Nov. 10, 1936. J. H. HAMMOND, JR 2,060,206

TORPEDO

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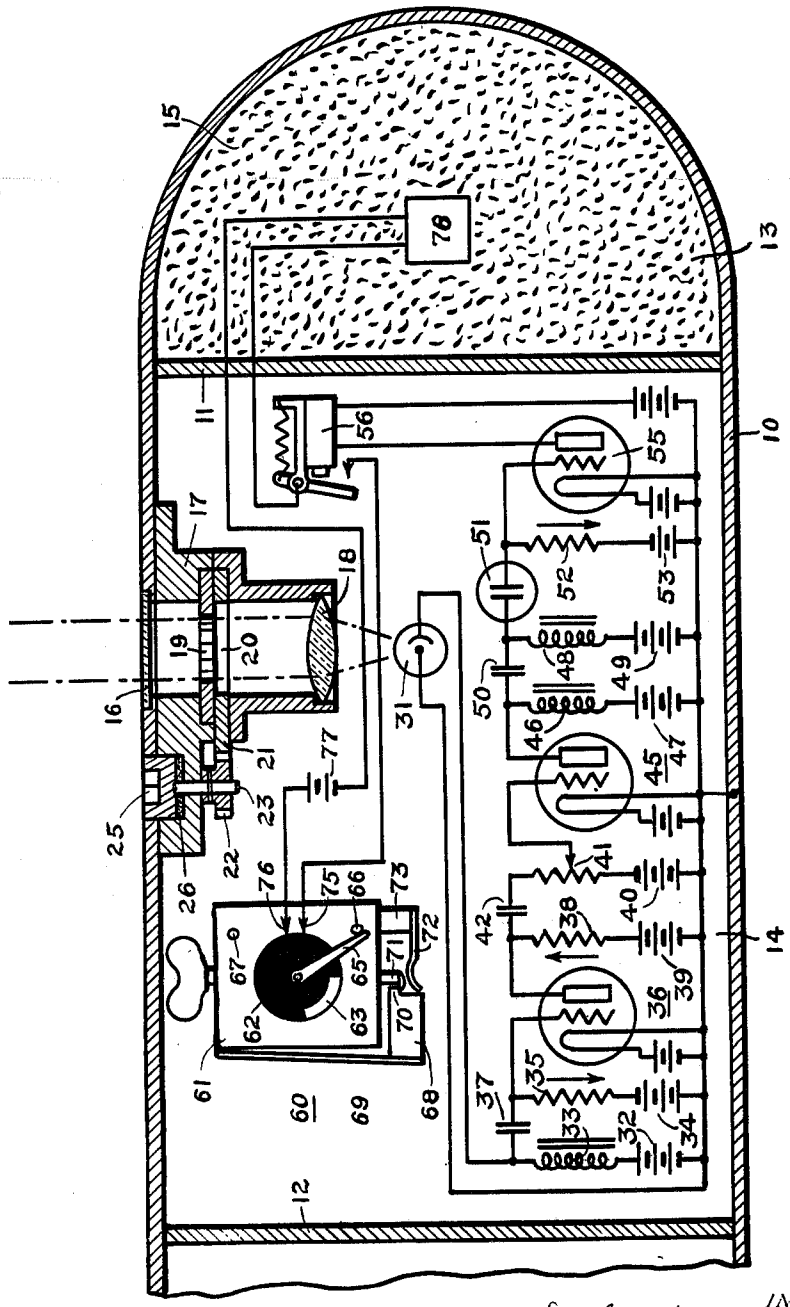


Fig. 1.

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Fig. 2.

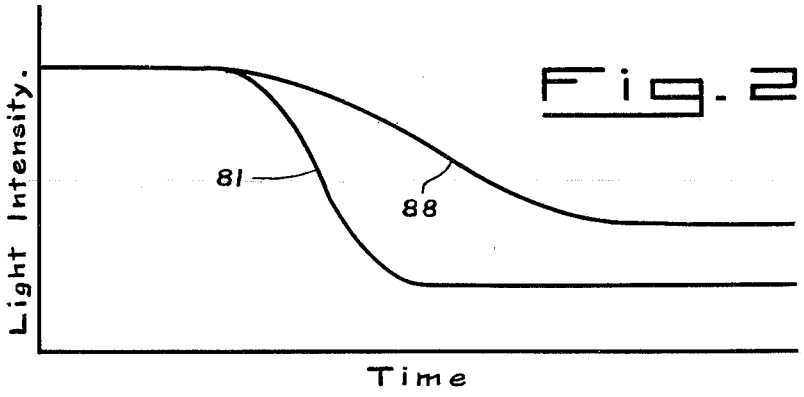


Fig. 3.

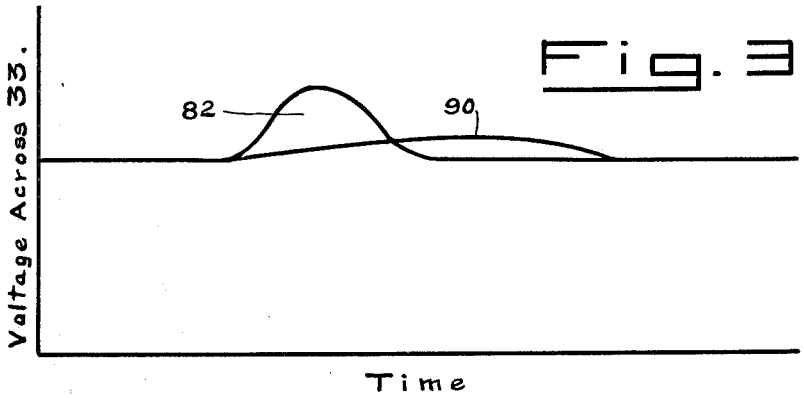
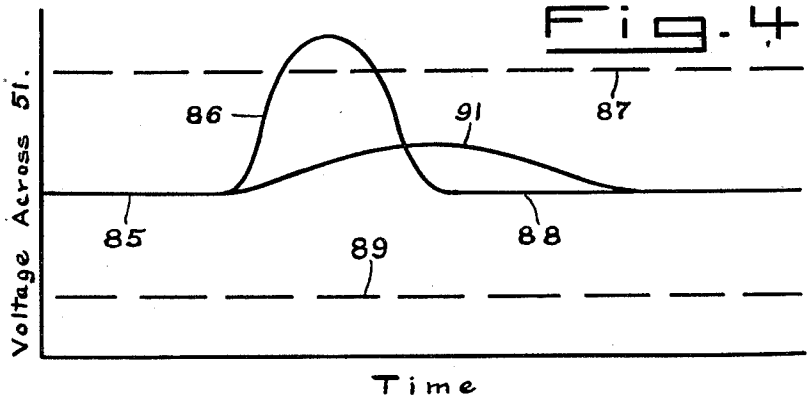


Fig. 4.



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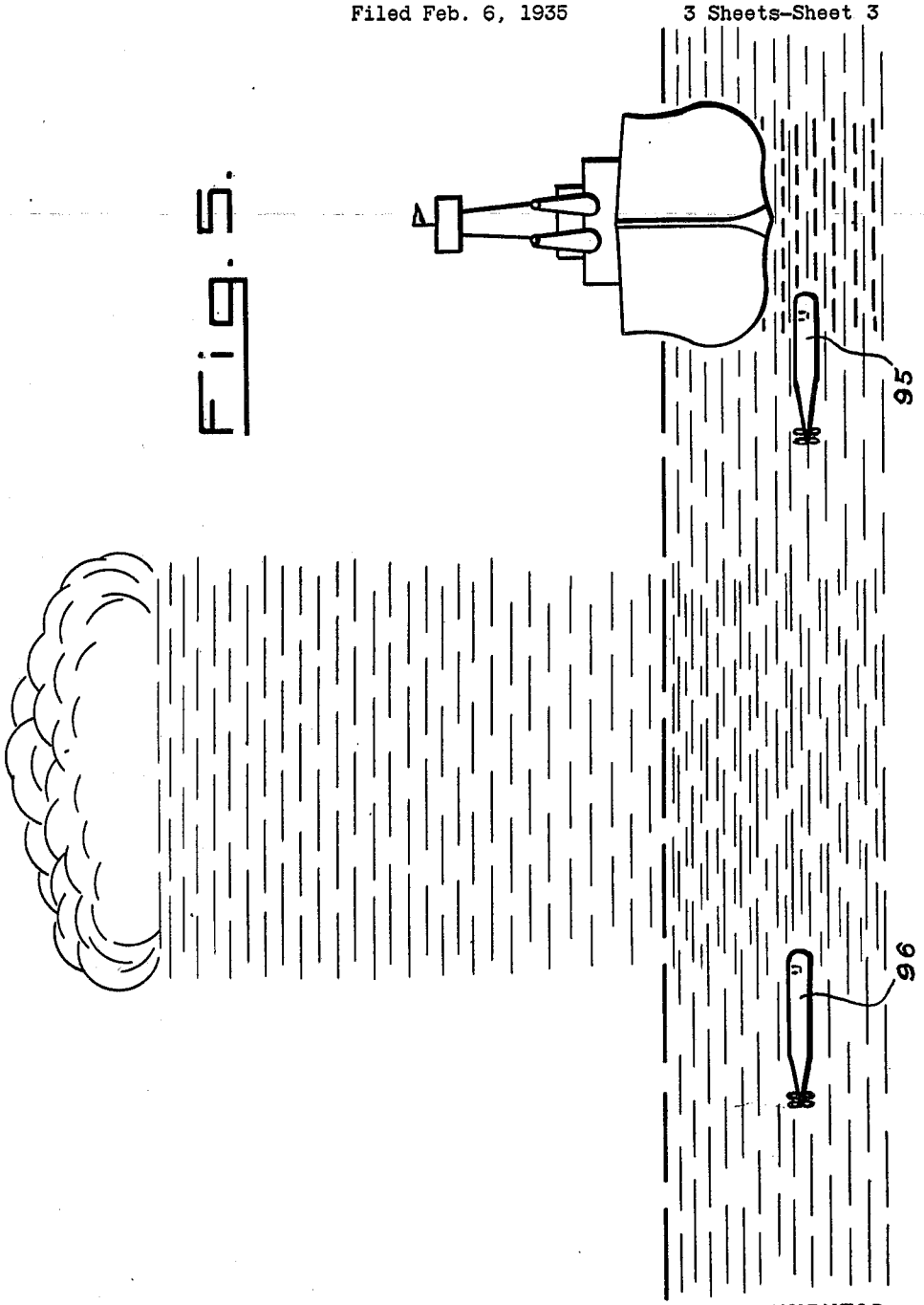
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Fig. 5.



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Patented Nov. 10, 1936 2,060,206

UNITED STATES PATENT OFFICE

2,060,206

TORPEDO

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Application February 6, 1935, Serial No. 5,221

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 is provided with a control mechanism which includes a light-sensitive device controlling the detonation of the explosive charge of the torpedo when the latter passes beneath a ship. The light-sensitive device, as for example a photoelectric cell, is energized by the light of day transmitted through the water lying above the torpedo. When the torpedo passes beneath the ship, the shadow causes the de-energization of the photoelectric cell, which energizes the control mechanism arranged to cause the detonation of the war head.

As most modern warships are provided on their sides with so-called "blisters" which make the explosion of a torpedo ineffective to cause a serious damage to the ship proper, it has been found necessary to detonate the torpedo beneath the center of a ship in order to cause any serious damage to the ship. In order to accomplish this result it is necessary to operate the torpedo at a depth several feet greater than the draft of the ship being attacked. Passage of the torpedo beneath the ship will thus be assured in spite of the unevenness of the course travelled by the torpedo, the variable draft of the enemy ship according to loading, and the effect of a seaway upon the torpedo.

The invention provides means for differentiating between the shadow effects produced by a cloud and those produced by the hull of a ship. The shadow produced by a cloud is different from that produced by a ship, as a cloud is at a greater distance from the torpedo than a ship so that its shadow is not as dense and the boundaries of it are not as clearly defined as those produced by a ship. The edge of a shadow produced by a cloud is quite diffused, due to the defraction of the light along the edges of the cloud, and due also to the light received from other parts of the sky not obscured by clouds. In the case of the shadow of a ship, however, the edge of the shadow is very clearly defined, because of the torpedo being directed in a course close to the hull of the ship. Thus the change in intensity of light illuminating the torpedo when the latter passes beneath the hull of a ship, is very rapid, whereas the change in intensity of light when the torpedo passes into the shadow of a cloud is much more gradual. The depth of the shadow beneath a ship is also greater than that produced by a cloud, as substantially all the light from above is cut off by the hull of a ship, whereas light from other portions of the sky illuminates the shadow produced by a cloud.

This invention relates to means for differentiating between the rapidity of light changes, so that when the intensity of the light which falls upon a torpedo changes rapidly, as it does when the torpedo passes beneath the hull of a ship, the detonation of the explosive charge carried by the torpedo will be effected. On the other hand, when the light intensity changes gradually, as it does when the torpedo passes into the shadow of a cloud, the mechanism controlling the detonation of the war head will not be operated.

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:

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

Fig. 2 shows various curves for changes of light intensity;

Fig. 3 depicts curves of voltage variations produced by the changes of light intensity;

Fig. 4 illustrates curves for the voltage control of a gas tube; and

Fig. 5 diagrammatically illustrates the course of a torpedo attacking an enemy vessel.

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 Fig. 1, there is shown a water-borne body such as a carrier of explosives having a water-tight torpedo hull 10, and arranged to be propelled by propellers (not shown) located at the after end. The hull 10 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.

An aperture is provided in the hull 10 at the top of compartment 14. This aperture is covered by a sheet 16 of glass or other transparent material. Mounted below the opening in the hull 10 is receptacle or tube 17, at the lower end of which is mounted a lens 18. The interior of the tube 17 is painted a flat black to prevent the reflection of any light. Mounted in the tube 17 is an iris diaphragm 19, which is controlled by a rotatable plate 20. This plate is provided at one side with a segmental gear 21 which meshes with a pinion 22 secured to a shaft 23 which is rotatably mounted in the casing of the tube 17. The upper end of the shaft 23 is enlarged to provide a square shaped socket 25. This socket projects through a circular opening in the hull 10, and is adapted to be engaged by a square shaped wrench (not shown), or other tool, for the purpose of rotating the gear 22 and thereby turning the plate 20, thereby to adjust the size of the opening in the iris diaphragm 19. This diaphragm mechanism is of a standard and well-known construction, and need not be more fully described herein. A packing 26 is provided beneath the socket 25 to provide a water-tight joint for the shaft 23.

Positioned at the focus of the lens 18 is a photoelectric cell 31, one side of which is connected to the negative terminal of a battery 32 and the other side to a choke coil 33. A bias battery 34 and a resistance 35 are connected across the input circuit of a resistance coupled amplifier 36. A condenser 37 is connected between the choke 33 and the resistance 35. The output circuit of the amplifier 36 includes a resistance 38 and a plate battery 39, across which are connected a bias battery 40, a potentiometer 41 and a condenser 42.

The potentiometer 41 is connected in the input circuit of an amplifier 45, the output circuit of which includes a choke coil 46 and a plate battery 47 across which are connected a second choke coil 48 and a battery 49. A condenser 50 is located between the chokes 46 and 48. Connected across the choke 48 and the battery 49 is a gaseous tube 51, (such as a neon lamp), a resistance 52 and a bias battery 53. The resistance 52 and the battery 53 are connected in the input circuit of a D. C. operated tube 55, the output circuit of which includes the winding of a relay 56.

A safety mechanism 60 is provided to ensure that the circuit which includes the detonator will remain open and the detonator will not be actuated until after the torpedo is launched. This mechanism includes a clock-work mechanism 61 which drives a commutator 62 having a conducting segment 63. To the shaft of the commutator 62 is secured an arm 65, which normally engages a pin 66. A second pin 67 is provided for limiting the motion of the arm 65 and the commutator 62.

For automatically starting the clock-work mechanism 61, a heavy weight 68 is secured to the end of a flat spring 69, the upper end of which is fixed to the end of the housing of the clock-work mechanism 61. The weight 68 is provided with a projection 70 which normally engages a finger 71 which controls the starting of the clock-work mechanism. Engaging the end of the finger 71 is a spring 72 which is supported on a bracket 73.

Engaging the commutator 62 are two brushes 75 and 76. The brush 75 is connected to the contact of the relay 56, and the brush 76 is connected through a battery 77 to a detonator 78 positioned in the explosive charge 15. The other side of the detonator 78 is connected to the armature of the relay 56.

In the operation of this system when the torpedo is fired, the inertia of the weight 68 causes it to be moved backward relative to the torpedo, thus disengaging the projection 70 from the finger 71 which is moved upward under the action of the spring 72, thus causing the clock-work mechanism to start turning the commutator 62 at a predetermined speed, under its own power. This rotation will continue until the arm 65 engages the pin 67, at which time the segment 63 will have moved into engagement with the brushes 75 and 76, thus connecting the detonator 78 to the relay 56. Thus, any accidental detonation of the explosive charge 15 is prevented while the torpedo is on or near the firing ship.

As the torpedo proceeds toward its objective, the photoelectric cell 31 is illuminated by the light transmitted from the sky through the water above the torpedo. In order that the photoelectric cell 31 may always receive approximately the same amount of illumination, independent of the condition of the weather, the iris diaphragm 19 may be adjusted before the torpedo is launched, by means of a wrench inserted in the socket 25, thus compensation may be made for any variations of illumination. Thus, for example, on a clear day the iris diaphragm will be set in a partially closed position, on a hazy day it will be set at a slightly more open position, and on a cloudy day it will be set at a wide open position.

With the photoelectric cell 31 receiving the normal amount of illumination, a fixed current will flow from the battery 32 through the choke coil 33 and photoelectric cell 31, this current being determined by the resistance of the cell 31 under normal illumination. Under these conditions the bias on the amplifier 36 will be determined by the voltage of the battery 34 and the resistance 35, this amplifier operating as a normal resistance coupled amplifier.

This condition is maintained until the torpedo passes beneath the hull of an enemy ship as indicated at 95 in Fig. 5, at which time the light illuminating the photoelectric cell 31 is rapidly decreased, as shown by the steep curve 81 of Fig. 2. This causes a rapid increase in the resistance of the cell 31, thus causing a rapid decrease of the current through the choke 33 which builds up a pulse of energy which depends upon the rapidity of the resistance change in cell 31. This pulse of energy is depicted by the curve 82 of Fig. 3.

This pulse of energy will pass through the condenser 37 and through the resistance 35 in the direction of the arrow, thus producing a positive potential, which will decrease the bias on the tube 36, thus allowing more current to flow through the amplifier 36 and the resistance 38 in the direction of the arrow. This will cause an increase of negative potential on the potentiometer 41, which will increase the bias on the tube 45, thereby cutting down the output current of this tube. This will cause an increase of the positive potential on the gaseous tube 51.

The steady voltage across the gaseous tube 51 is produced by the sum of the voltages of the batteries 49 and 53, as indicated by the straight line 85 in Fig. 4, and is not sufficient to break it down and let current pass. The sudden increase of positive potential on the gaseous tube 51 is indicated by the curve 86, which extends above the break down voltage of the tube, indicated by the broken line 87. This will cause current from

the batteries 49 and 53 to flow through the gaseous tube 51 and resistance 52 in the direction of the arrow. After the pulse of positive potential has died down to the value indicated by the line 88 the current in the gaseous tube 51 and the resistance 52 will continue to flow, as this voltage is greater than the minimum necessary to maintain the current flow, which is indicated by the broken line 89.

The flow of current through the resistance 52 in the direction of the arrow will produce a positive potential on the grid of the tube 55 which will oppose the biasing potential produced by the battery 53. This will reduce the bias on the grid of the tube 55 sufficiently to allow current to flow through it and through the relay 56, thus energizing this relay. This will close a circuit from the battery 77 through the contacts 76 and 75 and segment 63, to the detonator 78 which will be set off, thereby exploding the charge 15 directly beneath the hull of the enemy's ship.

It is thus seen that, after a voltage pulse from the plate circuit of tube 45 has started a current flow through the gaseous tube 51, it will be maintained after the pulse has subsided, thereby allowing time for the operation of the relay 56.

If the torpedo on its way to its target should pass into the shadow of a cloud, as shown at 96 in Fig. 5, the intensity of the light illuminating the photoelectric cell 31 will decrease gradually as depicted by the curve 88 of Fig. 2. This gradual decrease of illumination will cause a gradual increase of resistance of the photoelectric cell 31, thus causing a small pulse of energy to pass through the condenser 37, as shown by the curve 90 of Fig. 3. This will cause a small increase of current in the output circuit of the tube 36, thus producing a small increase of negative potential on the grid of the tube 45. This in turn will cause a decrease of current passing through the tube 45 which will cause a slight increase of potential on the gaseous tube 51, as shown by curve 91 of Fig. 4. This, however, will be less than the necessary breakdown potential of this tube, so that no current will flow through the resistance 52, and the condition of the amplifier 55 will remain unchanged, thus maintaining the relay 56 deenergized and preventing the detonation of the explosive charge 15.

The constants of the circuit may be suitably chosen so that the contrast between rapid and slow impulses occurring in the resistance 35 may be further increased and, in addition, may be so chosen that the pulses occurring in the amplifier will be of a unidirectional and non-oscillatory nature. Advantage may be taken of the quenching effect of the gaseous tube 51 to give non-oscillatory characteristics. The choke coils 33, 46 and 48 may be wound with resistance wire to dampen the system.

Fig. 3 depicts the curve of potential at the "hot" end of the choke coil 33. The areas under the curves 82 and 90 are equal for equal changes of current in the photoelectric cell 31. Therefore the greater the distinction between the change of illumination of cell 31, either as to the amount of change or the speed of change, the greater will be the distinction between the amplitude of the pulses transmitted to the amplifier.

The clock-work mechanism 61 may also be used to render the amplifier operative, preferably by arranging the same to control the energization of the filaments, whereby the thermal time lag will be sufficient to prevent a pulse in choke 46 from operating the gaseous tube 51.

It will be understood that the batteries may be grouped together into a common power supply circuit, that tubes may be of types other than tubes of the three-electrode type, that thermal detonation may be employed, and that other obvious modifications may be made.

Potentiometer 41 is provided as a gain control of the amplifier, which may be set from time to time if the tubes or batteries should change through aging.

It will be thus seen that as long as the torpedo is illuminated the mechanism will be kept in an inoperative position, but as soon as the illumination is decreased at a sufficiently rapid rate the explosive charge carried by the torpedo will be detonated; however, if the illumination is decreased at a gradual rate the explosive charge will not be detonated. In this way a very effective means is provided for differentiating between the shadow produced by an enemy ship and the shadows produced by clouds.

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 combination with a moving body, an explosive charge carried thereby, light-responsive means mounted on said body for receiving light from an external source, and a detonator operated by said light responsive means for detonating said explosive charge when the intensity of illumination is diminished more rapidly than a predetermined rate.

2. In a moving body, an explosive charge, means for detonating said charge, a light-sensitive device, an amplifier and a power circuit controlled by said light-sensitive device for operating said detonating means, and means active when the illumination on said light-sensitive device is changed at a predetermined rate, to cause a pulse of energy to be transmitted to said amplifier to cause operation of said power circuit.

3. In combination with a moving body, an explosive charge, light-sensitive means, an amplifier controlled by said means, a gaseous tube controlled by the output of said amplifier, a power circuit operated by the discharge of said gaseous tube, and detonating means for detonating said explosive charge and controlled by the output of said power circuit.

4. In a torpedo, an explosive charge, a detonator for said explosive charge, light-sensitive means for receiving illumination from an external source, and means active upon a predetermined rate of change of the intensity of illumination upon said light-sensitive means for energizing said detonator.

5. In a torpedo, an explosive charge, a detonator for said charge, light-sensitive means for receiving illumination from an external source, means active upon a predetermined rate of change of the intensity of illumination upon said light-sensitive means for energizing said detonator, and means for adjustably controlling the intensity of illumination receivable by said light-sensitive means.

6. In a torpedo, an explosive charge, a detonator for said explosive charge, light-sensitive means

for receiving illumination from an external source, circuit means including a gaseous conduction tube and active upon a predetermined rate of change upon said light-sensitive means for energizing said detonator.

7. In a torpedo, an exclosure charge, a detonator for said charge, light-sensitive means, means including a gaseous conduction tube for energizing said detonator, and means controlled by said light-sensitive means and active upon a predetermined rate of change in intensity of illumination of said light-sensitive means for operating said gaseous conduction tube to effect energization of said detonator.

8. In a torpedo, an explosive charge, a detonator for said charge, light-sensitive means, means for energizing said detonator and including a gaseous conduction tube operable by an energy impulse of predetermined intensity, and means actuated by the change of intensity of illumination of said light-sensitive means at a predetermined rate for supplying an energy impulse to said gaseous conduction tube to effect energization thereof.

9. In a torpedo, an explosive charge, a detonator therefor, light-sensitive means, control means operable by a predetermined energy impulse, means actuated by a predetermined rate of change of the intensity of illumination upon said light-sensitive means for producing an energy impulse sufficient to actuate said control means, and means for adjustably controlling the intensity of light receivable by said light-sensitive means.

10. In a torpedo, an explosive charge, a detonator for said charge, actuating means operable by an energy impulse of predetermined intensity for energizing said detonator, light-sensitive means and means controlled by said light-sensitive means for supplying to said actuating means an energy impulse having an intensity corresponding to the rate of change of the intensity of illumination on said light-sensitive means.

11. In a torpedo, an explosive charge, a detonator for said charge, means including a gaseous conduction tube and active upon a flow of current in said tube for energizing said detonator, light-sensitive means, and means controlled by said light-sensitive means and active upon a predetermined rate of change in intensity of the illumination on said light-sensitive means to supply an energy impulse to said gaseous conduction tube of sufficient intensity to effect a flow of current through said tube.

12. In a torpedo, an explosive charge, a detonator for said charge, light-sensitive means, control means active upon a predetermined rate of change in the intensity of illumination upon said light-sensitive means for actuating said detonator, lock-out means for rendering said control means ineffective to actuate said detonator, and means actuated by the initial forward movement of said torpedo for releasing said lock-out means.

13. In combination a water-borne body, an explosive charge carried by said body, light receptive means carried by said body and means active upon a predetermined rate of change in the intensity of illumination received by said light receptive means for discharging said explosive charge.

14. In combination, a moving body, a utility carried thereby, means mounted on said body and responsive to radiations received from an external source and means controlled by said first means for operating said utility when said body enters the shadow of a second body which produces a predetermined rate of change in the radiations received from said external source.

15. In a torpedo, a utility, means carried by said torpedo adapted to receive radiations from an external source and means operable by said first means to operate said utility when said torpedo enters the shadow of a ship under conditions such that a predetermined rate of change is effected in the radiations received by said first means.

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