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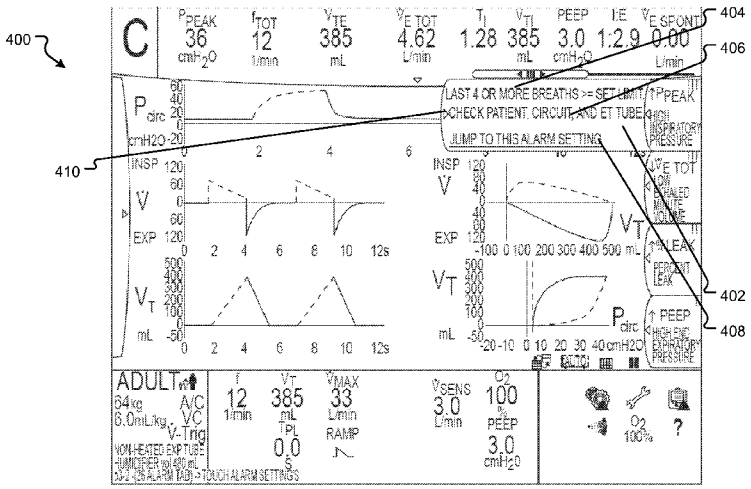

Fig. 4

(57) Abstract: This disclosure describes systems and methods for displaying alarms to a clinician in a ventilatory system. Specifically, embodiments described herein seek to optimize the informative presentation of alarms on a ventilator interface. Embodiments of the present disclosure may provide one or more selection elements, each selection element indicating a ranked alarm event. The ranking of an alarm event may be determined by alarm level. If two alarm events are associated with the same alarm level, the ranking of the alarm events may be determined by parameter priority. Alarm event ranking is communicated by display in a hierarchical structure. When an alarm event ranking changes, the alarm event may shift up or down the hierarchical structure, depending on whether the ranking increased or decreased.

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VISUAL INDICATION OF ALARMS ON A VENTILATOR GRAPHICAL USER INTERFACE

Introduction

A ventilator is a device that mechanically helps patients breathe by replacing some or all of the muscular effort required to inflate and deflate the lungs. During ventilation, the ventilator may be configured to generate various alarms upon detecting a change in the patient's condition, a malfunction of the ventilatory equipment, or other indication that clinician intervention may be warranted. Thus, alarms generally function to alert a clinician of an abnormal or unsafe condition that may impact the patient. In this sense, alarms are a very important and necessary feature of any therapeutic instrument. However, alarms may not convey enough information regarding which alarms need to be alleviated first. In addition, multiple simultaneous alarms may compound this insufficiency of alarm information, costing the clinician valuable time while deciding which alarm to address first.

Visual Indication of Alarms on a Ventilator Graphical User Interface

The disclosure describes improved systems and methods for displaying alarms to a clinician in a ventilatory system. Specifically, embodiments described herein seek to optimize the informative presentation of alarms on a ventilator interface. Embodiments of the present disclosure may provide one or more selection elements, each selection element indicating a summarized alarm message. The summarized alarm message may include a parameter indication, an alarm event indication, and an alarm level indication. The one or more summarized alarm messages are associated with ranked alarm events. The most highly ranked alarm event is displayed in a selection element at the top of a hierarchical display, with the next most highly ranked alarm event displayed below it in descending order of rank. An alarm event's ranking is determined, first by the alarm level. In some embodiments, alarm events are associated with high, medium or low alarm levels. If an alarm event is the only alarm event associated with a high alarm level, it will be ranked highest and displayed in the selection element at the top of the hierarchical display. However, if two alarm events are both associated with a high alarm level, a ranking determination is made by comparing the parameter priority associated with each alarm event. Each ventilatory parameter is assigned a priority level. In the

case of identical alarm levels, the alarm event associated with the parameter with the highest parameter priority will be ranked higher.

Alarm event rankings can change over time. For example, an alarm level for a given alarm event can elevate or de-elevate, depending on the condition of the patient. When an alarm event's ranking changes, the hierarchical display of alarm events is rearranged to reflect the new ranking. As will be appreciated, all alarm events, such as an alarm event with a low ranking, may not be provided in the graphical display. As a result, if an alarm event's ranking drops enough, it may disappear from the graphical display completely and a new alarm event may replace it. In some embodiments, the rearrangement is displayed by "floating" the alarm messages either up or down the hierarchical display based on whether the ranking has increased or decreased.

Other embodiments of the present disclosure provide for an expanded alarm message. Upon accessing a selection element in the hierarchical display, a clinician can ascertain more information about the alarm event including, but not limited to, suggested alarm alleviation measures, detailed alarm event description, and a hyperlink to an alarm settings window. In one embodiment, a clinician can access the hyperlink to access an alarm settings window providing more information about all the alarms. As discussed above, the graphical display may not display all currently emitting alarms. The alarm settings window provides the clinician with information about all currently emitting alarms with user adjustable parameters. The alarm settings window may also provide the clinician with an opportunity to adjust alarm settings for each ventilatory parameter.

Other embodiments of the present disclosure provide for an alarm log window. The alarm log window provides a clinician with a temporal log of all alarm events. In one embodiment, the alarm log window records all alarm events since manual reset of the ventilator. In another embodiment, the alarm log window records all alarm events since the ventilator began monitoring a new patient.

These and various other features as well as advantages which characterize the systems and methods described herein will be apparent from a reading of the following detailed description and a review of the associated drawings. Additional features are set forth in the description which follows, and in part will be apparent from the description, or may be learned by practice of the technology. The benefits and features of the technology will be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

Brief Description of the Drawings

The following drawing figures, which from a part of this application, are illustrative of described technology and are not meant to limit the scope of the invention as claimed in any manner, which scope shall be based on the claims appended hereto.

FIG. 1 is a diagram illustrating an embodiment of an exemplary ventilator connected to a human patient.

FIG. 2 is a block-diagram illustrating an embodiment of a ventilatory system having a graphical user interface for displaying structured and informative alarms.

FIG. 3 is an illustration of an embodiment of a user interface for hierarchically indicating alarms on a graphical display.

FIG. 4 is an illustration of an embodiment of a user interface for displaying an expanded alarm tab.

FIG. 5 depicts an alarm setup window for display in user interface.

FIG. 6 depicts an alarm log window for display in user interface.

Detailed Description

Although the techniques introduced above and discussed in detail below may be implemented for a variety of medical devices, the present disclosure will discuss the implementation of these techniques for use in a mechanical ventilator system. The reader will understand that the technology described in the context of a ventilator system could be adapted for use with other therapeutic equipment having user interfaces, including graphical user interfaces (GUIs), for prompt startup of a therapeutic treatment.

This disclosure describes systems and methods for displaying alarms to a clinician in a ventilatory system. Specifically, embodiments described herein seek to optimize the informative presentation of alarms on a ventilator interface. Embodiments of the present disclosure may provide one or more selection elements, each selection element indicating a ranked alarm event. The ranking of an alarm event may be determined by alarm level. If two alarm events are associated with the same alarm level, the ranking of the alarm events may be determined by parameter priority. Alarm event ranking is communicated by display in a hierarchical structure. When an alarm event

ranking changes, the alarm event may shift up or down the hierarchical structure, depending on whether the ranking increased or decreased.

As such, the present disclosure provides an institution or clinician with optimal control over routine ventilatory settings. Specifically, routine layout configuration settings may be preconfigured according to a hospital-specific, clinic-specific, physician-specific, or any other appropriate protocol. Moreover, layout configuration settings may be changed and edited in response to a particular patient's changing needs and/or condition.

FIG. 1 illustrates an embodiment of a ventilator connected to a human patient **150**. The ventilator includes a pneumatic system **102** (also referred to as a pressure generating system **102**) for circulating breathing gases to and from patient **150** via the ventilation tubing system **130**, which couples the patient to the pneumatic system via an invasive patient interface (*e.g.*, endotracheal tube).

Ventilation tubing system **130** may be a two-limb (shown) or a one-limb circuit for carrying gas to and from the patient **150**. In a two-limb embodiment as shown, a fitting, typically referred to as a "wye-fitting" **170**, may be provided to couple the patient interface to an inspiratory limb **132** and an expiratory limb **134** of the ventilation tubing system **130**.

Pneumatic system **102** may be configured in a variety of ways. In the present example, system **102** includes an expiratory module **108** coupled with the expiratory limb **134** and an inspiratory module **104** coupled with the inspiratory limb **132**. Compressor **106** or other source(s) of pressurized gases (*e.g.*, air, oxygen, and/or helium) is coupled with inspiratory module **104** to provide a gas source for ventilatory support via inspiratory limb **132**.

The pneumatic system may include a variety of other components, including sources for pressurized air and/or oxygen, mixing modules, valves, sensors, tubing, accumulators, filters, *etc.* Controller **110** is operatively coupled with pneumatic system **102**, signal measurement and acquisition systems, and an operator interface **120** that may enable an operator to interact with the ventilator (*e.g.*, reset alarms, change ventilator settings, select operational modes, view monitored parameters, *etc.*). Controller **110** may include memory **112**, one or more processors **116**, storage **114**, and/or other components of the type commonly found in command and control computing devices.

The memory **112** is computer-readable storage media that stores software that is executed by the processor **116** and which controls the operation of the ventilator. In an embodiment, the memory **112** includes one or more solid-state storage devices such as flash memory chips. In an alternative embodiment, the memory **112** may be mass storage connected to the processor **116** through a mass storage controller (not shown) and a communications bus (not shown). Although the description of computer-readable media contained herein refers to a solid-state storage, it should be appreciated by those skilled in the art that computer-readable storage media can be any available media that can be accessed by the processor **116**. Computer-readable storage media includes volatile and non-volatile, removable and non-removable media implemented in any method or technology for storage of information such as computer-readable instructions, data structures, program modules or other data. Computer-readable storage media includes, but is not limited to, RAM, ROM, EPROM, EEPROM, flash memory or other solid state memory technology, CD-ROM, DVD, or other optical storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other medium which can be used to store the desired information and which can be accessed by the computer.

As described in more detail below, controller **110** may monitor pneumatic system **102** in order to evaluate the condition of the patient and to ensure proper functioning of the ventilator based on various parameter settings. The specific parameter settings may be based on preconfigured settings applied to the controller **110**, or based on input received via operator interface **120** and/or other components of the ventilator. In the depicted example, operator interface **120** includes a display **122** that is touch-sensitive, enabling the display to serve both as an input and output device.

FIG. 2 is a block-diagram illustrating an embodiment of a ventilatory system **200** having a graphical user interface for displaying structured and informative alarms.

The ventilator **202** includes a display module **204**, memory **208**, one or more processors **206**, user interface **210**, and ventilation module **212**. Memory **208** is defined as described above for memory **112**. Similarly, the one or more processors **206** are defined as described above for the one or more processors **116**. Ventilation module **212** may oversee ventilation as delivered to a patient according to the ventilatory settings prescribed for the patient. For example, ventilation module **212** may deliver pressure and/or volume into a ventilatory circuit, and thereby into a patient's lungs, by any suitable method, either currently known or disclosed in the future.

The display module **204** presents various input screens and displays to a clinician, including but not limited to one or more structured alarm displays, as will be described further herein, for receiving clinician input and for displaying useful clinical data and alerts to the clinician. The display module **204** is further configured to communicate with user interface **210**. The display module **204** may provide various windows and elements to the clinician for input and interface command operations. Additionally, user interface **210** may accept commands and input through display module **204** and may provide useful alarm information to the clinician through display module **204**. Display module **204** may further be an interactive display, whereby the clinician may both receive and communicate information to the ventilator **202**, as by a touch-activated display screen. Alternatively, user interface **210** may provide other suitable means of communication with the ventilator **202**, for instance by a keyboard or other suitable interactive device.

Alarm display module **214** may be useful for providing comprehensive alarm information and access to alarm settings and data on a graphical user interface (GUI) of the ventilator, as may be provided by display module **204**. Specifically, a hierarchical alarm structure may be provided in which a summarized alarm message may be initially presented and, upon clinician selection, an additional detailed alarm message may be displayed. The summarized alarm message may further provide comprehensive information to the clinician in abbreviated form, for example the seriousness of an alarm message may be communicated via various icons and exclamation indicators and the priority of the alarm message vis-à-vis other alarm messages may be communicated via the relative graphical placement of the alarm message.

Additionally, a summary and/or detailed alarm message may provide immediate access to the display and/or settings window associated with an alarm event. For example, an associated alarm settings window may be accessed from an alarm message via a hyperlink such that the clinician may reconfigure alarm conditions as necessary. The alarm settings window allows a clinician to view patient information for various ventilatory parameters, even those parameters that are not currently associated with an alarm event. In this way, the clinician may access additional information regarding patient respiration.

In order to accomplish the various aspects of the hierarchical informative alarm display, the alarm display module **214** may communicate with various other components and/or modules. For instance, an alarm settings module **228** may be provided. Alarm

settings module **228** may monitor the various settings and other input provided by a clinician to the ventilator via the user interface **210** or display module **204**. Alarm settings module **228** may compare and evaluate parameter settings entered by the clinician according to any suitable method or procedure. For example, alarm settings module **228** may detect when patient settings are missing or otherwise inappropriate for a particular input field. Inappropriate parameter settings may be indicated where settings entered for different parameters are inconsistent, *e.g.*, one parameter setting indicates that the patient is a child, while another parameter setting indicates that the patient is an adult male, *etc.* In addition, alarm settings module **228** may evaluate parameter data received from monitor module **230** against the settings associated with the monitored parameters. When alarm settings module **228** determines that the parameter data falls outside applicable settings and ranges, alarm settings module **228** may communicate with alarm display module **214**, or other modules of the alarm display module **214**, in order to generate an informative alarm message.

Alarm display module **214** may also be configured with a hierarchical display module **216**. The hierarchical display module **216** may be in communication with the monitor module **230** and/or alarm settings module **228** to receive an indication that an alarm event has occurred. The hierarchical display module **216** may be responsible for generating a multi-level alarm message via any suitable means. For example, a first level summary alarm message may be provided as a tab, banner, dialog box, or other similar type of display. Further, a summary alarm messages may be provided along a border of the graphical user interface that is either blank or that displays minimally important information. The shape and size of the summary alarm message may also be optimized for easy viewing with minimal interference. The summary alarm message may be further configured with a combination of icons and text such that the clinician may readily identify the priority of the alarm message.

Hierarchical display module **216** may be preconfigured with various summary messages or alarm descriptions corresponding to each general type of alarm event. General summary messages may also be preconfigured to provide abbreviated information to a clinician. For example, when a pressure reading indicates that the peak pressure setting has been breached, an abbreviated summary message may be displayed: "$\uparrow P_{peak}$." This abbreviated summary message may provide both an indication that a high limit was breached, *i.e.* by the $\uparrow$ indicator, and an abbreviated indication of the particular breached parameter, *i.e.* by the P_{peak} notation. The same general summary

message may also include explanatory information regarding the particular breach, for instance: "↑ P_{peak} – High Inspiratory Pressure." In general, a summary level alarm message may be provided in any suitable position on the screen, by any suitable means, such that a general description of an alarm event and/or its gravity may be efficiently communicated to a clinician.

The hierarchical display module **216** may also generate a selectively accessed second level alarm message. The second level alarm message may provide additional details and information regarding the alarm event and may be accessible from the first level summary alarm message. Second level alarm messages may be preconfigured with a detailed alarm message or description corresponding to various types of alarm events. For example, a detailed alarm message may provide possible reasons for an alarm breach, suggested checks or procedures for mitigating the alarm, or other helpful information. Additionally, other embodiments may provide for semi-custom detailed alarm messages. For instance, portions of a detailed alarm message may be preconfigured for similar types of alarm events, while other portions may provide variable fields that may be populated with more specific information regarding a particular breach, for instance the extent that a parameter was breached, the number of breaths over which the breach occurred, whether a maximum or minimum parameter setting was breached, *etc.*

Alarm display module **214** may also be configured with a translucent display module **218**. Translucent display module **218** may allow for display of the summary alarm message and/or the detailed alarm message such that displayed respiratory data may be visualized behind the alarm message. This feature may be particularly useful for displaying the detailed alarm message. As described previously, alarm messages may be displayed in areas of the display screen that are either blank or that cause minimal distraction from the respiratory data and other graphical representations provided by the GUI. However, upon selective expansion of a detailed alarm message, respiratory data and graphs may be at least partially obscured. As a result, translucent display module **218** may provide the detailed alarm message such that it is partially transparent. Thus, graphical and other data may be visible behind the detailed alarm message.

Alarm display module **214** may also be configured with a selective display module **220**. As discussed above, a detailed alarm message may be selectively displayed in order to offer additional information or details regarding an alarm event to a clinician. According to some embodiments, the second level detailed alarm message may be

activated by clicking on the first level display message, touching a portion of the message, or otherwise. Additionally or alternatively, the first level summary alarm message may provide an arrow, or some other feature or icon for selection or activation of the detailed alarm message. Thus, a general summary alarm message may expand upon selection to provide a detailed alarm message. The detailed alarm message may be provided as a tab, banner, dialog box, or other similar type of display, which may extend from behind the general summary alarm message upon selection. In addition, according to some embodiments, the detailed alarm message may be condensed upon selection of an arrow, or some other feature or icon, via touching, clicking, or otherwise. Upon clearing or otherwise resetting an alarm following an alarm event, the summary alarm message and the detailed alarm message may also be cleared from the graphical user interface.

Alarm display module **214** may also be configured with an icon display module **222**. Icon display module **222** may provide various icons and other identifiers that may communicate additional abbreviated information to a clinician, for instance regarding the alarm level. An alarm level reflects the seriousness or priority of an alarm message. For instance, "!!!" may be represented in a corner, or other visible area, of the general summary message and may indicate that the alarm is a "High" alarm level and, therefore, is relatively serious. Alternatively, while "!!" or "!" may indicate that the alarm is a "Medium" or "Low" alarm level and is, therefore, less serious. In other embodiments, a number, letter, or other priority icon may be provided to communicate the priority of an alarm message vis-à-vis other displayed alarm messages. In still other embodiments, a status icon may be provided such that the status of an alarm message may be communicated, for instance, an active status or an inactive status, a high or low status, *etc*. Status may also refer to the number of times during a time period that the same alarm has occurred. In still other embodiments, an up-arrow, *e.g.*, "↑," or a down-arrow, *e.g.*, "↓," may be provided to communicate whether a high or low limit was breached, respectively. Indeed, any number or combination of icons or other indicators may be employed to communicate additional, abbreviated information to a clinician.

Alarm display module **214** may also be configured with a prioritized display module **224**. As noted above, multiple alarm events may occur at the same or similar time. In this case, it may be useful for the clinician to readily determine which alarm events are of higher priority and should be addressed more quickly. The present disclosure provides for presentation of one or more pending alarms events in a vertical

array, for example, that may convey an alarm event ranking and/or status. According to some embodiments, higher ranked alarm events may be presented above other alarm events. Thus, based on a graphical placement of alarm events relative to other alarm events, additional information regarding the priority or status of alarm events relative to other alarm events may be communicated to a clinician.

As will be discussed in further detail below, prioritized display module **224** is configured to rank an alarm event. The ranking of an alarm event determines whether the alarm event will be displayed in an alarm tab and, if so, where the alarm tab displaying the alarm event will be placed in the hierarchical display structure. Alarm event ranking is based on first, an alarm level and second, a parameter priority. An alarm event with a "High" alarm level will be assigned a higher ranking than an alarm event with a "Medium" or "Low" alarm level. If two alarm events have the same alarm level, ranking will be based on a predetermined parameter priority. Each ventilator parameter is assigned a priority. The assignment of parameter occurring may be done by a clinician during ventilator setup. A parameter priority may also be assigned automatically according to a hospital protocol. When two alarm events have the same alarm level, the alarm event with the higher parameter priority will be assigned the higher ranking.

Alarm display module **214** may also be configured with a hyperlink module **226**. Hyperlink module **226** may be configured to provide access from the various hierarchical alarm messages to various settings and display screens associated with an identified alarm event. For example, an icon or other link indicator may be provided in either the summary alarm message and/or the detailed alarm message that may be activated or otherwise selected. Upon selection, the icon may provide direct access, via a hyperlink or otherwise, to associated settings or display screens corresponding to a particular alarm event. When access to a settings screen is provided, the clinician may reset the alarm following clinician intervention or may reconfigure alarm settings as appropriate. When access to a display screen is provided, the clinician may view additional information and respiratory data regarding the alarm event. Hyperlink module **226** may further provide access to any useful display screen, settings screen, or other graphical user interface available on the ventilator that is associated with a particular alarm event.

Monitor module **230** may operate to monitor the physical condition of the patient in conjunction with the proper operation of the ventilator **202**. The monitor module **230**

may communicate with display module **204**, user interface **210**, alarm display module **214**, or other suitable modules or processors of the ventilator **202**. Specifically, monitor module **230** may communicate with alarm display module **214** and/or display module **204** such that information regarding alarm events may be displayed to the clinician. Monitor module **230** may further utilize one or more sensors to detect changes in various physiological or mechanical parameters. Indeed, any sensory or derivative technique for monitoring the physical condition of the patient or the mechanical operation of the ventilator may be employed in accordance with embodiments described herein.

FIG. 3 is an illustration of an embodiment of a user interface **300** for hierarchically indicating alarms on a graphical display.

User interface may be accessed via any suitable means, for example via a main ventilatory user interface on display module. As illustrated, user interface may provide one or more windows for display and one or more elements for selection and/or input. Windows may include one or more elements and, additionally, may provide graphical displays, instructions, or other useful information to the clinician. Elements may be displayed as buttons, tabs, icons, toggles, or any other suitable visual access element, etc., including any suitable element for input selection or control.

User interface **300** may include various icons for controlling the ventilator. These icons are selectable elements wherein selection results in display of a new window. Some exemplary control icons include a setup icon **306**, a tools icon **308**, a log icon **310**, an alarm adjustment icon **312**, an oxygen concentration icon **314**, and a help icon **316**. While each of these icons controls ventilatory function, only the setup icon **306** and log icon **310** will be discussed in detail below in relation to indicating alarms on a ventilator display.

According to one embodiment, as illustrated in FIG. 3, a user interface **300** is provided that includes one or more hierarchically structured alarm tabs **302A-D**. The alarm tabs **302A-D** are selectable elements that provide a summarized alarm message. As depicted in user interface **300**, the alarm tabs **302A-D** are stacked one on top of another in a hierarchical structure on the right side of user interface **300**. As will be appreciated by one skilled in the art, the alarm tabs can be located on any side of user interface **300** and can be arranged in any hierarchical structure as contemplated within the scope of the present disclosure. Furthermore, user interface **300** displays four alarm tabs **302A-D**. As will also be appreciated by one skilled in the art, the user interface **300** may display any number of alarm tabs.

Each of the four alarm tabs **302A-D** provides an alarm message that summarizes an alarm event **304A-D**. An alarm event corresponds to a change in a ventilatory parameter that causes the controller **110** monitoring the parameter to issue an alarm. For example, alarm tab **302A** provides an alarm message that summarizes an alarm event **304A** related to the Peak Pressure parameter as indicated by the abbreviation "P_{Peak}" on the alarm tab **302A**. As also indicated on alarm tab **302A,** the alarm event **304A** that caused the alarm was an increase in Peak Pressure. This alarm event **304A** is indicated on alarm tab **302A** in two different manners. First, an upwards arrow next to the "P_{Peak}" abbreviation signifies that Peak Pressure has increased. Second, the words "High Inspiratory Pressure" are also displayed on alarm tab **302A** to signify the alarm event **304A**. As will be appreciated by one skilled in the art, any number of methods of indicating an alarm event on an alarm tab is contemplated as within the scope of the present disclosure.

Each of the four alarm tabs **302A-D** summarizes an alarm message that corresponds to an alarm event **304A-D** that is different from the alarm event corresponding to another alarm tab **302A-D**. As discussed above, alarm tab **302A** corresponds to a "High Inspiratory Pressure" alarm event **304A**. Alarm tab **302B,** on the other hand, corresponds to "Low Exhaled Minute Volume" **304B**.

Each alarm tab **302A-D** also displays the alarm level associated with the alarm event **304A-D** in the summarized alarm message. In one embodiment, the alarm levels are indicated by one or more exclamation points on the alarm tab. For example, user interface **300** displays three different alarm levels each indicated by different numbers of exclamation points. A "High" alarm level is indicated by three exclamation points ("!!!"). A "Medium" alarm level is indicated by two exclamation points ("!!"). A "Low" alarm level is indicated by one exclamation point ("!"). Furthermore, multiple methods of indicating alarm level can be simultaneously employed by user interface **300**. For example, user interface might also color tabs differently based on alarm level. In one embodiment, an alarm tab with an alarm level of "High" is colored red, while alarm tabs with alarm levels of either "Medium" or "Low" are colored yellow. As can be appreciated by one skilled in the art, any symbol, color, or other method of alarm level indication can be used alone or in combination to indicate an alarm level.

Alarm tabs **302A-D** are stacked on top of one another in a hierarchical structure based on the ranking of the alarm event **304A-D** displayed by the alarm tab **302A-D**. The ranking is derived from alarm level and parameter priority level. For the purpose of

this disclosure, the alarm tab at the top of the stack, as exemplified by alarm tab **302A**, is said to display the highest ranked alarm event. The alarm tab **302B** below the alarm tab **302A** displaying the highest ranked alarm event is said to display the second highest ranked alarm event. The alarm tab **302C** below the alarm tab **302B** displaying the second highest ranked alarm event is said to display the third highest ranked alarm event. The alarm tab **302D** below the alarm tab **302C** displaying the third highest ranked alarm event is said to display the fourth highest ranked alarm event.

The ranking is derived from, first, the alarm level and second, if two alarm events have the same alarm level, from parameter priority level. An alarm event indicating an alarm level of "High" will be ranked higher than an alarm event indicating an alarm level of "Medium" which will be ranked higher than an alarm event indicating an alarm level of "Low." As illustrated by user interface **300**, alarm event **304A** is associated with an alarm level of "High." As a result, alarm event **304A** is ranked higher than alarm events **302C** and **302D** that indicate alarm events with alarm levels of "Medium" and "Low" respectively. As will be discussed in greater detail below, alarm levels are parameter specific. In other words, measurements that cross a certain threshold for a first parameter may trigger a "Low" alarm level while measurements that cross the same threshold for a second parameter may trigger a "Medium" or "High" alarm level.

If two alarm tabs indicate alarm events with the same alarm level, the ranking of each alarm event is then derived from parameter priority level. A ventilator monitors a multitude of ventiltatory parameters. Each parameter is assigned a priority. The parameter priority level may be assigned by a clinician or based on uniform protocol at ventilator setup. The priority level associated with a parameter is stored by the ventilator in storage **114** or RAM **112** of the controller **110**. In one embodiment, the parameter priority level can be changed by utilizing setup icon **306**.

As illustrated in user interface **300**, when two alarm events **302A** and **302B** have the same alarm level ("High"), one alarm event **302A** is still ranked higher than the other alarm event **302B**. In the case of exemplary user interface **300**, alarm event **304A** is ranked higher than alarm event **304B** because parameter "P_{Peak}" is assigned a higher priority than parameter "$V_{E\,TOT}$." As such, alarm event **304A** is displayed in alarm tab **302A** and alarm event **304B** is displayed in alarm tab **304B**.

An alarm level associated with an alarm event can increase or decrease over time. For example, a patient's condition may improve, causing the alarm level to either

decrease or disappear entirely. This is known as alarm level de-elevation. Alternatively, a patient's condition may worsen, causing the alarm level to increase. This is known as alarm level elevation. When the ventilatory system detects a de-elevation or elevation of an alarm event, a clinician or other ventilatory user is notified of the change by a warning symbol superimposed on setup icon **306** and/or log icon **310**. In one embodiment, the warning symbol is a yellow triangle, as exemplified in user interface **300**. As will be appreciated by one skilled in the art, any symbol, word, sound, or other notification method may be used to notify the clinician that an alarm event has changed. It should be noted that a change in an alarm event may or may not be displayed on alarm tabs **302A-D** depending on whether the alarm event is ranked high enough for display. The ventilator removes the warning symbol from an icon when clinician selects that icon. Selection of setup icon **306** causes user interface **300** to display alarm setup window **500**. Alarm setup window **500** will be discussed in detail with regard to FIG. 5 below. Selection of log icon **310** causes user interface **300** to display alarm log window **600**. Alarm log window **600** will be discussed in detail with regard to FIG. 6 below.

When an alarm level associated with an alarm event elevates to de-elevates, the change may trigger an increase or decrease in that alarm events ranking as well as the ranking of other alarm events. Changes to the ranking of alarm events necessitates that the alarm events be reordered in the user interface. As will be appreciated, reordering alarm events may cause the user interface **300** to display a previously undisplayed alarm event in an alarm tab or remove from display an alarm event previously displayed in an alarm tab.

As alarm events **304A-D** are reordered in the hierarchical structure, the alarm tabs displaying the alarm events slide up and down passed one another to reflect the reordered alarm events. For example, the ventilator may detect an elevation in alarm level for alarm event **304D** "High End Expiratory Pressure" from "Low" to "Medium." The elevated alarm level results in two alarm events **304C** and **304D** with "Medium" alarm levels. To determine the ranking of each alarm event, the system compares the parameter priority of "%LEAK" to the parameter priority for "PEEP." In one embodiment, "PEEP" has a higher parameter priority than "%LEAK." As a result, the ranking of alarm event **304D** associated with "PEEP" changes from fourth highest ranked to the third highest ranked. In a similar vein, the ranking of the alarm event **304C** associated with "%LEAK" changes from third highest ranked to the fourth highest ranked. Reordering of the alarm events **304C** and **304D** is visualized in user interface

300 by sliding the reordered alarm tabs 302D and 302C up and down, respectively, to occupy the new ranking position. Alarm tab 302D displaying alarm event 304D slides up to occupy the location of alarm tab 302C. Likewise, alarm tab 302C displaying alarm event 304C slides down to occupy the location of alarm tab 302D. In one embodiment, alarm tab 302D slides straight up while alarm tab 302C may partially retract, or partially fade, while sliding by alarm tab 302D. The alarm tabs 302A-D on user interface 300 now properly reflect the rankings of alarm events 304A-D.

As illustrated in user interface 300, alarm tabs 302A-D may be displayed by default in a minimized state. The minimized state of the alarm tab 302A-D still conveys information such as alarm event 304A-D, parameter, alarm level and ranking while not occupying too much space on the user interface. Alarm tabs may 302A-D also include an arrow 318A-D indicating that the minimized alarm tab can be expanded. Making a selection, such as by clicking, anywhere in alarm tab 312A-D will cause the selected alarm tab to expand. Expanding an alarm tab will be discussed in detail with reference to FIG. 4.

FIG. 4 is an illustration of an embodiment of a user interface 400 for displaying an expanded alarm tab.

With reference to like numerals from FIG. 3, FIG. 4 illustrates a user interface 400 that includes an expanded alarm tab 402. The expanded alarm tab 402 is accessed by making a selection anywhere in alarm tab 302A. Upon making the selection, the maximization arrow 318A is flipped in the opposite direction to indicate that maximization arrow is now a minimization arrow 410. When a clinician wants to deflate the expanded alarm tab 402, the clinician may make a selection anywhere in expanded alarm tab 402 and the expanded alarm tab 402 is minimized back to alarm tab 302A. Upon minimization, the minimization arrow 410 is converted back into maximization arrow 318A. User interface 400 illustrates single expanded alarm tab 402. However, as will be appreciated by one skilled in the art, any number of alarm tabs 302A-D may be expanded or minimized at any given time for display in user interface 400.

In another embodiment, certain alarm tabs associated with very high priority alarm events may be automatically expanded upon detection of the alarm event. The very high priority alarm events may be indicated by a clinician or may be industry standards. Upon initial detection of the high priority alarm event, the alarm tab will expand immediately. The clinician can then choose to minimize the expanded alarm

tabs by the any of the minimization methods as discussed above. This behavior of automatically expanding alarm tabs associated with very high priority alarm events has the added advantage of maximizing the visibility of the alarm. Because the expanded alarm tab may overlap other items on screen and thus interrupt on screen activity, the behavior, in one embodiment, may only be used on alarms that require immediate intervention. This may include alarm events associated with activity outside of the ventilatory parameters such as circuit disconnect, occlusion, etc.

As is illustrated in user interface **400**, expanded alarm tab **402** provides clinician with more detailed information about the alarm event. In one embodiment, expanded alarm tab **402** provides clinician with an explanation **404** as to why an alarm event is associated with a particular alarm level. For example, expanded alarm tab **402** may provide an explanation **404** for the "High" alarm level associated with alarm event **302A**, stating that "Last 4 Or More Breaths >= Set Limit." This explanation **404** provides the clinician with a reason why the alarm level for the alarm event **304A** is set to "High."

Expanded alarm tab **402** may also provide clinician with possible solutions **406** that may de-elevate the alarm level associated with an alarm event **304A**. For example, expanded alarm tab **402** may provide possible solutions **406** to increased Peak Pressure, suggesting "Check Patient, Circuit, and ET Tube." These possible solutions **406** provide clinician with suggestions that may alleviate the problem and, as a result, de-elevate the alarm level associated with an alarm event.

Expanded alarm tab **402** may also provide the clinician with a hyperlink **408** to alarm setup window **500**. The hyperlink **408** allows a clinician to "jump" to the alarm setup window **500** for that alarm without having to navigate to it through the setup icon **306**.

FIG. 5 depicts an alarm setup window **500** for display in user interface **300**. As discussed above, alarm setup window **500** may be accessed by selecting the hyperlink **408** in the expanded alarm tab **402**. By selecting the hyperlink **408**, a clinician is able to "jump" to the meter for the parameter associated with the selected alarm event. The alarm setup window **500** can also be accessed by selecting the setup icon **306** and navigating to the alarm setup window **500**. As depicted by alarm setup window **500**, alarm tabs **302A-D** may still be visible when alarm setup window **500** is displayed.

Alarm setup window **500** displays a meter for each ventilatory parameter associated. It will be appreciated that only those alarms with user-adjustable parameters,

i.e. those alarms associated with ventilatory parameters, may be associated with a meter in alarm setup window **500**. Some alarms issued by the ventilator are not user-adjustable alarm such as an alarm indicating apnea, procedure error, or circuit disconnect. As discussed above, a ventilator monitors a multitude of ventilatory parameters. As such, alarm setup window **500** may display meters for parameters that are not visible on alarm tabs **302A-D** in user interfere **300**. Parameters may not be visible on alarm tabs **302A-D** because either the parameter is not associated with an alarm event or, if the parameter is associated with an alarm event, the alarm event is not ranked high enough to be displayed in alarm tabs **302A-D**. In either event, alarm setup window **500** allows a clinician to view a meter for each ventilatory parameter, whether that parameter is displayed in alarm tabs **302A-D** or not.

Alarm setup window **500** displays five meters **504A-E**, each meter associated with a different parameter. As discussed above, ventilator may monitor more or less than five parameters. Additional meters for parameters not currently displayed in alarm setup window **500** can be accessed using scroll bar **506**. Scroll bar **506** includes multiple symbols, each symbol representing one parameter. In one embodiment, the symbols on the scroll bar **506** are bells. However, any symbol can be used within the scope of the present disclosure. Parameters associated with alarm events are further depicted on scroll bar **506** by superimposing an alarm event symbol onto the parameter symbol. As illustrated by scroll bar **506**, the bells representing the parameter may be superimposed with a yellow triangle representing that the parameter is associated with an alarm event. Furthermore, the yellow triangle may include the number of exclamation points associated with the alarm level of the alarm event for that parameter. For example, a parameter with an alarm event of alarm level medium might be represented in scroll bar **506** as a bell with a yellow triangle superimposed onto in it, the yellow triangle including two exclamation points. Again, any method of representing alarm events, alarm levels, or parameters on a scroll bar **506**, is contemplated within the scope of the present disclosure including differing colors, symbols, and graphical effects.

Scroll bar **506** may also include scroll bar window **508**. Scroll bar window **508** encases the parameter symbols representing the parameters with meters currently displayed in alarm setup window **500**. In one embodiment, alarm setup window **500** displays five meters **504A-E** so scroll bar window encases five parameter symbols, **506A-E**, representing the five meters. For example, the P_{Peak} parameter meter **504A** is

displayed in the left most position of alarm setup window **500**. The P_{Peak} parameter meter **504A** is, therefore, represented by symbol **506A** in the left most position of scroll bar **506**. The symbol **506A** in the left most position of scroll bar **506** indicates that it represents a parameter associated with "High" level alarm event. This description matches the P_{Peak} parameter which is associated with an "High" level alarm event, as indicated by alarm tab **302A**.

Scroll bar window **508** can be shifted to the left or right on scroll bar **506** to display meters associated with different parameters. For example, a clinician may access scroll arrows **516** to shift scroll bar window **508** one position to the right on scroll bar **506**. Such a shift would cause alarm setup window **500** to display parameters associated with symbols **506B-506F**. The scroll bar window **508** can be shifted in either direction until the end of the scroll bar **506** is reached. Clinician can also access a meter for a parameter by directly selecting its symbol from scroll bar **506**. For example, if clinician was interested in the "Medium" level alarm event associated with symbol **506I**, the clinician could directly click on symbol **506I** and alarm setup window **500** would display five meters, one being the parameter associated with symbol **506I.** In one embodiment, whenever the scroll bar **506** is accessed, whether by shifting the scroll bar window **508** using scroll bar arrows **516** or by clicking a symbol on scroll bar **506**, scroll bar **506** illuminates to inform a clinician of the shift.

Each meter **504A-E** displays ranges and measurements associated with a particular parameter. The big numbers **510A-I** indicate either an upper or lower limit of a safe range for a given parameter. The safe range is the range in which parameter measurements for a patient indicate that the patient is not in danger. For example, the P_{Peak} parameter has a safe range with an upper limit **510A** of 40 cmH2O and a lower limit **510B** of 14cmH2O. The f_{TOT} parameter, on the other hand, has a safe range with an upper limit **510C** of 40 1/min but does not have any lower limit. As a result, only one limit is displayed in association with the f_{TOT} parameter meter **504B**.

The upper and lower limit for each meter **504A-E** can be adjusted. For example a clinician can select the upper limit **510D** and drag it up or down. When upper limit **510D** is released at a new value, the big numbers inside upper limit **510D** will change to reflect the new value. If an upper limit **510A, C, D, F,** or **H** is dragged to the top of the meter, the upper limit may disappear, or read "OFF". Likewise, if a lower limit **510B, E, G,** or **I** is dragged to the bottom of the meter the lower limit may disappear, or read "OFF". An upper limit **510A, C, D, F,** or **H** can only be dragged as low as the lower

limit for that meter. Likewise, a lower limit **510B, E, G,** or **I** can only be dragged as high as the upper limit for that meter. In another embodiment, a meter may be associated with an alarm that has a factory preset limit and cannot be turned off.

The numbers **512A-D** represent the current measurement for a given parameter. For example, the current measurement for the P_{Peak} parameter is 40 cmH20. The current measurement **512A-D** is displayed as a line through a white box **514A-D** in the meter **504A-D** for the parameter. The white box **514A-D** represents the measurements of the parameter for a given period. In one embodiment, the period is a period of time, such as two minutes, and the white box represents the measurements for the parameter for the last two minutes. In another embodiment, the period is a period of breaths, such as 200 breaths, and the white box represents the measurements for the parameter for the last 200 breaths. As will be appreciated by one skilled in the art any sort of period can be used to define the bounds of the white box.

As is illustrated in alarm setup window **500**, some meters may not display any measurements. In one embodiment, a meter may not display any measurement because the alarm for the parameter associated with the meter may only be required under certain breath modes or breath types. For example, in alarm setup window **500**, the meter for the parameter $V_{TE\ SPONT}$ does not display any measurements. This is because the current breath mode does not require $V_{TE\ SPONT}$ measurements. In one embodiment, the alarm setup window **500** will automatically switch and begin displaying measurements for the $V_{TE\ SPONT}$ parameter when the current breath mode changes.

Alarm setup window **500** may also include one or more controls for alarm volume. As illustrated in alarm setup window **500**, alarm volume may be controlled by a volume adjust scrollbar **518**. By sliding volume adjust scrollbar **518** either left or right, clinician can control the volume of an emitted alarm. Volume adjust scrollbar **518** may also display the current alarm value as a numerical value. As displayed by alarm setup window **500**, the alarm volume may be based on a scale from one to ten. As will be appreciated by one skilled in the art, any scale or other manner of conveying alarm value may be used as contemplated within the scope of the present disclosure.

Alarm setup window **500** also includes a transparency button **522** and a pin-up button **524**. When the transparency button **522** is accessed, the alarm setup window **500** may be viewed simultaneously with other data displayed on user interface **300**, or other user interface. When the pin-up button **524** is accessed, the alarm setup window **500** may remain open unless and until a clinician desires to close the alarm setup window

500 by accessing the "Close" button **520**. Otherwise, the alarm setup window **500** may close automatically after some period of inactivity. In another embodiment, the alarm setup window **500** will close, and the changes to the alarm limits will be implemented, when an "Accept" button (not depicted) is accessed. When the alarm setup window **500** is pinned and the "Accept" button (not depicted) is accessed, the changes will be implemented, but the alarm setup window **500** will not be closed.

FIG. 6 depicts an alarm log window **600** for display in user interface **300**. As discussed above, selection of log icon **310** causes user interface **300** to display alarm log window **600**. This selection is indicated by the bold box surrounding log icon **602**. As will be appreciated, any manner of indicating selection may be used.

Alarm log window **600** provides a temporal log of alarm events. In one embodiment, the alarm log records all alarm events emitted since the last manual reset of the mechanical ventilator. In another embodiment, the alarm log records all alarm events emitted since the ventilator began monitoring a new patient. A variety of information categories related to alarm events may be provided by alarm log window **600**. For example, alarm log window **600** may provide information categories regarding the time **604**, event **606**, priority **608**, alarm **610**, and analysis **612**. These categories may be arranged as columns in a table. In other embodiments, some or different information categories associated with alarm events may be provided by alarm log window **600**.

Alarm log window **600** may provide a time **604** information category indicating the time at which an alarm event occurred. In one embodiment, the alarm events are arranged hierarchically from the most recent event to the least recent event. The time **604** information category may be accompanied by a flip arrow **614**. By accessing the flip arrow **614**, a clinician may flip the order the alarm log hierarchy such that the alarm events are displayed from the least recent event to the most recent event.

Alarm log window **600** may also provide an event **606** information category indicating a type of alarm event. In one embodiment, there are three types of alarm events: manual reset, augmented, and detected. However, it will be appreciated that there may be any number of alarm events. A manual reset alarm event may indicate that an alarm was manually reset by the operator pressing an alarm reset button on the ventilator. An augmented alarm event may indicate that an alarm has been escalated in priority. A detected alarm event may indicate that an alarm was first detected at that point in time.

Alarm log window **600** may also provide a priority **608** information category indicating an alarm level associated with an alarm event. As discussed above, an alarm event may be associated with an alarm level that reflects the severity of the alarm event. Exemplary alarm levels include high, medium, and low.

Alarm log window **600** may also provide an alarm **610** information category indicating a change in a parameter measurement associated with an alarm event. As discussed above, parameter names may be represented by parameter abbreviations. For example, Peak Pressure may be represented by the abbreviation "P_{Peak}." The parameter abbreviation may be accompanied by a symbol indicating the change in the parameter measurement. In one embodiment, the parameter abbreviation is accompanied by either an upward pointing arrow or a downward pointing arrow. For example, the "P_{Peak}" parameter may be accompanied by an upward pointing arrow indicating that the Peak Pressure has increased.

Alarm log window **600** may also provide an analysis **612** information category indicating more detailed information about the cause of the alarm event. The alarm **612** information category may provide the measurement that triggered the alarm event. For example, if the ventilator measures the last 4 or more breaths of the patient as greater than or equal to the set limit, the ventilator may trigger an increased Peak Pressure alarm event with a high alarm level.

Alarm log window **600** may also include a scroll bar **622.** By accessing the scroll bar **622**, a clinician can display different alarm events in the alarm log window **600**. In one embodiment, when the scroll bar **622** is accessed it is illuminated to indicate to the clinician that the alarm events displayed in the alarm log window **600** have changed.

Alarm log window **600** may also include a transparency button **616** and a pin-up button **618.** When the transparency button **616** is accessed, the alarm log window **600** may be viewed simultaneously with other data displayed on user interface **300**, or other user interface. When the pin-up button **618** is accessed, the alarm log window **600** may remain open unless and until a clinician desires to close the alarm log window **600** by accessing the "Close" button **620.** Otherwise, the alarm log window **600** may close automatically after some period of inactivity. When the alarm log window **600** is pinned, the changes will be implemented, but the alarm log window **600** will not be closed.

It will be clear that the systems and methods described herein are well adapted to attain the ends and advantages mentioned as well as those inherent therein. Those skilled in the art will recognize that the methods and systems within this specification may be implemented in many manners and as such is not to be limited by the foregoing exemplified embodiments and examples. In other words, functional elements being performed by a single or multiple components, in various combinations of hardware and software, and individual functions can be distributed among software applications at either the client or server level. In this regard, any number of the features of the different embodiments described herein may be combined into one single embodiment and alternative embodiments having fewer than or more than all of the features herein described are possible.

While various embodiments have been described for purposes of this disclosure, various changes and modifications may be made which are well within the scope of the present invention. Numerous other changes may be made which will readily suggest themselves to those skilled in the art and which are encompassed in the spirit of the disclosure and as defined in the appended claims.

Claims

What is claimed is:

1. A user interface for hierarchically indicating one or more alarm messages corresponding to an alarm event, the ventilator configured with a computer having a user interface including a graphical user interface for accepting commands and for displaying information, the user interface comprising:

at least one window associated with the user interface; and

one or more elements within the at least one window comprising one or more of:

a first selection element for indicating a first alarm event, the first alarm event having an first alarm level; and

a second selection element for indicating a second alarm event, the second alarm event having a second alarm level.

2. The graphical user interface of claim 1, wherein the first selection element and the second selection element are provided along the border of the graphical user interface.

3. The graphical user interface of claim 1, wherein the first alarm event is associated with a first ventilatory parameter and the second alarm event is associated with a second ventilatory parameter.

4. The graphical user interface of claim 1, wherein the first alarm level is ranked higher than the second alarm level.

5. The graphical user interface of claim 4, wherein the second ventilatory parameter is assigned is a higher priority than the first ventilatory parameter.

6. The graphical user interface of claim 5, wherein the ventilator receives an indication that the second alarm level has increased such that the second alarm level equals the first alarm level.

7. The graphical user interface of claim 6, wherein the priority of the second ventilatory parameter is compared to the priority of the first ventilatory parameter.

8. The graphical user interface of claim 7, wherein a determination is made that the second alarm event is now higher ranked than the first alarm event.

9. The graphical user interface of claim 8, wherein the second selection element is rearranged and displayed above the first selection element, indicating that the ranking of the second alarm event is higher than the ranking of the first alarm event.

10. The graphical user interface of claim 1, wherein the first selection element and the second selection element includes information summarizing an alarm message, the information comprising: an alarm level, a parameter indication, an alarm event.

11. The graphical user interface of claim 10, wherein the parameter indication is a parameter abbreviation.

12. The graphical user interface of claim 10, wherein the alarm level is indicated by an icon.

13. The graphical user interface of claim 1, wherein, upon accessing the first selection event, the alarm message is expanded.

14. The graphical user interface of claim 13, wherein the expanded alarm message includes a hyperlink.

15. The graphical user interface of claim 13, wherein the expanded alarm message provides one or more suggested alarm alleviation measures.

16. A computer-readable storage medium having instructions that when executed provide a graphical user interface for displaying one or more informative alarm messages corresponding to an alarm event, the graphical user interface comprising:

at least one window associated with the user interface; and

one or more elements within the at least one window comprising one or more of:

a first selection element for indicating a first alarm event, the first alarm event having an first alarm level; and

a second selection element for indicating a second alarm event, the second alarm event having a second alarm level.

17. The computer-readable storage medium of claim 16, wherein the first alarm event is associated with a first ventilatory parameter and the second alarm event is associated with a second ventilatory parameter.

18. The computer-readable storage medium of claim 16, wherein the first alarm level is ranked higher than the second alarm level.

19. The computer-readable storage medium of claim 18, wherein the first selection element is displayed above the second selection element to indicate that the first alarm level is ranked higher than the second alarm level.

20. The computer-readable storage medium of claim 16, wherein the first selection element and the second selection element includes information summarizing an alarm message, the information comprising: an alarm level, a parameter indication, an alarm event.

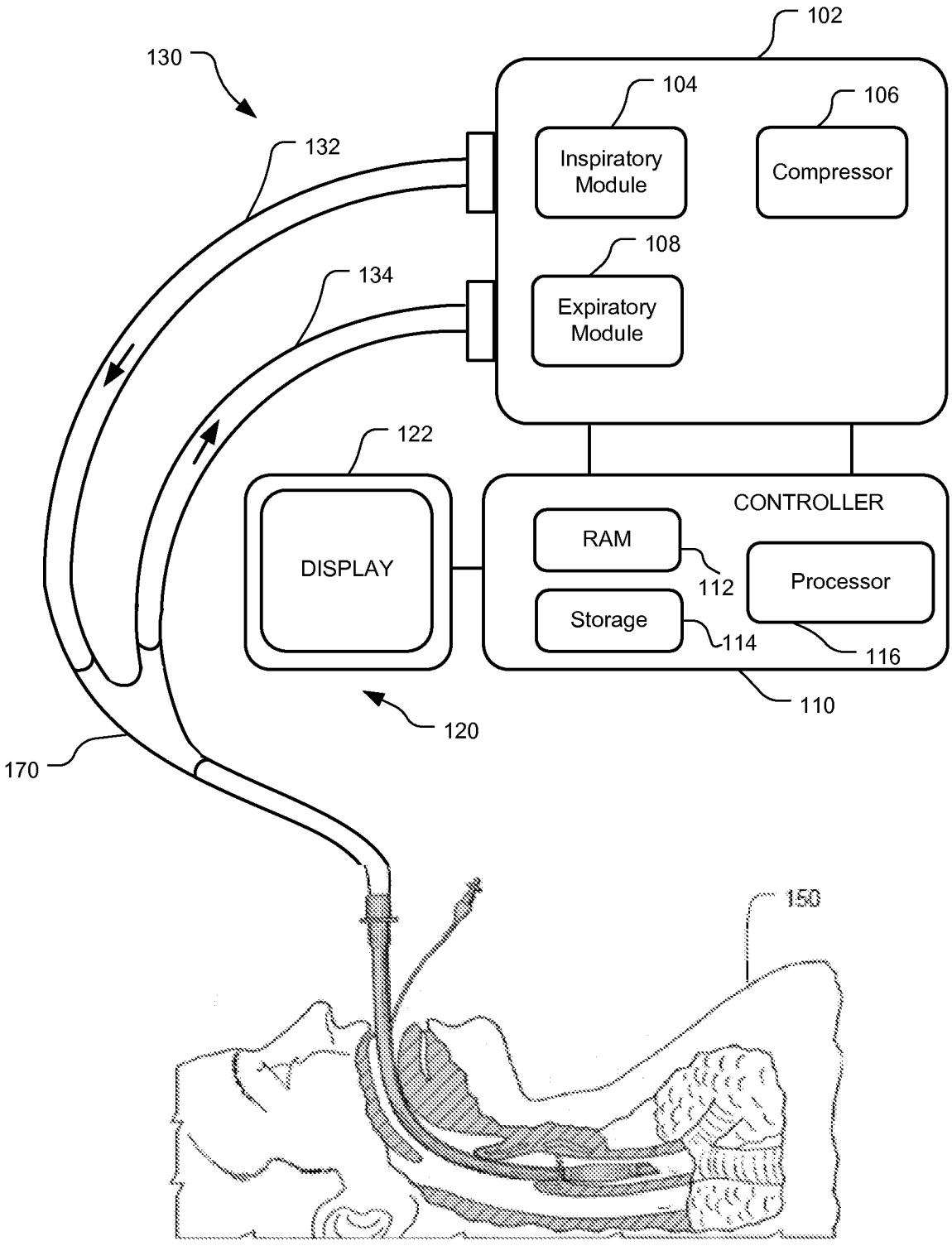
102
130
104
106
132
Inspiratory Module
Compressor
108
134
Expiratory Module
122
CONTROLLER
DISPLAY
RAM
112
Processor
Storage
114
116
110
120
170
150

FIG. 1

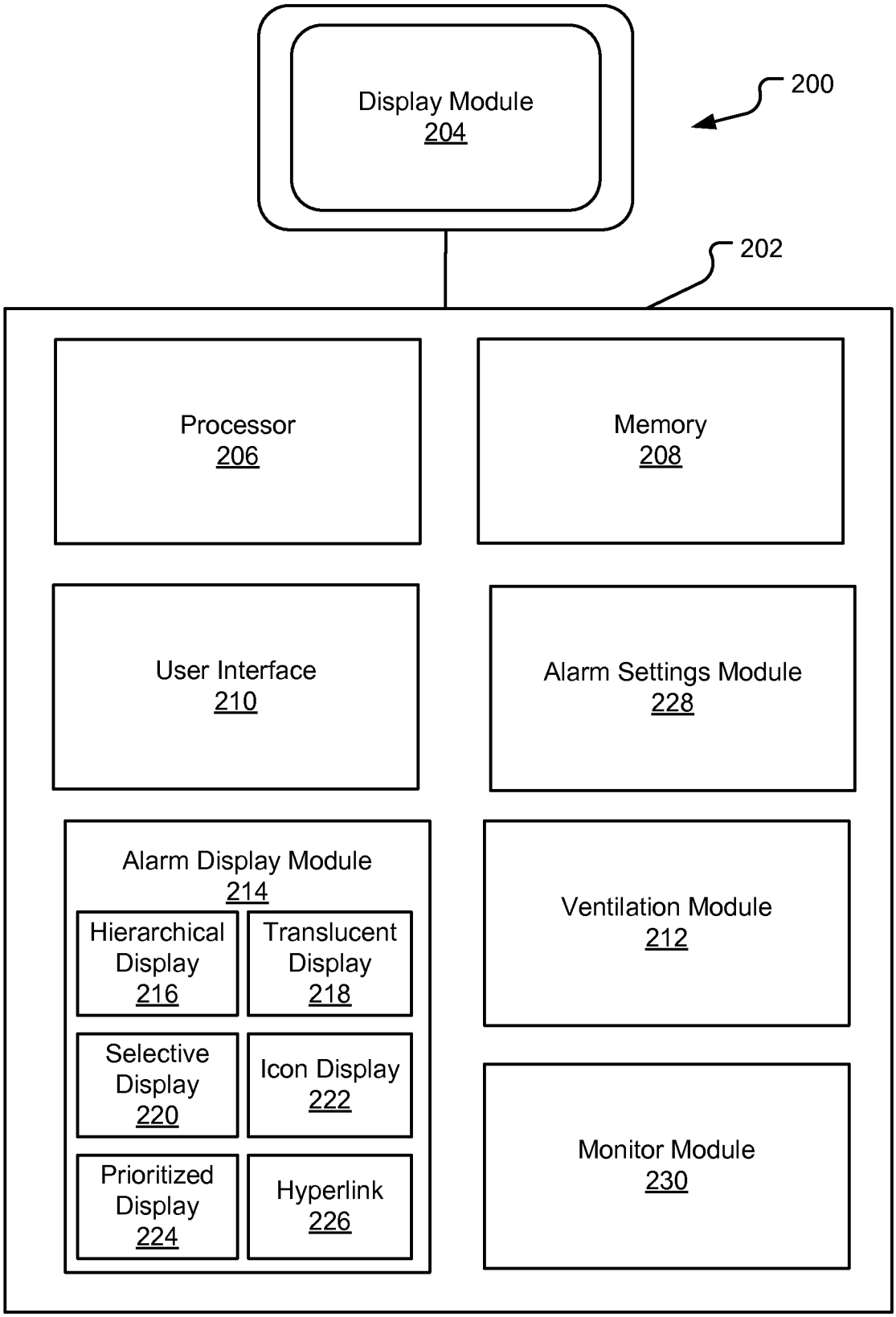
Display Module
204
200
202
Processor
206
Memory
208
User Interface
210
Alarm Settings Module
228
Alarm Display Module
214
Hierarchical Display
216
Translucent Display
218
Selective Display
220
Icon Display
222
Prioritized Display
224
Hyperlink
226
Ventilation Module
212
Monitor Module
230

FIG. 2

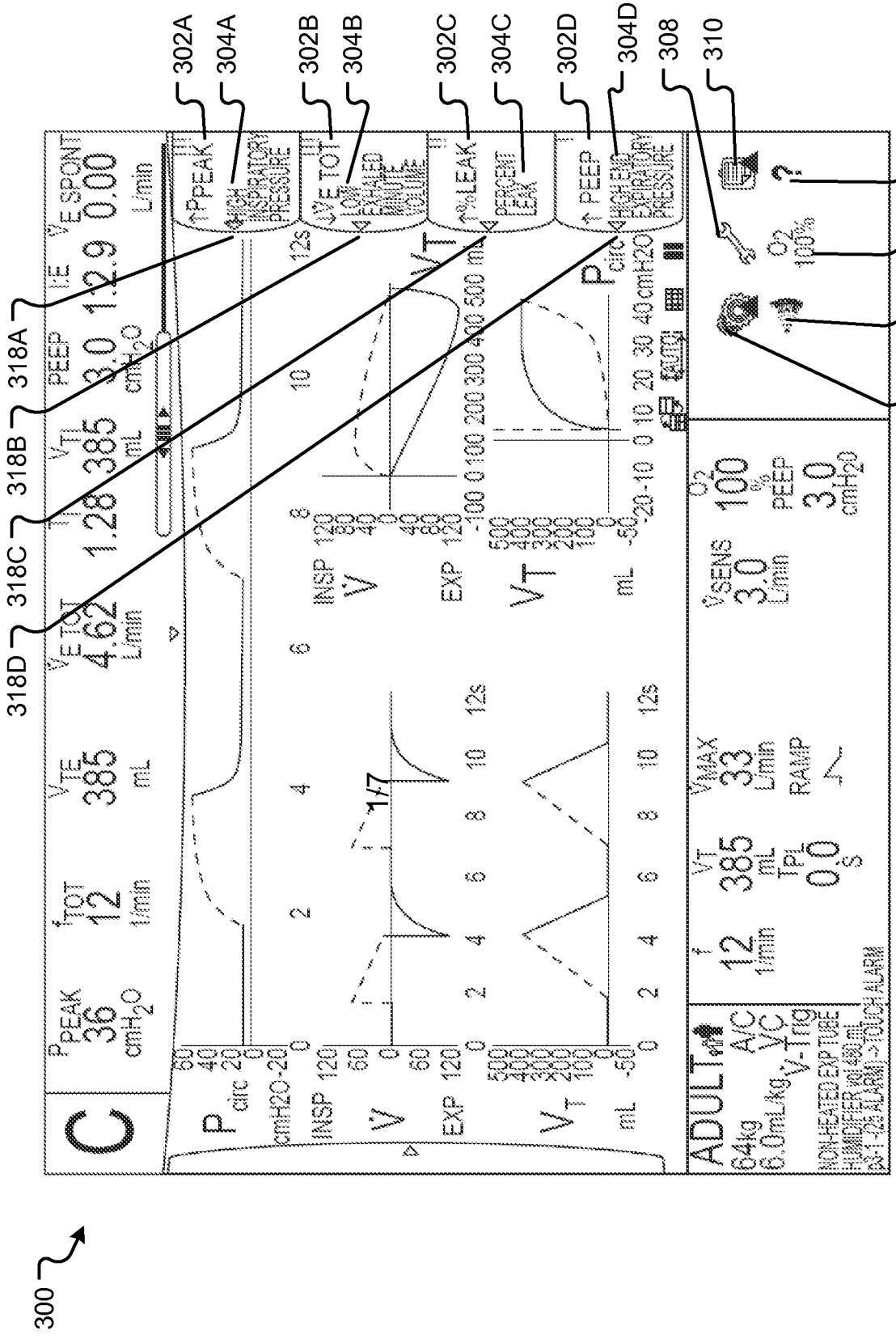
300
302A
304A
302B
304B
302C
304C
302D
304D
308
310
312
314
316
306
318A
318B
318C
318D
C
PEAK
TOT
TE
TOT
TL
PEEP
I:E
E SPONT
ADULT
VT
VMAX
VSENS
PEEP
RAMP
HUMIDIFIER
NON-HEATED EXP TUBE
INSP
EXP
1/7

Fig. 3

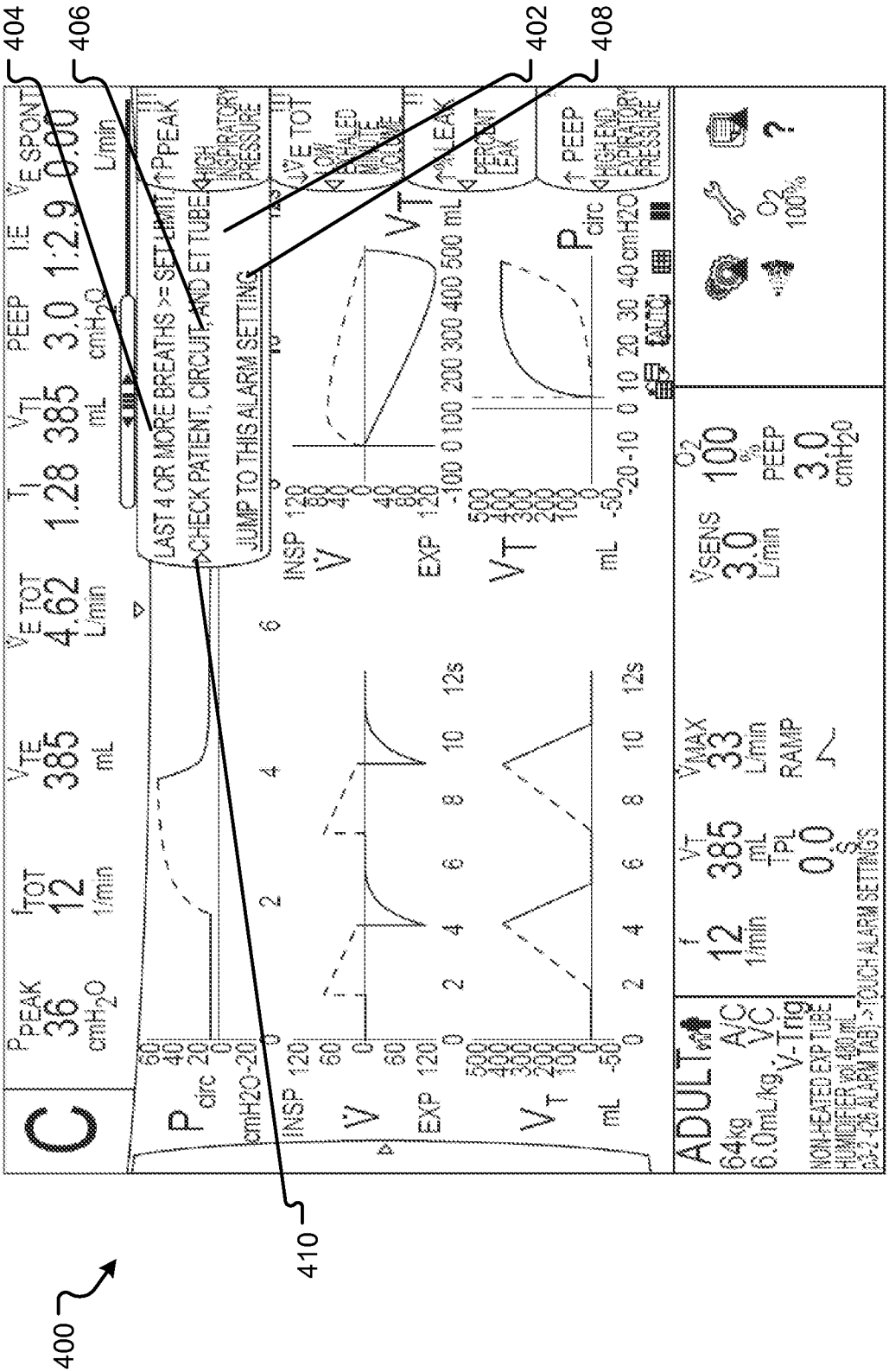
400
402
404
406
408
410
C
P_{PEAK} 36 cmH_2O
f_{TOT} 12 1/min
V_{TE} 385 mL
$V_{E\,TOT}$ 4.62 L/min
T_I 1.28
V_{TI} 385 mL
PEEP 3.0 cmH_2O
I:E 1:2.9
$V_{E\,SPONT}$ 0.00 L/min
LAST 4 OR MORE BREATHS >= SET LIMIT
CHECK PATIENT, CIRCUIT, AND ET TUBE
JUMP TO THIS ALARM SETTING
HIGH INSPIRATORY PRESSURE
↑ $V_{E\,TOT}$
LOW EXHALED MINUTE VOLUME
↑ LEAK
PERCENT LEAK
↑ PEEP
HIGH END EXPIRATORY PRESSURE
P_{circ}
INSP
EXP
V_T
mL
ADULT
64kg
6.0mL/kg
A/C
V-Trig
NON-HEATED EXP TUBE
HUMIDIFIER ON 40 mL
V_{SENS} 3.0 L/min
V_{MAX} 33 L/min
RAMP
V_T 385 mL
TPL 0.0 s
f 12 1/min
O_2 100 %
PEEP 3.0 cmH_2O
O_2 100%
?
TOUCH ALARM SETTINGS

Fig. 4

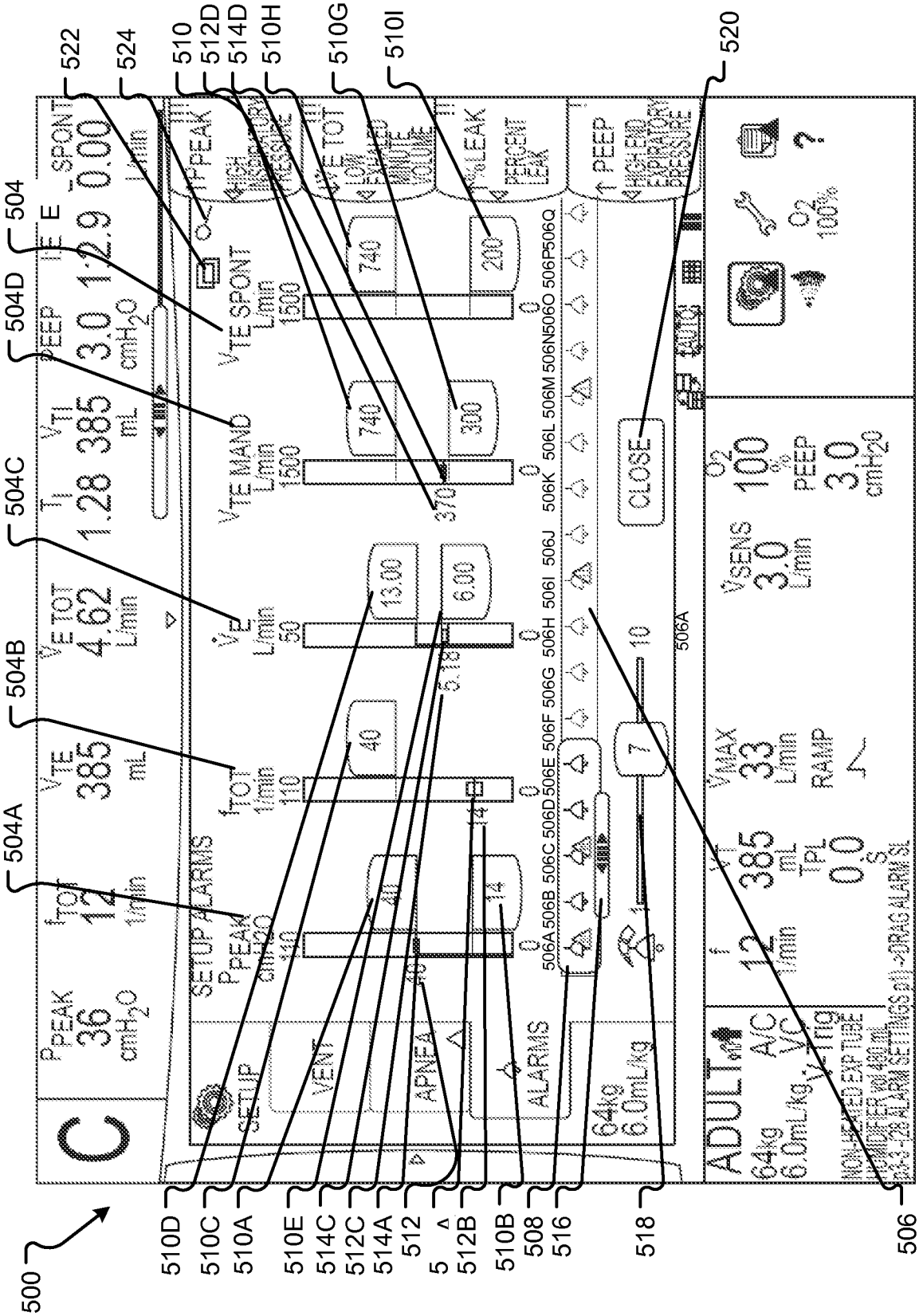
500
504
504A
504B
504C
504D
510
510A
510B
510C
510D
510E
510G
510H
510I
512
512B
512C
512D
514A
514C
514D
516
518
520
522
524
506
506A
SETUP
VENT
APNEA
ALARMS
CLOSE
ADULT
PEEP
VTE SPONT
VTE MAND
VTE TOT
PEAK
PERCENT LEAK
HIGH END EXPIRATORY PRESSURE
LOW EXHALED MINUTE VOLUME
HIGH INSPIRATORY PRESSURE
SETUP ALARMS
NON-HEATED EXP TUBE
MODIFIER (0) 400 mL
ALARM SETTINGS (1) - DRAG ALARM SET

Fig. 5

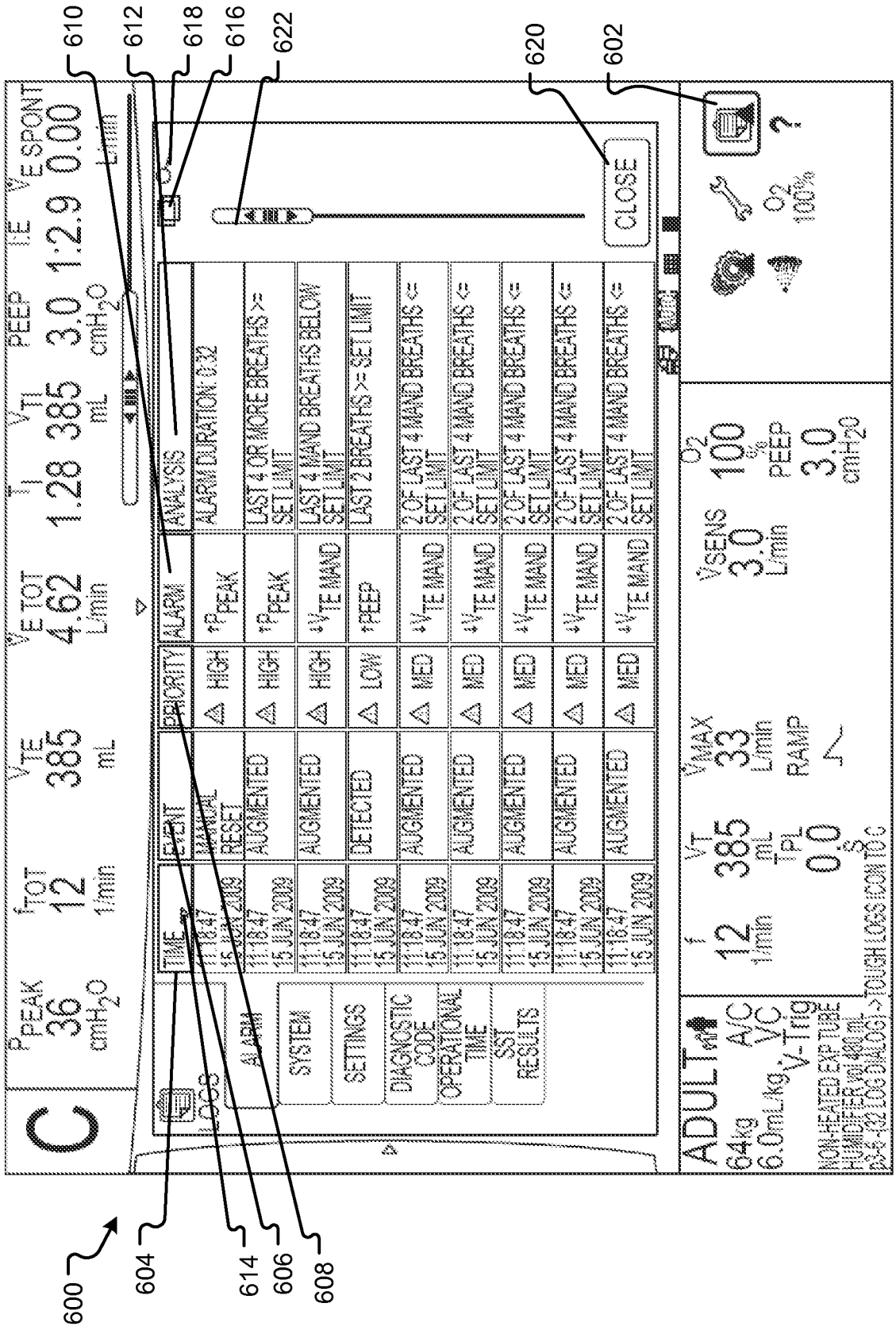
610
612
618
616
622
620
602
600
604
614
606
608
ALARM
ANALYSIS
CLOSE
SYSTEM
SETTINGS
DIAGNOSTIC CODE
OPERATIONAL TIME
SST RESULTS
ADULT
A/C
VC
V-Trig

Fig. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2010/060871

A. CLASSIFICATION OF SUBJECT MATTER
INV. G06F19/00 A61M16/00
ADD.

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)
G06F A61M

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, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	US 2009/054743 A1 (STEWART DONALD-BANE [GB]) 26 February 2009 (2009-02-26) paragraph [[0070]]; figure 2 -----	1-8, 10-20 9
A	WO 98/41267 A1 (NELLCOR PURITAN BENNETT INC [US]) 24 September 1998 (1998-09-24) figures 11-12 -----	1-20

☐ 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	Date of mailing of the international search report
29 March 2011	07/04/2011

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	Valfort, Cyril

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2010/060871

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