Nov. 10, 1936. J. H. HAMMOND, JR 2,060,200

PHOTOELECTRIC DETONATOR OPERATED BY REFLECTION

Filed Jan. 5, 1934 3 Sheets-Sheet 1

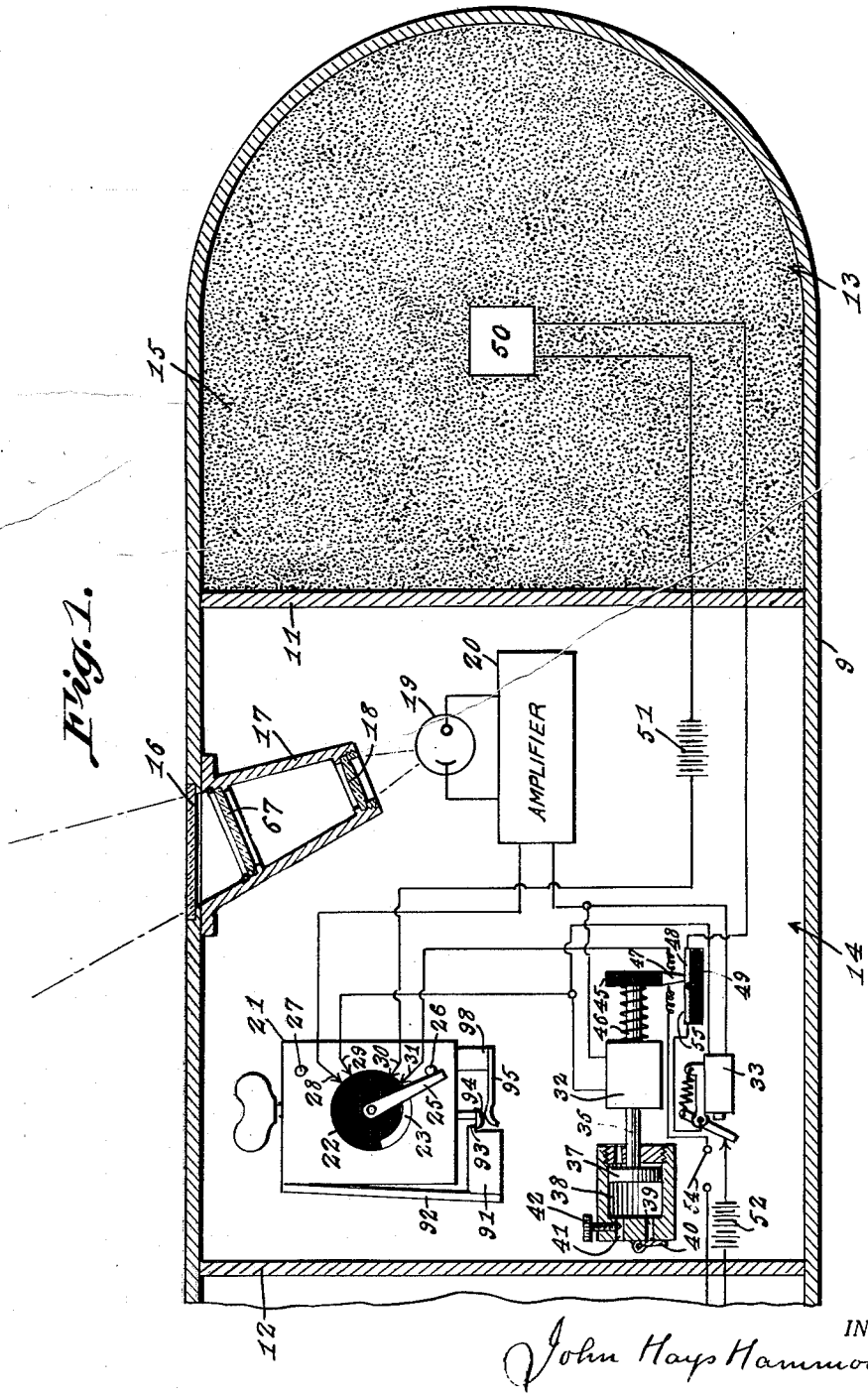


Fig. 1.

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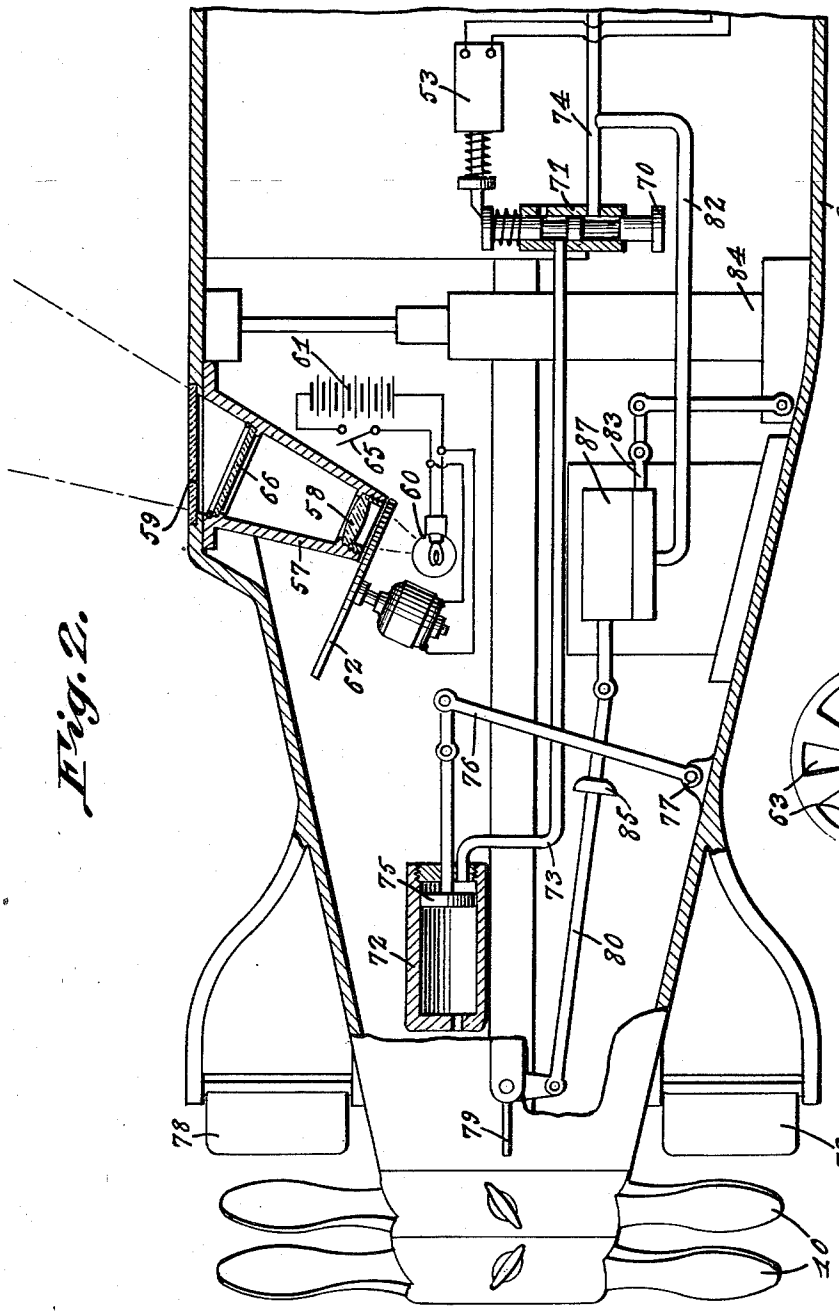


Fig. 2.

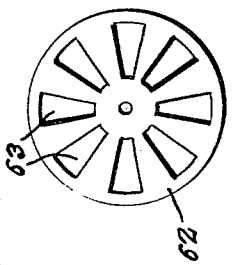


Fig. 4.

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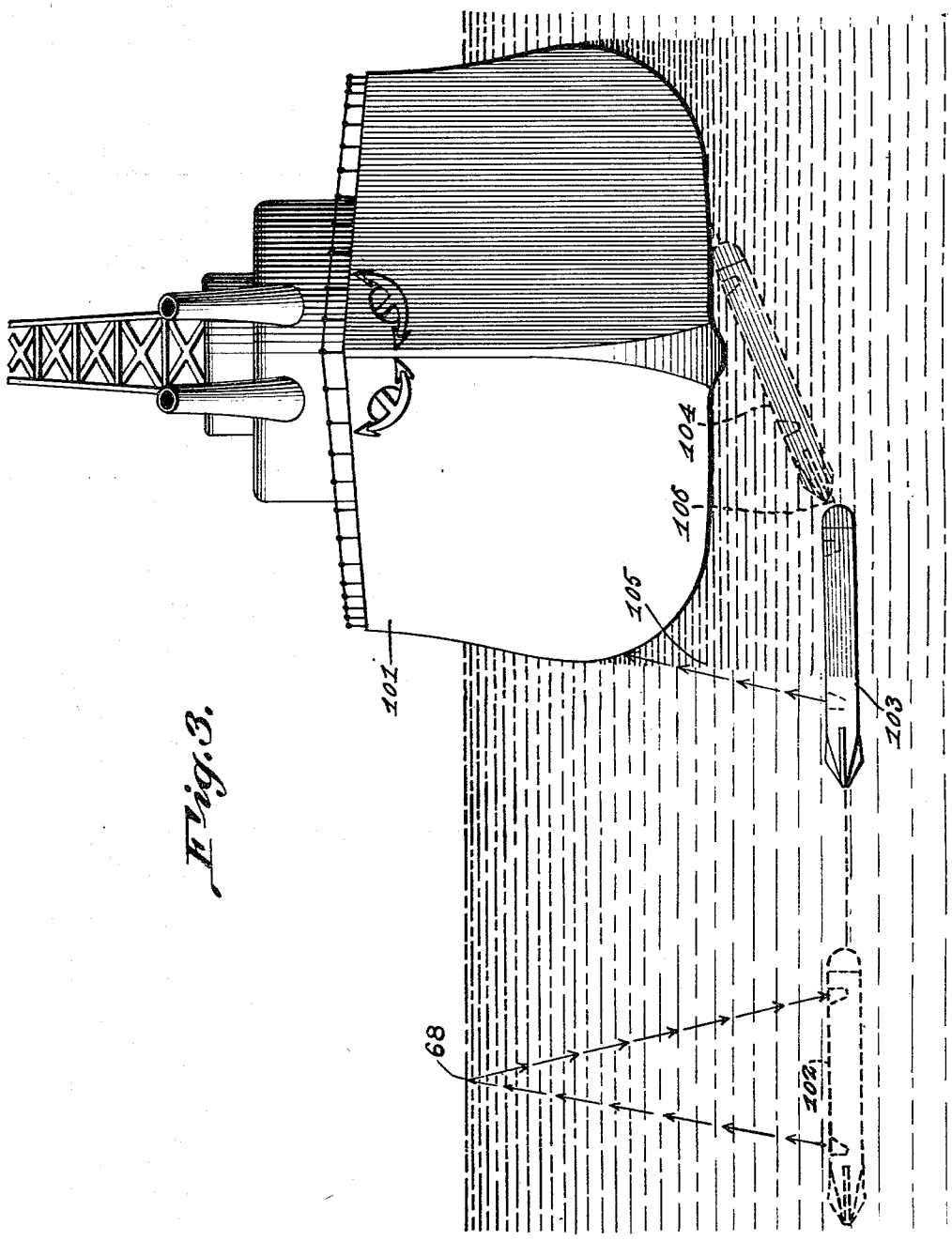


Fig. 3.

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2,060,200

PHOTOELECTRIC DETONATOR OPERATED BY REFLECTION

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Application January 5, 1934, Serial No. 705,355

15 Claims. (Cl. 114—21)

This invention relates to ordnance devices and more particularly to torpedoes.

According to one form of the invention, a torpedo may be provided with a light sensitive device which controls the detonation of the explosive charge thereof when it passes beneath a ship. The torpedo mechanism may include a photoelectric cell which is energized by a light source in the torpedo itself, the cell being so positioned that it will receive illumination from the light source after it has been reflected from the under surface of the water through which the torpedo is travelling. The light sensitive element may be arranged to control the direction of travel of the torpedo and the detonation of the explosive charge therein responsive to a cessation of light received. Thus, when the torpedo passes beneath the ship, the light from the light source will be absorbed by the hull and the light sensitive device will be no longer illuminated whereby the above results are accomplished.

Means may be provided for imposing a predetermined frequency upon the light emitted and for tuning the light receptive device to this frequency. The emitted light may be an invisible radiation to prevent the observance by the enemy of the approach of the torpedo at night.

The invention also consists in certain new and original features of construction and combinations of parts hereinafter set forth and claimed.

Although the novel features which are believed to be characteristic of this invention will be particularly pointed out in the claims appended hereto, the invention itself, as to its objects and advantages, the mode of its operation and the manner of its organization may be better understood by referring to the following description taken in connection with the accompanying drawings forming a part thereof, in which—

Figure 1 represents diagrammatically the forward portion of a torpedo provided with this invention.

Figure 2 represents diagrammatically the afterbody of the same torpedo.

Figure 3 diagrammatically illustrates the course of a torpedo attacking an enemy vessel, and

Figure 4 shows a detail of the mechanism shown in Fig. 2.

Like reference characters denote like parts in the several figures of the drawings.

In the following description and in the claims, parts will be identified by specific names for convenience, but they are intended to be as generic in their application to similar parts as the art will permit.

Referring to the accompanying drawings, and more particularly to Figs. 1 and 2, there is shown a water-borne body such as a carrier of explosives having a water-tight torpedo hull 9, and arranged to be propelled in the usual manner by propellers 10 located at the after end. The hull 9 is provided with two transverse bulkheads 11 and 12, thus providing two compartments 13 and 14, the former being filled with an explosive charge 15, such for example as TNT.

A hole is provided in the hull 9 at the top of the compartment 14. This hole is covered by a sheet of glass or other transparent material 16. Mounted in a tube 17 is a lens 18 which is positioned below the hole in the hull. The interior of the tube 17 is painted a flat black so as not to reflect any light. Positioned at the focus of the lens 18 is a photoelectric cell 19 which is connected in the input circuit of an amplifier 20.

A clock-work mechanism 21 is provided which drives a commutator 22. This commutator is provided with a conducting segment 23. To the shaft of the commutator is secured an arm 25 which normally engages a pin 26. A second pin 27 is provided for limiting the motion of the arm 25 and the commutator 22.

Engaging the commutator 22 are four brushes 28, 29, 30 and 31. The brush 28 is connected to one side of the output circuit of the amplifier 20. The brush 29 is connected to one side of a solenoid 32 and to one side of a relay 33, the other side of which is connected to the other side of the amplifier 20 and to the other side of the solenoid 32.

The solenoid 32 is provided with a core 36 which is adapted to be moved to the left as shown in Fig. 1 when this solenoid is energized. Secured to one end of this core is a piston 37 which reciprocates in a cylinder 38. This cylinder is provided with a port 39 covered by a flap valve 40 which is adapted to allow the air to escape rapidly from this cylinder. The cylinder is also provided with a port 41 the opening in which is controlled by a needle valve 42 for restricting the flow of air through this port.

To the other end of the core 36 is secured an insulating member 45 between which and the solenoid 32 is mounted a compression spring 46. Mounted on the insulating member 45 is a contact 47 which is connected to the contact 31 and at suitable times engages a conducting segment 48 mounted on an insulating base 49. The segment 48 is connected to one side of a detonator 50, the

other side of which is connected to the contact 30 through a battery 51. The back contact of the relay 33 is connected through a battery 52 to one side of a solenoid 53 located in the after body of the torpedo as shown in Fig. 2. The other side of the winding of this solenoid is connected through a switch 54 to the contact 47. A conducting segment 55 is provided in the insulating block 49 and is connected to the armature of the relay 33.

The core of the solenoid 53 normally engages a valve 70 which is mounted for reciprocation in a valve casing 71. The interior of this valve casing communicates with the interior of a cylinder 72 by means of a pipe 73. Also communicating with the interior of the valve casing 71 is a pipe 74 which is supplied with fluid under pressure from any suitable source (not shown). Slidably mounted in the cylinder 72 is a piston 75 which is operatably connected to an arm 76 which is pivoted for rotation about an axis 77 supported by the shell of the torpedo.

The torpedo is provided with the usual vertical and horizontal rudders 78 and 79. The latter are operated by means of a link 80 from the horizontal steering engine 87 which is supplied with fluid under pressure from a pipe 82 and is controlled by a valve 83 operated in a well-known manner from the depth control mechanism 84. Secured to the link 80 is a collar 85 which is located in the path of travel of the arm 76.

For automatically starting the clock-work mechanism 21 a heavy weight 91 is secured to the end of a flat spring 92 the upper end of which is fastened to the casing of the clock-work mechanism 21. The weight 91 is provided with a projection 93 which normally engages a finger 94 which controls the starting of the clock-work mechanism. Engaging the end of the finger 94 is a spring 95 which is supported on a bracket 98.

In the afterbody, shown in Fig. 2, is mounted a tube 57 in the lower end of which is secured a lens 58. A hole is cut in the hull of the torpedo above the tube 57 and is covered with a plate of glass 59 or other transparent material. Mounted at the focus of the lens 58 is a lamp 60 or other source of illumination, which receives energy from a battery 61. A motor driven rotary disc shutter 62 is provided, if desired, for breaking up the light beam into a plurality of impulses of a predetermined frequency depending on the speed of the motor and the number of openings 63 in the disc, as shown in Fig. 4. The light 60 and the shutter 62 are controlled by a switch 65. When the shutter 62 is used the amplifier 20 is tuned to the frequency produced in the light beam by the shutter.

If desired two filters 66 and 67 may be mounted in the tubes 57 and 17 respectively, so that the system may be operated with invisible light, such as ultra-violet or infrared, and thus make it impossible for the enemy to observe the approach of the torpedo.

In the operation of this system when the torpedo is fired the inertia of the weight 91 causes it to be moved backward relative to the torpedo thus disengaging the projection 93 from the finger 94 which is moved upwardly under the action of the spring 95 thus causing the clock-work mechanism to start turning the commutator 22 at a predetermined speed. Switch 54 is closed before firing. The circuit through the solenoid 53 will be open however, as the brush 47 does not make contact with the segment 55. After a predetermined interval of time the segment 23 of the commutator 22 will engage the brushes 28 and 29 thus connecting the amplifier 20 to the solenoid 32 and the relay 33 both of which will be energized, as the photoelectric cell 19 will by this time be receiving the light from the lamp 60. This illumination occurs due to the light from lamp 60 being reflected from the under surface of the water as shown at 68 in Fig. 3 and focused upon the cell 19 by means of the lens 18. On energization of solenoid 32 the core 36 will move rapidly to the left as the air in the cylinder 38 is freely exhausted through the port 39. The contact 47 moves off of the segment 48 thus keeping the circuit to the detonator 50 open. The solenoid 53 will still remain deenergized due to the opening of its circuit by the relay 33.

This condition continues as long as the photoelectric cell 19 receives reflected light from the lamp 60. When the torpedo passes beneath an enemy ship, however, the light will be cut off from the photoelectric cell 19 due to its being absorbed by the hull of the enemy ship, thus causing the deenergization and release of the relay 33 and the solenoid 32. The former action closes the circuit through the solenoid 53 as the contact 47 is then in engagement with the segment 55. This causes the core of solenoid 53 to be moved to the right thus releasing the valve 70 which is moved upwardly under the action of a spring surrounding this valve which allows the fluid under pressure to pass from the pipe 74 through the pipe 73 to the interior of the cylinder 72. This causes the piston 75 to be moved to the left, thus rotating the arm 76 in a counter clockwise direction. This arm engages the collar 85 and forces it together with the link 80 to the left against the action of the steering engine 87 thus throwing the horizontal rudders 79 into the hard-up position which causes the torpedo to be steered sharply upward.

The deenergization of the solenoid 32 allows the core 36 to be moved slowly to the right under the action of the spring 46, the speed of this motion being determined by the setting of the needle valve 42. After a predetermined interval of time the contact 47 will engage the segment 48 thus closing a circuit from the battery 51 through the segment 23 and contact 47 to the detonator 50 which is detonated thereby exploding the charge of explosive 15 in the war head of the torpedo.

This explosion will take place directly under the center of the ship and in contact with the hull as the mechanism has been so timed that it will give the torpedo a sufficient time to reach a position under the center of the ship and the horizontal rudders will have directed the torpedo upwardly so that it is in contact with the hull of the ship.

If it is desired to operate the system without the use of the horizontal rudders the switch 54 may be opened thereby causing the solenoid 53 to remain inoperative so that the horizontal rudders will not be effected.

Fig. 3 shows a torpedo of this construction attacking the enemy's ship. In this figure the enemy vessel is pictured at 101 and 3 positions of the torpedo at 102, 103 and 104 respectively. In the position shown at 102 the torpedo is running submerged at the required depth and the photoelectric cell is energized by light received by reflection from the under surface of the water. At 103 the torpedo is shown entering the shadow 105 of the hull of the vessel 101. At this instant the illumination of the photoelectric cell 19 has

been shut off by the absorption of the light by the hull of the enemy vessel and the operation of the horizontal rudders just described has been initiated causing the torpedo to follow the course indicated by the dotted line 106 until it reaches the position shown at 104 when the explosive charge will be detonated directly under the center of the ship and in contact with the hull thereof thus insuring the destruction of the enemy vessel.

It is thus seen that a system has been developed that is self contained and is independent of light from an external source and is equally effective during the day or night. It is also selective and invisible, so that it can not be interfered with or observed by the enemy.

In order to prevent the premature explosion of the torpedo in the event that it should pass under some floating debris and thereby momentarily occult the light sensitive means, any type of well known delay action circuit may be incorporated in the amplifier 20, so as to make it necessary for the photoelectric cell 19 to be occulted for an appreciable length of time before the operation of the mechanism will be initiated.

An important advantage of this system of running torpedoes at considerably greater depths than are now used is the fact that at these depths the wakes are much farther behind the torpedoes when they come to the surface due to the longer time it takes the bubbles of air to rise to the surface and that the wakes are much less conspicuous due to the fact that the air has had a longer time to become diffused in the water. It is, therefore, much more difficult to observe and locate these torpedoes than those run at present-day depths.

The photoelectric cell 19 may be of the new type developed by the Weston Instrument Company and the Westinghouse Electric and Manufacturing Company in which case the amplifier 20 may be replaced by a sensitive tuned relay, which controls the circuits of the solenoid 32 and the relay 33. These new cells generate sufficient current to operate a sensitive relay directly without the use of an amplifier or a battery. A condenser may be shunted across the relay or any other well known device may be employed to delay the operation of the relay, so that the mechanism will not be operated by a momentary occultation of the photoelectric cell, such as would be caused by the torpedo passing under floating debris. The tuned relay may be of any well known construction such as the vibrating reed type and is tuned to the frequency of the light source.

By using longer waves it is possible to achieve the same results. In this case the light source 60 would be a source of heat of any suitable form radiating through suitable lenses 58 and 66 and being received thru the lenses 67 and 18 by a bolometer substituted for the photoelectric cell 19. The effects of the received energy could likewise be amplified by any standard method.

Although only a few of the various forms in which this invention may be embodied have been shown herein, it is to be understood that the invention is not limited to any specific construction, but might be embodied in various forms without departing from the spirit of the invention or the scope of the appended claims.

What is claimed is:

1. In a moving body, an explosive charge, means for detonating said charge, a source of illumination, a light sensitive device for operating said detonating means so that when the illumination on said device is changed it will cause the detonation of said explosive charge and means for preventing the detonation of said explosive charge for a predetermined time after the launching of said body.

2. In combination with a submarine body, an explosive charge carried thereby, a source of illumination on said body, light receptive means for receiving the light from said source of illumination after reflection from the surface of the water and means for exploding said charge when the light received by said light receptive means is varied.

3. In combination with a submarine body, an explosive charge carried thereby, a source of invisible illumination on said body, light receptive means for receiving the invisible light from said source of illumination after reflection from the surface of the water and means for exploding said charge when the light received by said light receptive means is varied.

4. In combination with a body suspended in a medium, an explosive charge carried thereby, a source of illumination on said body, light receptive means for receiving the light from said source of illumination after reflection from the surface of said medium and means for exploding said charge when the light received by said light receptive means is varied.

5. In combination with a moving body a utility carried thereby, means for operating said utility under the influence of light produced on said body, and means for preventing said operation for a predetermined interval of time.

6. In a moving body, a source of illumination thereon, an explosive charge, means for detonating said charge, a light sensitive device for operating said detonating means so that when the illumination on said device is changed it will cause the detonation of said explosive charge and means for preventing the detonation of said explosive charge for a predetermined time after the illumination on the light sensitive device has been changed.

7. In combination with a moving body, a source of illumination thereon, an explosive charge, means for causing the detonation of said charge and light sensitive means for controlling said detonating means so that at a predetermined interval after the intensity of illumination of said light sensitive means is changed it will cause the detonation of said explosive charge.

8. In combination with a submarine body, an explosive charge carried thereby, a source of radiation on said body, radiation receptive means for receiving energy from the source of radiation after reflection from the surface of the water and means for exploding said charge from the radiation received by said radiation receptive means when said radiation is varied.

9. In combination with a body suspended in a medium, an explosive charge carried thereby, a source of radiation on said body, radiation receptive means for receiving the radiation from said source of radiation after reflection from the surface of said medium, and means for exploding said charge when the radiation received by said radiation receptive means is varied.

10. In a submarine torpedo, a utility, a light source, a light sensitive device adapted to receive light from said source after reflection from the surface of the water, and means for operating said utility responsive to variations in light.

received by said device caused by the presence of an external object in the path of said light.

11. In combination with a torpedo, an explosive charge carried thereby, a source of light on said torpedo, means carried by said torpedo for receiving light from said source after passage through the surrounding water and means operated by variation of the light thus received caused by the presence of an external object for causing detonation of said explosive charge.

12. In combination with a torpedo, an explosive charge carried thereby, a source of radiation on said torpedo, means carried by said torpedo for receiving radiations from said source after passage through the surrounding water and means operated by variation in the radiations thus received caused by the presence of an external object for causing detonation of said explosive charge.

13. In combination with a torpedo, a utility carried thereby, a source of radiation on said torpedo, means carried by said torpedo for receiving radiation from said source after passage through the surrounding water and means operated by variation in the radiations thus received caused by the presence of an external object for operating said utility.

14. In combination with a torpedo, a utility carried thereby, a source of light on said torpedo, means carried by said torpedo for receiving light from said source after passage through the surrounding water and means operated by variation of the light thus received caused by the presence of an external object for operating said utility.

15. In combination with a torpedo, a utility carried thereby, a source of light of predetermined characteristics on said torpedo, means carried by said torpedo selectively responsive to light of said characteristics for receiving said light after passage through the surrounding water and means operated by variation of the light thus received caused by the presence of an external object for causing operation of said utility.

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