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(71) Applicant *(for all designated States except US)*: **NELLCOR PURITAN BENNETT LLC** [US/US]; 6135 Gunbarrel Avenue, Boulder, Colorado 80301 (US).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **THIESSEN, Ron** [CA/CA]; 23880 133rd Avenue, Maple Ridge, British Columbia V4R2V1 (CA).

(74) Agent: **DOUGHERTY, Thomas**; ATTN IP Legal, 6135 Gunbarrel Avenue, Boulder, Colorado 80301 (US).

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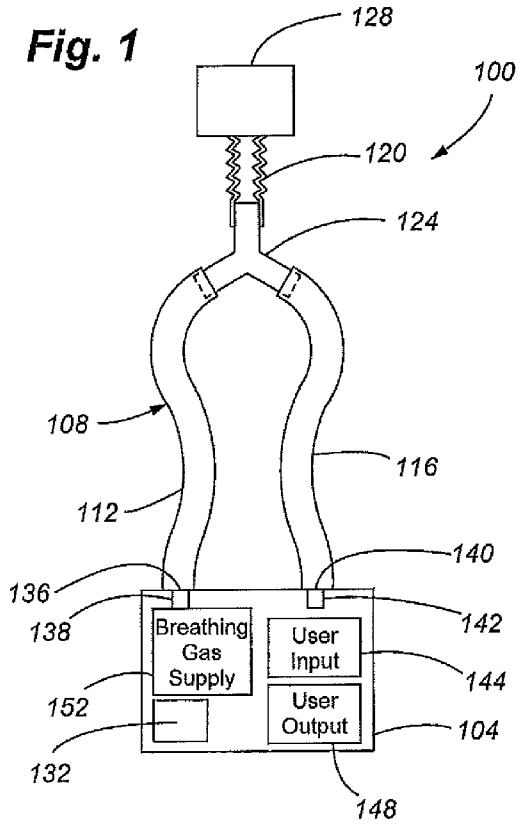

(57) Abstract: A ventilator with a safe standby mode is provided. The safe standby mode allows a user to disconnect a patient from the ventilator, without the ventilator generating alarms and while maintaining previously entered ventilation parameters. In addition, while in the safe standby mode, a patient connection status is monitored, and a ventilation mode is entered automatically if the ventilator determines that a patient is connected to the ventilator while the ventilator is in the safe standby mode.

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SAFE STANDBY MODE FOR VENTILATOR

FIELD OF THE INVENTION

The present invention is generally directed to a safe standby mode for a ventilator.

BACKGROUND

Ventilators are used to provide a breathing gas to a patient who is unable to breathe sufficiently without assistance. In modern medical facilities, pressurized air and oxygen sources are often available from wall outlets. Accordingly, ventilators may provide pressure regulating valves connected to centralized sources of pressurized air and pressurized oxygen. The pressure regulating valves function to regulate flow so that respiratory air having a desired concentration of oxygen is supplied to the patient at desired pressures and rates. Ventilators capable of operating independently of external sources of pressurized air and oxygen are also available.

A typical ventilator has a number of settings that can be used to control parameters according to which breathing gas is supplied to a patient. In order to facilitate the entry of ventilator settings by a user, some ventilators have provided a standby mode. In a conventional standby mode, a user may set operating parameters, without breathing gas being provided at the supply port of the ventilator. Accordingly, in order to provide breathing gas to a patient, the user must remember to exit the standby mode and enter a normal operating mode. If this is not done, no benefit is provided to the patient, as no breathing gas is supplied in a conventional standby mode. Accordingly, such standby modes may be considered unsafe, as the ventilator may appear to be on, even though no breathing gas is being supplied to the patient.

After ventilation of a patient has begun, a disconnect mode can be entered if the ventilator determines that the patient has become disconnected. In the disconnect mode, an alarm will typically sound if the disconnect state has persisted for some threshold period of time. Because of this, a medical professional may need to repeatedly silence the disconnect alarm, for example while performing procedures that require the disconnection of the patient from the ventilator. Moreover, in such situations, turning off the ventilator is not an attractive option, because there typically is a ventilator boot time or delay between powering on the ventilator and obtaining a breathing gas from the ventilator. In addition, patient settings will typically need to be reentered after the

ventilator has been powered off. Although some ventilators provide the option of entering a standby mode during procedures that require disconnecting the patient, the use of such a conventional standby mode is not particularly safe. In particular, no breathing gas is supplied to the patient if the user forgets to restart normal ventilation after entering the standby mode, even if the patient is connected to the ventilator.

SUMMARY

Ventilators with safe standby modes are provided. In some embodiments, a ventilation mode providing breathing gas to a patient is entered in response to determining that the ventilator is connected to a patient while in the safe standby mode. In accordance with some embodiments of the present invention, the ventilator can also provide a prompt to a user that allows the user to select entry into the safe standby mode upon the ventilator determining that the patient has become disconnected from the ventilator. In accordance with other embodiments of the present invention, a user may be offered an option of selecting a safe standby mode while the ventilator is in a normal ventilation mode.

More particularly, in response to detecting that a patient has become disconnected from the ventilator while the ventilator is in a normal ventilation mode, the ventilator enters a disconnect mode. In the disconnect mode, an alarm is periodically generated if the disconnect status is not resolved, for example by reconnecting the patient to the ventilator or powering off the ventilator. In the disconnect mode, embodiments of the present invention allow the user to select the safe standby mode. In the safe standby mode, an alarm is not periodically generated, and the ventilator may remain in the safe standby mode indefinitely. In addition, embodiments of the present invention monitor a connection status of the patient while the ventilator is in the safe standby mode. If the ventilator determines that the patient has been connected to the ventilator while in a safe standby mode, a normal ventilation mode in which breathing gas is supplied to the patient is entered automatically.

In accordance with further embodiments of the present invention, a user may select the safe standby mode while the ventilator is in the normal ventilation mode. In response to a selection of the safe standby mode, the ventilator may output a message to the user requesting that the user confirm entry into the safe standby mode, and indicating that a specified period of time will be allowed for completing patient disconnection. After receiving confirmation from the user that the safe standby mode is to be entered, a

countdown to the specified or defined period of time may be output. If the user completes patient disconnection within the defined period of time, the safe standby mode is entered. After entering the standby mode, if the ventilator then determines that the patient has been reconnected to the ventilator, normal ventilation resumes. Also, if the user does not successfully disconnect the patient within the defined period of time, normal ventilation is continued. In accordance with further embodiments of the present invention, following a failure to disconnect the patient within the defined period of time, another opportunity to confirm entry into the safe standby mode is presented, together with a notification of the defined period of time in which disconnection will need to be completed.

Additional features and advantages of embodiments of the present invention will become more readily apparent from the following description, particularly when taken together with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a depiction of a ventilation system in accordance with embodiments of the present invention;

Fig. 2 is a block diagram depicting components of a ventilator providing a safe standby mode in accordance with embodiments of the present invention; and

Figs. 3A-3B present a flow chart depicting aspects of the operation of a ventilator providing a safe standby mode in accordance with embodiments of the present invention.

DETAILED DESCRIPTION

Fig. 1 is a depiction of a ventilation system 100 in accordance with embodiments of the present invention. In general, the system 100 includes a ventilator 104 connected to a patient circuit 108. The patient circuit includes an inspiratory limb 112, an expiratory limb 116, and a patient limb 120. The inspiratory limb 112, expiratory limb 116 and patient limb 120 are interconnected to one another by a patient wye 124. The inspiratory 112 and expiratory 116 limbs respectively connect the patient wye 124 to a supply port 136 and a return port 140 provided by the ventilator 104. The patient supply limb 120 interconnects the patient wye 124 to a patient breathing apparatus 128. The ventilator 104 generally operates to provide a breathing gas to the inspiratory limb 112 for delivery to the patient breathing apparatus 128 via the patient wye 124 and the patient supply branch 120. The ventilator 104 may also receive exhaled air from the

patient that is delivered to the return port 140 via the patient breathing apparatus 128, the patient supply limb 120, the patient wye 124, and the expiratory limb 116. The ventilator 104 may include a supply sensor 138 and a return sensor 142 to monitor the supplied breathing gas and the returned gas, respectively. Sensors 138 and 142 may be flow and/or pressure sensors, including flow or pressure transducers. In accordance with embodiments of the present invention, information regarding the flow of gas detected by the supply 138 and return 142 flow transducers is provided to a controller 132.

In addition, the ventilator 104 includes user input 144 and user output 148 facilities. In general, the user input 144 receives input from a user, such as a clinician, respiratory therapist, or other medical professional, related to controlling the operation of the ventilator 104. The user output 148 provides information to a user regarding the operational status of the ventilator 104, and may include any alarm conditions.

The breathing gas supply 152 is operated at the direction of the controller 132, and includes the mechanical components used to control the composition and flow characteristics according to which breathing gas is supplied to a patient. In accordance with embodiments of the present invention, the breathing gas supply 152 is not limited to any particular type of breathing gas supply. Examples of a breathing gas supply 152 include piston and/or bellows based air delivery systems or air delivery systems comprising turbines. The breathing gas supply 152 may additionally include pressure regulating valves. For example, pressure regulating valves may be used in connection with a mechanism for compressing air included in the breathing gas supply 152, such as a piston or turbine. In accordance with other embodiments, the breathing gas supply 152 provides pressure regulating valves that are used to control the flow of a gas or gasses provided by sources of pressurized gas that are external to the ventilator 104, such as when the ventilator 104 receives pressurized air and/or oxygen from centralized sources through wall outlets. In some embodiments, pressure regulating valves include proportional solenoid valves.

Breathing gas from the breathing gas supply 152 may be provided to the patient circuit 108 by the supply port 138. The supply flow sensor or transducer 138 provides information regarding the flow of breathing gas that is being output by the ventilator 104 through the supply port 136. This flow information is passed back to the controller 132, to provide the controller 132 with feedback regarding the flow actually provided from the supply port 136 of the ventilator 104 to a patient. The return port flow sensor or

transducer 142 monitors the flow of exhaled air from a patient that is received at the return port 140 of the ventilator 104. The information regarding the flow returned to the ventilator 104 from the patient circuit 108 is provided to the controller 132, which allows the controller 132 to perform various monitoring activities. These monitoring activities can include detecting the connection status of a patient.

The user input 144 generally functions to receive control commands from a user regarding the operation of the ventilator 104. Accordingly, the user input 144 can include one or more devices, such as a keyboard, a numeric keypad, a pointing device operated in connection with a display device, a touch screen interface and/or a microphone for receiving spoken commands. The user input 144 may additionally or alternatively include buttons or switches, either physical or virtual, that are dedicated to the control of specific ventilator 104 functions.

The user output 148 may comprise one or more devices that are operable to providing human perceptible output signals. Accordingly, examples of user output devices 148 include visual displays, indicator lamps, or audible signals. In addition, a user output 148 may include a device provided separately from or external to the ventilator 104. For instance, the user output 148 may comprise a communication interface provided as part of the ventilator 104 that provides a signal that is communicated to a user communication endpoint, such as a cellular telephone, pager or personal computer that causes the user endpoint to provide a human perceptible signal.

Fig. 2 is a block diagram depicting components of a ventilator 104 that provides a safe standby mode in accordance with embodiments of the present invention. As shown in **Fig. 2**, the ventilator 104 controller 132 may comprise a number of separate or integrated components. These components may include a processor 204 that is operable to execute program code, instructions or firmware related to the operation of the ventilator 104. The processor 204 may therefore comprise a general purpose programmable processor, an application specific integrated circuit or other processor. The code or instructions executed by the processor 204 may be stored in memory 208. The memory 208 generally comprises one or more solid state memory devices. Alternatively or in addition, the memory 208 may include other types of data storage devices, such as magnetic or optical storage devices. In general, at least some of the memory 208 is non-volatile, to allow for the long term storage of operating instructions for execution by the processor 204. Such instructions may include a ventilation control

application 212. In addition, the memory 208 may be used to store user settings 216, for example entered in connection with use of the ventilator 104 to provide breathing gas to a particular patient.

The ventilation control application generally controls the operation of the ventilator 104 in providing a breathing gas to a patient. Accordingly, this may include controlling the breathing gas supply 152 such that breathing gas having desired composition and flow characteristics is provided to the patient. In addition, the ventilation control application 212 may implement various sub-functions of the ventilator 104, such as a patient connect/disconnect detection function 220, a safe standby mode function 224, and the implementation of one or more timers 228 that may be set and monitored in connection with the execution of other functions. The user settings 216 generally include operating parameters entered by a user that relate to controlling the composition and flow characteristics of the breathing gas supplied to a patient, and any other user configurable operating parameters.

The controller 132 may also include one or more input/output interfaces 232. The input/output interfaces 232 operatively connect the controller 132 to other components of the ventilator 104. Accordingly, examples of input/output interfaces 232 may include communication bus or network interfaces, and/or dedicated input or output signal lines. In accordance with embodiments of the present invention, the controller 132 may be provided as a set of discrete components. Alternatively, the controller 132 may comprise a fully or partially integrated controller device.

In accordance with embodiments of the present invention, the user input 144 and user output 148 may operate in association with the ventilation control application 212 executed by or running on the processor 204 to provide a graphical user interface (GUI). Accordingly, a user may interact with the ventilator 104 by making selections and receiving information through a GUI provided by the ventilator 104. Alternatively or in addition, dedicated control inputs and outputs, such as switches, buttons, indicator lamps and audible alarms may be provided.

Figs. 3A and **3B** provide a flow chart depicting aspects of the operation of a ventilator 104 with a safe standby mode in accordance with embodiments of the present invention. Starting at step 300, ventilation of a patient is initiated. While the patient is being ventilated, the controller 132 may monitor the patient circuit 108 to determine whether the patient has become disconnected from the ventilator 104 (step 304). If it is

determined that the patient has become disconnected from the ventilator 104, a disconnect mode is entered, and the user is prompted to select a safe standby mode or to cancel (step 308). For example, the following message may be displayed by the GUI of the ventilator 104:

Do you want to enable SAFE STANDBY?
[YES] [CANCEL]

At step 312, a determination as to whether a safe standby mode has been selected. If the safe standby mode has not been selected, a determination is made as to whether the "cancel" button has been selected (step 314). If "cancel" has been selected, the normal ventilation mode is resumed (step 318), and the process returns to step 304.

If "cancel" is not selected, the disconnect mode is continued (step 316). In the disconnect mode, the ventilator 104 does not provide breathing gas through the supply port 136 with the flow characteristics applied while in the ventilation mode. Instead, gas is supplied at a greatly reduced rate. As can be appreciated by one of skill in the art, by providing gas at a reduced rate through the supply port 136, the chance that microorganisms or other dangerous substances might be aerosolized and sprayed out of the patient circuit 108 is reduced. For example, whereas the ventilator 104 might supply breathing gas at flows of one hundred and fifty to two hundred (150-200) liters per minute during normal ventilation, in the disconnect mode gas is supplied at a rate of three (3) liters per minute. Providing some gas, even at a reduced flow, allows the ventilator 104 to monitor whether the patient has been reconnected. In particular, if a flow (or certain pressure) is detected at the return port 140 by the return port transducer 142, it may be taken as an indication that a patient has been reconnected, and normal ventilation may resume. Accordingly, while the ventilator 104 is in the disconnect mode, a check may be performed continually to determine whether the disconnect status has been resolved by connecting a patient to the ventilator (step 320). If it is determined that a patient has been connected to the ventilator 104, the normal ventilator mode is resumed (step 318).

If a connection to the patient is not detected at step 320, a determination may be made as to whether the period of time that the ventilator 104 has been in the disconnect mode exceeds some threshold period (step 324). As an example, the threshold period

may be defined or selected to be five (5) seconds. If the threshold period of time has been exceeded, a high priority disconnect alarm is generated (step 328). After generating the alarm or after determining that the threshold period of time has not been exceeded, the process may return to step 312.

If it is determined at step 312 that a safe standby mode has been selected, the safe standby mode is entered (step 332). In the safe standby mode, the ventilator 104 is powered on and all settings entered by the user are maintained. However, in the safe standby mode breathing gas is not supplied at normal rates of ventilation. Instead, gas is delivered from the supply port 138 at reduced rates in order to monitor whether a patient is connected to the ventilator 104 while the ventilator 104 is in the safe standby mode. That is, the same techniques that are used to determine whether a patient has been connected to the ventilator in the disconnect mode are used in the safe standby mode. However, the safe standby mode differs from the disconnect mode in that a disconnect alarm is not periodically generated. Therefore, the patient can remain disconnected from the ventilator indefinitely, without requiring the user to periodically take action to silence a disconnect alarm. At step 336, a determination is made as to whether a patient connection to the ventilator 104 has been detected. If the monitoring determines that the patient remains disconnected, monitoring for a connection to a patient is continued. If a connection to a patient is detected, the normal ventilation mode is resumed (step 340). When the normal ventilation mode is resumed, ventilation of the patient may be performed in accordance with the parameters previously set by the user.

As can be appreciated by the description provided herein, the safe standby mode provided by some embodiments of the present invention automatically resumes the supply of a breathing gas according to previously selected flow characteristics if the ventilator 104 detects that the patient has been reconnected to the ventilator 104. This is in contrast to conventional ventilator standby modes, in which no automatic restart of ventilation is provided if the patient is reconnected to the ventilator. In addition, no disconnect alarm is sounded in the safe standby mode of embodiments of the present invention.

In some embodiments, after ventilation of the patient has been resumed at step 340, or if a patient disconnect has not been detected at 304, a determination may be made as to whether a selection of the safe standby mode has been received from a user while the ventilator 104 is in the normal ventilation mode (step 344) (see **Fig. 3B**). A

safe standby mode can be selected by a user through, for example, a menu selection entered through the ventilator graphical user interface. If a selection of the safe standby mode has been received, the user is prompted by the ventilator 104 to confirm or cancel the safe standby mode selection (step 348). For example, the following message may be displayed by the GUI of the ventilator 104:

Do you want to enable SAFE STANDBY?
(You will have 5 seconds to disconnect patient)
[YES] [CANCEL]

A determination is then made as to whether the user has confirmed or canceled the safe standby mode selection (step 352). If the user selects YES to confirm, the ventilator 104 will display a countdown) (step 356). A determination is then made as to whether a patient disconnect has been detected within the countdown period (step 360). The countdown period may be a set period of time, for example, five (5) seconds, seven (7) seconds, ten (10) seconds, or the like. In alternative embodiments, the duration of the countdown period may be based on the respiration rate. For example, the countdown may last for a period of time equal to one full breath, two full breaths, or the like. Other methods of establishing a desired countdown period are possible within the scope of the present invention. As described previously, detection of a patient connection to the ventilator may be performed by monitoring whether a return flow is sensed by the return flow transducer 142 of the ventilator 104. If a patient disconnect is not detected within the countdown period, ventilation of the patient is continued (step 364). In addition, a low priority alarm may be generated, and/or the user may be further prompted to confirm or cancel the safe standby mode (step 368). For example, the following may be displayed by the ventilator GUI:

Patient Disconnect has taken too long
Do you still want to enable SAFE STANDBY?
(You will have 5 seconds to disconnect patient)
[YES] [CANCEL]

The process may then return to step 352 to determine whether the user has confirmed or canceled the safe standby mode selection. In accordance with embodiments of the present invention, ventilation of the patient is also continued if a selection of a safe standby mode is not received while the ventilator 104 is in the ventilation mode, or if the user fails to confirm a selection of the safe standby mode.

If it is determined at step 360 that the patient has been disconnected within the countdown period, the process proceeds to step 332, in which the safe standby mode is entered.

If it is determined at step 352 that the user has not confirmed entry into the safe standby mode, a determination may be made as to whether the user has canceled the safe standby mode selection (step 370). If the selection of the safe standby mode has been canceled, the process proceeds to step 318, and normal ventilation is resumed. If the user has not canceled the selection of the safe standby mode, a determination may be made as to whether a threshold time period since the user was prompted to confirm or cancel the safe standby mode exceeds some threshold amount (step 372). If the threshold time period has elapsed without receiving an entry from the user, normal ventilation may be resumed (step 318). If the threshold time has not been exceeded, the process may return to step 352 to monitor for a user selection.

In addition, a user may choose to discontinue ventilation at any time. If ventilation has not been discontinued, the process may return to step 304. If ventilation has been discontinued the process may end. Also, although processes that may be performed by a ventilator in accordance with embodiments of the present invention have been described in connection with steps that are performed in series, it should be appreciated that embodiments of the present invention are not limited to linear or serial operations. For example, the ventilator 104 may continuously monitor for any of a plurality of inputs from a user, for patient disconnect status, and/or for other inputs or conditions.

The foregoing discussion of the invention has been presented for purposes of illustration and description. Further, the description is not intended to limit the invention to the form disclosed herein. Consequently, variations and modifications commensurate with the above teachings, within the skill or knowledge of the relevant art, are within the scope of the present invention. The embodiments described hereinabove are further intended to explain the best mode presently known of practicing the invention and to

enable others skilled in the art to utilize the invention in such or in other embodiments and with various modifications required by the particular application or use of the invention. It is intended that the appended claims be construed to include alternative embodiments to the extent permitted by the prior art.

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What is claimed is:

1. A method for controlling a ventilator, comprising:

connecting a patient to a ventilator;

initiating ventilation of the patient using the ventilator;

after initiating ventilation of the patient using the ventilator, entering a safe standby mode;

while in the safe standby mode, detecting that the patient is connected to the ventilator;

in response to detecting that the patient is connected to the ventilator while in the safe standby mode, one of initiating and continuing ventilation of the patient using the ventilator.

2. The method of Claim 1, wherein the safe standby mode is entered in response to a user selection.

3. The method of Claim 1, further comprising:

after entering the safe standby mode, starting a timer;

prior to the timer reaching a predetermined time value, continuing ventilation of the patient;

after the timer has reached the predetermined time value, determining whether the ventilator is connected to the patient;

in response to determining that the ventilator has not been disconnected from the patient after the timer has reached the predetermined count value, exiting the safe standby mode, wherein ventilation of the patient is continued.

4. The method of Claim 1, further comprising:

after entering the safe standby mode, determining that the ventilator is disconnected from the patient;

after determining that the ventilator is disconnected from the patient, discontinuing ventilation.

5. The method of Claim 4, further comprising:

after discontinuing ventilation, and while in the safe standby mode, providing breathing gas at a rate that is less than the rate at which breathing gas is supplied during ventilation.

6. The method of Claim 1, further comprising:

while in the safe standby mode, maintaining a plurality of ventilator settings for use during said one of the initiating or continuing ventilation of the patient.

7. The method of Claim 6, wherein the plurality of ventilator settings comprises at least one parameter selected from a target tidal volume and a target pressure..

8. The method of Claim 1, wherein detecting that the patient is connected to the ventilator includes:

delivering a flow of gas from the ventilator through an inspiratory limb of a patient circuit;

determining that a flow of gas back to the ventilator through an expiratory limb of the patient circuit is greater than a threshold amount.

9. The method of Claim 1, further comprising:

entering a disconnect mode;

while in the disconnect mode, receiving a user selection of the safe standby mode; in response to the user selection, entering the safe standby mode, wherein breathing gas is supplied by the ventilator at a rate that is less than the rate at which breathing gas is supplied during ventilation of the patient.

10. The method of Claim 1, wherein while in the safe standby mode a disconnect alarm signal is not generated.

11. The method of Claim 1, further comprising:

after initiating ventilation of the patient and while in a normal ventilation mode, detecting that the patient has become disconnected from the ventilator;

in response to detecting that the patient has become disconnected from the ventilator:

1) entering a disconnect mode; and
2) while in the disconnect mode, making the safe standby mode available,

entering the safe standby mode in response to receiving a selection from a user of the safe standby mode after the safe standby mode has been made available, wherein in the safe standby mode a disconnect alarm is not generated.

12. The method of Claim 1, wherein the safe standby mode is entered while the patient is connected to the ventilator.

13. The method of Claim 1, further comprising:

before initiating ventilation of the patient, entering the safe standby mode.

14. A method for controlling a ventilator, comprising:

connecting a patient to a ventilator;

initiating ventilation of the patient using the ventilator;

after initiating ventilation of the patient using the ventilator, detecting that the patient has become disconnected from the ventilator;

after detecting that the patient has become disconnected from the ventilator, entering a disconnect mode and making a safe standby mode available for user selection;

receiving a user selection to enter the safe standby mode;

in response to the user selection, entering the safe standby mode, wherein while in the safe standby mode a disconnect alarm is not generated.

15. The method of Claim 14, further comprising:

in response to determining that a predetermined amount of time has elapsed while in the disconnect mode, generating an alarm, wherein after receiving the user selection to enter the safe standby mode the alarm is discontinued.

16. The method of Claim 14, further comprising:

while in the safe standby mode, detecting that the patient is connected to the ventilator;

in response to detecting that the patient is connected to the ventilator while in the safe standby mode, resuming ventilation of the patient using the ventilator.

17. The method of Claim 14, wherein making a safe standby mode available includes prompting a user to make a selection.

18. The method of Claim 14, further comprising:

after connecting the patient to the ventilator and after initiating ventilation of the patient using the ventilator, receiving a selection of safe standby mode;

after receiving the selection of the safe standby mode, continuing ventilation of the patient;

while continuing ventilation of the patient and after receiving the selection of the safe standby mode, detecting that the patient is disconnected from the ventilator;

after detecting that the patient is disconnected from the ventilator, providing breathing gas from the ventilator at a reduced rate.

19. A ventilation system, comprising:

a controller;

a user output interconnected to the controller;

a user input interconnected to the controller;

a breathing gas supply interconnected to and operated in response to instructions from the controller;

a patient circuit interconnected to the breathing gas supply;

a patient breathing apparatus interconnected to the patient circuit;

a return flow transducer interconnected to the patient circuit;

wherein in a safe standby mode of operation ventilator settings are maintained and a connection status of the patient breathing apparatus is monitored, and wherein after a selection of the safe standby mode and after detecting that a patient is connected to the ventilator ventilation of the patient is one of started or resumed.

20. The system of Claim 19, wherein in a disconnect mode of operation a disconnect alarm is periodically provided by the user output.

21. The system of Claim 19, wherein in response to a selection by a user to enter the safe standby mode a timer is started, and wherein the safe standby mode is not entered and ventilation of the patient is continued if it is determined that the ventilator is not disconnected from the patient before the timer reaches a predetermined time.

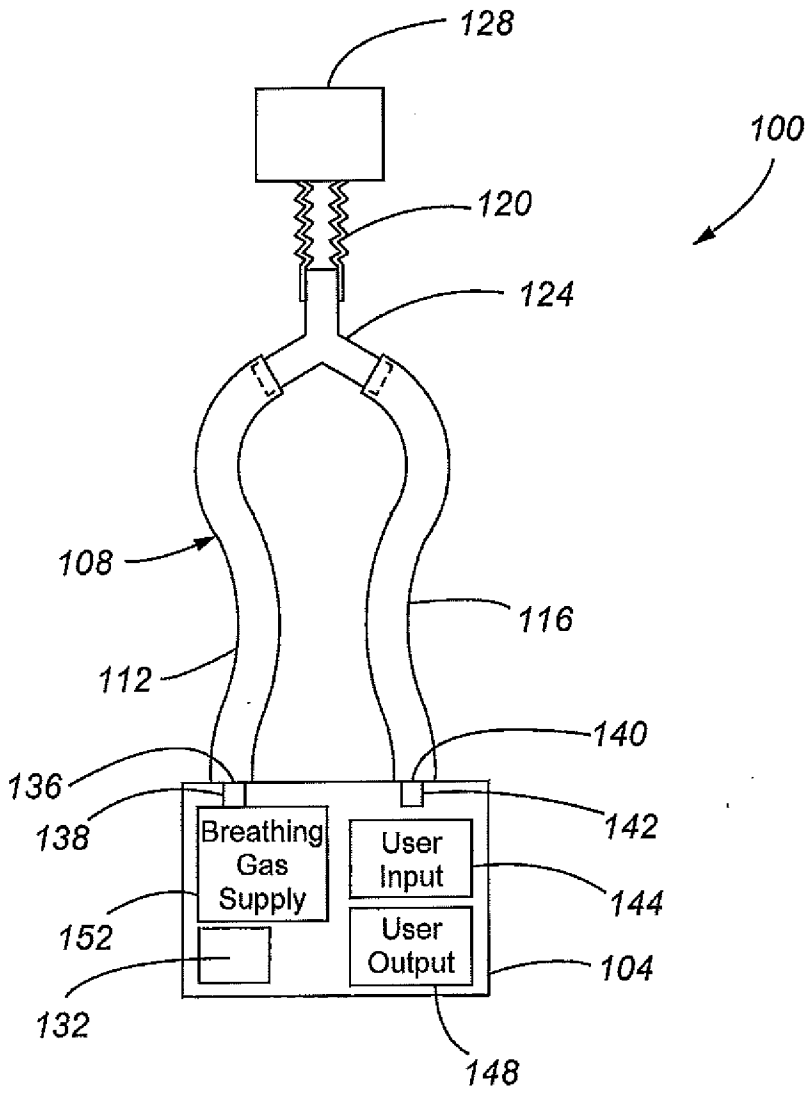
128
100
120
124
108
116
112
140
136
138
142
Breathing Gas Supply
User Input
144
152
User Output
104
132
148

Fig. 1

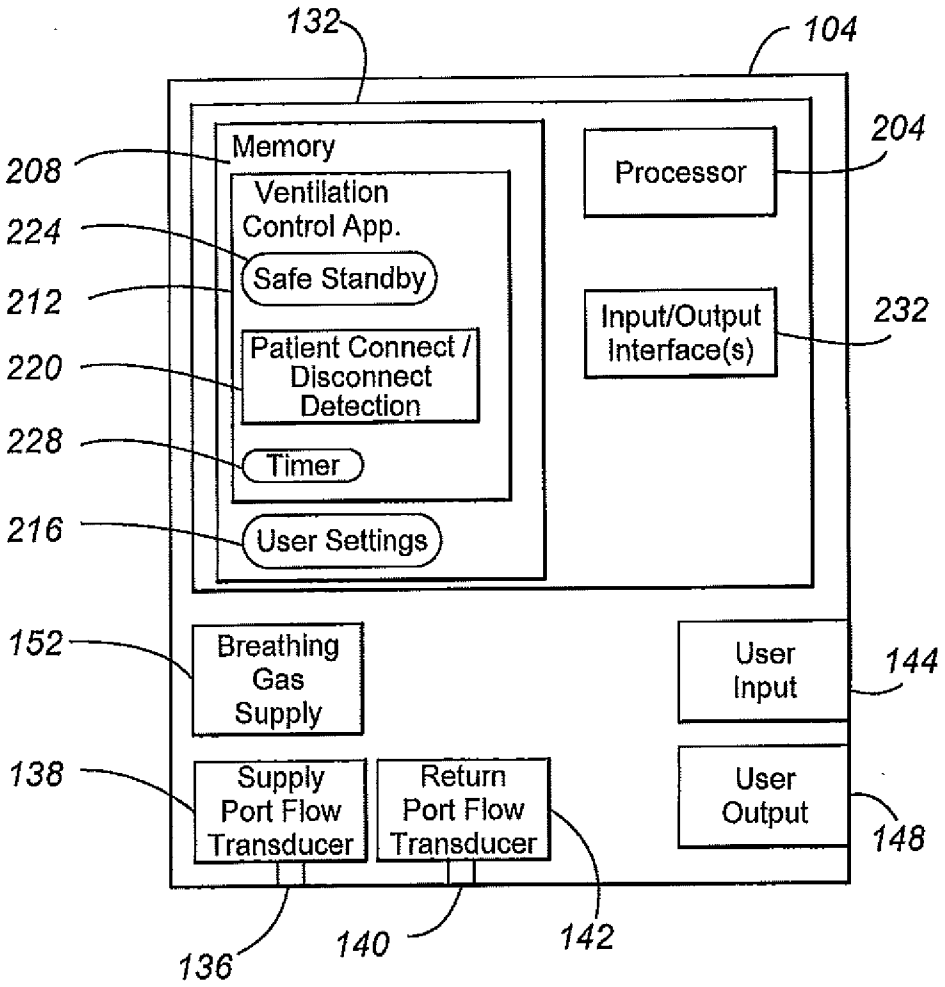
132
104
Memory
208
Ventilation Control App.
224
Safe Standby
212
Patient Connect / Disconnect Detection
220
Timer
228
User Settings
216
Processor
204
Input/Output Interface(s)
232
152
Breathing Gas Supply
User Input
144
138
Supply Port Flow Transducer
Return Port Flow Transducer
User Output
148
136
140
142

Fig. 2

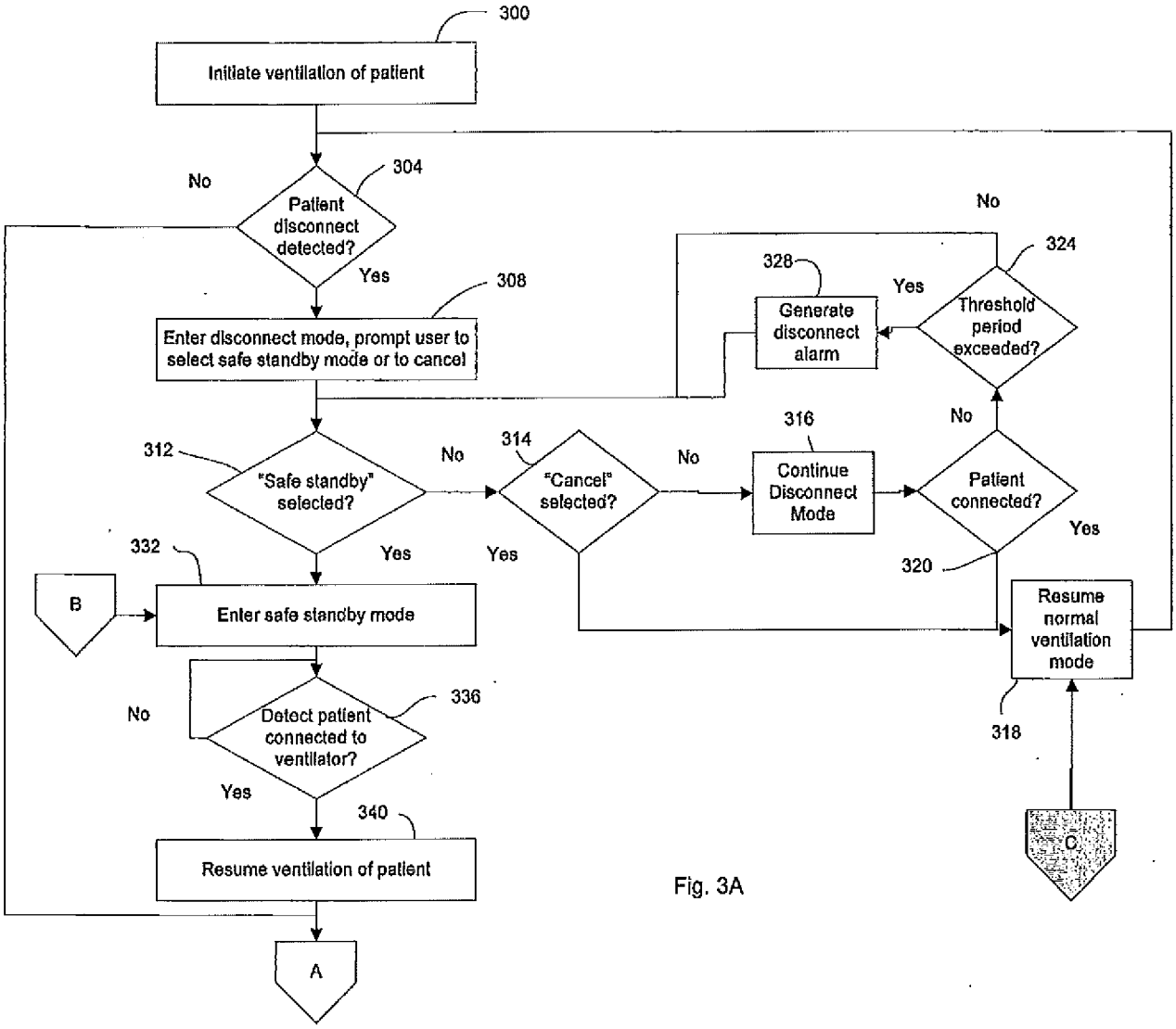
300
Initiate ventilation of patient
304
Patient disconnect detected?
No
Yes
308
Enter disconnect mode, prompt user to select safe standby mode or to cancel
312
"Safe standby" selected?
No
314
"Cancel" selected?
No
316
Continue Disconnect Mode
Yes
Yes
332
B
Enter safe standby mode
No
336
Detect patient connected to ventilator?
Yes
340
Resume ventilation of patient
A
328
Generate disconnect alarm
Yes
324
Threshold period exceeded?
No
No
Patient connected?
Yes
320
Resume normal ventilation mode
318
C

Fig. 3A

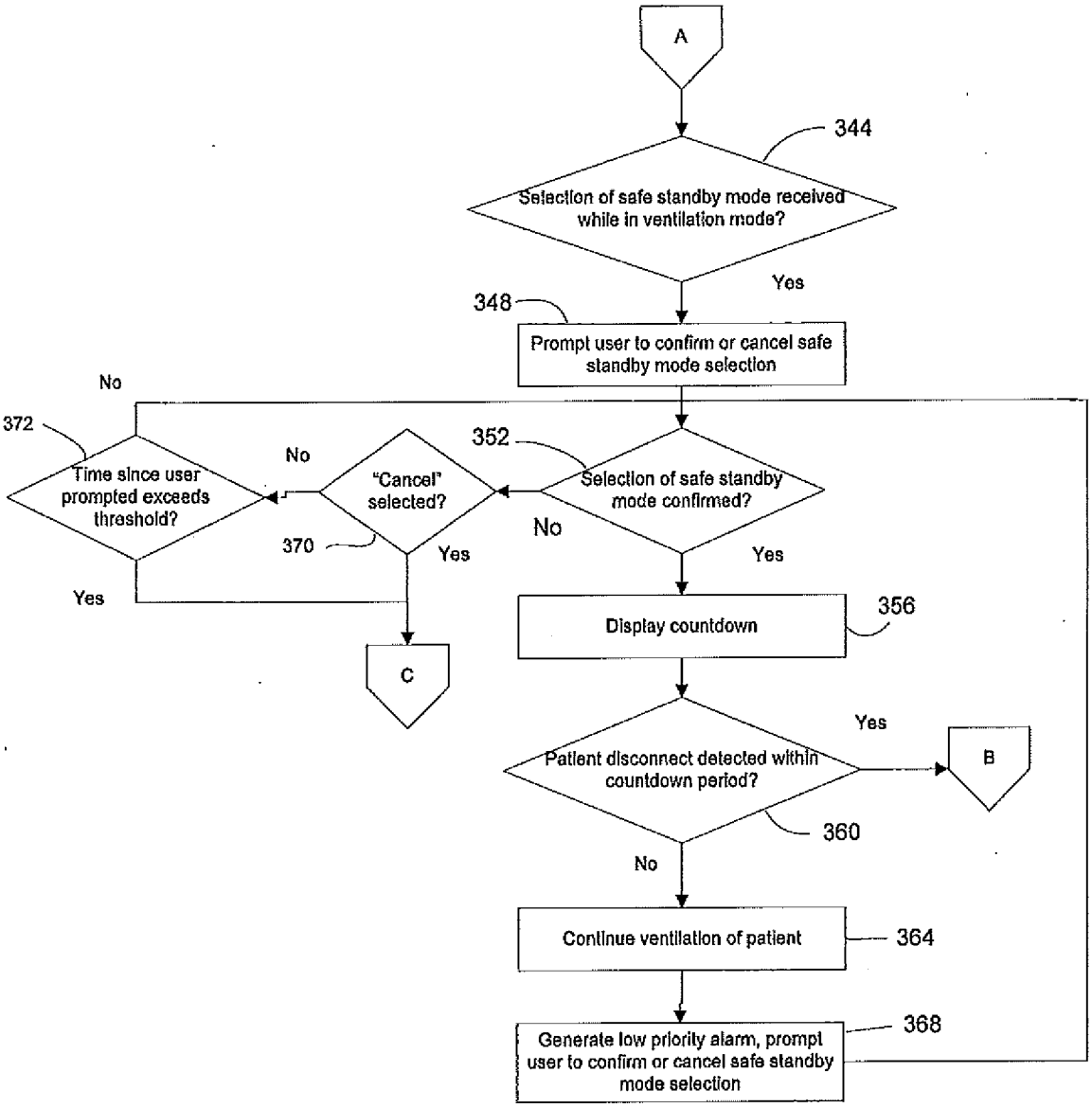
A
344
Selection of safe standby mode received while in ventilation mode?
Yes
348
Prompt user to confirm or cancel safe standby mode selection
No
372
Time since user prompted exceeds threshold?
No
"Cancel" selected?
352
Selection of safe standby mode confirmed?
370
No
Yes
Yes
Yes
Display countdown
356
C
Yes
B
Patient disconnect detected within countdown period?
360
No
Continue ventilation of patient
364
Generate low priority alarm, prompt user to confirm or cancel safe standby mode selection
368

Fig. 3B

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2009/057871

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61M16/00

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
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	EP 0 722 747 A2 (DEVILBISS HEALTH CARE INC [US]) 24 July 1996 (1996-07-24) column 13, line 12 - column 13, line 47; figures	19-21
A	US 6 158 433 A (ONG RAYMOND Y [US] ET AL) 12 December 2000 (2000-12-12) abstract; figure 3	19-21
A,P	WO 2009/059359 A1 (RESMED LTD [AU]; BERTINETTI MARK [AU]; WAWRZONEK DAVID PETER [AU]; HIL) 14 May 2009 (2009-05-14) abstract; figures	19-21

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

☒ See patent family annex.

* Special categories of cited documents :

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

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

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

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 November 2009	04/12/2009

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2009/057871

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. [X] Claims Nos.: 1-18
because they relate to subject matter not required to be searched by this Authority, namely:

Rule 39.1(iv) PCT - Method for treatment of the human or animal body by therapy

2. [ ] Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. [ ] Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. [ ] As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. [ ] As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. [ ] As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. [ ] No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

[ ] The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

[ ] The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

[ ] No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2009/057871

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0722747 A2	24-07-1996	AU 703829 B2	01-04-1999
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		JP 2000140113 A	23-05-2000
WO 2009059359 A1	14-05-2009	NONE	