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(71) Applicant: **Alford IP Limited**

Trowbridge, Wiltshire BA14 0XG (GB)

(72) Inventor: **GALE, Clive**

Trowbridge, Wiltshire BA14 7PF (GB)

(74) Representative: **Bryers LLP**

7 Gay Street

**Bath, Bath and North East Somerset BA1 2PH
(GB)**

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(54) **MINE NEUTRALISATION SYSTEM**

(57) A tethered naval mine neutralisation system is provided and comprises a neutralising charge, means for engaging the charge on a mine mooring beneath a mine and means for causing the charge to move to or towards a mine.

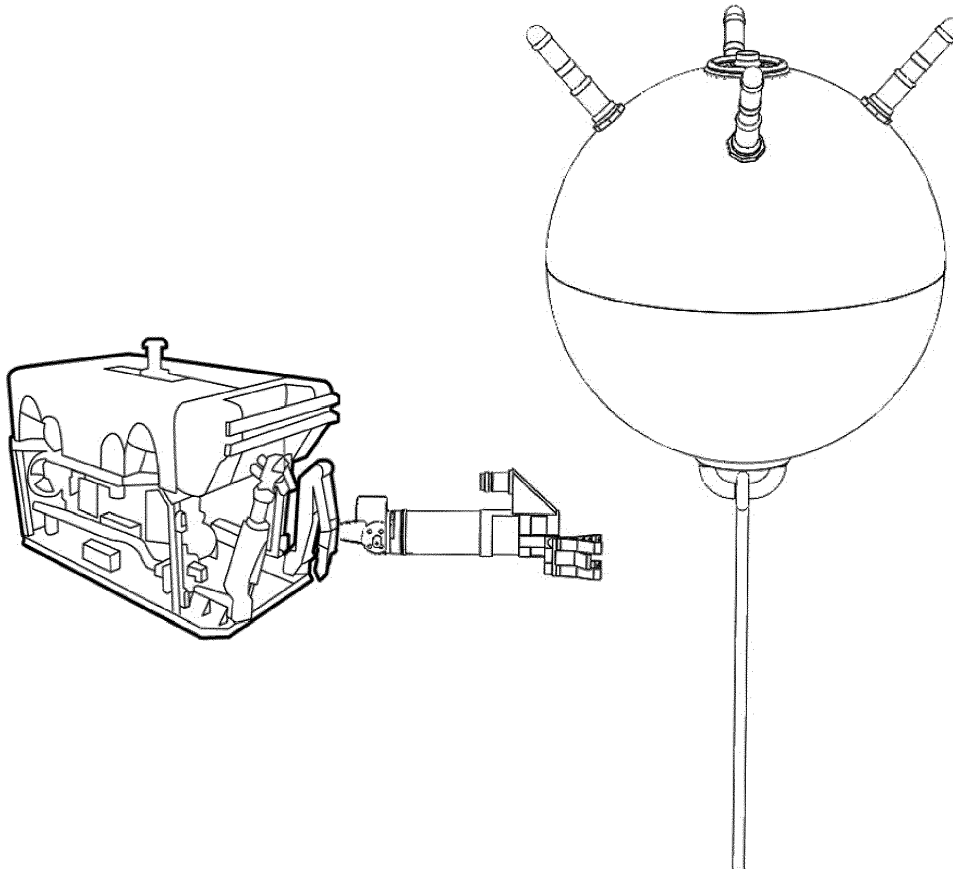


Figure 13

EP 3 851 368 A1

Description

[0001] The present invention relates generally to the field of naval mines and particularly, although not exclusively, to a system and/or method and/or apparatus for neutralising naval mines.

[0002] A naval mine is a self-contained explosive device placed in water to damage or destroy surface ships or submarines.

[0003] One type of naval mine is a moored mine: a contact or influence-operated mine of positive buoyancy held below the surface by a mooring/tether that is attached, for example, to a sinker or anchor on the sea bottom.

[0004] Some aspects and embodiments of the present invention relates to a system for attaching a device, such as a neutralising explosive charge, to an object, such as a moored or floating mine. The invention also relates to a deployment system for deploying a device and attaching it to an object. The invention relates to a disposal charge deployment system for ordnance neutralisation.

[0005] Different types of ordnance disposal systems are known, and enable remote, i.e. remote from a vessel such as a mine countermeasures vessel (MCMV), operation. Examples of such known systems are diver placed charges, remotely operated single charge systems, and multiple charge deployment systems.

[0006] The diver placed charges may be attached to the ordnance by a variety of means such as a rope, or mechanical fixings, etc and can be triggered by a variety of means such as a timer, or a flash exploder. Diver placed charges are inherently dangerous for the diver, and time consuming to clear an area containing the ordnance to be disposed.

[0007] Remotely operated charge systems provide the advantage over diver placed charges that a human is not required to enter the area containing the ordnance. A means of simplifying and speeding up attachment by diver or a fully remote method may be preferable.

[0008] It is therefore an object of the present invention to provide a system for ordnance neutralisation which reduces the cost, and time, associated with ordnance neutralisation, while improving accuracy and safety. It is a further object of the present invention to provide an effective system for attaching a device, such as a charge device, to an object, such as ordnance.

[0009] An aspect of the present invention provides a tethered naval mine neutralisation system comprising a neutralising charge, means for engaging the charge on a mine mooring beneath a mine and means for causing the charge to move to or towards a mine.

[0010] A further aspect provides a floating mine disposal system comprising an unmanned underwater vehicle, means for carrying a neutralising charge, means for engaging a floating mine tether distant from a mine, and means for moving a charge up the tether to a mine.

[0011] There are various ways a charge could be brought into proximity with a mine and/or moved to the

tether and/or moved up the tether. For example using a diver and/or an unmanned vehicle.

[0012] The system may comprise a clamp, clip or the like for engaging a charge, directly or indirectly, onto a mooring/tether.

[0013] There are various different ways the charge could be moved up to the mine. For example an ROV may be used to actively move the charge upwards, for example by crawling up the mine tether. Alternatively or additionally the system may comprise buoyancy means for causing a charge to rise up. For example the vehicle and/or charge may be attached to a tether and then floated up to the mine from underneath.

[0014] The system may comprise means for attaching a charge to a mine, for example a nail gun.

[0015] The charge may be carried on or by an unmanned vehicle.

[0016] In some embodiments the charge is a shaped charge.

[0017] The charge may be movable from a tether engaged position to a firing position. In some embodiments the firing position is generally vertical.

[0018] The present invention also provides a method for neutralising a tethered naval mine comprising the steps of: providing a neutralising charge, locating a naval mine tether, attaching, directly or indirectly, the charge to the tether at a point beneath a mine, moving the charge (or causing the charge to be moved) up the tether to the mine.

[0019] The charge may be carried on or by an unmanned vehicle.

[0020] The present invention also provides a method for neutralising a tethered naval mine comprising the steps of: providing an unmanned vehicle carrying a neutralising charge, locating a naval mine tether, attaching, directly or indirectly, the charge and/or the unmanned vehicle to the tether at a point beneath a mine, moving the unmanned vehicle up the tether to the mine.

[0021] The method may comprise the step of attaching the charge to the mine. For example the charge may be physically attached to the mine e.g. using a nail gun or the like. Alternatively or additionally the charge may be positioned immediately adjacent, adjacent or spaced from the mine.

[0022] The method may further comprise the step of detaching the unmanned vehicle.

[0023] The method may further comprise the step of activating the charge to neutralise the mine.

[0024] The unmanned vehicle may, for example, be an autonomous underwater vehicle or a remotely operated vehicle.

[0025] The method may further comprise the step of detaching the unmanned vehicle.

[0026] The vehicle may be an underwater vehicle: a marine craft that can operate below sea level.

[0027] In systems and methods of the present invention the unmanned vehicle may be an autonomous underwater vehicle (AUV) or a remotely operated vehicle

(ROV).

[0028] An AUV is often pre-programmed to complete a mission. Once the AUV is deployed in the water they take their own decision, complete the task and return back by themselves (autonomously). They can be programmed in that way and trained but once programming and training is done sufficiently they are self-capable to complete mission without human help.

[0029] The AUV may follow a pre-programmed set of movements/actions and/or may have intelligence of its own.

[0030] An ROV is deployed in the water and operated remotely by human sitting outside using some wired or wireless communication and remote control. ROVs can be fully remote or may be tethered to the control system - i.e. a wire/umbilical connects the ROV to the operator's controls.

[0031] In some embodiments an attachment system is deployed to "clamp" a mine neutralisation system (MNS) Charge, directly to the mine mooring cable, below the mine. The MNS is then aimed vertically through the bottom of the mine. This technique can offer several advantages over attachment by known systems:

- Attachment to the mooring cable reduces the risk of accidental impact with the mine case and subsequent risk of mine actuation by the mine's contact or influence firing systems.
- A Shaped Charge, aimed upwards, in line with the mooring cable will always be in an optimum position to hit the explosive section in most known moored mines.
- A Shaped Charge has a degree of stand-off capability through sea water and will be effective, even if not in direct contact with the mine case.
- In some embodiments the arming depth for the Charge may be approximately 0.5m deeper than the bottom of the mine case; a positive advantage if the mine is moored close to the surface.
- In other embodiments a similar system is used but with a nail gun, for example.

[0032] In some variants a clamp fixes on and then the charge rotates vertically so that it is pointing "up" towards the mine. That means that the ROV swims with a pointed thing it aims at the cable even though the final orientation needs to be vertical. In some embodiments the charge is a shaped charge, but need not be.

[0033] In one embodiment a clamp has a series of barbs that reduce the gap the closer they are to the charge. This means when the clamp is pushed it will find its own natural fixing point for a particular diameter of cable or rope.

[0034] Different aspects of the present invention may be used separately or together.

[0035] Further particular and preferred aspects of the present invention are set out in the accompanying independent and dependent claims. Features of the depend-

ent claims may be combined with the features of the independent claims as appropriate, and in combination other than those explicitly set out in the claims.

[0036] Referring now to the drawings, wherein like reference numbers are used to designate like elements throughout the various views, several embodiments of the present invention are further described by way of example.

[0037] The example embodiments are described in sufficient detail to enable those of ordinary skill in the art to embody and implement the systems and processes herein described. It is important to understand that embodiments can be provided in many alternate forms and should not be construed as limited to the examples set forth herein.

[0038] Accordingly, while embodiment can be modified in various ways and take on various alternative forms, specific embodiments thereof are shown in the drawings and described in detail below as examples. There is no intent to limit to the particular forms disclosed. On the contrary, all modifications, equivalents, and alternatives falling within the scope of the appended claims should be included. Elements of the example embodiments are consistently denoted by the same reference numerals throughout the drawings and detailed description where appropriate.

[0039] Unless otherwise defined, all terms (including technical and scientific terms) used herein are to be interpreted as is customary in the art. It will be further understood that terms in common usage should also be interpreted as is customary in the relevant art and not in an idealised or overly formal sense unless expressly so defined herein.

[0040] In the following description, all orientational terms, such as upper, lower, radially and axially, are used in relation to the drawings and should not be interpreted as limiting on the invention.

[0041] Figures 1 to 7 show a mine neutralisation system formed in accordance with the present invention.

[0042] This embodiment is formed as a moored mine cable clamp attachment system.

[0043] In Figure 1 an ROV makes a generally horizontal approach to a moored mine, in this embodiment just below the lower mine hemisphere. The mouth of the cable clamp is pushed onto the mine mooring cable by the ROV using forward thrust (Figure 2).

[0044] In this embodiment the cable clamp has a tapered body with flexible teeth. The teeth fold back as the mooring cable is forced past them, and then spring back into position, behind the cable (figure 3). In the centre of the Cable Clamp, there is also a springloaded Locking Clamp that pushes back against the cable until the cable is pushed into the V-of the clamp and can go no further (Figure 4).

[0045] Figures 5 and 6 illustrates release of the clamping assembly from the ROV. The ROV releases the cable clamp and backs off. In this embodiment, following release the mine neutralisation system rotates approxi-

mately 90° from a generally horizontal to a generally vertical position (Figure 5). The MNS locks into a generally vertical firing position, allowing it to be deployed (Figure 6).

[0046] Figure 7 illustrates some further, optional, design considerations that may form part of embodiments of the present invention.

[0047] Figures 8 to 11 show a mine clamp system formed according to a further embodiment. The drawings show Approach (Figure 8), initial Clamp position (Figure 9), the movement from the horizontal to the vertical attack position (Figure 10) and the attack position (Figure 11). The charge, in this embodiment being a shaped charge, can be moved to the mine, for example using a diver and/or an unmanned vehicle.

[0048] Figure 12 shows a diver-based system.

[0049] Figure 13 shows an ROV-based system.

[0050] Referring to Figure 14 there is shown a moored naval mine comprising a seabed anchor 5, a mooring cable 10 and a floating mine 15.

[0051] An ROV 20 is provided and carries a neutralising explosive charge 25. The ROV 20 is equipped with a clamp 30.

[0052] The ROV manoeuvres to the cable 10 and the clamp 30 engages onto the cable 10 (beneath the mine 15), as shown in Figure 15.

[0053] The ROV then moves upwards, using the cable/tether 10 until it reaches the mine 15, as shown in Figure 16. Moving up to the mine from underneath using the tether 10 avoids mine horns 16. The charge 25 is then attached to the mine 15, for example using an on-board nail gun.

[0054] The ROV then detaches from the charge, as shown in Figure 17, before the charge is detonated to neutralise the mine.

[0055] There are a variety of different ways a system of this type could be used, for example:

- the entire apparatus remains with the mine for detonation (including the ROV); or
- the ROV detaches from the mine, leaving the charge plus the fixing means (e.g. nail gun) and/or cable/tether attachment means; or
- the ROV, including cable/tether attachment means and/or charge securing means detach.
- a diver moves a charge plus tether attachments means to the tether then the charge is attached to the tether and moves/moved up the tether into a position in preparation for firing.

[0056] In other embodiments (not shown) the ROV detaches from a sub-assembly comprising the charge once it is attached to a mooring cable. The subassembly then moves up to the mine. When the charge reaches the mine it may or may not be secured thereto before deto-

nation.

[0057] Although illustrative embodiments of the invention have been disclosed in detail herein, with reference to the accompanying drawings, it is understood that the invention is not limited to the precise embodiments shown and that various changes and modifications can be effected therein by one skilled in the art without departing from the scope of the invention.

Claims

1. A tethered naval mine neutralisation system comprising a neutralising charge, means for engaging the charge on a mine mooring beneath a mine and means for causing the charge to move to or towards a mine.
2. A floating mine disposal system comprising an unmanned underwater vehicle, means for carrying a neutralising charge, means for engaging a floating mine tether distant from a mine, and means for moving a charge up the tether to a mine.
3. A system as claimed in claim 1 or claim 2, comprising a clamp, clip or the like for engaging a charge onto a mooring/tether.
4. A system as claimed in any preceding claim, comprising buoyancy means for causing a charge to rise up.
5. A system as claimed in any preceding claim, comprising means for attaching a charge to a mine.
6. A system as claimed in claim 5, in which the attachment means comprise a nail gun.
7. A system as claimed in any preceding claim, in which the charge is carried on or by an unmanned vehicle.
8. A system as claimed in any preceding claim, in which the charge is a shaped charge.
9. A system as claimed in any preceding claim, in which the charge is movable from a tether engaged position to a firing position.
10. A system as claimed in claim 9, in which the firing position is generally vertical.
11. A method for neutralising a tethered naval mine comprising the steps of: providing a neutralising charge, locating a naval mine tether, attaching, directly or indirectly, the charge to the tether at a point beneath a mine, moving the unmanned vehicle up the tether to the mine.

12. A method for neutralising a tethered naval mine comprising the steps of: providing an unmanned vehicle carrying a neutralising charge, locating a naval mine tether, attaching, directly or indirectly, the charge and/or the unmanned vehicle to the tether at a point beneath a mine, moving the charge up the tether to the mine. 5
13. A method as claimed in claim 11 or claim 12, comprising the step of attaching the charge to the mine. 10
14. A method as claimed in any of claims 11 to 13, comprising the step of detaching the unmanned vehicle.
15. A method as claimed in any of claims 11 to 14, in which the unmanned vehicle is an autonomous underwater vehicle or a remotely operated vehicle. 15

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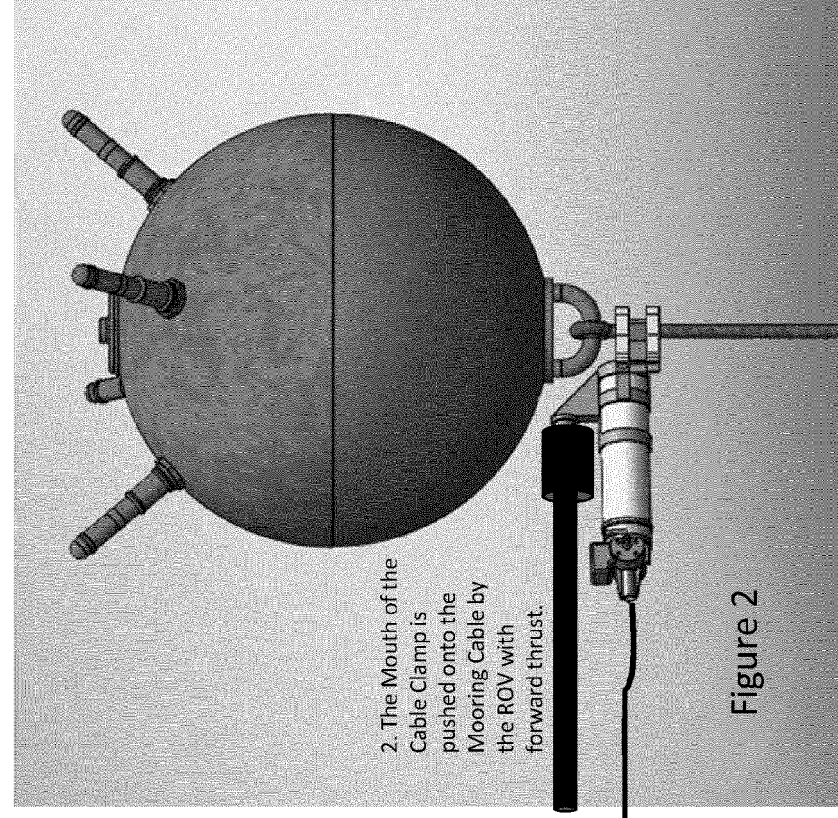
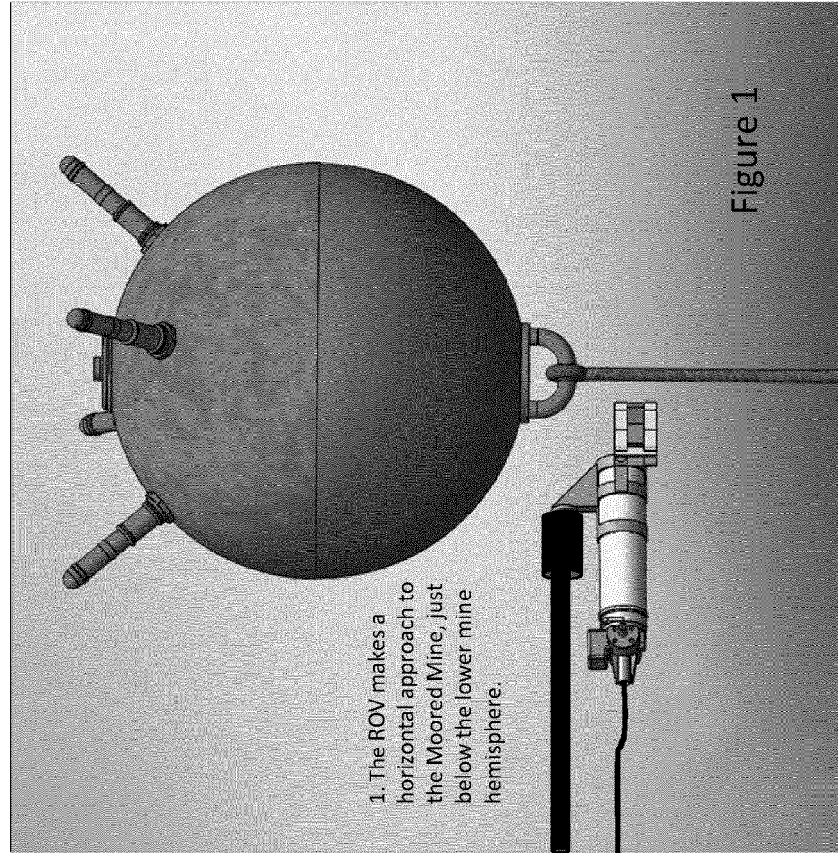
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MNS Charge Attachment using a Mine Cable Clamp:



Mine Clamp

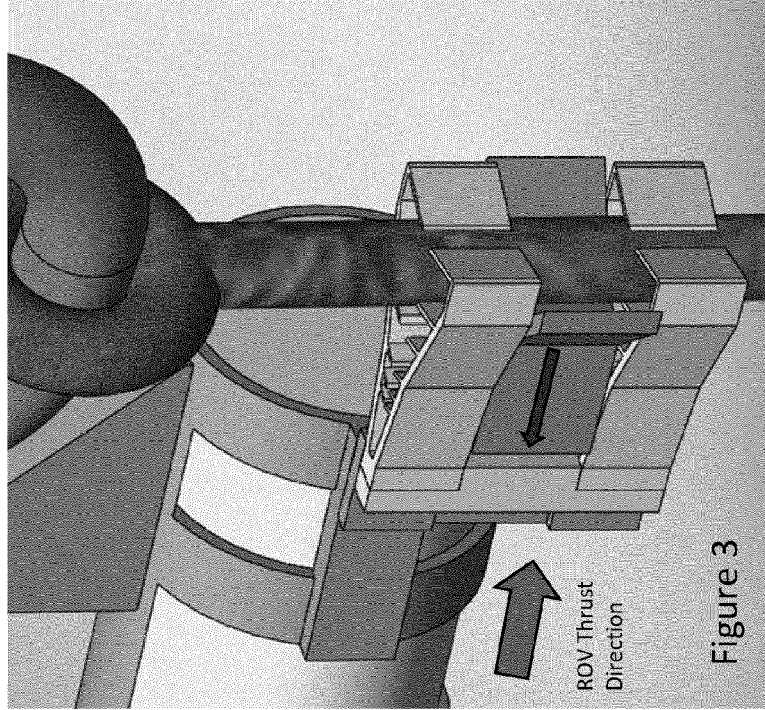


Figure 3

The Cable Clamp has a tapered body with flexible teeth. The teeth fold back as the mooring cable is forced past them, and then spring back into position, behind the cable.

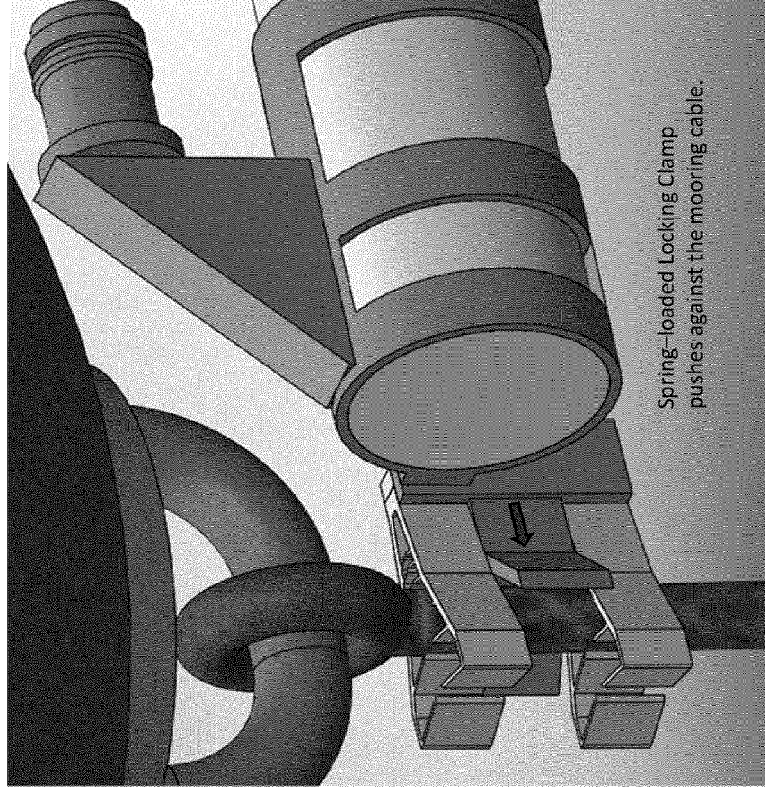
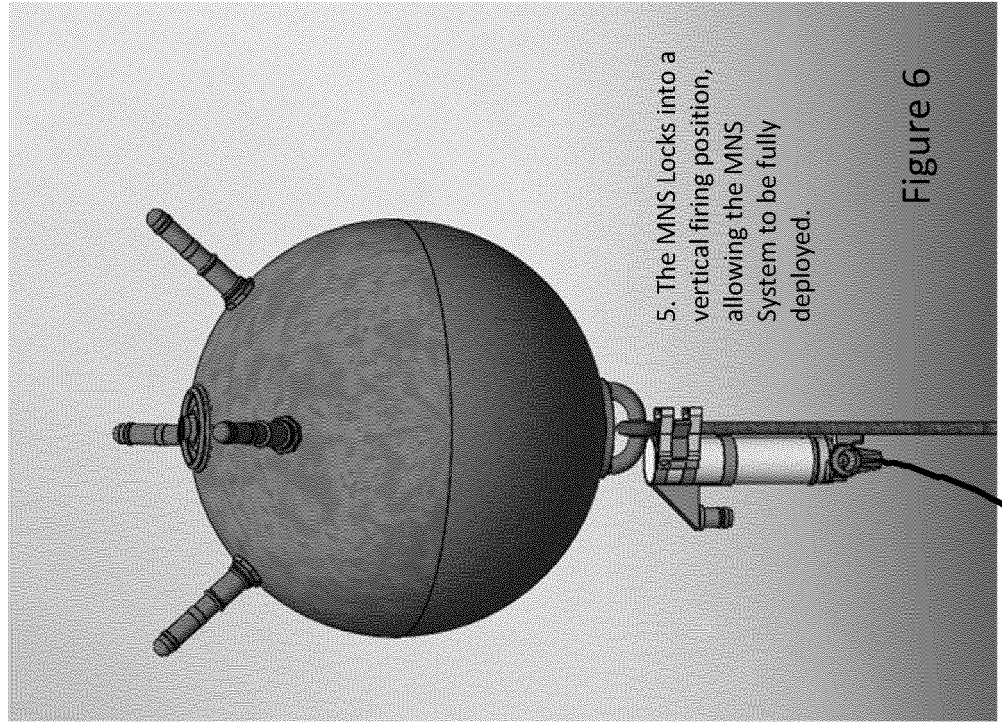
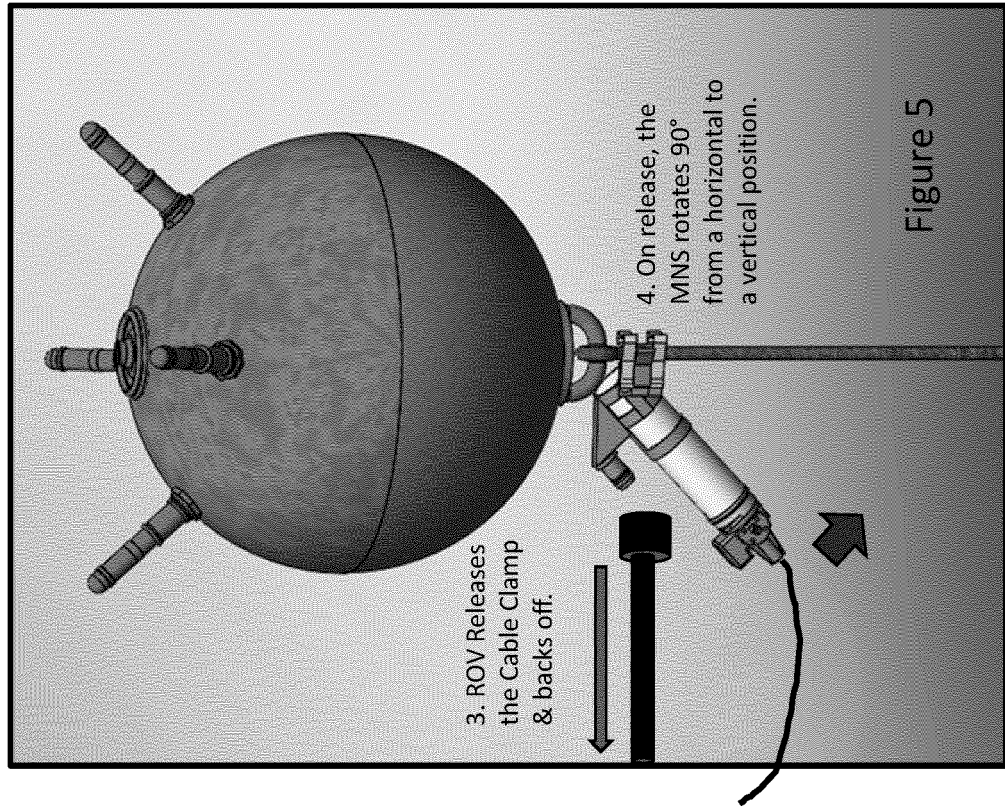


Figure 4

In the center of the Cable Clamp, there is also a spring-loaded Locking Clamp that pushes back against the cable until the cable is pushed into the V-of the clamp and can go no further.

Mine Cable Clamp - Release From The ROV

EP 3 851 368 A1



Other Possible Design Considerations:

- The Cable Clamp must be capable of firm attachment to a variety of mooring cable types. Typically small diameter wire (approx 5 -10mm) or synthetic rope, but also mine mooring systems that incorporate mooring chain or a swivel or shock absorber feature.
- It must be capable of being move upwards towards the mine, but not able to slide down the mooring cable.
- The design may be be non-magnetic and manufactured in materials that will not be reactive to Galvanic or UEP mine firing systems.

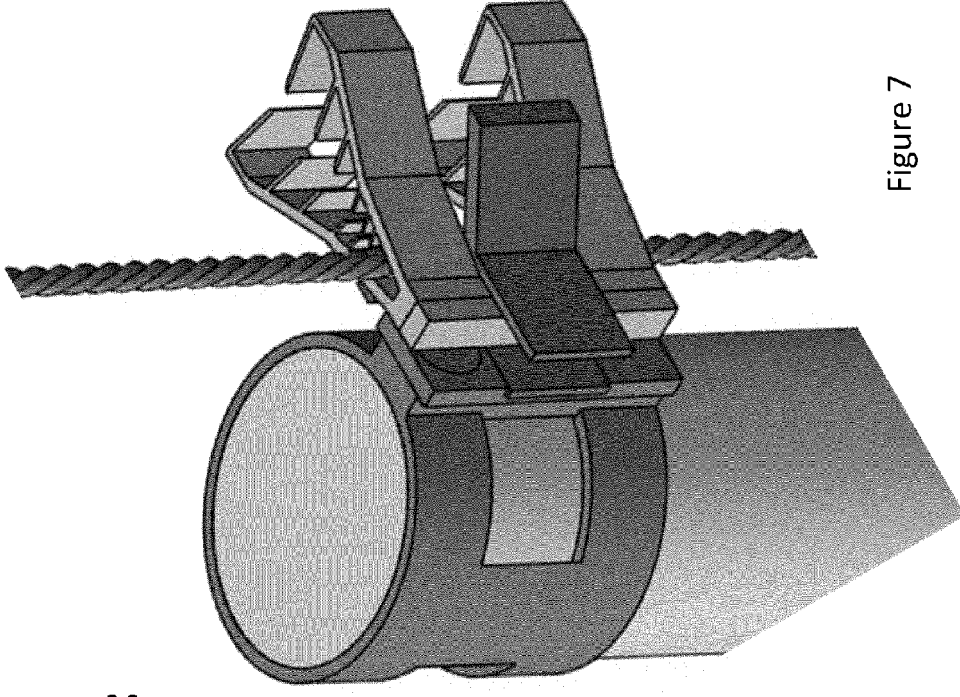


Figure 7

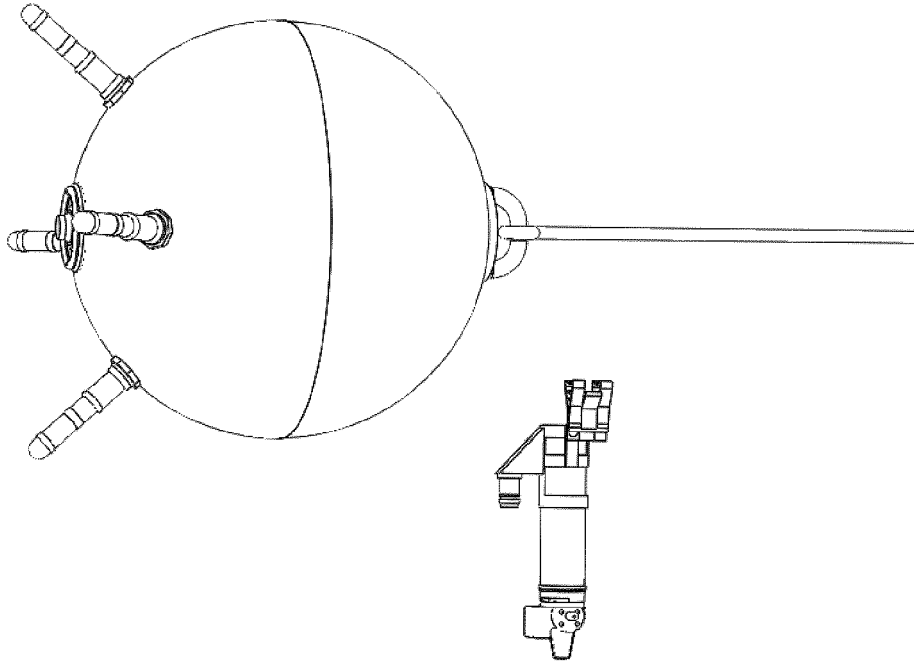


Figure 8

Approach to Target

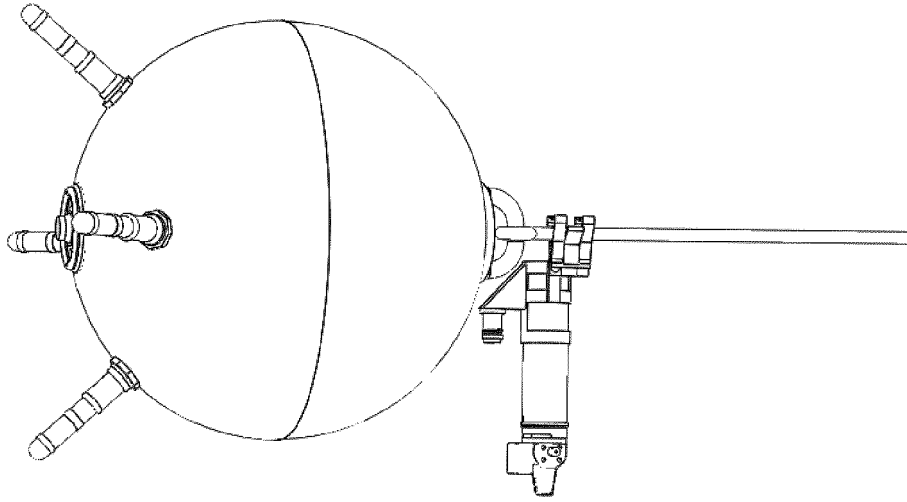


Figure 9

Initial Clamp Position

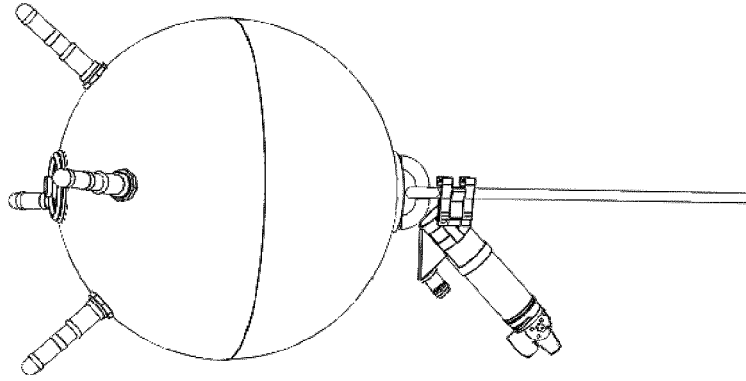


Figure 10

Moves from Horizontal to Attack Position

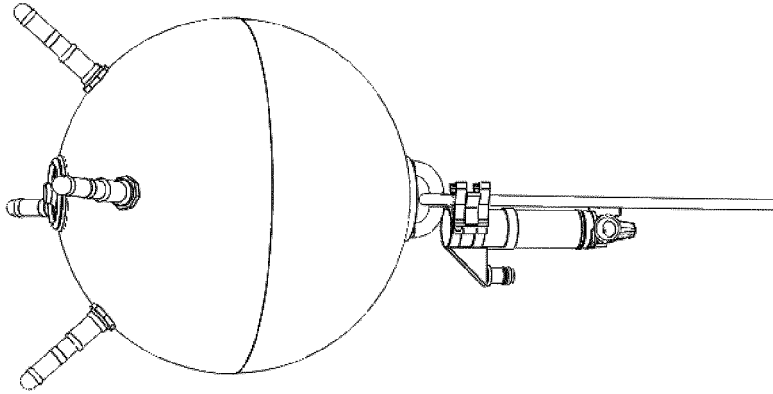


Figure 11

Attack Position

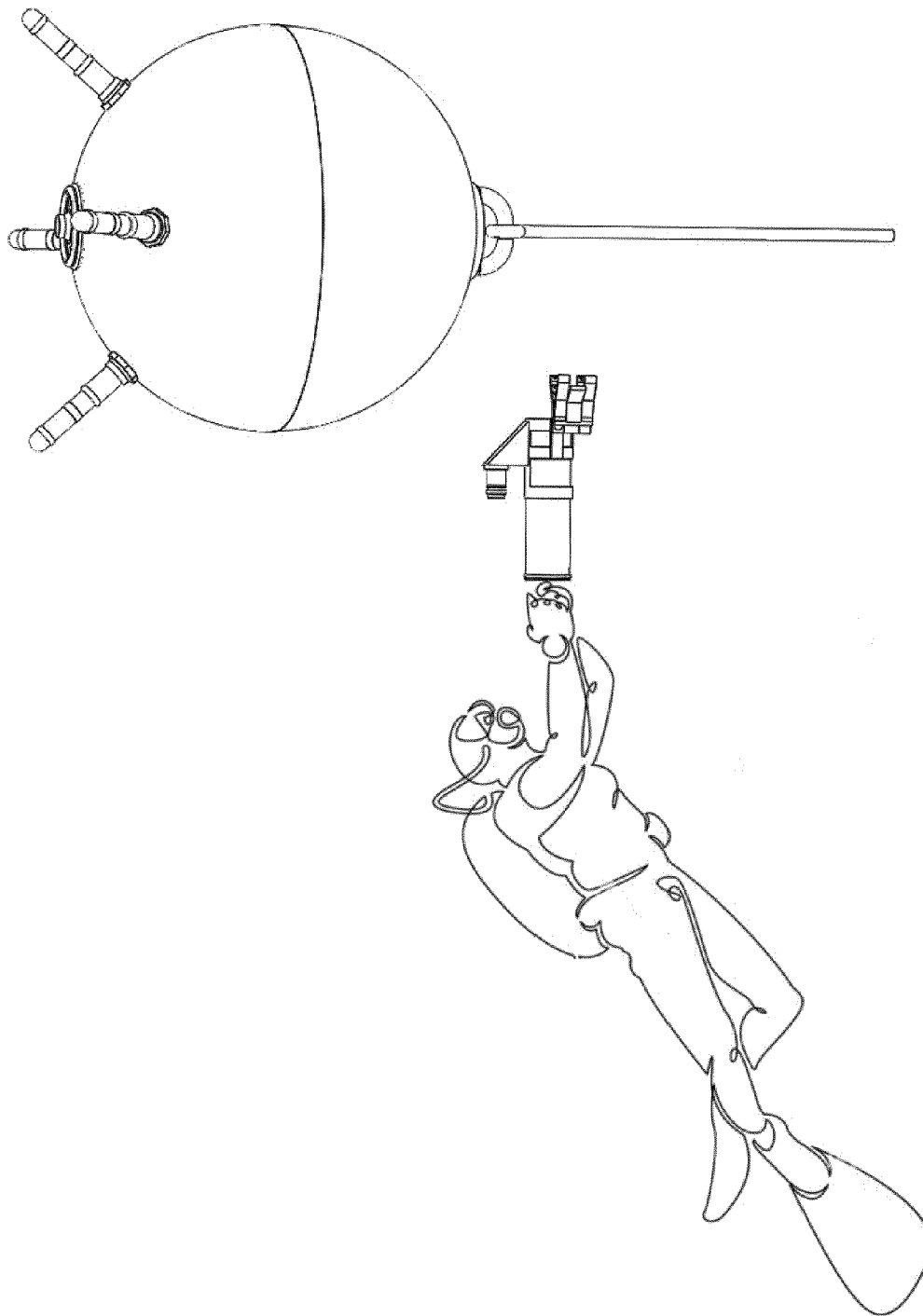


Figure 12

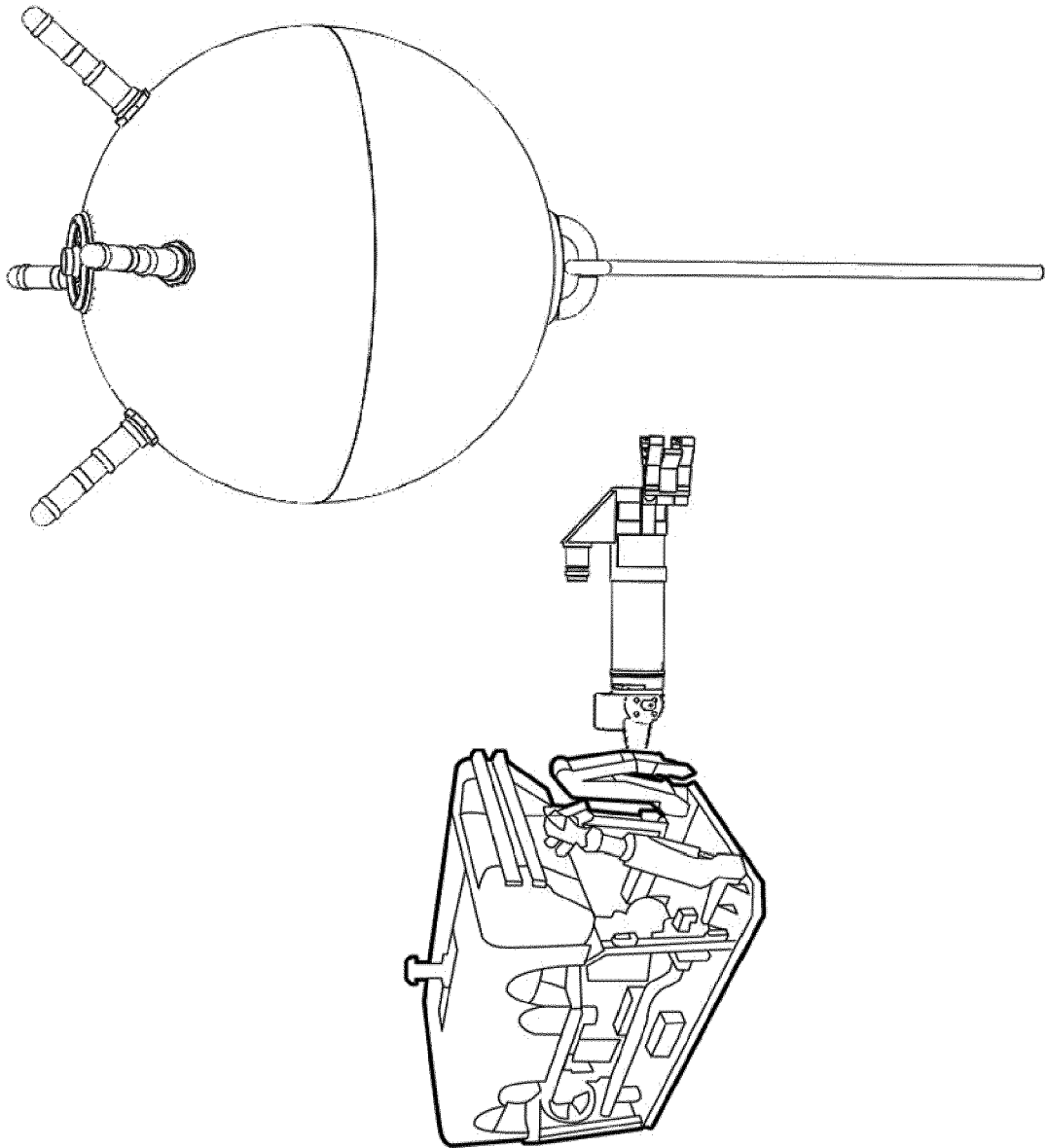


Figure 13

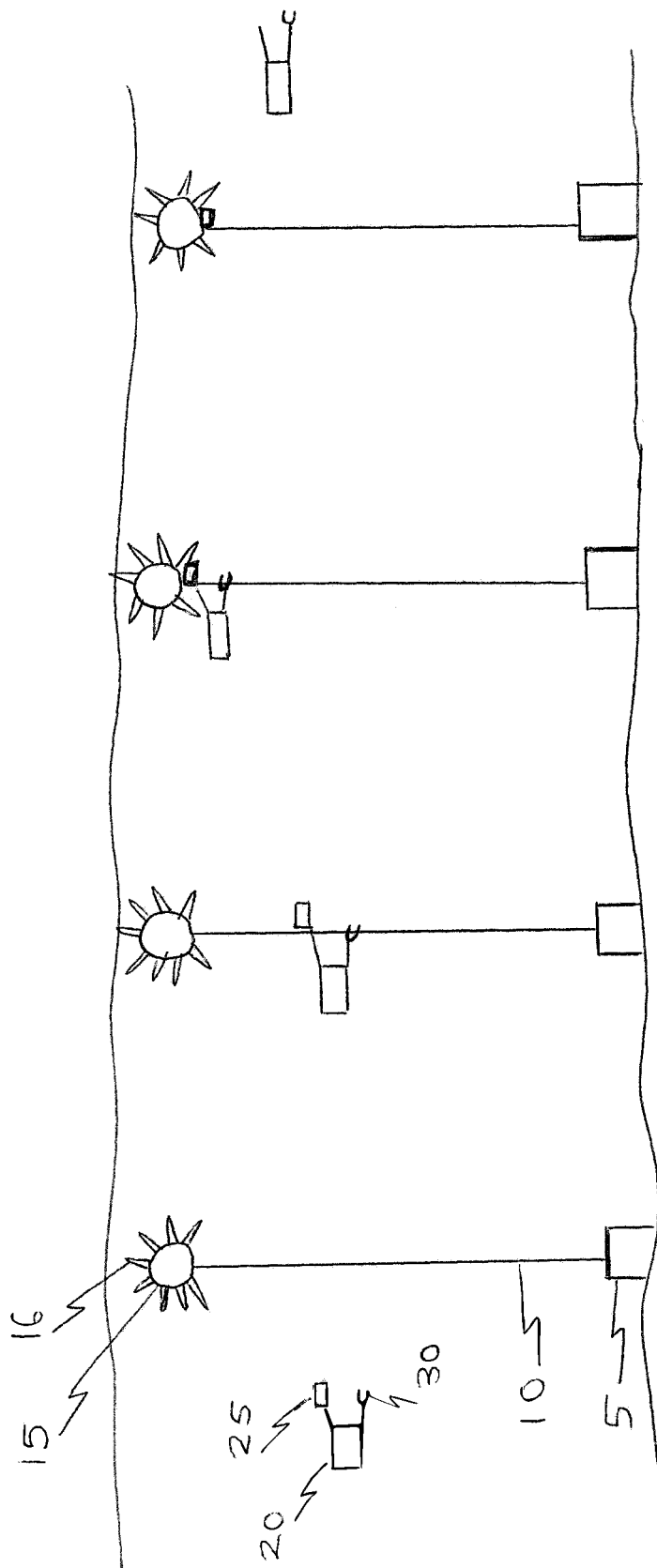


Figure 14

Figure 15

Figure 16

Figure 17



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Application Number
EP 21 15 0003

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Place of search The Hague		Date of completion of the search 27 May 2021	Examiner Freire Gomez, Jon
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			

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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The members are as contained in the European Patent Office EDP file on
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