

A DEVICE FOR THE MEASUREMENT OF A PHYSIOLOGICAL PARAMETER OF A DIVER

5 FIELD OF THE INVENTION

The invention relates to a device for use in an underwater environment to monitor a condition of a diver.

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BACKGROUND OF THE INVENTION

People engage in underwater diving for the purposes of recreational, exploration and commercial activities. To prolong the length of time a diver may stay underwater, breathing apparatus and breathable air storage have been developed and improved
15 upon, including increasing air pressure storage in air tanks, preparing breathable blends of mixtures with the use of nitrogen and helium and recycling breathable air in a rebreather.

20 However, increasing air pressure in air tanks is potentially dangerous especially when storing, and breathable mixtures containing nitrogen and helium become harmful at high concentrations.

Presently, pressure gauges are placed in direct communication with air tanks to
25 measure the air pressure of the tank thereby providing an indication of the quantity of air available to a diver during the dive.

However, a drawback of the present arrangement is that the pressure gauge only indicates the pressure of gas contained in the tank, and is independent of whether or not
30 the contents of the gas in the tank is beneficial to the diver.

Hypoxia is a condition where the partial pressure of tissue oxygen has fallen below the value necessary to sustain normal cellular function. Here, normally cellular aerobic metabolism becomes less effective in producing biological energy and a toxic state develops and cellular failure and death will result unless corrected immediately.

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In a healthy individual, normal partial pressure of O_2 (PO_2) ranges between 0.21 and 0.16 ATP (atmospheric pressure). Hypoxia develops when the PO_2 drops to 0.16 ATP or below. If the PO_2 falls below 0.16 ATP and is sustained, or reaches to a level of 0.12 ATP, then life-threatening signs of hypoxia will develop. At a PO_2 level of 0.10 ATP, unconsciousness and seizures will occur. Below a PO_2 level of 0.10 ATP, coma and/or death will result and once the PO_2 level reaches zero, life cannot be sustained. This fatal state is called anoxia.

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Physically a person may experience hypoxia due to various causes such as:

1. exhaustion of gas supply,
2. decreased oxygen content in the gas supply,
3. a reduction of haemoglobin or in its capacity to carry oxygen, such as in carbon monoxide poisoning, sickle cell disease and acute haemorrhage.

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In diving, hypoxia is a constant threat and it is a leading cause for diving accidents. There are three common potential causes of diving-related hypoxia and they all relate to inadequate oxygen concentration in the breathable gas supply.

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The first potential cause is when the air tank has been stored for a prolonged period of time in a cylinder containing moist breathable gas (particularly air). Oxidation may occur forming either rust on the steel tanks, or aluminium oxide on the aluminium tanks. This decreases the concentration of oxygen in the gas mixture. In this situation, the pressure may indicate a full tank, but the actual useful content within the tank may be disproportionate. In some diving accidents, it was found that rust in an air tank used for diving reduced the oxygen content to 4 percent, and the diver who used the tank died.

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The second common cause of diving-related hypoxia occurs when an air tank is accidentally filled with a wrong gas or with a wrong concentration of gases. In order to minimize the risk of decompression illness at shallow dives or to avoid oxygen toxicity at deep dives, the concentration of oxygen in an air tank is deliberately altered (this category of diving is known as nitrox, trimix diving). If the blending of gas is done correctly, there should not be a problem. But gas-mixtures for deep or saturation diving usually contain a concentration of oxygen of 10 percent or less (to prevent oxygen toxicity due to increasing partial pressure of O₂ at depth). If such a mixture was mistakenly used for a shallow dive, hypoxia would develop.

The third cause of diving-related hypoxia is due to the use of a rebreather, which is becoming more common in recreational diving. This can result in hypoxia if the oxygen sensor or the flow rate mechanism malfunctions, leading to a reduced supply of oxygen necessary for a diver. Further, when the CO₂ absorbent malfunctions or is inefficient, CO₂ poisoning may result.

During a dive, communication with a diver is limited. More importantly, a diver may not be aware of any of the above situations that may be occurring and may attribute any discomfort to disorientation or lack of experience. Prolonged exposure to any of the situations above may lead to death.

It is an objective of the present invention to alleviate the above problems.

SUMMARY OF THE INVENTION

According to the invention, there is provided a device for measuring an oxygen level of a diver, said device including an oximeter for obtaining a reading of the oxygen level the diver, a housing for said oximeter, said housing hermetically sealed so as to prevent fluid

flow there-through and a sensor operationally coupled to said oximeter to be in contact with or in close proximity to said diver so as to measure the oxygen level of the diver,

wherein the device further includes an alarm configured to alert the diver when the reading is not within a pre-determined safe range, for the diver to take precautionary measures,

wherein the pre-determined range may be manipulated by the diver.

Preferably, the sensor extends from the housing.

In an embodiment, the implement further includes computing device to extract and retain the readings from the implement.

Still preferably, the alarm may be a visual and/or audio alert to bring attention to the diver when the reading obtained from the diver is outside of the pre-determined safe range.

Still preferably, the device further includes a real-time clock to time an interval within which a measurement of the physiological parameter of the diver is obtained, so as to enable real time monitoring of a diver's physiological parameter.

In a preferred embodiment, the device further includes a display means in communication with the computing device to visually indicate a reading of the measured physiological parameter.

In a preferred embodiment, the device further includes a pressure sensor to record a depth of the diver.

Preferably, the sensor is mounted onto an apparel suitable for use of the diver, so that the sensor is in contact with the diver.

In a preferred embodiment, the apparel is a glove of the diver.

In an alternative embodiment, the apparel is a hood of the diver.

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Still preferably, the display means may visually indicate the numerical value of the oxygen level of the diver being monitored.

10 Preferably, the display means visually indicates the level of oxygen in the form of colours or shapes.

Preferably, the computing device is a microprocessor.

15 **DESCRIPTION OF THE FIGURES**

In order that the present invention might be more fully understood, embodiments of the invention will be described, by way of example only, with reference to the accompanying drawings, in which:

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Figure 1 shows a first embodiment of the present invention;

Figure 2 shows a second embodiment of the present invention;

25 Figure 3 shows a location of a sensor of the invention;

Figure 4 shows a third embodiment of the present invention; and

Figure 5 shows a fourth embodiment of the present invention.

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In each of the embodiments and variations, the same reference numerals have been used for similar components, merely for ease of understanding the specification.

5 DETAILED DESCRIPTION OF THE INVENTION

Reference will now be made in detail to the preferred embodiments of the invention, examples of which are illustrated in the accompanying drawings. While the invention will be described in conjunction with the preferred embodiments, it will be understood that
10 they are not intended to limit the invention to these embodiments. On the contrary, the invention is intended to cover alternatives, modifications and equivalents, which may be included within the spirit and scope of the invention as defined by the appended claims. Furthermore, in the following detailed description of the present invention, numerous specific details are set forth in order to provide a thorough understanding of the present
15 invention. However, it will be obvious to one of ordinary skill of the art that the present invention may be practiced without these specific details. In other instances, well known methods, procedures, components, and features have not been described in detail as not to unnecessarily obscure aspects of the present invention.

20 According to the invention as seen in Figure 1, there is provided a device 100, including an implement 10, capable of obtaining a reading of a desired physiological parameter of a dive, a housing 20 dimensioned to receive the implement 10 therein, and a sensor 30 operationally coupled to said implement 10, to be in contact with or in close proximity to a surface of the diver so as to measure a desired physiological parameter of the diver.
25 The housing 20 is hermetically sealed so as to prevent fluid flow therethrough, in order to maintain the integrity of the implement 10.

In the present embodiment, a sensor 30 is positioned in an optimal or desired location, on a diver to measure the desired physiological parameter of this said diver. The sensor
30 30 obtains this reading, and this reading is then extracted by the device 100, for further processing or analysis.

It is to be understood that the sensor need not extend from the housing, and may be enclosed within the housing, as long as the sensor 30 is able to reliably obtain a reading of a physiological parameter of the diver.

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In a second embodiment as shown in Figure 2, the device 100 further includes a computing device in the form of a microprocessor 50 to extract the reading from the sensor 30 and to retain the reading(s) for further processing or analysis, should the need be. The device 100 further includes an alarm 60, configured to be activated when the
10 readings obtained fall above or below a pre-determined value or a range or otherwise known safe range. The alarm 60 may be in the form of a visual alarm 61, for example, flashing lights, colour coded lights etc, or in the form of audio alarm 62, for example a buzzer, ringer, beeper etc, as long as it may draw attention to the diver when the physiological parameter being monitored is not within the pre-determined safe range so
15 that the diver may take precautionary measures. The alarm is shown in the form of an audio alarm in Figure 2.

Depending on the differential between the measured value and the pre-determined value or range, the visual and/or audio alarm may be accordingly adjusted, for example, low
20 frequency beeps or flashes when the measured value is close to, or within the safe range, and high frequency beeps or flashes when the measured value is out of the safe range.

In the present embodiment of the invention, the physiological parameter desired to be
25 monitored in a diver is a blood oxygen level. Therefore, in this embodiment, the implement 10 is in the form of an oximeter 11. However, it is to be understood that the present invention is not limited to merely the use of a suitable implement for the purposes of obtaining the desired physiological parameters, described only in an exemplary embodiment of the present invention. Further, suitable implements
30 necessary for the measurement of alternative or further physiological parameters, for

example, pulse rate, temperature, blood pressure, tension or stress levels of a diver are also envisioned.

As shown in Figure 2, the implement 10 is an oximeter 11. A suitable sensor 30 is
5 operationally coupled to the oximeter 11, and extended to a desired location of the diver to allow measurement of the blood oxygen levels of the diver. As the device 100 is for use in an underwater environment, the implement 10, in the form of an oximeter 11, and further including a microprocessor 50, is retained within a housing 20, hermetically sealed to prevent fluid therethrough. The presence of fluid may corrode the oximeter 11
10 and microprocessor 50, or otherwise impair the performance of the oximeter 11 and microprocessor 50, which is not a desired effect. The hermetic seal may be effected by any presently known seals in the art.

The sensor 30 extends from the housing 20 to be located on a desired location of the
15 diver. The housing 20 therefore has to at least one through-hole 21 to allow the sensor 30 therethrough. The sensor 30 may be located on the underside of a diver's apparel, for example a glove or a hood of the diver, so as not to obstruct the diving activities of the diver being monitored.

20 As seen in Figure 3, the sensor 30 is incorporated into the glove 90 of the diver being monitored, and the device 100 may be worn on the wrist of the diver using any suitable known attachment means, for example retaining straps or bands.

In a third embodiment as seen in Fig 4, the device 100 further includes a real time clock
25 70 to time the reading interval of the sensor 30. Therefore, when in use for the purposes of monitoring the blood oxygen level of a diver, the pre-determined safe range is between 0.16 and 0.21 ATP. When the blood oxygen level measured is 0.20 ATP, the audio alarm will not sound. However, when the blood oxygen level measured is 0.16 ATP, the audio alarm will provide slow frequency beeps to alert the diver to his condition,
30 and to take precautionary measures. When the blood oxygen level measured is 0.15

ATP, then high frequency beeps are emitted so that the diver may be alerted to take immediate measures and to abort the dive.

In a fourth embodiment as seen in Figure 5, the device 100 further includes a display means 40 to display the readings obtained from the oximeter 11, and/ or other alternative physiological measurement devices. As shown in Figure 5, the display means visually indicates the actual reading of the blood oxygen level of the diver being monitored. In an alternative form, the display means 40 visually indicates a representative value of the blood oxygen levels by the use of indicator bars, a longer length of bar meaning a safe level of blood oxygen level is being measured, and a shorter length of bar is displayed when the blood oxygen level falls below or rises above the pre-determined safe range. Or, in an alternative, the display means indicates a representative value of the blood oxygen levels by the use of colour codes, for example green meaning the level of oxygen in the blood of the diver is within the pre-determined safe range, amber when the level of oxygen in the blood of the diver is nearing an unsafe range, and red when the level of oxygen in the blood of the diver is in the unsafe range. As previously explained, these values will also trigger the alarm, so that the diver may be properly notified to take appropriate action.

In alternative embodiments, the desired physiological parameter to be measured is a pulse reading, and the implement 10 is in the form of a pulse reader. In another alternative embodiment, the desired physiological parameter to be measure is a temperature, and the implement 10 is in the form of a temperature gauge or a thermometer. In these alternative embodiments, the display means display the readings obtained from the pulse reader and temperature gauge or thermometer respectively. The display may either be in the form of a numerical or graphical representation.

In a further embodiment, the device 100 further includes further gauges beneficial to a diver, for example, a pressure or depth gauge or dive timer to measure the dive duration.

The embodiments of the invention have been advanced by way of example only, and modifications are possible within the scope of the invention as defined by the appended claims.

CLAIMS

1. A device for measuring a oxygen level of a diver, said device including
an oximeter for obtaining a reading of the oxygen level of the diver;
5 a housing for said oximeter, said housing hermetically sealed so as to prevent fluid
flow there-through; and
a sensor operationally coupled to said oximeter to be in contact with or in close
proximity to said diver so as to measure the oxygen level of the diver,
wherein the device further includes an alarm configured to alert the diver when the
10 reading is not within a pre-determined safe range, for the diver to take precautionary
measures,
wherein the pre-determined range may be manipulated by the diver.
2. A device for measuring an oxygen level of a diver, according to claim 1, where the
15 sensor extends from the housing.
3. A device for measuring an oxygen level of a diver, according to any one of the
preceding claims, wherein the implement further includes a computing device to extract and
retain the readings from the implement.
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4. A device for measuring an oxygen level of a diver according to any one of the
preceding claims 4, wherein the alarm may be a visual and/or audio alert.
5. A device for measuring an oxygen level of a diver according to any one of the
25 preceding claims 3 to 4, wherein the device further includes a real-time clock to time an
interval within which a measurement of the oxygen level of the diver is obtained.
6. A device for measuring an oxygen level of a diver according to any one of the
preceding claims, wherein the device further includes a display means in
30 communication with the computing device to visually indicate a reading of the measured
oxygen level.

7. A device for measuring a physiological parameter of a diver according to any one of the preceding claims, wherein the device further includes a pressure sensor to record a depth of the diver.

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8. A device for measuring an oxygen level of a diver according to any one of the preceding claims, wherein said sensor is mounted onto an apparel suitable for use of the diver, so that the sensor is in contact with the diver.

10 9. A device for measuring an oxygen level of a diver according to claim 8, wherein the apparel is a glove of the diver.

10. A device for measuring an oxygen level of a diver according to claim 8, wherein the apparel is a hood of the diver.

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11. A device for measuring an oxygen level of a diver according to claim 1, wherein the device further includes a display means for visually indicating the numerical value of the oxygen level of the diver being monitored.

20 12. A device for measuring an oxygen level of a diver according to claim 1, wherein the device further includes a display means for visually indicating the level of oxygen in the form of colours or shapes.

25 13. A device for measuring an oxygen level of a diver according to any one of the preceding claims 3 to 12, wherein the computing device is a microprocessor.