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(54) **MOORING SYSTEM WITH A PLURALITY OF BUOYS WITH AUTOMATIC IMMERSION AND RADIO CONTROLLED ASCENT**

(57) There is described a mooring system (200) comprising a plurality of buoys (100) with automatic Immersion and radio-controlled ascent and a control unit (300) comprising signal transmission/reception means (6, 8) for exchanging data with the buoys (100) with automatic Immersion and radio-controlled ascent and/or with an external control unit (7), said buoy (100) comprising a floating watrproof casing (1) comprising a winding/unwinding device (17, 18, 22) on which the cable (19) is wound, having one end connectable to a dead body (24) located on the seabed (25), said winding/unwinding device comprising motor means (22) which operates it to hold the buoy submerged, control means of the buoy (100) configured to exchange data with the control unit (300) of the mooring system (200), and an internal electronic control unit (10) to control and command the buoy (100), electrical power supply means (14, 23) for powering the components of the buoy (100).

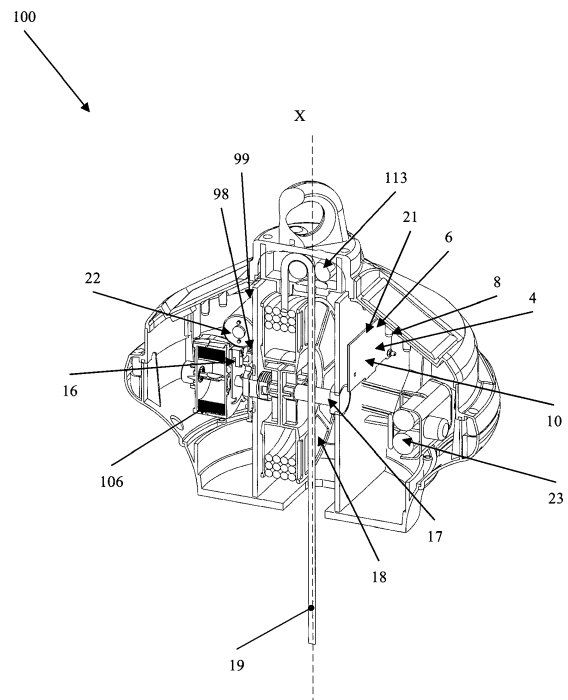


FIG. 1

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Description

[0001] The present invention relates to a mooring system comprising a plurality of buoys with automatic immersion and radio-controlled ascent, in particular a system comprising a management and control unit, which can be located inside a floating buoy or on a boat, and communicates via ultrasound and/or radio frequency with a plurality of floating buoys with automatic immersion and radio-controlled ascent.

[0002] There are known mooring systems (buoy fields) that use floating mooring buoys, as in protected marine areas boaters are not allowed to anchor to the seabed, which would jeopardize the original natural appearance of the seascape, in particular damaging the posidonia.

[0003] However, said known mooring systems with floating buoys have the problem of giving the seascape an appearance that is not natural.

[0004] The document WO 2020/229708 A1 discloses a mooring system according to the pre-characterizing part of claim 1.

[0005] The object of the present invention is to provide a mooring system that is invisible and protected when not in use, with no environmental impact. In fact, each buoy of the system can return below the surface of the water when not used, radically transforming the appearance of the seascape in buoy fields.

[0006] These and other objects and advantages of the invention, which will be apparent from the description below, are achieved with a mooring system with a plurality of buoys with automatic immersion and radio-controlled ascent such as the one claimed in the main claim. Preferred embodiments and non-trivial variants of the afore-said invention form the subject matter of the dependent claims.

[0007] It is understood that the appended claims form an integral part of the present description.

[0008] It will be immediately obvious that numerous variants and modifications (for example in relation to the shape, size, arrangements and parts with equivalent functions) can be made to what has been described herein, without departing from the scope of protection of the invention as it appears in the appended claims.

[0009] The present invention will be better described by a preferred embodiment, provided by way of non-limiting example, with reference to the accompanying drawings, wherein:

- Fig. 1 shows a perspective view of a section of a buoy for a mooring system according to the invention;
- Fig. 2 shows a perspective view of a buoy for a mooring system according to the invention;
- Fig. 3 shows a perspective view of a control unit for a mooring system according to the invention;
- Figs. 4-5 show exploded views of an engagement/disengagement system of the shaft of a buoy for a mooring system according to the invention;

- Figs. 6A-6D show schematic views of a method of use of a mooring system according to the invention.

[0010] With reference to the figures, the mooring system 200 of the invention comprises a plurality of buoys 100 with automatic immersion and radio-controlled ascent and a control unit 300, which by way of example can be located inside a floating buoy and comprises signal transmission/reception means 6, 8, for example a radio frequency transmitter/receiver 6, preferably a GSM module or a Bluetooth, WiFi or similar module, and/or an ultrasonic transmitter/receiver 8 for exchanging data with the buoys 100 with automatic immersion and radio-controlled ascent and/or with an external control unit 7 which can, for example, be a smartphone, or a specific transmitter/receiver device, used, for example, on a boat. Preferably, the control unit 300 can also be a self-powered portable unit with internal or external battery, or can also be a unit designed to be installed, for example, on a boat.

[0011] The buoy 100 with automatic immersion and radio-controlled ascent of the mooring system 200 of the invention comprises:

- a floating waterproof casing 1 comprising a winding/unwinding device 17, 18, 22 on which the cable 19 is wound, having one end connectable to a dead body 24 located on the seabed 25; preferably the winding/unwinding device comprises motor means 22 which drives the winding/unwinding device in the winding/unwinding direction of the cable 19; for example, the motor means comprise an electric motor 22 which rotates a shaft 17 to which a reel 18 on which the cable 19 is wound is connected;
- a plurality of sensors preferably comprising: a twilight sensor 11, a pressure sensor 15, a revolution counter sensor 16, for example an encoder or a position sensor, configured to count the revolutions of the rotating winding/unwinding device 17, 18, a liquid level sensor 21 configured to detect immersion of the buoy 100; preferably, the buoy 100 of the invention comprises light 12 and/or acoustic 13 signalling means, for example activatable following the detection of a variation of luminosity by the twilight sensor 11, and at least one programmable clock that determines the ascent and immersion times of the buoy 100;
- control means of the buoy 100 comprising signal transmission/reception means 6, 8 and an internal electronic control unit 10 configured to control and command the buoy 100 of the invention; the signal transmission/reception means 6, 8, for example a radio frequency transmitter/receiver 6, preferably a GSM module, and/or an ultrasonic transmitter/receiver 8 or a Bluetooth, WiFi or similar module, are preferably configured to exchange data with the internal electronic control unit 10, with the control unit 300 of the mooring system 200 of the invention; preferably, data are exchanged with the control unit 300

of the mooring system 200 of the invention by means of the radio frequency transmitter/receiver 6 when the buoy 100 of the invention is in float mode, or by means of the ultrasonic transmitter/receiver 8 when the buoy 100 of the invention is submerged; preferably, the electronic control unit 10 inside the main body 1 comprises a microprocessor and known memory means configured to control the sensors 11, 15, 20, 21, the motor means 22 and the signal transmission/reception means 6, 8, as will be described more in detail below;

- electrical power supply means 14, 23 for powering the components of the buoy 100 according to the invention, preferably comprising batteries 23, for example lithium batteries and/or photovoltaic means 14, for example a cell or a panel, for charging the batteries 23.

[0012] Preferably, said winding unwinding device comprises a speed reduction system 99, for example a worm screw system, configured to transmit motion from the motor 22 to the shaft 17; rotation of the speed reduction system 99 and of the shaft 17 is blocked when the power supply of the motor 22 is interrupted, with the function of holding the buoy submerged, as will be explained in greater detail below.

[0013] Preferably, the winding/unwinding device comprises an engagement/disengagement system 98 which, when the motor 22 is powered in the unwinding direction of the cable 19, is configured to disconnect the shaft 17 from the speed reduction system 99 so as not to transmit the motion from the motor 22 to it, causing the buoy to re-emerge by hydrostatic thrust and unwind the cable 19 from the reel 18.

[0014] Preferably, the engagement/disengagement system 98 comprises a gear 97 which transmits motion from the motor 22 to the shaft 17, and a wheel 108 connected to the shaft 17, preferably by means of a connection element 109, which will be explained in detail below.

[0015] The gear 97 comprises motion transmission means 93 to the shaft 17, preferably comprising at least one movable detent 93 or a friction pad which transmit the motion of the gear 97 to a wheel 108 connected to the shaft 17.

[0016] The gear 97 comprises at least one movable detent 93, for example oscillating around a first pin 91 fixed to the gear 97, which engages with/disengages from a wheel 108 connected to the shaft 17.

[0017] A second pin 94, which engages on a track 94 provided with two lanes, one external and one internal, is fixed on the detent 93. When the motor 22 moves the gear 97 in the unwinding direction of the cable 19 (Fig. 9), the second pin 94 moves and remains in the internal lane of the track 96 causing the detent 93 to move towards the inside of the gear 97 and disengaging the wheel 108; the wheel 108 and the shaft 17 thus remain disconnected from the gear 97, and the shaft 17 can rotate freely determining unwinding of the cable 19 by hydrostatic thrust

of the submerged buoy 100.

[0018] When the motor 22 is powered in the winding direction of the cable 19, the engagement/disengagement system 98 is configured to connect the shaft 17 to the speed reduction system 99, which transmits motion from the motor 22 to it, causing the cable 19 to wind on the reel 18 by means of the continuous rotation of the motor 22.

[0019] When the motor 22 moves the gear 97 in the winding direction of the cable 19 (Fig. 10), the second pin 94 moves and remains in the external lane of the track 96 causing the detent 93 to move towards the outside of the gear 97 and engaging the wheel 108; the wheel 108 and the shaft 17 thus remain connected to the gear 97, and the shaft 17 receives motion from the motor 22 determining winding of the cable 19 on the reel 18.

[0020] To block unwinding of the cable 19 the motor 22 is powered in the winding direction of the cable 19 only for the time required to connect the shaft 17 to the speed reduction system 99.

[0021] Preferably, the engagement/disengagement system 98 of the shaft 17 to/from the speed reduction system 99 comprises the connection element 109, for example with direct coupling or with friction, configured to cause sliding of the shaft 17 with respect to the speed reduction system 99, preferably with respect to the wheel 108, when it is subjected to a force that exceeds a predetermined limit corresponding to the normal operating conditions.

[0022] In a second embodiment of the buoy 100 of the invention, the engagement/disengagement system 98 comprises an electromechanical actuator configured to disconnect the shaft 17 from the speed reduction system 99.

[0023] Preferably, the shaft 17 is equipped with at least one elastic spring 106 which is preloaded during unwinding of the cable 19, configured to rewind the cable on the reel when it is no longer subjected to traction or force.

[0024] In a preferred embodiment of the invention, the buoy 100 with automatic immersion and radio-controlled ascent further comprises stop means 113 configured to block the cable 19 and allow an optimal positioning of the combination between the dead body 24, cable 19 and buoy 100. For example, the stop means 113 comprise a cam cleat interposed between cable 19 and buoy 100 and can replace the engagement/disengagement system 98 or be added thereto to hold the buoy 100 when it is submerged.

[0025] Preferably, the buoy 100 of the invention further comprises:

- at least one image capture module 2, such as a video camera, fixed or manually and/or automatically adjustable and preferably equipped with a servomotor 3, configured to acquire sequential and/or video images of the environment, and/or
- at least one position detection module 4, preferably of GPS type,

said image capture module 2 and position detection module 4 being controlled by the internal electronic control unit 10.

[0026] Preferably, the buoy 100 comprises at least one hook 116 which can be mechanically or electrically fixed or extensible, to which a mooring line of a boat is connected. The hook 116 can be equipped with a presence sensor 117 that detects whether the boat is hooked to the buoy 100.

[0027] For example, the presence of the line of the boat moored to the hook 116 can be detected by:

- a load cell that monitors the tensile force applied by the line on the hook 116,
- a video camera that captures an image,
- a photoelectric or laser cell,
- a capacitive or inductive proximity sensor,
- an ultrasonic or microwave doppler sensor.

[0028] The control unit 300 of the mooring system 200 according to the invention comprises:

- a floating waterproof casing 1 comprising a lower hook (not shown in the figures) to which a cable 19 is connected, having one end connectable to a dead body 24 located on the seabed 25;
- a plurality of sensors, preferably comprising a twilight sensor 11 configured to detect the ambient light; preferably, the control unit 300 of the invention comprises light 12 and/or acoustic 13 signalling means, for example activatable following the detection of a variation of luminosity by the twilight sensor 11;
- control means of the control unit 300 comprising signal transmission/reception means 6, 8 and an internal electronic control unit 10 configured to control and command the control unit 300 of the invention; the signal transmission/reception means 6, 8, for example a radio frequency transmitter/receiver 6, preferably a GSM module, and/or an ultrasonic transmitter/receiver 8 or a Bluetooth, WiFi or similar module, are preferably configured to exchange data with the internal electronic control unit 10, with the buoys 100 of the mooring system 200 of the invention and with an external control unit 7 which can, for example, be a smartphone, or a specific transmitter/receiver device, used on a boat or on shore; preferably, the data are exchanged with the buoys 100 of the mooring system 200 of the invention by means of the radio frequency transmitter/receiver 6 when the buoy 100 of the invention is in float mode, or by means of the ultrasonic transmitter/receiver 8 when the buoy 100 of the invention is submerged; preferably, the electronic control unit 10 inside the main body 1 comprises a microprocessor and known storage means configured to control the sensors 11, 15 and the signal transmission/reception means 6, 8, as will be described in more detail below;
- electrical power supply means 14, 23 for powering

the components of the control unit 300, preferably comprising batteries 23, for example lithium batteries and/or photovoltaic means 14, for example a cell or a panel, for charging the batteries 23.

[0029] Operation of the mooring system 200 of the invention will be described below, in an example shown in Figs. 6A-6D comprising a first buoy 100 and a second buoy 100A with automatic immersion and radio-controlled ascent and a control unit 300, the buoys 100, 100A being anchored to the seabed 25 by means of dead body 24 and used according to a process that comprises the following steps:

- the buoys 100, 100A anchored to the seabed 25 are submerged waiting to receive an ascent command, and the control unit 300 is positioned at a distance from the buoys 100, 100A which allows it to reach them through the signals emitted by the ultrasonic transmitter/receiver 8. The control unit 300 is anchored to the seabed 25 by means of a dead body 24 and floats; it can receive, via Bluetooth, WiFi or similar module, data transmitted by a user 33, for example the service manager on shore or by a service user, for example on a boat 34, via an external control unit 7 which can, for example, be a smartphone, or a specific transmitter/receiver device, or also via underwater ultrasound via a portable or fixed device 32 installed on the boat 34 (Fig. 6A),
- the signals received by the control unit 300 can command the ascent (or also the descent) of any buoy 100, 100A via a unique code. When the control unit 300 receives the data transmitted from the shore 33 or from a boat 34, it re-transmits an ascent command for example with a unique code corresponding to the second buoy 100A via ultrasonic transmission 30. By way of example, the data are sent via Bluetooth, WiFi or similar module 7 from the boat 34; all the submerged buoys 100, 100A receive the information. Only the second buoy 100A with the unique code corresponding to the one transmitted by the control unit 300 re-emerges (Fig. 6B),
- the service user, i.e., the boat 34, can approach the second emerged buoy 100A, and can be secured to it via a cable that connects the boat 34 to the second buoy 100A, which can remain on the surface until the end of use. The second buoy 100A can be equipped with at least one presence sensor 117 in proximity of the mooring hook 116 (Fig. 6C),
- when the boat 34 releases the mooring from the hook 116 of the second buoy 100A, it can submerge autonomously (Fig. 6D).

[0030] Alternatively, management of immersion of the second buoy 100A can be commanded by third parties via ultrasonic transmitter/receiver 8 and/or via Bluetooth, WiFi or similar module, sending data from and to the control unit 300.

[0031] Advantageously, the mooring system with a plurality of buoys with automatic immersion and radio-controlled ascent of the invention provides a mooring system that is invisible and protected when not in use, with no environmental impact, which is able to radically transform the appearance of the seascape in buoy fields.

[0032] Preferred embodiments of the invention have been described, but naturally it is susceptible to further modifications and variants within the scope of the same inventive concept. In particular, numerous variants and modifications, functionally equivalent to the above, which fall within the scope of the invention as set forth in the appended claims, in which any reference signs in brackets shall not be interpreted in the sense of limiting said claims, will be immediately apparent to those skilled in the art. Moreover, the word "comprising" does not exclude the presence of elements and/or steps differing from those listed in the claims. The article "a" or "an" preceding an element does not exclude the presence of a plurality of these elements. The simple fact that some features are cited in different dependent claims one another does not indicate that it is not possible for a combination of these features to be advantageously used.

Claims

1. Mooring system (200) comprising a plurality of buoys (100)
 2. with automatic immersion and radio-controlled ascent and a control unit (300) comprising signal transmission/reception means (6, 8) for exchanging data with the buoys (100) with automatic immersion and radio-controlled ascent and/or with an external control unit (7), said buoy (100) comprising:
 - a floating waterproof casing (1) comprising a winding/unwinding device (17, 18, 22) on which the cable (19) is wound, having one end connectable to a dead body (24) located on the seabed (25), said winding/unwinding device comprising motor means (22) which drives it in the winding/unwinding direction of the cable (19) and a speed reduction system (99) which is blocked when the power supply to the motor means is interrupted (22) to hold the buoy submerged,
 - buoy control means (100) comprising signal transmission/reception means (6, 8) configured to exchange data with the mooring system control unit (300) (200), and an internal electronic control unit (10) to control and command the buoy (100),
 - electrical power supply means (14, 23) for powering the components of the buoy (100), **characterized in that** the winding/unwinding device (17, 18, 22) of the buoy (100) comprises a shaft (17) to which a reel (18) is connected on which

the cable (19) is wound, **in that** the motor means comprise an electric motor (22) which rotates the shaft (17), said speed reduction system (99) being configured to transmit motion from the motor (22) to the shaft (17), wherein the winding/unwinding device of the buoy (100) comprises an engagement/disengagement system (98) which, when the motor (22) is powered in the unwinding direction of the cable (19), is configured to disconnect the shaft (17) from the speed reduction system (99) so as not to transmit the motion from the motor (22) to it, causing the buoy to re-emerge by hydrostatic thrust and unwind the cable (19) from the reel (18) and, when the motor (22) is fed in the winding direction of the cable (19), the engagement/disengagement system (98) is configured to connect the shaft (17) to the speed reduction system (99) which transmits the motion from the motor (22) to it, causing the cable (19) to wind on the reel (18) by means of the continuous rotation of the motor (22).

2. Mooring system (200) according to claim 1, **characterized in that** the engagement/disengagement system (98) comprises a gear (97) equipped with motion transmission means (93) to the shaft (17) comprising at least one movable detent (93) or a friction pad which transmit the motion of the gear (97) to a wheel (108) connected to the shaft (17).
3. Mooring system (200) according to any one of the preceding claims, **characterized in that** the buoy (100) comprises at least one image capture module (2) for acquiring sequential and/or video images of the environment, and/or comprises at least one position detection module (4).
4. Mooring system (200) according to any one of the preceding claims, **characterized in that** the buoy (100) comprises stop means (113) configured to block the cable (19) and allow an optimal positioning of the combination between the dead body (24), cable (19) and buoy (100).
5. Mooring system (200) according to any one of the preceding claims, **characterized in that** the signal transmission/reception means (6, 8) of the buoy (100) and of the control unit (300) comprise a radio frequency receiver (6) and/or an ultrasonic transmitter/receiver (8) to exchange data by means of the radio frequency transmitter/receiver (6) when the buoy (100) is in float mode, or by means of the ultrasonic transmitter/receiver (8) when the buoy (100) is submerged.
6. Mooring system (200) according to any one of the preceding claims, **characterized in that** the buoy

(100) comprises at least one hook (116) which can be mechanically or electrically fixed or extensible, to which a mooring line of a boat is connected.

7. Mooring system (200) according to any of the preceding claims, **characterized in that** the control unit (300) comprises:

- control means of the control unit (300) comprising signal transmission/reception means (6, 8) configured to exchange data with the buoys (100) of the mooring system (200) and with an external control unit (7), and an internal electronic control unit (10) for controlling and commanding the control unit (300),
- electrical power supply means (14, 23) for powering the components of the control unit (300).

8. Process for using a mooring system (200) according to any of the preceding claims, **characterized in that** it comprises the following steps:

- the buoys (100, 100A) anchored to the seabed (25) are submerged waiting to receive an ascent command, and the control unit (300) is positioned at a distance from the buoys (100, 100A) which allows it to reach them through the signals emitted by the ultrasonic transmitter/receiver (8), the control unit (300) is anchored to the seabed (25) by means of a dead body (24) and floats and can receive data transmitted by a user (33) located on shore or on a boat (34) via an external control unit (7),
- the signals received by the control unit (300) can command the ascent or descent of any buoy (100, 100A) via a unique code, all the buoys submerged (100, 100A) receive the information and only the buoy (100A) with the unique code corresponding to the one transmitted by the control unit (300) re-emerges,
- the boat (34) can approach the emerged buoy (100A), and can be secured to it via a cable that connects the boat (34) to the buoy (100A) which can remain on the surface until the end of use,
- when the boat (34) releases the mooring of the buoy (100A), said buoy (100A) can submerge autonomously.

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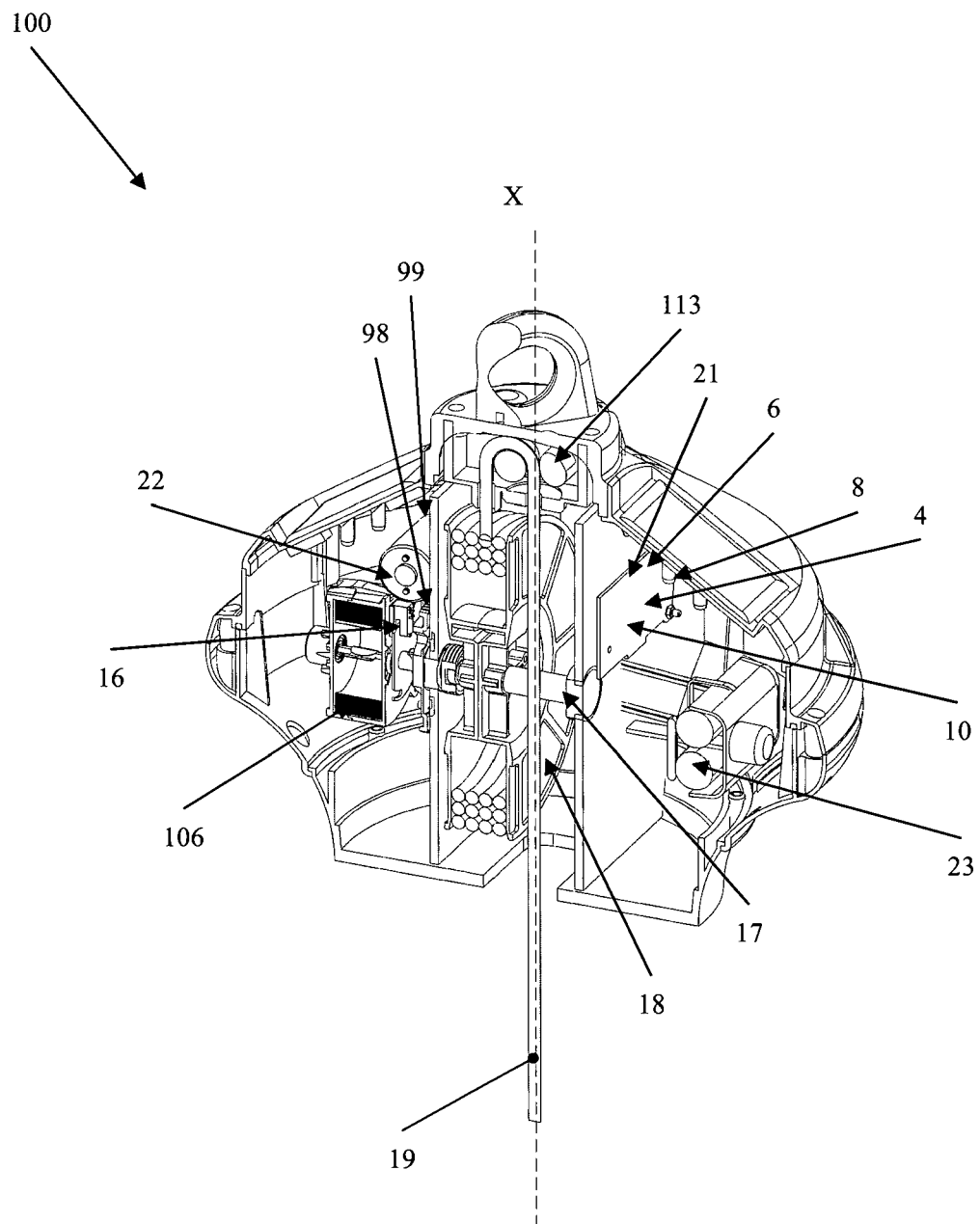


FIG. 1

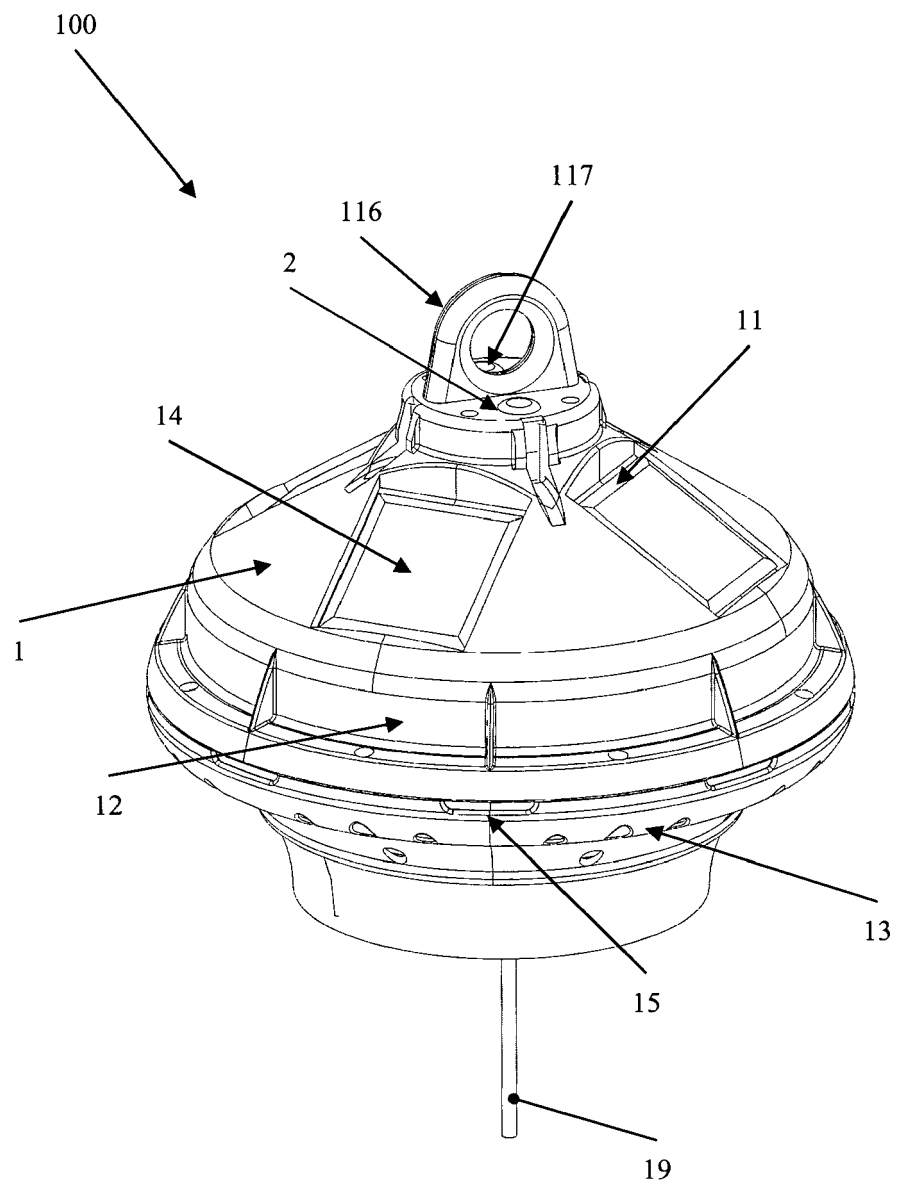


FIG. 2

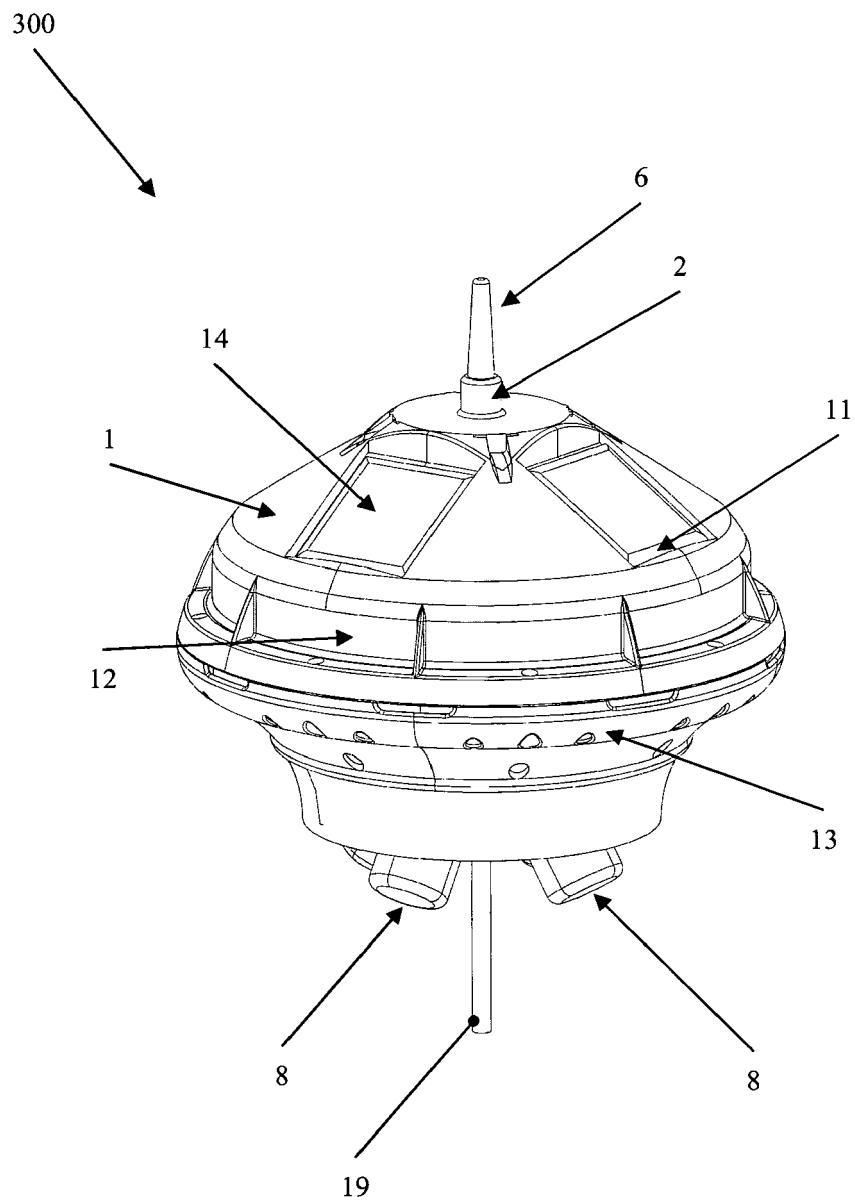


FIG. 3

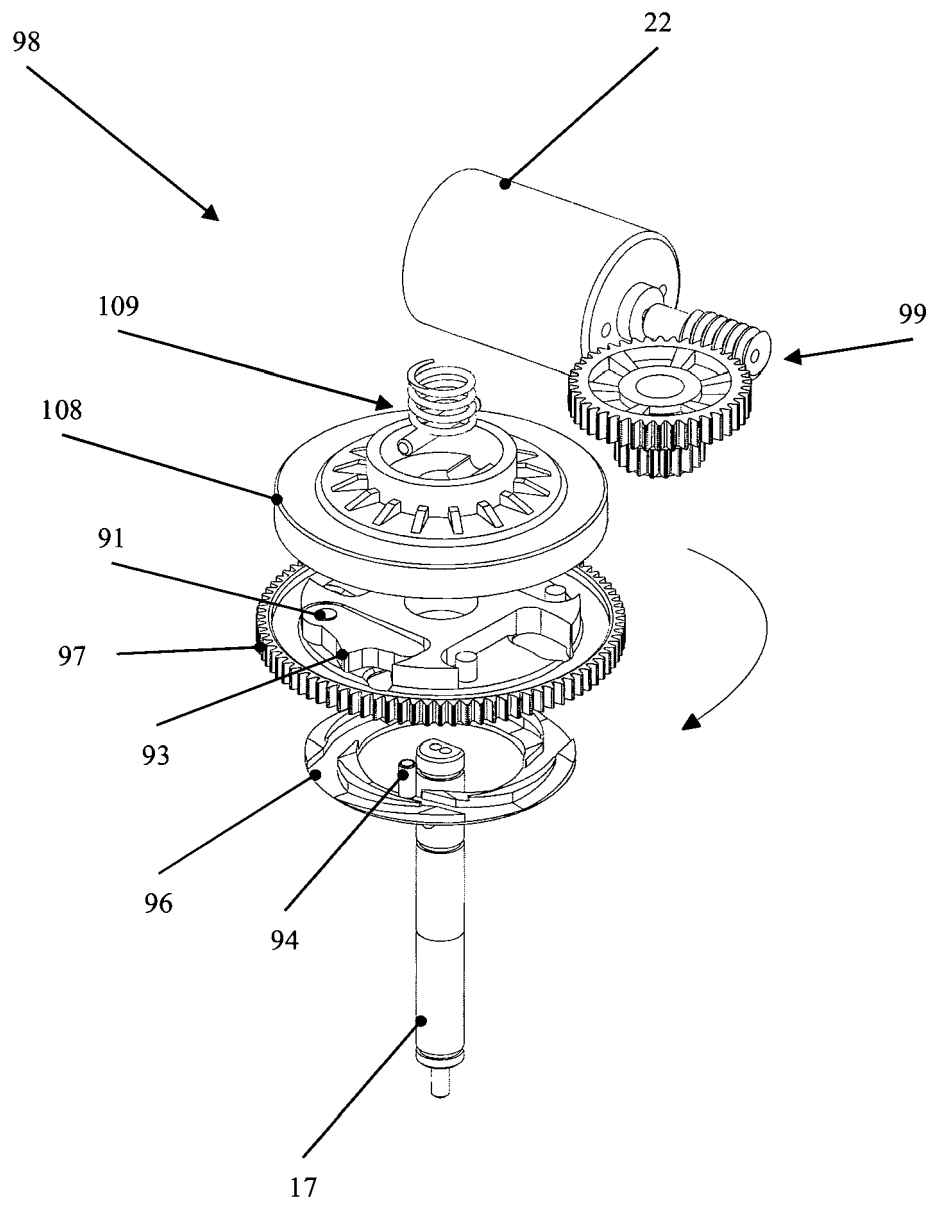


FIG. 4

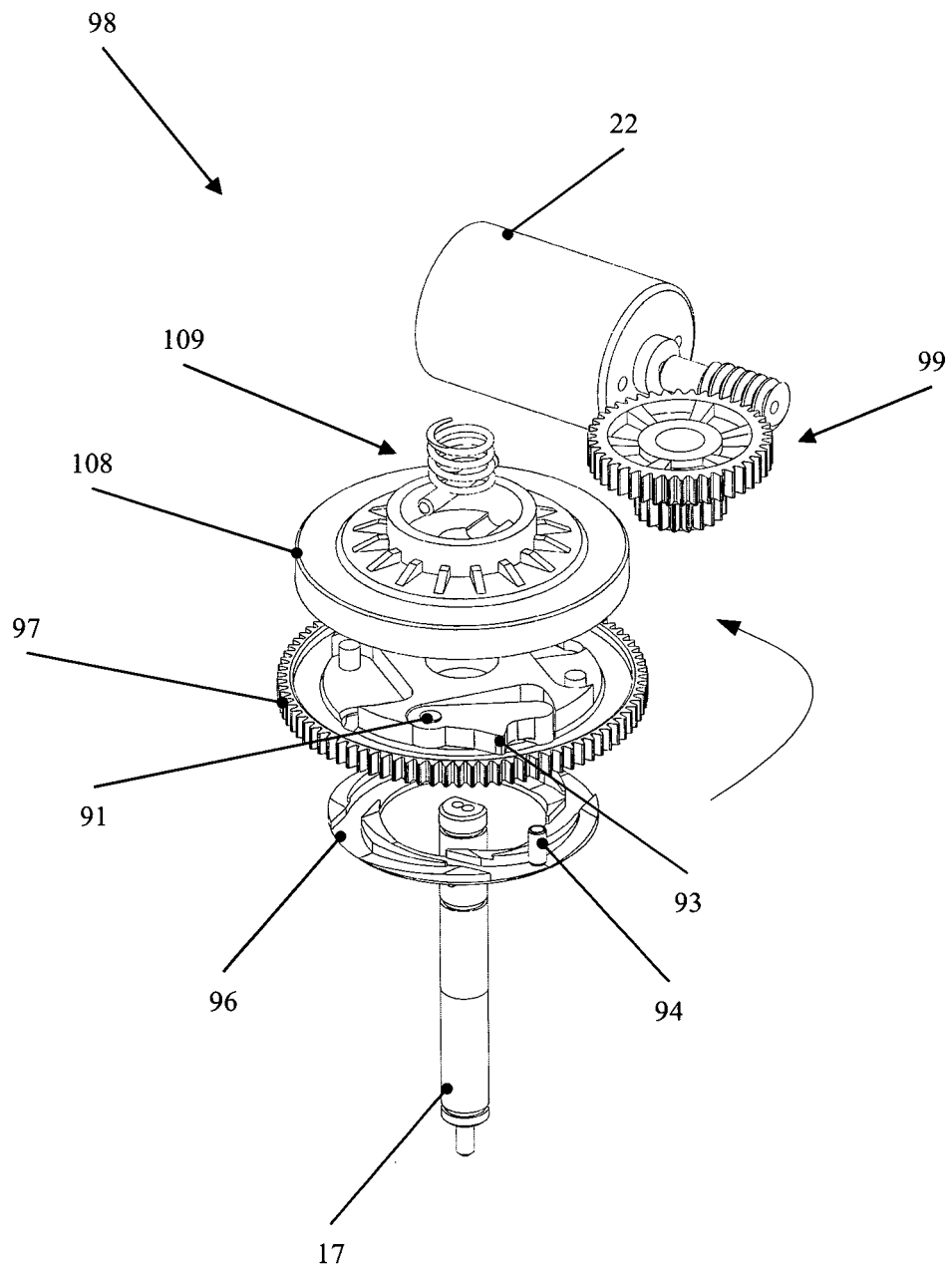


FIG. 5

FIG. 6 A

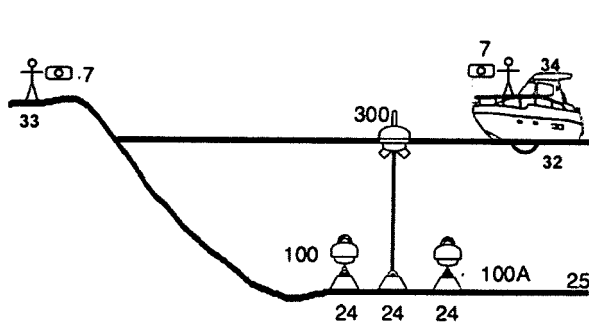


FIG. 6 B

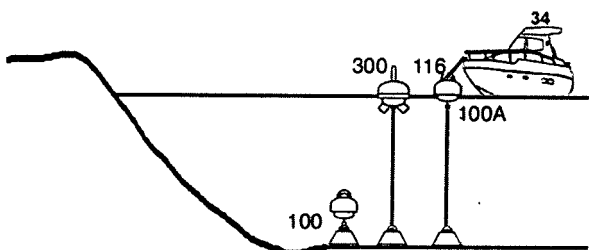
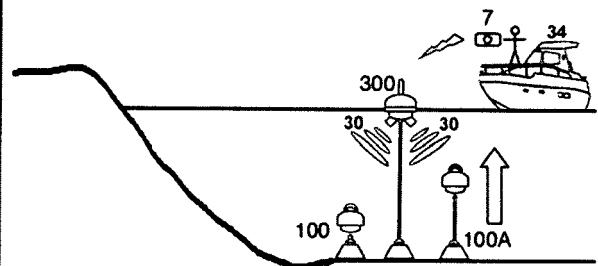


FIG. 6 C

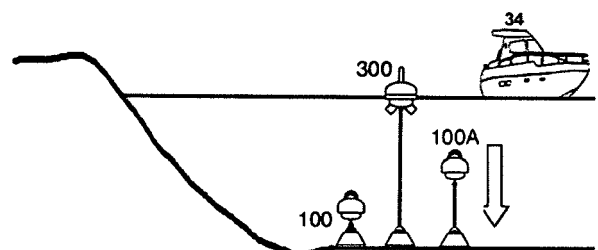


FIG. 6 D



EUROPEAN SEARCH REPORT

Application Number

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DOCUMENTS CONSIDERED TO BE RELEVANT			
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A	WO 2020/229708 A1 (IP BUOYS S L [ES]) 19 November 2020 (2020-11-19) * paragraphs [0028] - [0031], [0038], [0039], [0068]; claim 4; figures 1-3 *	1-8	INV. B63B22/02 B63B22/06 B63B21/50
A	EP 2 990 323 A1 (PME SAS DI DE SANTI INVANO & C [IT]) 2 March 2016 (2016-03-02) * paragraphs [0053] - [0063], [0069]; claims 1,5; figures 6-12 *	1-8	
A	WO 2011/096901 A1 (SKLAD NEPREMICNIN D O O [SI]; GRIVIC BORIS [SI]) 11 August 2011 (2011-08-11) * page 9, paragraph 2 - page 10, paragraph 3; figures 1-3 *	1-8	
A	DE 10 2019 125238 A1 (KABON MORITZ [AT]; PROSSER MARTIN [AT]) 25 March 2021 (2021-03-25) * paragraphs [0010] - [0012]; figures 4-6 *	1-8	
			TECHNICAL FIELDS SEARCHED (IPC)
			B63B
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 3 October 2022	Examiner Mauriès, Laurent
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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