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Goodson

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(54) **BREATHING APPARATUS WITH ONE OR MORE SAFETY SENSORS**

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G08B 21/14	(2006.01)
G08B 3/06	(2006.01)
G08B 7/06	(2006.01)

(52) **U.S. Cl.**

CPC ***G08B 21/14*** (2013.01); ***G08B 3/06*** (2013.01); ***G08B 7/06*** (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

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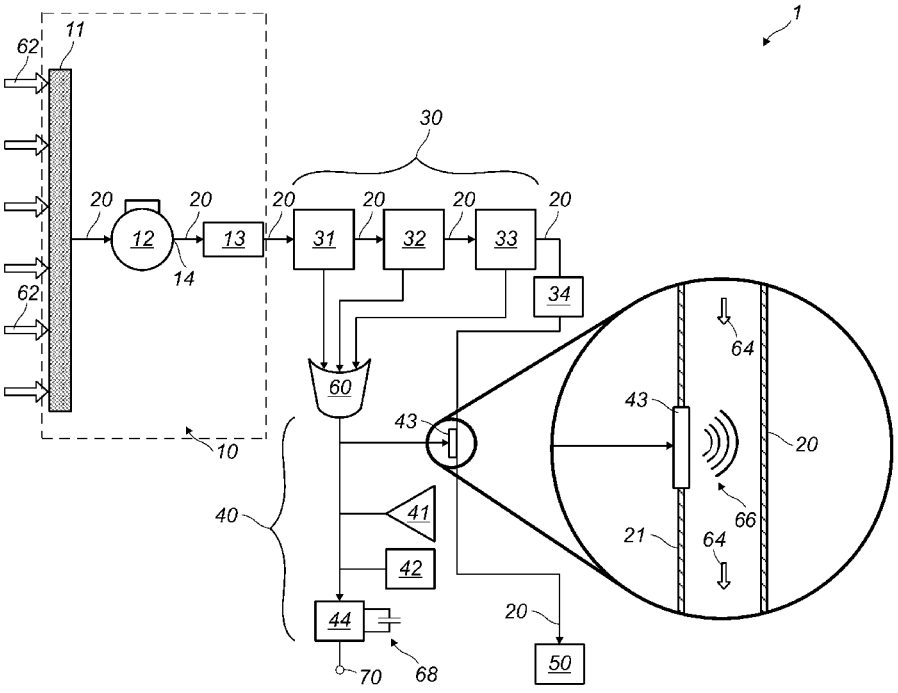
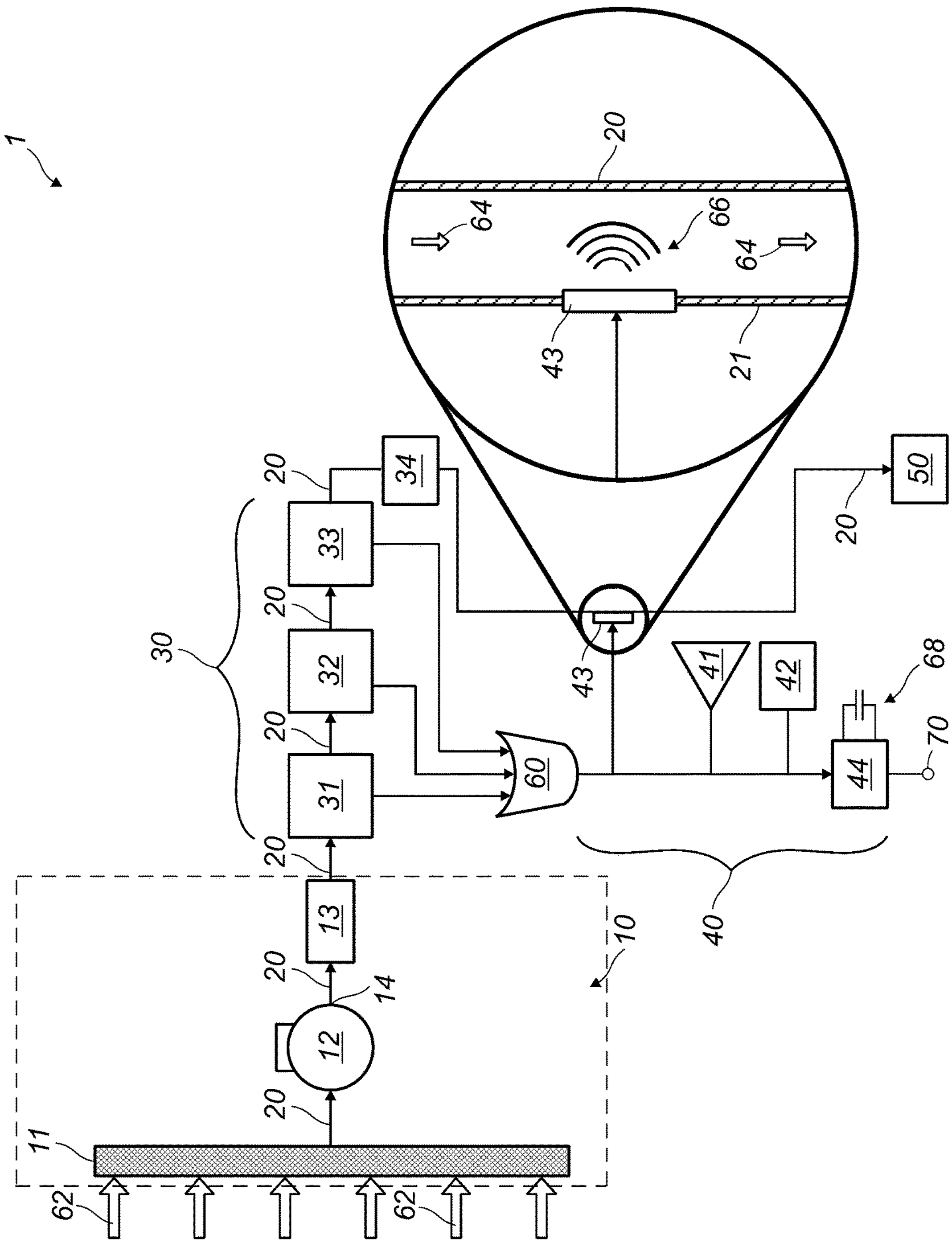
(57) **ABSTRACT**

A breathing apparatus having one or more safety sensors that monitor the breathing gas supplied to a ventilation interface for contaminants. Upon detection of a threshold value of a contaminant, the apparatus activates one of more alarms, such as strobe lights, horns and/or piezo buzzers, to waken the user to the dangerous condition. The alarm may also comprise a notification system to first responders.

12 Claims, 1 Drawing Sheet

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BREATHING APPARATUS WITH ONE OR MORE SAFETY SENSORS

CROSS-REFERENCES TO RELATED APPLICATIONS

This application claims the benefit of and priority to U.S. Provisional Application Ser. No. 62/358,082, filed Jul. 4, 2016, which is incorporated by reference herein.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not applicable.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention generally relates to a breathing apparatus, such as a continuous positive airway pressure (CPAP) machine. More specifically, the invention relates to a breathing apparatus with one or more safety sensors for the detection of air contaminants.

2. Background of the Related Art

CPAP machines administer pressurized air to a user with obstructive sleep apnea (OSA). Individuals with OSA suffer from airway collapses, which can result in a hypoxic state and lowered O2 saturation of the blood. When this occurs, the body reacts violently, with the person suddenly gasping for air. Individuals with untreated OSA are subject to several serious conditions, including transient ischemic attacks, apoplectic events (strokes), and even Alzheimer's disease.

A CPAP machine works by taking ambient air, regulating it, and delivering a continuous stream of slightly pressurized air to the user via a mask or nasal cannula. The raised pressure of the air keeps the soft tissues of the nose, mouth, and throat open to prevent obstruction. Generally, the air is not treated, but some CPAP machines heat or humidify the air for the user's comfort.

While CPAP machines are effective at treating OSA, use can increase the risk of a user's inability to hear safety alarms, such as household fire or carbon monoxide (CO) alarms. Because these machines help induce REM or deep sleep in a user, it is more difficult to wake a person using external stimuli, such as noise. Moreover, CPAP machines make noise that may drown out alarms, and some users of CPAP machines suffer hearing loss. As a result of that noise, a person using a CPAP machine may not hear a smoke alarm, carbon monoxide detector, or sense a contaminated or noxious atmosphere. Furthermore, despite the use of filters, CPAP machines still deliver some contaminants to the user.

SUMMARY OF THE INVENTION

The present invention addresses these problems by sensing excessive levels of CO, soot particulate, and/or ionized particles. When sensed, a local alarm is sounded to wake the user through audible and visual means. An output is also provided to electrically or wirelessly connect to an alarm system or dispatching system to notify a fire department or other third party.

It is an aim of this invention to actively sample gasses delivered to the user and to alert the user if contaminants or toxic gasses are present.

It is a further aim of this invention to continuously sample incoming air to be delivered to a CPAP user for CO (carbon monoxide), soot particulate, and ions from a fire and to alert the user that a hazard exists.

It is a further aim of this invention to alert the user by both aural and visual means that a hazard exists.

It is also a goal of this invention to have a relay contact closure tied into an existing fire alarm system, or to have a signal sent wirelessly to a dispatching service or public sector agency.

It is a further goal to modulate the air pressure of the delivered air gas to the user with an audible tone so as to further alert the user of the alarm condition.

BRIEF SUMMARY OF THE DRAWINGS

FIG. **1** is a block diagram of an embodiment of the invention.

DETAILED DESCRIPTION

Referring to FIG. **1**, one embodiment **1** of the invention includes an air flow generator **10**, a conduit **20**, safety sensors **30**, alarms **40**, and a ventilation interface **50**. The air flow generator **10** includes a 40-micron dust filter **11**, compressor **12** with an outflow port **14**, and a regulator **13**. The regulator **13** is a pressure regulator used to control the pressure of the airflow. The safety sensors **30** include a carbon monoxide (CO) detector **31**, a soot detector **32**, and/or an ion detector **33**. A 0.3-micron HEPA filter **34** is positioned downstream of the safety sensors **30**.

The alarm signals **40** include a strobe light **41**, a horn **42**, a piezo buzzer **43**, and a third-party emergency notification system **44**. The ventilation interface **50** is a mask, but may alternatively be a mouthpiece or any other device commonly used to act as the interface for a user to receive air. A conduit **20** provides an air pathway from the outflow port **14** of the compressor **12** to the ventilation interface **50**. The regulator **13**, safety sensors **30**, and ventilation interface **50** are interconnected with the conduit **20**. In other embodiments, however, the safety sensors may be located within the ventilation interface **50**.

In operation, ambient air **62** is drawn by the compressor **12** through the filter **11**, which removes particulate from the air that is larger than 40 microns. The dust filter **11** does not remove soot particular resultant from a fire, which is about 2.5 microns in size. The compressed and filtered air exits the outflow port **14** into the conduit **20**, where it is conditioned/regulated by the regulator **13** and provided as regulated air **64**. The air may be regulated for pressure based on user comfort and medical requirements.

The regulated air **64** continues through the conduit **20** to the safety sensors **30**, which include a CO detector **31**, a soot detector **32**, and an ion detector **33**. Each sensor is in fluid communication with the conduit **20** allowing access to the regulated air **64**.

The CO detector **31** is configured to detect a certain level of CO, such as the OSHA limit of 50 ppm or NIOSH level of 35 ppm. If the CO detector **31** measures CO within a specified parameter, such as greater than 35 or 50 ppm, a logical output "1" signal is generated and fed to a logical OR gate **60**; otherwise, the CO detector **33** outputs a logical "0." An example of a suitable CO detector is circuitry based on the Integrated Circuit (IC) RE46C800 made by Microchip of Chandler, Ariz.

The soot detector **32** senses the presence of soot through use of photoelectric means. Specifically, an infrared LED is

used to flash infrared pulses into a chamber containing the regulated air **64**. If soot particulate is present, the IR light pulses reflect off the soot particulate and are detected by an optical transistor or photodiode composing the detector **32**. If the soot detector **32** detects a level of soot based on a predetermined parameter, a logical output "1" signal is generated and fed to the logical OR gate **60**; otherwise, the soot detector **32** outputs a logical "0." An example of a suitable soot detector is circuitry based on the Integrated Circuit (IC) RE46C140 manufactured by Microchip brand of Chandler, Ariz.

The ion detector **33** detects the presence of ions that are typically generated by flame combustion. The ion detector **33** senses a current flow based on radioactive emissions from a source pellet of Americium 241. Ionized smoke particles, if present, disrupt the current flow. If the ion detector **33** detects a disruption of current of a predetermined amount, a logical output "1" signal is generated and fed to the logical OR gate **60**; otherwise, the ion detector **33** outputs a logical "0." An example of a suitable ion detector is the circuit described by Freescale Semiconductor of Tempe, Ariz. utilizing the IC known in the art as MC14668.

After regulated air **64** passes through the safety sensors **30** via conduit **20**, it passes through the HEPA filter **34**. The HEPA filter **34** works downstream from the safety sensors **30** to insure that airborne soot particles are not provided to the ventilation interface **50**.

The safety sensors **30** are individually directly connected to the OR gate **60**. The OR gate **60** generates an output signal of logical output "1" if it receives a logical output "1" from any of the safety sensors **30**. Once activated, the OR gate **60** sends a signal to the safety alarms **40**. This activates the strobe light **41**, the horn **42**, the piezo buzzer **43**, and the third-party emergency notification system **44**. Thus, each of the strobe light **41**, horn **42**, piezo buzzer **43**, and notification system **44** is indirectly connected to each of the CO detector **31**, soot detector **32**, and ion detector **33** through the OR gate **60**.

The strobe light **41** provides a visual cue, and the horn **42** provides an auditory cue, to awaken and alert the user. The strobe light **41** and horn **42** may be physically connected to the device or placed remotely.

The piezo buzzer **43** is located within the sidewall **21** of the conduit **20**. When activated, the piezo buzzer **43** modulates the regulated air **64** being supplied to the user, effectively transmitting sound waves **66** into the oral and/or nasal cavities. The sound waves **66** create a vibration that will awaken or alert the user.

The third-party emergency notification system **44** ties into an existing home alarm system or other commercially available alarm system that provides notification to the whole home and/or a third-party system that contacts emergency first responders. In this embodiment, for example, the system **44** provides a contact closure **68** or a DC signal **70** to tie into an existing fire alarm system.

In alternative embodiments, the strobe light **41**, horn **42**, piezo buzzer **43**, and third-party emergency notification system **44** may be activated through wireless means such as RF transmission. For example, the OR gate **60** may send a signal to a transmitter that is wirelessly connected to receivers located on the strobe light **41**, horn **42**, piezo buzzer **43**, and the third-party emergency notification system **44**.

The present invention is described in terms of a specific embodiment of a breathing apparatus with one or more safety sensors. Those skilled in the art will recognize that alternative constructions of such an apparatus can be used in carrying out the present invention and may be applied to any breathing device, including those that draw air from a designated supply tank. For example, this invention may be applied to any self-contained breathing apparatus such as those used in SCUBA diving and by first responders such as fire fighters. Moreover, while the present invention teaches the use of specific safety sensors to monitor the regulated air being delivered to a user, other safety sensors may be implemented to detect other types of air contaminants. Other aspects, features, and advantages of the present invention may be obtained from a study of this disclosure and the drawings, along with the appended claims.

I claim:

1. A breathing apparatus comprising:

a compressor having an inflow of ambient air and an outflow;

a ventilation interface;

a conduit in fluid communication with the outflow of the compressor and the ventilation interface;

at least one sensor in fluid communication with the outflow of the compressor capable of measuring at least one combustion generated contaminant within the ambient air-having an output;

at least one alarm connected to the output of the at least one sensor; and

a filter within the conduit downstream from the at least one sensor.

2. The apparatus of claim **1** wherein the output is determined based on a threshold value of the at least one combustion generated contaminant.

3. The apparatus of claim **1** wherein the at least one sensor is a carbon monoxide detector.

4. The apparatus of claim **1** wherein the sensor is a photoelectric sensor.

5. The apparatus of claim **1** wherein the sensor is an ion detector.

6. The apparatus of claim **1** wherein the at least one alarm is a strobe light.

7. The apparatus of claim **1** wherein the at least one alarm is a horn.

8. The apparatus of claim **1** wherein the at least one alarm is a piezo buzzer at least partially within the conduit.

9. The apparatus of claim **1** further comprises a third-party notification system connected to an alarm.

10. The apparatus of claim **2** further comprising an indicator light having an input connected to the output of the at least one sensor.

11. The apparatus of claim **1** wherein the at least one alarm generates a vibration through the conduit.

12. The apparatus of claim **1** wherein the at least one alarm modulates the air pressure in the conduit.

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