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(54) **Portable light**

(57) A portable lighting device (1), the device comprising:
a light source (2);
a housing (3) for mounting the light source; and
a light controlling system for operating the light source so as to control the emitted light output;

a position detection system for determining the position of the lighting device;
characterised in that depending on the position of the lighting device detected by the position detection system, the light controlling system is provided to operate the light source such that a predetermined output is emitted.

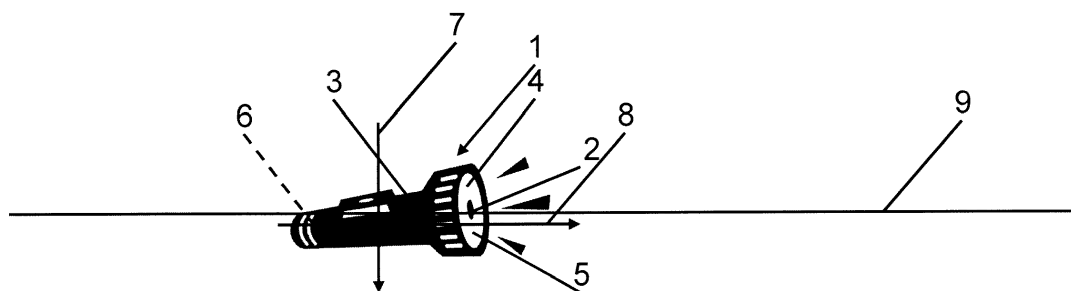


Fig. 1

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Description

Field of the invention

[0001] The present invention is in the field of lighting, particularly portable lighting devices, automation, electronics, as well as navigation instruments.

Background of the invention

[0002] When light hits the water surface, some light is reflected and some light penetrates water. Water is eight hundred times denser than air and thus light entering the water interacts with the water molecules in ways different to the air medium. In addition, light interacts with suspended particles, altogether causing loss of light, colour changes, diffusion, loss of contrast, and other effects.

[0003] Light penetrating the water surface is thus absorbed and scattered by the water molecules, plus suspended and dissolved particles. Even very clear water attenuates light at a significant rate. For example in very clear water, less than one tenth of the light that penetrates the water surface still remains at a depth of 30 meters (Dustan, 1982), and in less clear water, 90% attenuation may occur at shallower depths, such as 15 m on an in-shore reef (Fabricius and Alderslade, 2001).

[0004] Visible "white" light is composed of a spectrum of colours: violet, blue, green, yellow, orange, red (given in the order of increasing wavelength). Water particles interact with light by absorbing certain wavelengths. This selective absorption underwater causes colour loss. Indeed, under water there is a rapid (exponential) loss of light intensity which depends upon the wavelength of each component. This selective absorption is for example due to vibrations and deformations of water molecules excited by the absorption of light. The absorption is strongest at longer wavelengths, the exact values depending upon the water's transparency, which depends on the presence of sediment, plankton, etc.

[0005] Thus, colour changes with depth as water filters out the warm colours. Indeed, first the reds and oranges (590 to 700 nm) disappear, later the yellows, greens and purples and last the blue. Loss of the colour red is dramatic and is already noticeable at 50 cm. At 5 metres depth red colour is essentially lost underwater.

[0006] On the other hand, clear oceanic water has its least loss in the blue colour (between 440 and 490 nm), which means that distant objects look blue. In coastal waters, more blue light is absorbed due to more suspended matter and phytoplankton in the water, and green light penetrates the furthest.

[0007] A number of other factors may affect the quantity and quality of light passing through water. Turbid water can significantly increase both absorption and scattering, generally resulting in less transmitted light. The turbidity may come from rough weather stirring up sediment or coastal runoff. Additionally, turbid water differentially affects the wavelengths of light that are absorbed

and scattered, changing the spectra of available light at different depths, with more blue light being absorbed as previously mentioned. Plankton blooms may also affect the transmittance of light.

[0008] It is well known that white light scares fishes. This is not desirable for divers and vehicles exploring the marine fauna, flora, or underwater geographical elements. It is also known that red light does not have the same effect on the seagoing creatures, who often do not see or react to red light due to the filtering effect of the water.

[0009] Mastering colour loss and light intensity underwater requires the manipulation of artificial light and working close to the observed objects and living organisms. However, this manipulation of artificial light is cumbersome for the diver, usually carrying plenty of equipment.

[0010] It is an objective of the present invention to restore the loss of light colour(s) and optionally the loss of light intensity under water.

[0011] It is an objective of the present invention to restore the loss of light colour(s) and optionally the loss of light intensity under water, in order to be able to operate in darkness or very low light situations.

[0012] It is an objective of the present invention to selectively manipulate light colour(s) and optionally light intensity under water.

[0013] It is an objective of the present invention to provide a hands-free portable lighting device that selectively adjusts its output under water, depending on the position of the lighting device.

[0014] It is an objective of the present invention to provide a lighting device that adapts light colour(s) and optionally light intensity, depending on the position of the lighting device.

[0015] It is an objective of the present invention to use a lighting device as a guiding means for a predetermined travelling direction.

[0016] It is an objective of the present invention to adjust the lighting to an underwater environment while at the same time diminishing power consumption.

[0017] WO 2012/067657 A1 (Light & Motion Industries) discloses a LED underwater light, which can be hand-held or mounted on an underwater camera housing and is switchable between two light modes. A first embodiment of the dive light is a focus light, used for initial focusing with a still underwater camera. Incorporated in the focus light is a red light source to which the focus light can be switched from initially projected white light. The switch is used to switch off a series of white LEDs while switching on a series of red LEDs. In another embodiment, the dive light is a flood/spot light, or with another two types of selectable LED arrays, and enables a diver to quickly switch between two types of light projection. Another feature is a laser beam projecting device within the housing, with a momentary switch on the housing to power the laser, as for pointing out underwater objects of interest.

[0018] US 2011/031901 A1 (Zedel) discloses a porta-

ble electric lamp comprising a lighting module with LEDs and user control means connected to an electronic control circuit to define different lighting modes. An optic sensor is housed in the casing near the light-emitting diode LED to transmit to the control circuit a signal representative of the lighting induced by the lamp to automatically regulate the power of the LED according to a predefined threshold.

[0019] US 2008/052930 A1 (John Suckow) discloses a combined laser light and compass unit comprising: a magnetic compass having a sight lens and a slotted cover to form a sight line, a laser light capable of emitting a pin-point beam and being aligned with the sight line; and a pivotal laser light mounting member that pivotally secures the laser light to the compass such that while a user holds the combined laser light and compass unit level, the laser light marks an object at a distance with the pin-point beam in a direction chosen by said user and the pivotal laser light mounting member allows the user to mark the object upward or downward of the user.

Summary of the invention

[0020] The present invention relates to a lighting device, the device comprising:

- a light source, preferably comprising a plurality of Light Emitting Diodes (LEDs);
- a housing for mounting the light source; and
- a light controlling system for operating the light source, preferably, if present, for selectively operating each of the plurality of LEDs of the light source, so as to control the emitted light output;
- a position detection system for determining the position of the lighting device.

[0021] Depending on the position of the lighting device detected by the position detection system, the light controlling system is provided to operate the light source such that a predetermined output is emitted.

[0022] The present invention further relates to a device as described above, wherein said position detection system is further arranged for setting a predetermined angular and spatial position for the lighting device, and depending on said predetermined angular and spatial position, a predetermined output of the light source, for example one or more light colour(s) and/or optionally a predetermined light intensity, are arranged to be emitted by the light controlling system.

[0023] The device of the invention may further comprise a camera or a video recording system, and alternatively a power source.

[0024] The device of the invention preferably is suitable for use under water.

Brief description of the figures

[0025] The invention will be further elucidated by

means of the following description and the appended figures.

Figure 1 shows a horizontal side view of a portable lighting device according to one embodiment of the invention.

Figure 2 shows a top view of a portable lighting device according to another embodiment of the invention.

Description of the invention

[0026] A portable lighting device, the device comprising:

- a light source, preferably comprising a plurality of Light Emitting Diodes (LEDs);
- a housing for mounting the light source; and
- a position detection system for determining the position of the lighting device.

[0027] According to preferred embodiments of the present invention, the lighting device comprises an output controlling system for operating output means of the lighting device so as to control output emitted by the output means; wherein depending on the position of the lighting device detected by the position detection system, the output controlling system is provided to operate the output means such that a predetermined output is emitted. Such portable lighting device allows to relate the position of the lighting device, angular and/or spatial, to the output of the output means, making it possible for the user to obtain information on the position of the lighting device depending on the output of the output means.

[0028] The output means can comprise any one or more of: the light source, sound emitting device, vibration emitting device.

[0029] According to preferred embodiments, the lighting device comprises a light controlling system as output controlling system for operating the light source, the light source being comprised in the output means, preferably, if present, for selectively operating each of the plurality of LEDs, so as to control the emitted light output; wherein depending on the position of the lighting device detected by the position detection system, the light controlling system is provided to operate the light source such that a predetermined output is emitted. Such portable lighting device allows to relate the position of the lighting device, angular and/or spatial, to the output, for example intensity and/or spectrum, determined by for example the outputted frequencies or colours and expressed as for example colour temperature, of the light, making it possible for the user to obtain information on the position of the lighting device depending on the output of the light source.

[0030] According to preferred embodiments, the lighting device comprises additional output means next to the light source such as for example a sound emitting device and/or a vibration emitting device. The sound emitting

device and/or the vibration emitting device together with the light source indicating to a user the position of the lighting device.

[0031] According to preferred embodiments of the present invention, the light source comprises at least two light source components, preferably different light source components, and the light controlling system is provided to selectively operate each of the at least two light source components of the light source so as to control the emitted light output such that the predetermined output is emitted.

[0032] According to further preferred embodiments of the current invention, the light source components are Light Emitting Diodes (LEDs).

[0033] According to preferred embodiments of the current invention, the light controlling system is further arranged for setting at least one predetermined position for the lighting device, and depending on said predetermined position, the light controlling system is provided to operate the light source such that the light source emits a predetermined output when the position detection system determines a position corresponding to the predetermined position. Such configuration allows to reflect to the user the position of the lighting device in the output of the light source with respect to a reference predetermined position, angular and/or spatial.

[0034] According to preferred embodiments of the present invention, the position detection system comprises an angular position detection module for determining at least part of the angular position of the lighting device. Such module allows to determine the angular position of the lighting device.

[0035] According to preferred embodiments of the present invention, the light controlling system is further arranged for setting at least one predetermined angular position for the lighting device, and depending on the predetermined angular position, the light controlling system is provided to operate the light source such that the light source emits a first predetermined output when the position detection system determines a first angular position corresponding to the predetermined angular position. Such configuration allows to reflect to a user the angular position of the lighting device with respect to a predetermined angular position such as to be able to determine the angular position of the device with respect to the predetermined angular position.

[0036] According to preferred embodiments of the present invention, the light controlling system is provided to operate the light source such that the light source emits a second different predetermined output when the position detection system determines a second angular position different from the predetermined angular position. Such configuration allows to indicate when the predetermined angular position is preached in contrast with different angular positions.

[0037] The change between the first and the second predetermined output preferably is also controlled by the light controlling system and can be gradual or abrupt,

depending on the desired application.

[0038] According to preferred embodiments of the present, the predetermined angular position of the lighting device corresponds to the light source being pointed in a downwards direction and the light controlling system is provided to operate the light source such that the light source emits the first predetermined output when the angular position detection module determines the first angular position of the lighting device corresponding to the light source being pointed in a downwards direction, and the second different predetermined output when the light source is pointed in any other direction different to downwards. Such configuration allows the light controlling system to adapt the output of the light source in response to the angular position of the lighting device with respect to a vertical direction substantially along the gravitational direction allowing that the light controlling system adapts the output of the light source when the light source is pointed downwards. Especially when used during, for example, diving such configuration allows that the light controlling system adapts the output of the light source when the light source is pointed downwards to the seabed to, for example take a closer look at some marine fauna or flora.

[0039] According to further preferred embodiments of the invention the first predetermined output has a colour temperature which is substantially lower than the second predetermined output.

[0040] According to preferred embodiments of the present invention, the intensity of the first predetermined output is lower than the intensity outputted by the light source when the light source is pointed in any other direction different to downwards. In such a way the output can for example be changed so that the intensity of the outputted light is reduced so that carrier of the lighting device is not blinded by the outputted light reflected by the seabed and/or the marine fauna or flora when the light source is pointed in the downward direction.

[0041] According to preferred embodiments of the present invention, the first predetermined output has a wider angle, a so-called wide beam lighting, than the second predetermined output, creating a so-called narrow beam lighting. Although such an effect can be achieved by changing the optics of the lighting device, for example adding or moving lenses present in the lighting device, such an effect preferably is more easily achieved by selecting appropriate respective light source components.

[0042] According to preferred embodiments of the present invention, the first predetermined output is substantially white light. In such a way, the first predetermined output can be changed such as to include red light in the outputted light such as to be able to better observe the colours of the marine fauna and/or flora situated on the seabed.

[0043] According to other preferred embodiments of the present invention, the first predetermined output is substantially red light. It has been found that although red light allows to study close-by information, for example

a map, when directing the light source in a downward direction, it is less perceivable in darkness for others. This can for example be used by a hunter hunting in the dark and wanting to take a close look at for example his gun, a map, some edibles, etc. whereas he wants a different light to be emitted at objects more remote, for example game. In such a case the first predetermined output is red light and the light controlling system operates the light source such as to emit a different light, for example infrared light to be able to see game with special goggles, in all different directions. A similar configuration could be used by a soldier, a police officer, etc.

[0044] According to preferred embodiments of the present invention, the light controlling system is for example provided to operate the light source such that at least one red light source component, for example a red LED, of the light source is turned off when detecting that the light source is pointed in any other direction different to downwards, the light controlling system further being provided to operate the light source such that the at least one red light source component is turned on in the first angular position. In such a configuration, upon returning the lighting device to a more horizontal position with respect to the predetermined vertical direction, the light controlling system can adapt the output of the light source again, for example by increasing the intensity of the outputted light such as to be able to see a greater distance and/or by switching the at least one red light source component off as such light is less useful under water as it is filtered away by the water, thus saving the energy otherwise spent on the at least one red light source component and thus saving battery life.

[0045] According to preferred embodiments of the present invention, the angular position detection module comprises any one or more of: an electronic compass, for example a solid state compass, determining the horizontal angle at which light is emitted by the light source with respect to the magnetic north, an accelerometer determining the vertical angle at which light is emitted by the light source with respect to the direction of the gravitation pull, a gyroscope, preferably an electric gyroscope, determining the direction at which light is emitted by the light source with a reference direction.

[0046] According to preferred embodiments of the present invention, the predetermined angular position of the lighting device corresponds to the light source being pointed in a target horizontal direction and wherein the light controlling system is provided to operate the light source such that the light source emits the first predetermined output when the angular position detection module determines the first angular position of the lighting device corresponding to the light source being pointed in the target horizontal direction, and the second different predetermined output when the light source is pointed in any other direction different to the target horizontal direction. Such a configuration allows for the lighting device to be used to indicate a desired direction, the target horizontal direction, by the light controlling system changing the out-

put of the light source. In such configuration, the change of the output of the light device indicates to the user of the light device that he needs to change his travelling direction or is going in the right direction. As in use a lighting device usually is swung to the left and to the right a visible change in the output of the light source is a clear indication to the user of its direction, without the user for example having to check his travelling direction on a separate compass.

[0047] According to preferred embodiments of the present invention, the device comprises additional output means next to the light source, such as for example a sound emitting device and/or a vibration emitting device and wherein the predetermined angular position of the lighting device corresponds to the light source being pointed in a target horizontal direction and wherein the light controlling system is provided to operate the additional output means such that the additional output means emit the further first predetermined output when the angular position detection module determines the first angular position of the lighting device corresponding to the light source being pointed in the target horizontal direction, and a further second different predetermined output when the light source is pointed in any other direction different to the target horizontal direction. The further first predetermined output can for example be sound emitted by the sound emitting device and/or a vibration emitted by the vibration emitting device. The further second predetermined output can for example be a different sound emitted by the sound emitting device and/or a different vibration emitted by the vibration emitting device. The further second sound and/or vibration for example differ in, for example, frequency and/or intensity.

[0048] According to preferred embodiments of the present invention, the lighting device according to the present invention comprises input means for setting the target horizontal direction. For example, the input means can be a control knob, either a turning knob or for example a sliding knob, on which the desired compass direction, usually in angles, can be inputted. The input means can also comprise a keypad allowing to input the target horizontal direction. According to other embodiments the target horizontal direction can be pointed at with the lighting device and then be set by, for example, using any known input means such as for example by pushing a button or by tapping onto the lighting device.

[0049] According to preferred embodiments of the present invention, the output for example changes colour becoming the first predetermined output when the first angular position reaches the target horizontal direction, for example red.

[0050] Changes in colour can for example be controlled by the light controlling system by controlling the output of different light source components, for example LEDs, in the light source, for example by turning off green and blue light source components, for example LEDs, and turning on red light source components, for example LEDs, when desiring to output substantially red light, de-

pending on the desired application.

[0051] According to preferred embodiments of the present invention, the light source comprises a LASER source, the light controlling system operating the LASER source such that the first predetermined output is outputted by the LASER source. It has been found that such LASER sources allow to indicate a travelling direction over a long distance and with increase precision. Moreover, it has been found that under certain conditions a beam of light becomes visible indicating the desired travelling direction. It has been especially found that such beam can be created under water, for example when diving. In such case it has been found that especially a green LASER source is desired as it travels over a great distance under water and usually allows to create the desired beam indicating the desired travelling direction.

[0052] According to preferred embodiments of the present invention, the light controlling system comprises a spatial position detection module for determining at least part of the spatial position of the lighting device.

[0053] According to preferred embodiments of the present invention, the spatial position detection module comprises a satellite navigation system, for example any one or more of: global positioning system (GPS), GLO-NASS, Beidou, Galileo. It has been found that such systems are especially desired in above water conditions, for example during walking, hunting, etc., as it has been found that satellite navigation system signals are hampered by water during underwater use.

[0054] According to preferred embodiments of the present invention, the light controlling system comprises an aiming module provided to determine the target horizontal direction based on the spatial position determined by the spatial position detection module and a predetermined target spatial position of the lighting device. According to such a configuration, it would become possible for the user to input a target location, for example using a keypad provided to the lighting device, after which the aiming module would be able to determine the target horizontal direction based on the spatial position of the lighting device. Such a configuration would allow to indicate the correct travelling direction to a user to a target location.

[0055] According to embodiments of the present invention, the light source is provided for emitting substantially white light and comprises at least one red light source component, for example LED, arranged for emitting a substantially red light colour.

[0056] According to embodiments of the present invention, the light source, for example the light source components, for example a plurality of LEDs, are arranged at least partly in combination for emitting one or more light colour(s).

[0057] According to embodiments of the present invention, the light source comprises a plurality of light source components, for example LEDs, which comprise a green light source component, for example a green LED, arranged for emitting a substantially green light colour, a

red light source component, for example a red LED, arranged for emitting a substantially red light colour, and a blue light source component, for example a blue LED, arranged for emitting a substantially blue light colour. Such a combination of light source components, for example LEDs, allows a great versatility of colours that can be outputted by the light source.

[0058] According to preferred embodiments of the present invention the light source is provided for emitting light having a colour temperature of between 1000 K and 5000 K and light having a colour temperature of between 5000 K and 10000 K. Such configuration has for example been found to be usable in under water conditions with the colour temperature of between 1000 K and 5000 K serving as first predetermined output when the light source is pointed in the downwards direction and the light having a colour temperature of between 5000 K and 10000 K as the second predetermined output in any other more horizontal direction.

[0059] According to preferred embodiments of the present invention, the light source comprises at least one first light source component, for example a LED, provided for emitting light having a colour temperature of between 1000 K and 5000 K and at least one second light source component, for example a LED, provided for emitting light having a colour temperature of between 5000 K and 10000 K. It has been found that by using such first and second at least one light source components, for example LEDs, a more homogeneous output of light can be obtained than using, for example, the combination of red, green and blue light source components, for example LEDs. Moreover, it has been found that the efficiency with which the light is emitted is superior.

[0060] According to preferred embodiments of the present invention, the light controlling system is provided to operate the light source such that the light source emits light having a colour temperature of between 5000 K and 10000 K when detecting that the light source is pointed in any other direction different to downwards, the light controlling system further being provided to operate the light source such that the light source emits light having a colour temperature of between 1000 K and 5000 K.

[0061] According to preferred embodiments of the present invention, the light source is arranged for emitting one or more colour temperatures.

[0062] According to preferred embodiments of the present invention, the light source comprises at least one first light source component, for example a LED, provided for emitting a first colour temperature and at least one second light source component, for example a LED, provided for emitting a second colour temperature. It has been found that this way several colour temperatures can be obtained, especially the first and the second colour temperature for by switching between the at least one first light source component, for example LED, and the at least one second light source component, for example LED, and that in addition also output having a colour temperature in between the first and the second col-

our temperature can be obtained by gradually fading the at least one first and second light source component in and out.

[0063] In one embodiment of the present invention, the housing comprises at least one reflector arranged for directing the light emitted by the light source in the forward direction.

[0064] According to embodiments of the present invention, the housing comprises at least one lens arranged for diffracting the light emitted by the light source for converging or diverging the light emitted by the light source.

[0065] In one embodiment of the present invention, the device further comprises attachment means positioned at the exterior of the housing arranged for attaching the device to a carrier or to a man.

[0066] In one embodiment of the present invention, the housing is waterproof.

[0067] In one embodiment of the present invention, the device further comprises a camera or a video recording system.

[0068] In one embodiment of the present invention, the device further comprises a power source.

[0069] The present invention further relates to the use of the device according to the invention, under water.

[0070] The present invention will be described with respect to particular embodiments and with reference to certain drawings but the invention is not limited thereto but only by the claims. The drawings described are only schematic and are non-limiting. In the drawings, the size of some of the elements may be exaggerated and not drawn on scale for illustrative purposes. The dimensions and the relative dimensions do not necessarily correspond to actual reductions to practice of the invention.

[0071] Furthermore, the terms first, second, third and the like in the description and in the claims, are used for distinguishing between similar elements and not necessarily for describing a sequential or chronological order. The terms are interchangeable under appropriate circumstances and the embodiments of the invention can operate in other sequences than described or illustrated herein.

[0072] Moreover, the terms top, bottom, over, under and the like in the description and the claims are used for descriptive purposes and not necessarily for describing relative positions. The terms so used are interchangeable under appropriate circumstances and the embodiments of the invention described herein can operate in other orientations than described or illustrated herein.

[0073] The term "comprising", used in the claims, should not be interpreted as being restricted to the means listed thereafter; it does not exclude other elements or steps. It needs to be interpreted as specifying the presence of the stated features, integers, steps or components as referred to, but does not preclude the presence or addition of one or more other features, integers, steps or components, or groups thereof. Thus, the scope of the expression "a device comprising means A and B" should not be limited to devices consisting only of components

A and B. It means that with respect to the present invention, the only relevant components of the device are A and B.

[0074] Unless otherwise noted or apparent from the context, the term "or" is inclusive, thus including the conjunction "and".

[0075] The term "light source" refers to an entity that generates light for the lighting device of the invention. The light source of the lighting device or apparatus of the present invention may be electrically powered (e.g. power is supplied by electric batteries, electric cells, electric generators, flexible cables for electric mains constructions), non-electrically powered (e.g. power is created by combustible fuels, triboluminescence) or powered by sunlight.

[0076] The term light source component refers to an entity that generates light for the light source of the invention. The light source component of the lighting device or apparatus of the present invention may be electrically powered (e.g. power is supplied by electric batteries, electric cells, electric generators, flexible cables for electric mains constructions), non-electrically powered (e.g. power is created by combustible fuels, triboluminescence) or powered by sunlight. Examples of a light source component is for example any one or more of a Light Emitting Diode (LED), for example an organic light emitting diode (OLED), an incandescent light bulb, an arc lamp, a gas discharge lamp, for example a fluorescent light, a compact fluorescent lamp, a neon lamp, a flood lamp, etc., a laser, a sulfur lamp, etc.

[0077] LED or "light emitting diode" refers to semiconductor devices with at least one potential-jump barrier or surface barrier specially adapted for light emission.

[0078] The light source of the present invention for example incorporates a plurality of individually controllable RGB LEDs. Also preferably, the LEDs are at least red, green, blue, and optionally white. In one embodiment, the light source comprises a minimum of three LEDs, one green, one blue and one red. Incorporating individually controllable RGB LEDs affords multiple colours to be displayed.

[0079] The term "light intensity", briefly "intensity" or "luminous intensity" refers to the measure of the wavelength-weighted power emitted by a light source in a particular direction per unit solid angle, based on the luminosity function, a standardized model of the sensitivity of the human eye. In the present invention it may also be referred to as brightness, and it is expressed in candela units.

[0080] The term "position detection system" refers to means for determining the angular and/or spatial position of the lighting device according to the invention.

[0081] The angular position for example refers to the polar angle θ (theta) and the azimuthal angle ϕ (phi).

[0082] The spatial position for example refers to two or preferably the three-dimensional space coordinates x, y, z.

[0083] The change in the angular and spatial position

can be measured in view of time, which gives an indication of the path or direction that the lighting device moves along.

[0084] For determining the angular and spatial position of the lighting device, the position detection system may comprise, without being limited to, compasses; devices for ascertaining true or magnetic north for navigation or surveying purposes; including magnetic compasses and sun- or astro-compasses; gyroscopes; turn-sensitive devices using vibrating masses; turn-sensitive devices without moving masses; measuring angular rate using gyroscopic effects; rotary gyroscopes; turn-sensitive devices using vibrating masses, e.g. vibratory angular rate sensors based on Coriolis forces; turn-sensitive devices without moving masses; astronomical means for measuring position and for example direction, for example space-based satellite navigation systems like GPS (US Global Positioning system), GLONASS (Russian Global Navigation Satellite System), DORIS (French Doppler Orbitography and Radio-positioning Integrated by Satellite), "Compass" (called Beidou or Big Dipper, the Chinese Compass navigation system), "Galileo" (the European satellite navigation system), IRNSS (Indian Regional Navigational Satellite System), QZSS (the Japanese Quasi-Zenith Satellite System), and the like, and depending on the number of countries or regions developing their own navigation satellite systems; MEMS (miniature electro-mechanical sensors), accelerometers, magnetometers, strain gauges, and any other suitable position detection system known by the person skilled in the art.

[0085] The "light controlling system" of the device according to the invention may comprise a chip or a printed circuit board, which interconnect a processor, a power supply circuit coupled to a power source, light-emitting diodes, control switches, and the position detection system according to the present invention.

[0086] The power source may for example be a battery and may include any suitable battery, e.g., non-rechargeable alkaline batteries, lead-acid batteries, or similar battery sources. The power source may also include rechargeable lithium-ion polymer, nickel-metal hydride and the like. In alternative embodiments the power source may be moved outside of the protective housing and off the lighting device altogether and onto the user in order to lessen the weight of the lighting device. In this configuration, the power source may be enclosed in a belt pack or pack that can strap to the user's arm, waist, or leg and connect to the controller housing with a cable and possibly a quick-disconnect coupling for easy release from the lighting device.

[0087] The power supply circuit sources its power from a power source and supplies power to the light controlling system, the light source, and the position detection system.

[0088] A switch is provided for on/off control and may also provide mode selection for multiple lighting pro-

grams. A low-power radio transceiver may be incorporated to allow wireless communication and remote control. The switch is used to switch off or on one or more light source components, for example colour emitting LEDs, while switching on or off one or more red light source components, for example colour emitting LEDs, or viceversa, or the switch is used to switch off one or more light source components, for example coloured LEDs, while switching on one or more different light source components, for example coloured LEDs. A manual switch may optionally be provided.

[0089] The light controlling system preferably individually controls each of the light source components, in order to change the emitting light colours. For example, by adjusting the brightness of the three primary additive colours of each the light source components, for example RGB LEDs, reproduction of any colour in the visible electromagnetic spectrum is possible independently on each of the light source components, for example RGB LEDs.

[0090] The light controlling system is programmed to control the emission of a specific colour from the plurality of combined light source components, for example LEDs, depending on the angular and spatial position of the lighting device. The light controlling system may also be programmed to control the emitted colour by switching on or off each of the light source components, for example LEDs, such that the colour is a steady colour chosen or predetermined by the user.

[0091] The light controlling system may also be programmed to control the output of each of the light source components, for example LEDs, such that the colour is flashed in a strobing fashion using a single colour or sequence of colours.

[0092] The light controlling system may be programmed to control the output of each of the light source components, for example LEDs, such that periodic readings from the position detection system, like reading from two axes of an accelerometer, a single axis of rotation of a gyroscope, or a compass angle, or the readings from a GPS receiver are used in an algorithm that calculates and displays an associated colour for specific changes in angular and spatial positions. This algorithm may create a timeline across the array of light source components, for example LEDs, to display a history of a portion of the last colour values. The algorithm may also use the readings of an accelerator to move the timeline across the array of light source components, for example LEDs, in the direction that the carrier or user is currently moving.

[0093] Further, the light controlling system may be configured to change the colour or intensity of the light source based upon equipment attitude, geoposition, velocity or acceleration.

[0094] A computer interface may be provided to allow the user to program custom-defined colours, colour sequences, patterns of colours, or graphics. A computer interface may also be provided to allow the user to program new colour changing and graphics algorithms that may become available in the future. The computer inter-

face may include RS-232 serial, universal serial bus (USB), IEEE 802.15.1 (Bluetooth) wireless, Radiofrequency identification (RFID), or similar computer interface technology.

[0095] The processor may be one or more computer-based processors. Such a processor may be implemented by a field programmable gated array (FPGA), application specific integrated chip (ASIC), programmable circuit board (PCB), or other suitable integrated chip (IC) device.

[0096] A processor in effect comprises a computer system. Such a computer system includes, for example, one or more central processing units (CPUs) that are connected to a communication bus. The computer system can also include a main memory, such as, without limitation, flash memory, read-only memory (ROM), or random access memory (RAM), and can also include a secondary memory. The secondary memory can include, for example, a hard disk drive and/or a removable storage drive. The removable storage drive reads from and/or writes to a removable storage unit in a well-known manner. The removable storage unit, represents a floppy disk, magnetic tape, optical disk, and the like, which is read by and written to by the removable storage drive. The removable storage unit includes a computer usable storage medium having stored therein computer software and/or data.

[0097] Computer programs (also called control logic) are stored in the main memory and/or secondary memory. Computer programs can also be received via the communications interface. Such computer programs, when executed, enable the computer system to perform certain features of the present invention as discussed herein. In particular, the computer programs, when executed, enable a control processor to perform and/or cause the performance of features of the present invention. Accordingly, such computer programs represent controllers of the computer system.

[0098] In an embodiment where the invention is implemented using software, the software can be stored in a computer program product and loaded into the computer system using the removable storage drive, the memory chips or the communications interface. The control logic (software), when executed by a control processor, causes the control processor to perform certain functions of the invention as described herein.

[0099] In another embodiment, features of the lighting device of the invention are implemented primarily in hardware using, for example, hardware components such as ASICs, FPGAs, PCBs, microcontrollers, or a multi-chip module (MCM). Implementation of the hardware state machine so as to perform the functions described herein will be apparent to persons skilled in the relevant art(s). In yet another embodiment, features of the invention can be implemented using a combination of both hardware and software.

[0100] In one embodiment, the housing comprises a reflector arranged for directing the light emitted by the

light source in the forward direction. This reflector may be a disc with several openings positioned in front of the light source. A desired angle of reflection may be configured by providing conical annuluses in each of the openings. The reflector may be "a-focal" or a parabolic reflector.

[0101] The portable lighting device according to the invention may be designed or specially adapted to be carried, e.g. attached to the head or any other part of the body like the wrist, arm, leg, waist, or otherwise transported by hand or on wheeled supports, in order to provide illumination as and where required. Alternatively, the portable lighting device according to the invention may be fixed or embedded into a moving carrier or vehicle, like a submarine, remote control underwater vehicle, bottom-side of a boat, and the like.

[0102] In one embodiment, the lighting device may incorporate one or more flexible organic light-emitting diode (OLED) video displays. Incorporating flexible OLED video displays affords static or full-motion video graphics to be displayed on the lighting device, allowing the user to change the look of the apparatus.

[0103] In use a diver for example mounts the portable lighting device on his head, with the light emission heading frontwards. When the diver is in horizontal position under the sea, the lighting device is able to sense this horizontal position (by means of a gyroscope, a compass, or a GPS) and adapt its light source such that they do not emit red light or at least emit less red light or for example emit light of a higher colour temperature, for example by adapting the colour temperature, as the red light would otherwise be lost just after half a meter and would be a waste of energy. Instead a more blueish or greenish color can be emitted. In this manner, the lighting device has more power available to, for example increase the intensity of the light in order to be able to see much further objects or save battery life. When the diver moves his head downwards in order to view and observe a close object (be it marine fauna, marine flora or geographical elements under water), the lighting device is able to sense this downwards position and adapts its light source such that they emit a more red colour in order to view the close object with much higher quality and resolution, for example by adapting the outputted light to light having a lower colour temperature. The intensity of the emitted light can conversely be diminished such as to avoid blinding of the user.

[0104] Alternatively or in combination, the user may decide to select a programmable destination in the lighting device. When the diver moves into the right direction an auditory, visual or kinaesthetic, for example a vibration, signal, is provided. For example, a blue, green or turquoise colour is emitted with a relatively high intensity. If the diver deviates from the programmed destination, this is sensed by the gyroscope and/or the compass and/or the GPS, if possible, present in the lighting device, and the lighting device for example gradually turns off the light source and/or decreases the colour temperature

of the outputted light, in correspondence with the amount of deviation and/or changes the auditory or kinaesthetic, for example vibration, signal, if present.

[0105] Figure 1 shows a side view of a portable lighting device 1 used for diving according to one embodiment of the invention in which the light source's 2 intensity and colour temperature is adapted by a light controlling system depending on an angle relative to the horizontal plane 9. When the light source 2 is pointing to a downwards direction 7, a relatively low intensity light with a relatively wide beam and a relative low colour temperature are emitted. When the light source 2 is positioned in a more horizontal position 8, a higher intensity light with a relatively narrow beam and a relatively higher colour temperature are emitted.

[0106] Figure 2 shows a top view of a portable lighting device 1 according to another embodiment of the invention in which a predetermined intensity and colour temperature are emitted by the light source 2 if pointed in a programmable direction 10, relative to the geographical north. The horizontal plane 9 is no longer shown as figure 2 is a top view. When rotating the diving light to the opposite direction 11 from the right direction 10 over the arrow 12 in the substantially horizontal plane 9, the intensity and colour temperature are gradually turned off, indicating thereby to the user, for example a diver, that he is deviating from the programmed direction. When rotating the diving light to the right direction 10 from the direction 11 over the arrow 12 in a substantially horizontal plane 9, the intensity and colour temperature are gradually turned on, indicating thereby to the user, for example a diver, that he is deviating from the programmed direction and angle. In addition to the change in outputted light by the light source also, as described above, other signals such as for example auditive signals and/or kinaesthetic signals can be provided to indicate the programmed direction.

[0107] The lighting device 1 shown in the figures comprises a reflector 4, a lens 5 and a power supply 6, more in particular a battery.

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[0108]

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Claims

1. A portable lighting device (1), the device comprising:

a light source (2);

a housing (3) for mounting the light source; and a light controlling system for operating the light source so as to control the emitted light output; a position detection system for determining the position of the lighting device;

characterised in that depending on the position of the lighting device detected by the position detection system, the light controlling system is provided to operate the light source such that a predetermined output is emitted.

2. The device according to claim 1, wherein the light source (2) comprises at least two light source components and wherein the light controlling system is provided to selectively operate each of the at least two light source components of the light source so as to control the emitted light output such that the predetermined output is emitted.

3. The device according to claim 2, wherein the light source components are Light Emitting Diodes (LEDs).

4. The device according to any one of claims 1 - 3, wherein the light controlling system is further arranged for setting at least one predetermined position for the lighting device, and depending on said predetermined position, the light controlling system is provided to operate the light source such that the light source emits a predetermined output when the position detection system determines a position corresponding to the predetermined position.

5. The device according to any one of claims 1 - 4, wherein the position detection system comprises an angular position detection module for determining at least part of the angular position of the lighting device.

6. The device according to claim 5 when depending from claim 4, wherein the light controlling system is further arranged for setting at least one predetermined angular position for the lighting device, and depending on the predetermined angular position, the light controlling system is provided to operate the light source such that the light source emits a first predetermined output when the position detection system determines a first angular position corresponding to the predetermined angular position.

7. The device according to claim 6, wherein the light controlling system is provided to operate the light source such that the light source emits a second different predetermined output when the position detection system determines a second angular position different from the predetermined angular position.

8. The device according to claim 7, wherein the predetermined angular position of the lighting device corresponds to the light source being pointed in a downwards direction and wherein the light controlling system is provided to operate the light source such that the light source emits the first predetermined output when the angular position detection module determines the first angular position of the lighting device corresponding to the light source being pointed in a downwards direction, and the second different predetermined output when the light source is pointed in any other direction different to downwards. 5
9. The device according to claim 8, wherein the intensity of the first predetermined output is lower than the intensity outputted by the light source when the light source is pointed in any other direction different to downwards. 10
10. The device according to claim 8 or 9, wherein the first predetermined output is substantially white light. 15
11. The device according to any one of claims 8 - 10, wherein the first predetermined output has a wider angle than the second predetermined output. 20
12. The device according to any one of claims 5 - 11, wherein the angular position detection module comprises any one or more of: an electronic compass, an accelerometer, for example an electronic accelerometer, a gyroscope, preferably an electric gyroscope. 25
13. The device according to any one of claims 5 - 12, when depending from claim 7, wherein the predetermined angular position of the lighting device corresponds to the light source being pointed in a target horizontal direction and wherein the light controlling system is provided to operate the light source such that the light source emits the first predetermined output when the angular position detection module determines the first angular position of the lighting device corresponding to the light source being pointed in the target horizontal direction, and the second different predetermined output when the light source is pointed in any other direction different to the target horizontal direction. 30
14. The device according to claim 13, wherein the device comprises additional output means next to the light source, such as for example a sound emitting device and/or a vibration emitting device, and wherein the predetermined angular position of the lighting device corresponds to the light source being pointed in a target horizontal direction and wherein the light controlling system is provided to operate the additional output means such that the additional output means emit the further first predetermined output when the angular position detection module determines the first angular position of the lighting device corresponding to the light source being pointed in the target horizontal direction, and a further second different predetermined output when the light source is pointed in any other direction different to the target horizontal direction. 35
15. The device according to any one of the preceding claims, wherein the light controlling system comprises a spatial position detection module for determining at least part of the spatial position of the lighting device. 40
16. The device according to claim 15 wherein the spatial position detection module comprises a satellite navigation system, for example any one or more of: global positioning system (GPS), GLONASS, Beidou, Galileo. 45
17. The device according to claim 15 or 16 when depending from claim 13 or 14, wherein the light controlling system comprises an aiming module provided to determine the target horizontal direction based on the spatial position determined by the spatial position detection module and a predetermined target spatial position of the lighting device. 50
18. The device according to any one of claims 1 to 17, wherein the light source is provided for emitting light having a colour temperature of between 1000 K and 5000 K and light having a colour temperature of between 5000 K and 10000 K. 55
19. The device according to claim 18 when depending from claim 2, wherein the light source comprises at least one first light source component provided for emitting light having a colour temperature of between 1000 K and 5000 K and at least one second light source component provided for emitting light having a colour temperature of between 5000 K and 10000 K.
20. The device according to claim 18 or 19 when depending from claim 10, wherein the light controlling system is provided to operate the light source such that the light source emits light having a colour temperature of between 5000 K and 10000 K when detecting that the light source is pointed in any other direction different to downwards, the light controlling system further being provided to operate the light source such that the light source emits light having a colour temperature of between 1000 K and 5000 K.
21. The device according to any one of the preceding claims when dependent from claim 2, wherein the at least two light source components are arranged for emitting one or more colour temperature.

22. The device according to claim 21, wherein the light source comprises an at least one first light source component provided for emitting a first colour temperature and an at least one second light source component provided for emitting a second colour temperature. 5
23. Use of the device according to any one of the preceding claims, under water. 10

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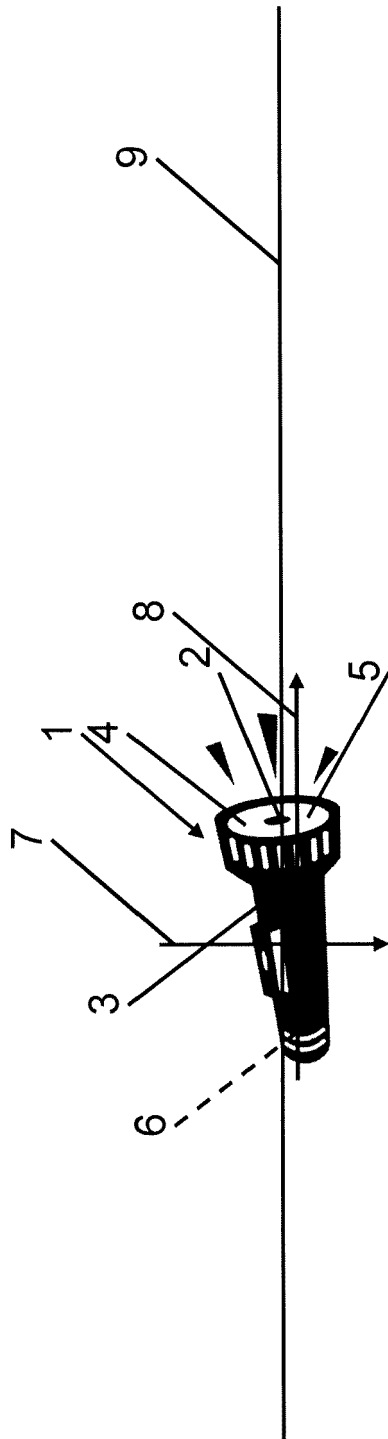


Fig. 1

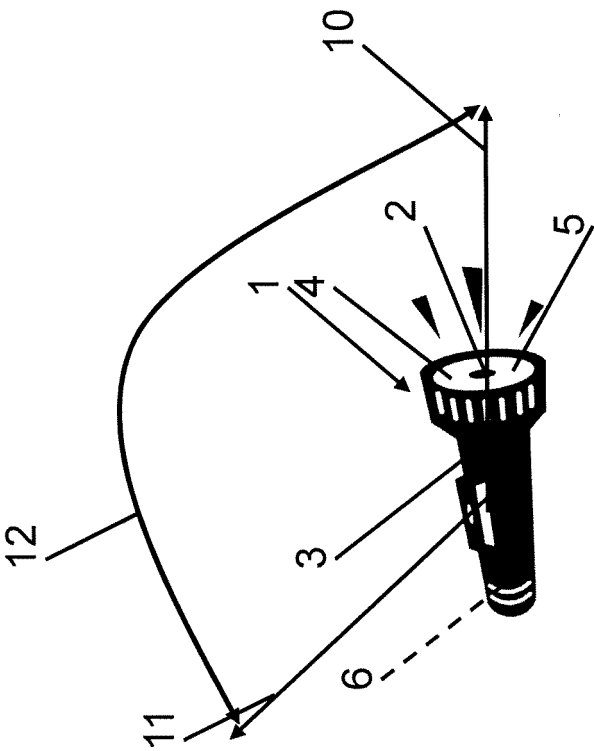


Fig. 2



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