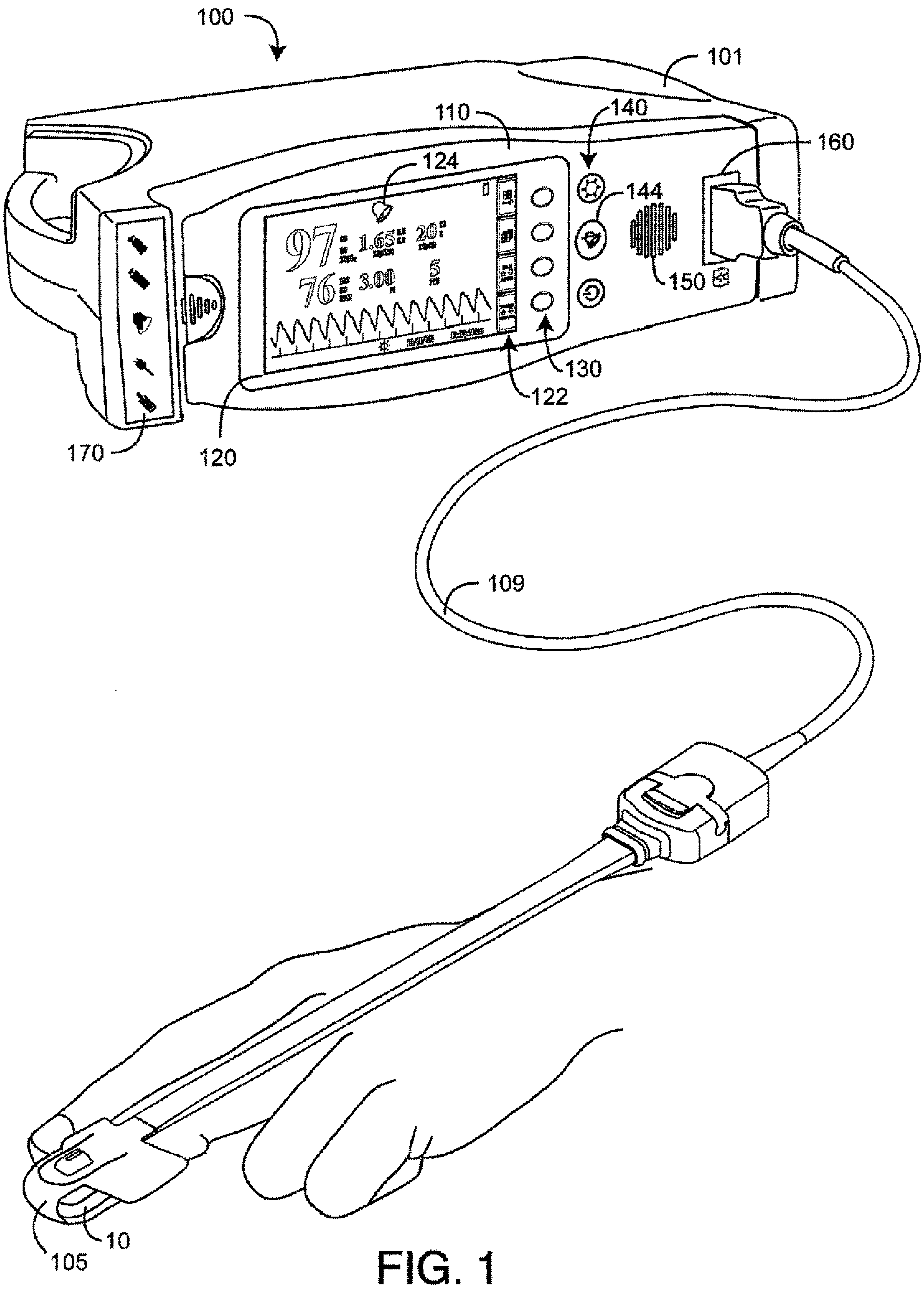

FIG. 1

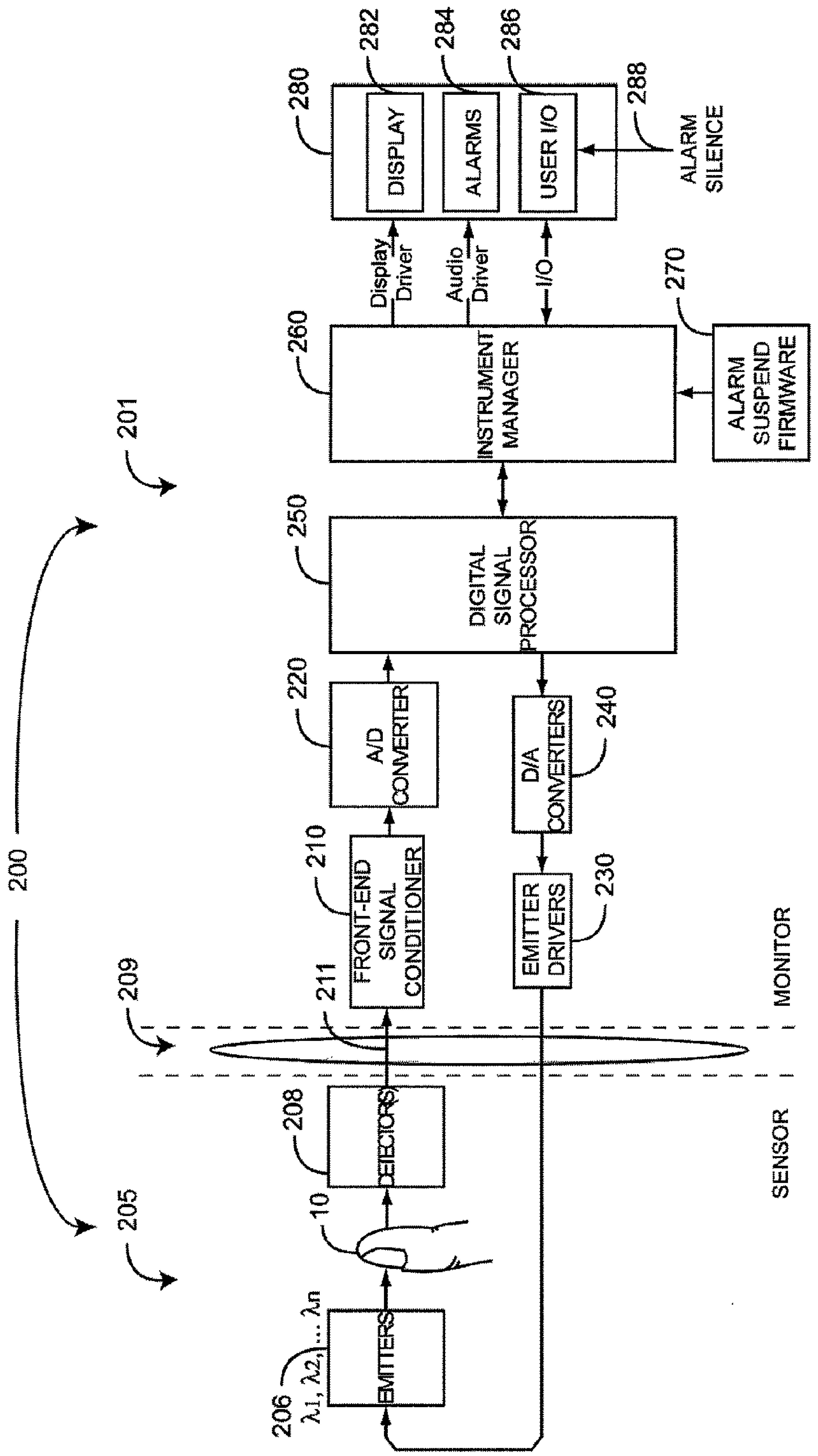
200
201
205
206
λ1, λ2, ... λn
EMITTERS
10
DETECTORS
208
209
211
SENSOR
MONITOR
FRONT-END SIGNAL CONDITIONER
210
A/D CONVERTER
220
EMITTER DRIVERS
230
D/A CONVERTERS
240
DIGITAL SIGNAL PROCESSOR
250
INSTRUMENT MANAGER
260
ALARM SUSPEND FIRMWARE
270
Display Driver
Audio Driver
I/O
280
DISPLAY
282
ALARMS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

FIG. 2

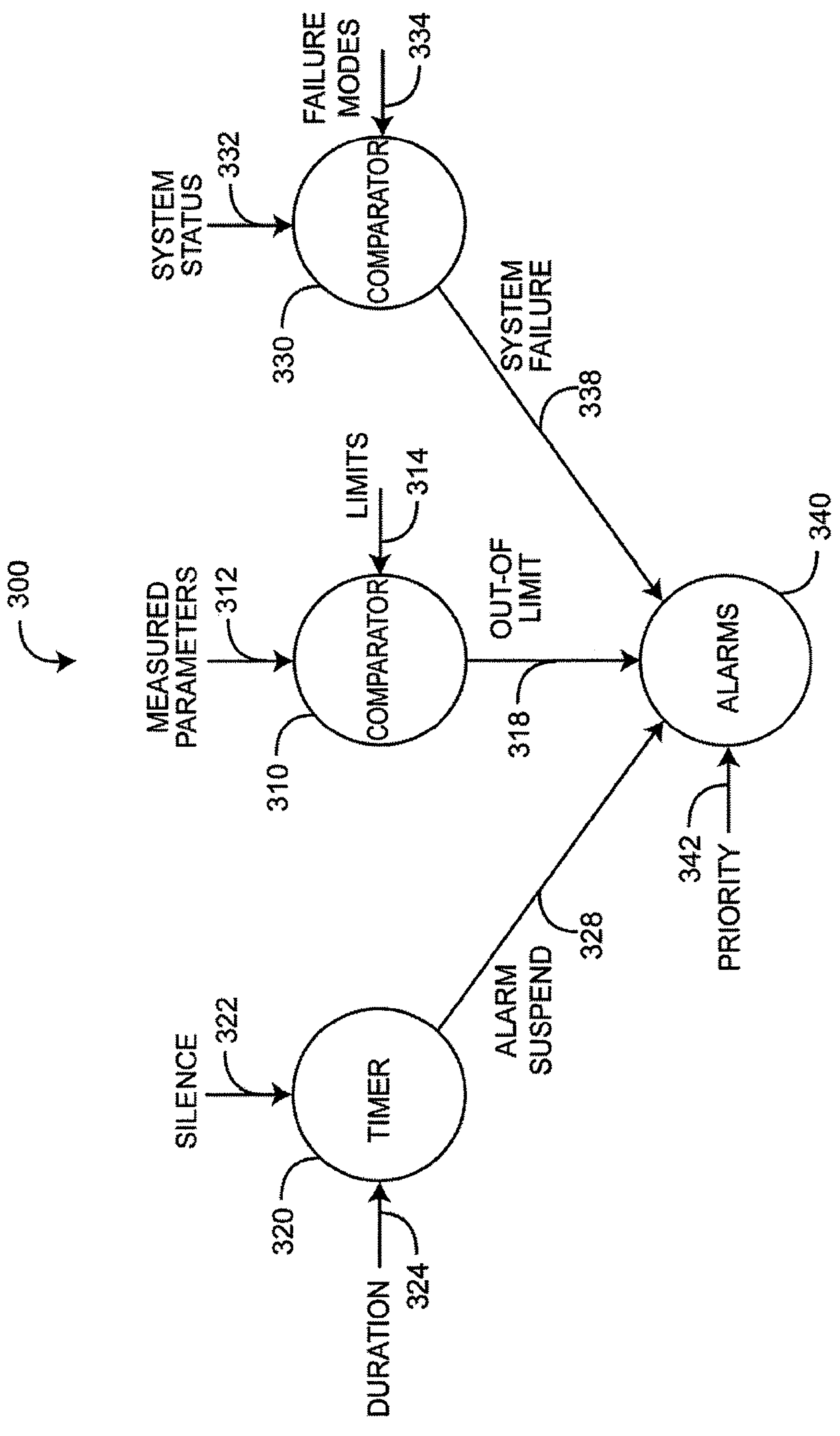
300
MEASURED PARAMETERS
312
COMPARATOR
310
LIMITS
314
OUT-OF LIMIT
318
SYSTEM STATUS
332
COMPARATOR
330
FAILURE MODES
334
SYSTEM FAILURE
338
SILENCE
322
TIMER
320
DURATION
324
ALARM SUSPEND
328
ALARMS
340
PRIORITY
342

FIG. 3

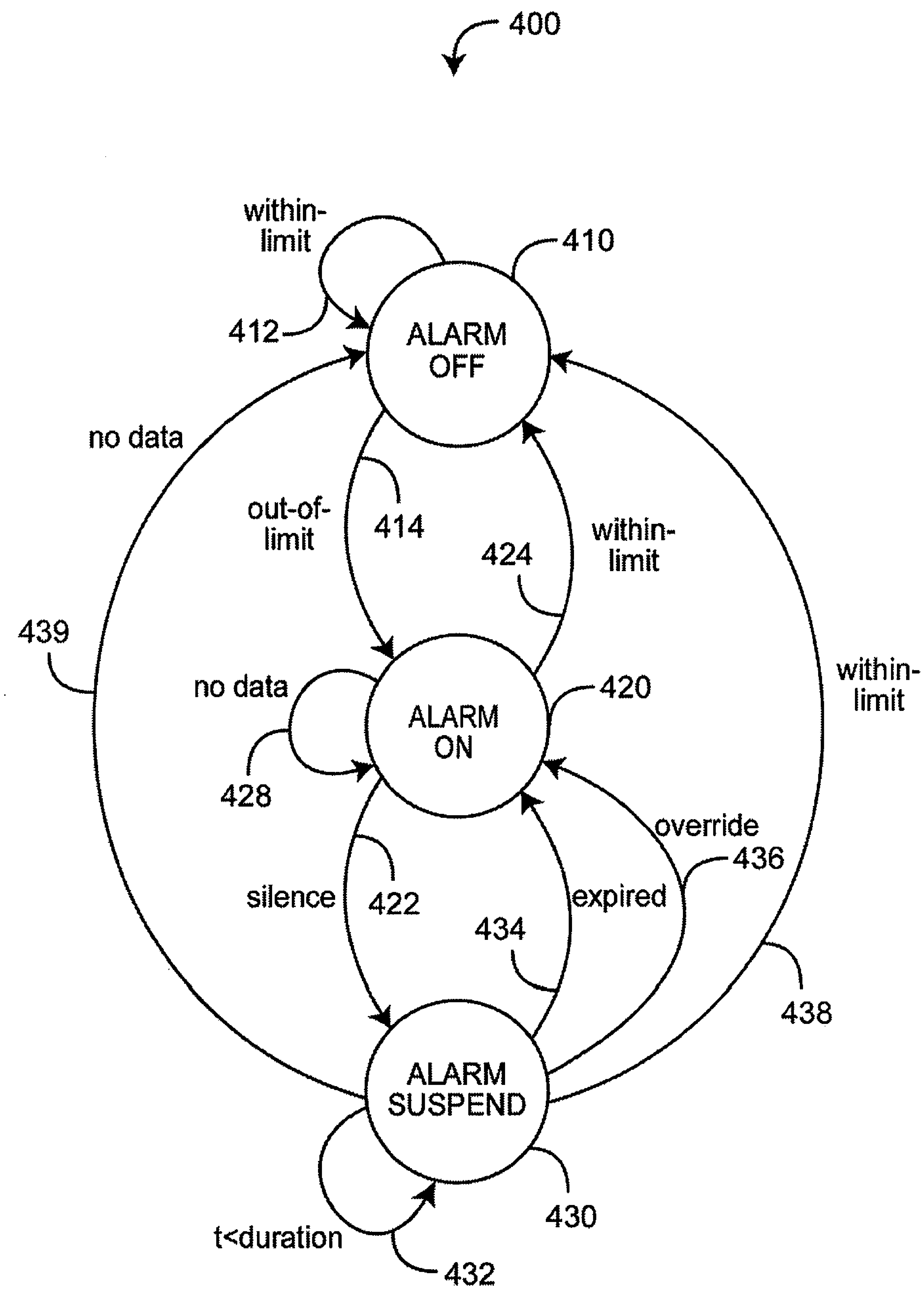
400
within-
limit
410
412
ALARM
OFF
no data
out-of-
limit
414
424
within-
limit
439
no data
ALARM
ON
420
within-
limit
428
override
436
silence
422
expired
434
438
ALARM
SUSPEND
430
t<duration
432

FIG. 4

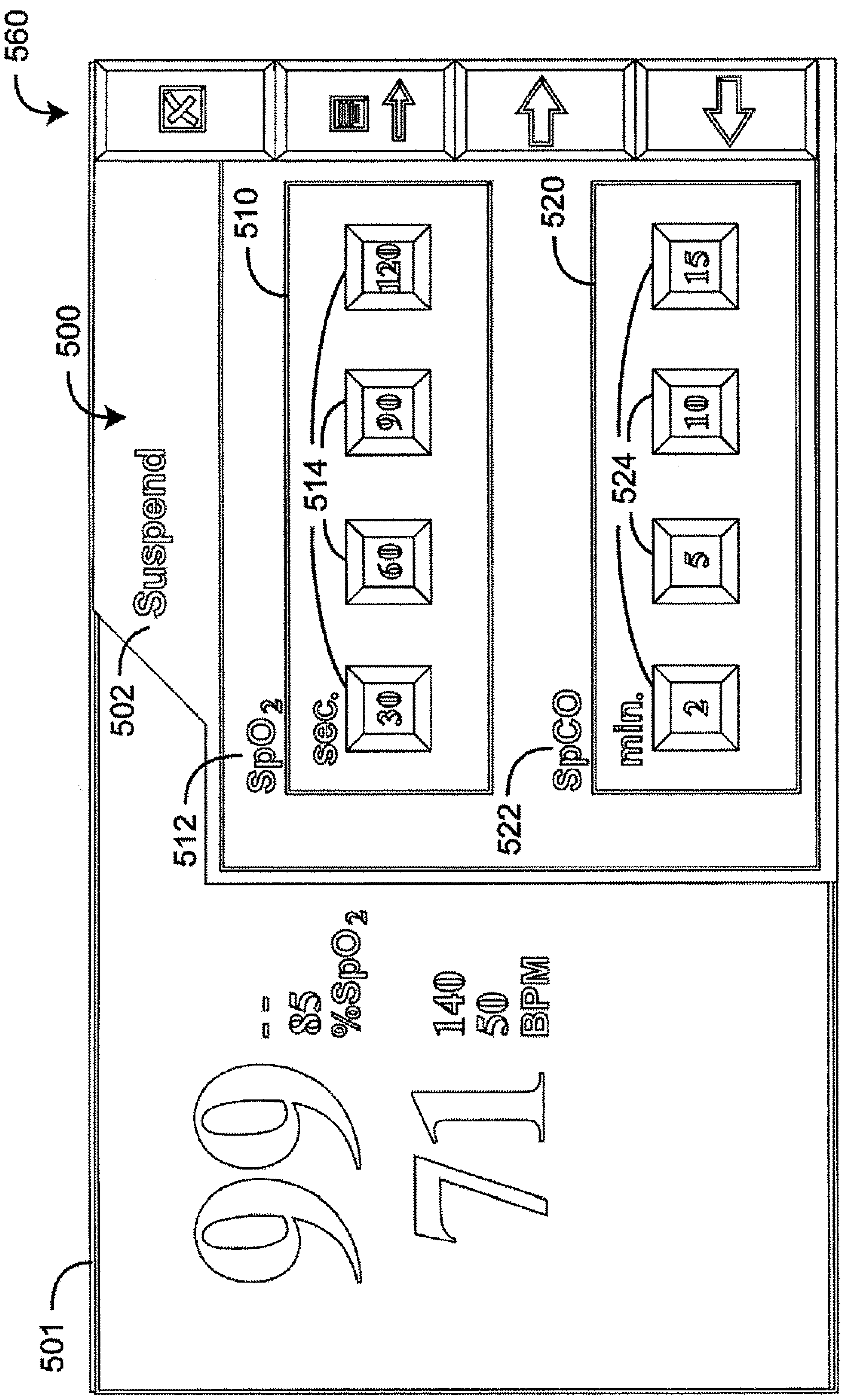
560
500
501
502
Suspend
510
512
SpO_2
sec.
30
60
90
120
514
520
522
SpCO
min.
2
5
10
15
524
99
71
--
85
$\%SpO_2$
140
50
BPM

FIG. 5

ALARM SUSPEND SYSTEM

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue; a claim printed with strikethrough indicates that the claim was canceled, disclaimed, or held invalid by a prior post-patent action or proceeding.

CROSS-REFERENCE TO RELATED APPLICATIONS

This [application] is *an application for reissue of U.S. Pat. No. 9,153,121, issued on Oct. 6, 2015 and titled "Alarm Suspend System," which is* a continuation of U.S. patent application Ser. No. 14/036,496, filed Sep. 25, 2013 and titled "Alarm Suspend System," which is a continuation of U.S. patent application Ser. No. 13/476,725, filed May 21, 2012 and titled "Alarm Suspend System," which is a continuation of U.S. patent application Ser. No. 12/510,982 filed Jul. 28, 2009 and titled "Alarm Suspend System," which claims priority benefit under 35 U.S.C. § 119(e) to U.S. Provisional Patent Application Ser. No. 61/084,615, filed Jul. 29, 2008, titled "Alarm Management System[."]*;" more than one reissue application has been filed for the reissue of U.S. Pat. No. 9,153,121, including U.S. patent application Ser. No. 15/583,922 (the present application), U.S. patent application Ser. No. 15/583,948, and U.S. patent application Ser. No. 15/583,935.* All of the above-referenced applications are hereby incorporated by reference herein in their entireties.

BACKGROUND

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).

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. Pat. Nos. 6,088,607 and 5,782,757; all of which are assigned to Masimo Corporation, Irvine, Calif. ("Masimo") and are incorporated by reference herein.

Physiological monitors and corresponding multiple wavelength optical sensors are described in at least U.S. patent application Ser. No. 11/367,013, filed Mar. 1, 2006 and titled Multiple Wavelength Sensor Emitters and U.S. patent application Ser. No. 11/366,208, filed Mar. 1, 2006 and titled Noninvasive Multi-Parameter Patient Monitor, both assigned to Masimo Laboratories, Irvine, Calif. (Masimo Labs) and both incorporated by reference herein.

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

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.

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.

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.

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.

In various embodiments, a short duration suspend time is less than or equal to about two minutes and a long 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.

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.

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.

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

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

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

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

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

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

DETAILED DESCRIPTION

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

TABLE 1

Override Unit Changes for Selected Parameters

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

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.

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.

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.

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 physiological measurement system comprising:

a *noninvasive* physiological sensor [including: a plurality of light emitting diodes] configured to [transmit wavelengths of light onto a tissue site of a patient; and at least one detector configured to measure an indication of the wavelengths of light after attenuation by tissue of the patient and] *be positioned on a patient and* output a signal responsive [of the attenuated light] *to a physiological condition of the patient*; and

one or more processors in communication with the *noninvasive* physiological sensor, the one or more processors configured to *electronically*:

process the signal to determine a measurement of a physiological parameter based at least in part upon the signal;

determine that an alarm should be activated in response to the measurement of the physiological parameter satisfying an alarm activation threshold;

[receive, from a user,] *determine that* an [indication of] *alarm suspension should be initiated for* a parameter-specific alarm suspension period of time corresponding to the physiological parameter, the parameter-specific alarm suspension period of time being [selected from] *one of at least* a plurality of parameter-specific alarm suspension periods of time, the parameter-specific alarm suspension period of time being different from at least one other parameter-specific alarm suspension period of time corresponding to at least one other physiological parameter *for which the one or more processors are configured to determine at least one measurement*; [activate an alarm in response to determining that an alarm activation threshold has been satisfied by the physiological parameter measurement; receive an alarm suspension indication; and in response to receiving the alarm suspension indication,]

suspend the alarm for the [indicated] parameter-specific alarm suspension period of time*; and*

activate the alarm when the measurement of the physiological parameter satisfies the alarm activation threshold after the parameter-specific alarm suspension period of time has passed.

2. The physiological measurement system of claim **1**, wherein the one or more processors are further configured to:

provide a user interface to the user including at least a plurality of user-selectable elements, each of the [selectable] *plurality of user-selectable* elements corresponding to one of the plurality of parameter-specific alarm suspension periods of time.

3. The physiological measurement system of claim **2**, wherein providing the user interface further includes:

constructing a pop-up window for a display; and

displaying the plurality of user-selectable elements in the pop-up window.

4. The physiological measurement system of claim **3**, wherein the plurality of user-selectable elements are configured to allow a user to select a specific one of the plurality of parameter-specific alarm suspension periods of time.

5. The physiological measurement system of claim **4**, wherein [the] *a* selected parameter-specific alarm suspension period of time is selected by selection of one of the plurality of user-selectable elements.

6. The physiological measurement system of claim **1**, wherein the one or more processors are further configured to:

associate [the] *a* selected parameter-specific *alarm suspension* period of time [is] with the physiological parameter.

7. The physiological measurement system of claim **6**, wherein the selected parameter-specific period of time is stored in a memory device in communication with the one or more processors.

8. The physiological measurement system of claim **1**, wherein the one or more processors are further configured to:

process the signal to determine a *measurement of a* second physiological parameter [measurement] based at least in part upon the signal;

determine that a second alarm should be activated in response to the measurement of the second physiological parameter satisfying a second alarm activation threshold;

[receive, from the user,] *determine that* a second [indication of] *alarm suspension should be initiated for* a second parameter-specific alarm suspension period of time corresponding to the second physiological parameter, the second parameter-specific alarm suspension period of time being [selected from] *one of* a second plurality of parameter-specific alarm suspension periods of time; [activate a second alarm in response to determining a second alarm activation threshold has been satisfied by the second physiological parameter measurement; and in response to receiving the alarm suspension indication,] suspend the second alarm for the [indicated] second parameter-specific alarm suspension period of time*; and*

activate the second alarm when the measurement of the second physiological parameter satisfies the second alarm activation threshold after the second parameter-specific alarm suspension period of time has passed.

9. The physiological measurement system of claim **8**, wherein the one or more processors are further configured to:

provide a user interface to the user including at least a first plurality of user-selectable elements and a second plurality of user-selectable elements, wherein each of the first plurality of user-selectable elements corresponds to one of the plurality of parameter-specific alarm suspension periods of time, and each of the second plurality of user-selectable element corresponds to one of the second plurality of parameter-specific alarm suspension periods of time.

10. The physiological measurement system of claim **9**, wherein the one or more processors are further configured to:

construct a pop-up window for a display; and

display both the first and second plurality of user-selectable elements in the pop-up window.

11. The physiological measurement system of claim **10**, wherein [the] *a* selected *first* parameter-specific alarm suspension period of time is selected by selection of one of the first plurality of user-selectable elements, and [the] *a* selected second parameter-specific alarm suspension period of time is selected by selection of one of the second plurality of user-selectable elements.

12. The physiological measurement system of claim **11**, wherein the at least one of the [first] plurality of parameter-specific alarm suspension periods of time is different from any of the second plurality of parameter-specific alarm suspension periods of time.

13. [An] *A* method *of electronically delaying an alarm while an electronically calculated measurement of a physiological parameter satisfies an alarm activation threshold, the measurement of the physiological parameter responsive to a signal from a noninvasive sensor positioned at a monitored patient, the method* comprising:

[measuring] *electronically processing a signal from a noninvasive sensor to determine a first measurement of* a *first* physiological parameter *and a second measurement of a second physiological parameter* using a patient monitoring device, the patient monitoring device including a processor and a memory device [configured to store]*;*

electronically storing, in the memory device, a *first* parameter-specific alarm suspension period of time *corresponding to the first physiological parameter and a second parameter-specific alarm suspension period of time corresponding to the second physiological parameter, the first parameter-specific alarm suspension period of time being different from the second parameter-specific alarm suspension period of time*;

electronically determining when the first measurement of the first physiological parameter satisfies a first alarm activation threshold;

[receiving, from a user, an indication of a] *electronically determining that a first alarm suspension should be initiated for the first* parameter-specific alarm suspension period of time [corresponding to the physiological parameter, the parameter-specific alarm suspension period of time being selected from a plurality of parameter-specific alarm suspension period periods of time, the parameter-specific alarm suspension period of time being different from at least one other parameter-specific alarm suspension period of time corresponding to at least one other physiological parameter; activating an alarm in response to determining an alarm activation threshold has been satisfied by the physiological parameter measurement; receiving an alarm suspension indication];

[and in response to receiving the alarm suspension indication,] *electronically* suspending [the] *a first* alarm *for the first physiological parameter* for the [indicated] *first* parameter-specific alarm suspension period of time*; and*

electronically activating the first alarm when the first measurement of the first physiological parameter satisfies the first alarm activation threshold subsequent to the first parameter-specific alarm suspension period of time passing.

14. The method of claim **13**, wherein the *first* alarm includes an audible component and a visual component, and wherein suspending the *first* alarm comprises suspending the audible component and not suspending the visual component.

15. The method of claim **13** further comprising:

providing a user interface to the user including at least a plurality of user-selectable elements, each of the [selectable] *plurality of user-selectable* elements corresponding to one of [the] *a* plurality of parameter-specific alarm suspension periods of time*,*

wherein the plurality of parameter-specific alarm suspension periods of time comprise the first parameter-specific alarm suspension period of time.

16. The method of claim **15** further comprising:

constructing a pop-up window for a display; and

displaying the plurality of user-selectable elements in the pop-up window.

17. The method of claim **16**, wherein [the] *a* selected parameter-specific alarm suspension period of time is selected by selection of one of the plurality of user-selectable elements.

18. A physiological measurement system comprising:

a *noninvasive* physiological sensor [means for outputting] *configured to output* a signal responsive to [a noninvasive measurement of attenuated light transmitted through a tissue site] *a physiological condition* of a patient;

a memory configured to store a first alarm activation threshold; and

[a processing means] *one or more processors* in communication with the *noninvasive* physiological sensor [means] and configured to:

process the signal to determine a *first* measurement of [a] *the first measured* physiological parameter based at least in part upon the signal;

[receive, from a user, an indication of a] *determine that a first alarm suspension should be initiated for a first* parameter-specific alarm suspension period of time [corresponding to the physiological parameter], the *first* parameter-specific alarm suspension period of time *corresponding to the first measured physiological parameter and* being [selected from a plurality of parameter-specific alarm suspension periods of time, the parameter-specific alarm suspension period of time being] different from [at least one other] *a second* parameter-specific alarm suspension period of time corresponding to [at least one other] *a second* *measured* physiological parameter *for which the one or more processors are configured to determine a second measurement*;

[activate an alarm in response to determining an] *determine that the first measurement satisfies the first* alarm activation threshold [has been satisfied by the physiological parameter measurement; receive an alarm suspension indication]; and

[in response to receiving the alarm suspension indication,] suspend [the] *activation of a first* alarm for the [indicated] *first* parameter-specific alarm suspension period of time *and then activate the first alarm*.

19. The physiological measurement system of claim **18**, wherein the [processing means is] *one or more processors are* further configured to:

process the signal to determine [a] *the* second [physiological parameter] measurement based at least in part upon the signal;

[receive, from the user,] *determine that* a second [indication of a] *alarm suspension should be initiated for the* second parameter-specific alarm suspension period of time [corresponding to the second physiological parameter, the second parameter-specific alarm suspension period of time being selected from a second plurality of parameter-specific alarm suspension periods of time];

[activate a second alarm in response to determining a] *determine that the second measurement satisfies a* second alarm activation threshold [has been satisfied by the second physiological parameter measurement]; and

[in response to receiving the alarm suspension indication,] suspend *activation of* the second alarm for the [indicated] second parameter-specific alarm suspension period of time *and then activate the second alarm*.

20. The physiological measurement system of claim **19**, wherein the [processing means is] *one or more processors are* further configured to:

provide a user interface to the user including at least a first plurality of user-selectable elements and a second plurality of user-selectable elements, wherein each of the first plurality of user-selectable elements corresponds to one of [the] *a first* plurality of parameter-specific alarm suspension periods of time, and each of the second plurality of user-selectable [element] *elements* corresponds to one of [the] *a* second plurality of parameter-specific alarm suspension periods of time*,*

wherein the first plurality of parameter-specific alarm suspension periods of time comprise the first parameter-specific alarm suspension period of time, and the second plurality of parameter-specific alarm suspension periods of time comprise the second parameter-specific alarm suspension period of time.

21. The physiological measurement system of claim **20**, wherein [the] *a* selected *first* parameter-specific alarm suspension period of time is selected by selection of one of the first plurality of user-selectable elements, and [the] *a* selected second parameter-specific alarm suspension period of time is selected by selection of one of the second plurality of user-selectable elements.

22. The physiological measurement system of claim **21**, wherein at least one of the first plurality of parameter-specific alarm suspension periods of time is different from any of the second plurality of parameter-specific alarm suspension periods of time.

23. The physiological measurement system of claim 1, wherein the alarm comprises an audible alarm.

24. The physiological measurement system of claim 1, wherein the one or more processors are further configured to output a visual indicator with modification for the parameter-specific alarm suspension period of time and then output the visual indicator without modification.

25. The physiological measurement system of claim 1, wherein the physiological parameter is indicative of the physiological condition of a circulatory system of the patient.

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(54) **ALARM SUSPEND SYSTEM**

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AS A RESULT OF THE INTER PARTES REVIEW PROCEEDING, IT HAS BEEN DETERMINED THAT:

Claims **1-25** are cancelled.

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