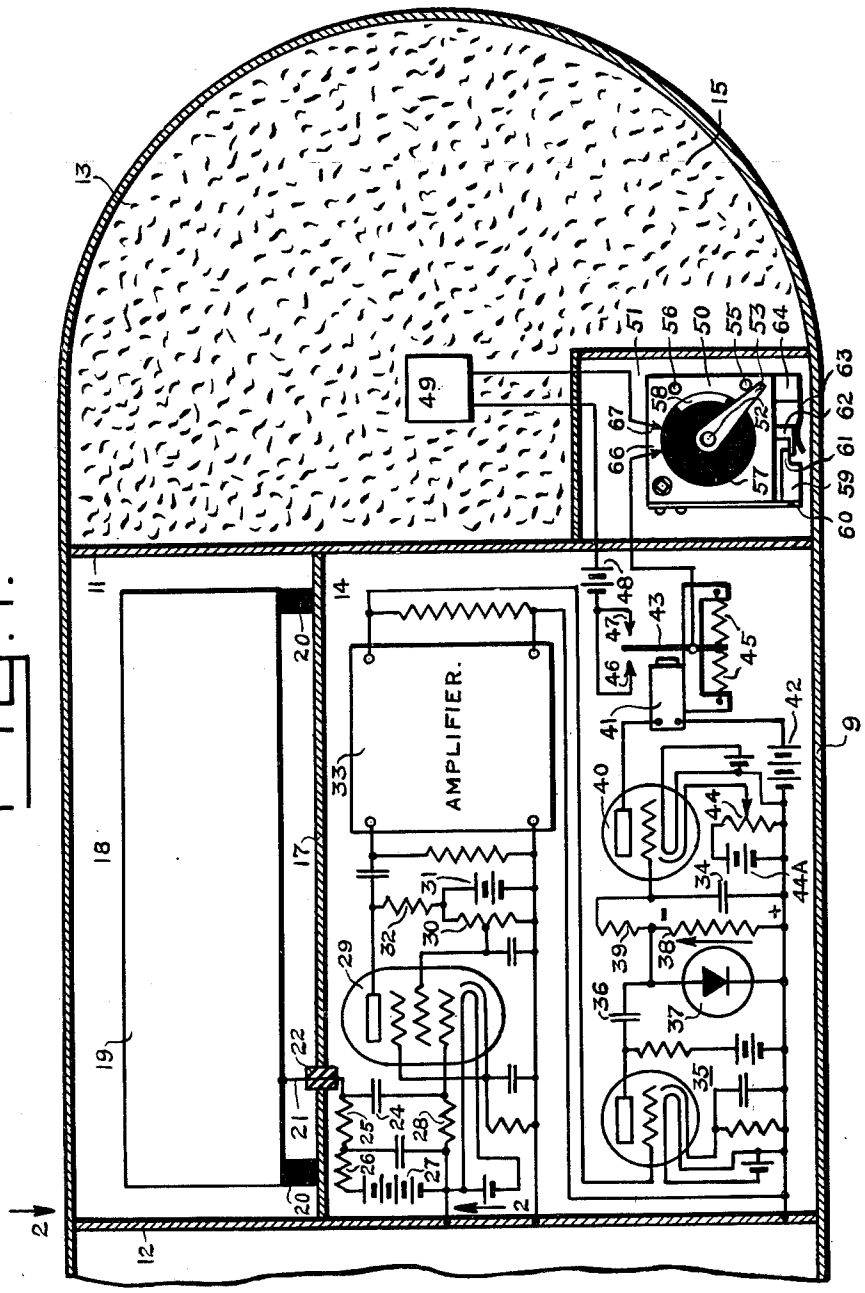
Nov. 10, 1936. J. H. HAMMOND, JR 2,060,208

COSMIC RAY DETONATOR

Filed Aug. 31, 1935 3 Sheets-Sheet 1

Fig. 1.



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Fig. 2.

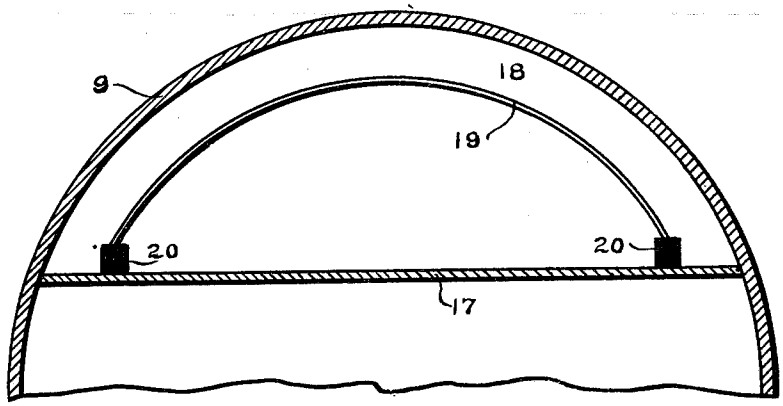
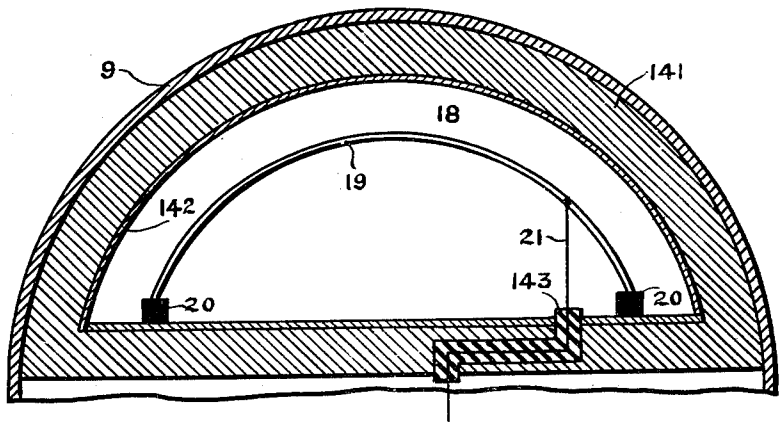


Fig. 4.



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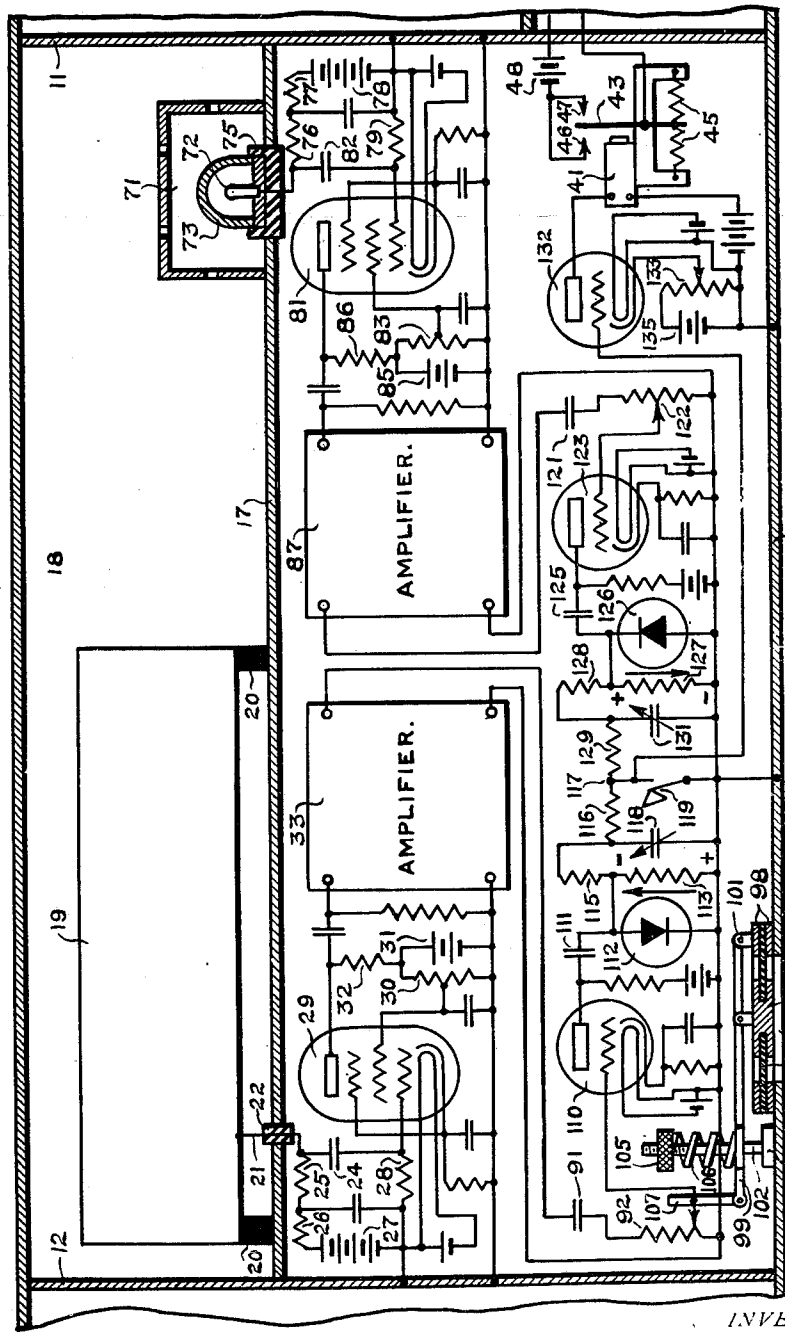
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COSMIC RAY DETONATOR

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Fig. 3.



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2,060,208

COSMIC RAY DETONATOR

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Application August 31, 1935, Serial No. 38,804

16 Claims. (Cl. 114—21)

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

An object of this invention is to provide a system for controlling torpedoes or the like by natural radiations, such as cosmic rays, which do not vary in intensity during the day or night and are not affected by clouds, etc.

According to one form of the invention, a torpedo is provided with radiation sensitive devices which control the detonation of the explosive charge thereof when it passes beneath a ship.

The torpedo mechanism includes an ionization device for receiving radiation from an external source. When the amount of radiation received by this device is constant the detonating means of the torpedo will be held inoperative; but whenever the amount of this radiation is changed, as for example, when the torpedo passes beneath an enemy ship, the mechanism will be operated to cause the detonation of the explosive charge.

Means are also provided to compensate for the change of radiation received by the ionization device due to the change of depth while the torpedo is running, and also for the change of temperature and pressure in the ionization chamber.

The invention also provides means whereby the detonation of the war head of the torpedo is prevented for a predetermined length of time after firing.

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 embodying this invention,

Figure 2 is a partial section taken on line 2—2 of Figure 1,

Figure 3 illustrates diagrammatically a modified form of the invention,

And Fig. 4 is a section similar to Fig. 2 showing a further modified form of the invention.

Like reference characters refer to 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 waterborne body, such as a torpedo or other carrier of explosives, having a water-tight hull 9, and adapted to be propelled in the usual manner by propellers (not shown) 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.

Compartment 14 is provided with a horizontal air-tight bulkhead 17 forming an air-tight chamber 18 which may be filled with argon or other suitable ionizable gas under pressure. Located in the chamber 18 is an electrode 19 in the shape of a curved plate of metallic material which is supported on insulators 20, from the horizontal bulkhead 17. Connected to the electrode 19 is a conductor 21 which passes through an insulator 22 mounted in the bulkhead 17. The conductor 21 is connected through two resistors 25 and 26 and a battery 27 to a ground connection on the bulkhead 12. The negative side of the battery 27 is connected through a resistor 28 to the first grid of a pentode tube 29. A condenser 24 is connected from this grid to the conductor 21.

The screen grid of this tube is connected to a tap on a resistor 30 which is connected across a battery 31. The positive side of the battery 31 is connected through a second resistor 32 to the plate of the tube 29. The output circuit of the tube 29 is connected by a blocking condenser and resistor to the input circuit of an amplifier 33 which may be of any desired type and may comprise the necessary number of stages. The third grid and cathode of the tube 29 are joined together and a condenser and a resistor are connected between them and ground.

The output circuit of the amplifier 33 is connected to the input circuit of a second amplifier 35. The output circuit of the amplifier 35 includes a condenser 36 and a rectifier 37. Across the rectifier 37 is a resistor 38. One side of this resistor is connected through a second resistor 39 to the grid of a tube 40, and a condenser 34 is placed between the grid and ground. The cathode circuit of tube 40 includes a potentiometer 44 and battery 44A by which the cathode may be polarized positively with respect to ground.

The output circuit of the tube includes the winding of a balanced relay 41 and a battery 42.

The balanced relay 41 is so constructed that the armature 43 is normally held in a central position by means of springs 45 when a predetermined current, adjusted by potentiometer 44, flows through the winding of the relay 41. When this current is either increased or decreased, the armature 43 will engage one of two contacts 46 or 47. These contacts are in a circuit including a battery 48 and a detonator 49 located in the explosive charge 15.

In order to prevent the detonation of the explosive charge for a predetermined time after the firing of the torpedo, a clockwork mechanism 50 is provided which is located in a chamber 51. This clockwork mechanism is provided with a shaft 52 to which is secured an arm 53. This arm normally engages a pin 55. A second pin 56 is provided for limiting the motion of the arm 53. Also secured to the shaft 52 is a commutator 57 made of insulating material. This commutator is provided with a segment 58 of conducting material.

A heavy weight 59 is fastened to the end of a spring 60 which is secured to the casing of the clockwork mechanism 50. The weight 59 is provided with a projection 61 which engages the end of an arm 62. The arm 62 is pressed upwardly by means of a spring 63 which is carried by a block 64 secured to the casing of the clockwork mechanism 50.

When the torpedo is fired, the weight 59 is moved rearwardly due to its inertia, thus causing the projection 61 to release the arm 62 which is moved upwardly under the action of the spring 63, thus starting the clockwork mechanism which causes the arm 53 and commutator 57 to be rotated in a clockwise direction until the arm 53 engages the stop pin 56. At this time the conducting segment 58 will engage two contacts 66 and 67 which put the detonator 49 in operative relation to the balanced relay 41.

In the operation of the form of the invention shown in Fig. 1, after the torpedo is fired it will run a predetermined depth below the surface of the water. While running at this depth, the ionization chamber 18 will receive radiations, such for example as cosmic rays, which come from above and penetrate through the intervening water. The term "cosmic rays", as used herein, refers to natural radiations originating in the upper atmosphere or beyond which are universally present and exist as a source of ionization after all other sources, such as light, gas flames, radium, etc. are removed These radiations cause ionization of the gas contained in the chamber 18 which will be proportional to the intensity of the radiations received. The potential produced on the electrode 19 by the battery 27 acting through resistors 25 and 26 will cause a current of a pulsating nature to pass through the ionization chamber 18. The nature and amount of the pulsations will be dependent upon the strength and frequency of the radiations received from above through the water as well as the structure and gas content of the ionization chamber.

The voltage across the ionization chamber 18 from the electrode 19 to ground, by transfer through condenser 24, will cause an alternating potential to be applied across resistor 28 and therefore to the first grid of the amplifier tube 29, which amplifies the energy in a well known manner. The output energy from the tube 29 will then pass to the amplifier 33 where it will be amplified and will be fed to the input circuit of the second amplifier 35 where the energy will be further amplified and will pass to the rectifier 37. This rectifier will rectify the energy and cause a rectified current to pass through the resistor 38 in the direction of the arrow, the pulses of current through the resistor 38 being smoothed out by resistor 39 and condenser 34.

This rectified current will produce a potential difference across the condenser 34 so that the negative potential applied to the grid of the tube 40 will be dependent upon the strength of this current. With the torpedo running at a constant depth this current will produce a definite negative potential on the grid of the tube 40, thus causing a definite output current from this tube to flow through the winding of the balanced relay 41. Under these conditions this current is just sufficient to maintain the armature 43 of this relay in a central position as shown in Fig. 1 so that it will not engage either of the contacts 46 or 47. When the torpedo continues running at the predetermined depth, this condition will be maintained. When, however, the torpedo passes beneath an enemy's ship, the radiation received by the ionization chamber 18 will be changed. Thus, for example, if the ship absorbs more of these radiations than the water which it displaces, the amount of ionization in the chamber 18 will decrease, thereby reducing the current flowing through the resistor 38. This will decrease the negative potential applied to the grid of the tube 40, thus allowing more current to flow through this tube and through the winding of the balanced relay 41. This will cause the armature 43 to be moved to the left thus engaging the contact 46 which will close a circuit from the battery 48 to the detonator 49, thus causing the explosion of the charge 15 carried in the war head of the torpedo.

If less of the radiation should be absorbed by the enemy's ship than by the water which it displaces, a greater amount of current will flow through the resistor 38, thereby increasing the negative potential on the grid of the tube 40, which in turn will cut down the current flowing through the winding of the relay 41. This will allow the armature 43 to be moved to the right, thus engaging the contact 47 which will close the circuit from the battery 48 to the detonator 49, thus exploding the war head of the torpedo.

It is thus seen that when the radiation received by the chamber 18 remains constant at a predetermined amount, the detonating means for the explosive charge will be held inoperative; but as soon as this radiation changes in intensity due to the passage of the torpedo beneath the enemy's ship, it will cause the operation of the detonating means, thus exploding the war head of the torpedo directly beneath the hull of the enemy's ship.

In the modified form of the invention shown in Fig. 3, the ionization chamber 18 is larger than the corresponding chamber shown in Fig. 1. The apparatus from the electrode 19 to the amplifier 33 is similar to that shown in Fig. 1 and the corresponding parts bear the same numerals.

For compensating for the variations in temperature and pressure in the ionization chamber 18, a secondary ionization chamber 71 is provided which is similar in construction and operation to that described in the article entitled "A precision recording cosmic ray meter" by Compton, Wollan and Bennett in the R. S. I. Journal for December, 1934, vol. 5.

Mounted in the secondary ionization chamber

71 is a uranium rod 72 which is covered by a screen 73 which is so constructed, preferably of aluminum, that it absorbs the alpha rays and soft beta rays before they reach the secondary ionization chamber 71. The penetrating beta rays and the feeble gamma rays penetrate the shield 73. The beta rays traverse the secondary ionization chamber 71 but are completely stopped by the walls of this chamber which are preferably made of brass. The gamma rays are not completely absorbed by the walls of the secondary chamber 71 and produce a small residual ionization in the main ionization chamber 18 which is approximately proportional to the pressure and appears as a part of the constant zero correction. The secondary ionization chamber 71 with the uranium rod 72 is for the purpose of compensating for temperature and pressure changes in the main ionization chamber 18.

The uranium rod 72 passes through an insulator 75 mounted in the bulkhead 17 and is connected through two resistors 76 and 77 and a battery 78 to a ground connection on the bulkhead 11. The negative side of the battery 78 is connected through a resistor 79 to the first grid of a pentode tube 81. A condenser 82 is connected from this grid to the uranium rod 72.

The screen grid of the tube 81 is connected to a tap on a resistor 83 which is connected across a battery 85. The positive side of the battery 85 is connected through a second resistor 86 to the plate of the tube 81. The output circuit of the tube 81 is connected by a blocking condenser and resistor to the input circuit of an amplifier 87 of any well known type. The third grid and cathode of the tube 81 are joined together and a condenser and resistor are connected between them and ground.

The output circuit of the amplifier 33 is connected through a blocking condenser 91 to a potentiometer 92.

The hull 9 of the torpedo is provided with an opening 95 in which is mounted a diaphragm 96. This diaphragm is flexibly suspended by means of a rubber diaphragm 97 which is secured to a circular frame 98. Pivoted to the diaphragm 96 is an arm 99 which is fulcrumed in a bracket 101 carried by the frame 98. Passing through a hole in the arm 99 is a rod 102 which is secured to a base 103 secured to the hull 9 of the torpedo. The rod 102 is threaded at its upper end to receive a nut 105. Mounted on the rod 102 between the arm 99 and the nut 105 is a spring 106.

Secured to the end of arm 99 is an insulated rod 107 which carries the movable contact of the potentiometer 92. This contact is connected to the input circuit of an amplifier 110, the output circuit of which includes a condenser 111 and a rectifier 112. Across this rectifier is a resistor 113. One side of this resistor is connected through resistors 115 and 116 to a point 117. A condenser 118 is connected between the junction of the resistors 115 and 116 and ground. A key 119 is connected between the point 117 and ground.

The output of the amplifier 87 is connected through a blocking condenser 121 and a potentiometer 122 to the input circuit of an amplifier 123. The output circuit of this amplifier includes a condenser 125 and a rectifier 126. Across the rectifier 126 is a resistor 127. One side of this resistor 127 is connected through two resistors 128 and 129 to the point 117. A condenser 131 is connected between the junction of the resistors 128 and 129 and ground.

The point 117 is connected to the grid of a tube 132. The cathode circuit of this tube includes a potentiometer 133 and a battery 135 by which the cathode may be polarized positively with respect to ground. The output circuit of the tube 132 includes the winding of the balanced relay 41. The contacts of this relay are connected through the battery 48 to the detonator 49 and back through the timing device 50 to the armature 43, as already described in connection with Fig. 1.

In the operation of the modified form of the invention shown in Fig. 3, when the torpedo is launched and is running at its pre-determined depth, the diaphragm 95 will be moved upwardly due to the pressure of the water exerted against its lower surface, thus causing the contact of the potentiometer 92 to be moved up until the compression of the spring 106 balances the pressure of the water on the diaphragm 95. The potentiometer 92 is so constructed that for any depth at which the torpedo may run, the contact will be so positioned that the energy fed to the amplifier 110 will be maintained constant, thus compensating for the absorption of the rays passing through the water before reaching the ionization chamber 18. Thus as the torpedo increases its depth, the amount of these rays reaching the chamber 18 will be decreased due to the absorption of the greater amount of water through which they have to pass. This decrease will be compensated for, however, by the potentiometer 92 so that a constant potential will be maintained on the grid of the amplifier 110.

The output energy from the amplifier 110 will pass to the rectifier 112 where it will be rectified and will cause a rectified current to pass through the resistor 113 in the direction of the arrow. The pulses of current through the resistor 113 will be smoothed out by the resistor 115 and condenser 118. The current passing through the resistor 113 will cause a negative potential to be built up at the upper end of this resistor which will be proportional to the current passing through the rectifier 112 and the resistor 113.

The ionization produced in the secondary chamber 71 by radiation from the uranium rod 72 will cause a potential to be built up by the battery 78 on the uranium rod 72 which is proportional to the radiation produced by this rod. This will cause a current of pulsating nature to pass through the ionization chamber 71. These pulsations will be of a much higher frequency than those produced in the main ionization chamber by the cosmic rays. The voltage across the secondary ionization chamber 71 from the uranium rod 72 to ground, by transfer through the condenser 82, will cause an alternating potential to be applied across the resistor 79 and therefore to the first grid of the amplifier tube 81 which amplifies the energy in a well known manner.

The output energy from the tube 81 will then pass to the amplifier 87 where it will be amplified and fed through a blocking condenser 121 and potentiometer 122 to the input circuit of the amplifier 123 where the energy will be further amplified and will pass to the rectifier 126. Here the current will be rectified and will pass through the resistor 127 in the direction of the arrow, the pulses of current through this resistor being smoothed out by the resistor 128 and condenser 131. The current through the resistor 127 will produce a positive potential at the upper end of this resistor which is proportional to the current

passing through the rectifier 126 and the resistor 127.

The potentiometer 122 is set at the surface before the torpedo is fired so that the negative and positive potentials at the upper ends of the resistors 113 and 127 respectively are equal, thus producing a zero potential at the point 117. The key 119 is used for testing this condition so that when zero potential is produced, the output of the amplifier 132 will be the normal current for the setting of the potentiometer 133 to maintain the armature 43 of the relay 41 in a central position.

After firing, the torpedo submerges to the predetermined depth in a well known manner. As it does so, the diaphragm 95 will be moved upwardly against the compression of the spring 106, thus causing the movable contact of the potentiometer 92 to be moved upwardly an amount sufficient to maintain the output current of the amplifier 110 constant, as already described.

It is thus seen that as the torpedo proceeds at the required depth the negative and positive potentials on the upper ends of the resistors 113 and 127 will be maintained equal. Should there be any change in the ionization in the main chamber 18 due to a change of temperature or pressure of the gas therein, this will also produce a corresponding change in the secondary chamber 71 so that in this manner the point 117 is always maintained at a zero potential independent of the depth at which the torpedo is running and independent of any changes of temperature or pressure in the ionization chamber itself. When the point 117 is maintained at a zero potential the armature of the relay 41 will be held in a central position, as already described.

When the torpedo passes beneath an enemy's ship, the intensity of the cosmic or other ionization producing rays received thereby will be changed. If this intensity is decreased, a decreased current will flow through the resistor 113 in a manner similar to that described in connection with Fig. 1. This will decrease the negative potential at the upper end of this resistor so that it will no longer balance the positive potential produced at the upper end of the resistor 127, thus causing the point 117 to become positive an amount depending upon the decrease of intensity of the rays received by the ionization chamber 18.

The positive potential of the point 117 will be applied to the grid of the tube 132, thereby increasing the output current from this tube, which will flow through the winding of the relay 41, thus causing the armature 43 to be moved to the left into engagement with the contact 46, which, in turn, will close the circuit through the detonator 49 which will cause the explosion of the charge 15 in the war head of the torpedo.

If the intensity of the rays received in the chamber 18 is increased due to the passage beneath the ship, the current flowing in the resistor 113 will be increased, thereby increasing the negative potential produced at the upper end of this resistor which will then become greater than the positive potential produced at the upper end of the resistor 127 so that the point 117 will become negative. This negative potential will be applied to the grid of the tube 132 thus causing a decrease in the output current from this tube which, in turn, will cause a decrease in the current passing through the winding of the relay 41. This will allow the armature 43 to be moved to the right into engagement with the contact 47, thus closing the circuit to the detonator 49 and exploding the war head of the torpedo.

Due to the presence of other types of radiation, such as soft beta or gamma rays which may emanate from the sea water or other adjacent material, and may be traveling in any direction, it may be found desirable to insulate the ionization chamber 18 with a shield which will prevent the passage of the undesired rays but will allow the transmission of the cosmic rays. This may be accomplished by means of a lead shield such as that shown at 141 in Fig. 4. This shield completely surrounds the ionization chamber 18, which is provided with a metallic lining 142. The conductor 21 passes through an insulator 143 which is shaped so that it will prevent the direct passage of any of the undesired rays into the ionization chamber 18. The shield of lead may be replaced by lead shot, if desired, or other suitable material for preventing the passage of the rays other than hard beta or gamma rays.

It is to be understood that the invention is applicable to various uses, as will be apparent to a person skilled in the art. For example, the control may be caused to actuate a vertical rudder as well as a detonator. In some instances, the carrier may be stationary and may be actuated when a moving body passes thereover. It is to be understood that I am not to be limited by the specific embodiments of my invention shown and described herein for the purpose of illustration, but only by its scope as set forth in the appended claims, when interpreted in view of the prior art.

What I claim is:

1. In combination with a moving body, a control device, means sensitive to cosmic rays, and means to actuate said control device in response to a change in characteristics of said rays.

2. In combination with a moving body, a control device, means sensitive to cosmic rays, means to actuate said control device in response to a change in characteristics of said rays caused by the proximity of a foreign object, and means to prevent actuation of said control device in response to other changes in characteristics of said rays.

3. In combination with a moving body, an explosive charge carried thereby, means carried by said body for receiving cosmic rays and means operated by the variation of the intensity of said rays for causing detonation of said explosive charge.

4. In combination with a moving body, an explosive charge, means for causing detonation of said explosive charge and cosmic ray sensitive means for controlling said detonating means so that when the intensity of radiation is changed by the proximity of an object it will cause the detonation of said explosive charge.

5. In combination with a moving body, a control device carried thereby, an ionization chamber mounted on said body for receiving cosmic rays and means operated by said ionization chamber for actuating said control device when the intensity of said rays is changed.

6. In combination with a moving body, a control device, means for actuating said device, an ionization chamber for receiving cosmic rays, and means controlled by the rate of ionization in said chamber for controlling said actuating means in response to a change in the intensity of said cosmic rays.

7. In combination with a torpedo having a war head, an ionization chamber for receiving

cosmic rays and means for exploding said war head when the intensity of said ionizing rays received by said cosmic chamber is changed.

8. In combination with a moving body, an explosive charge, means for causing detonation of said charge, cosmic ray sensitive means for actuating said detonating means in response to a change in the intensity of said cosmic rays and means for preventing detonation of said explosive charge for a predetermined time after the launching of said body.

9. In combination with a torpedo carrying an explosive charge, an ionization chamber sensitive to cosmic rays and means for exploding said charge when the ionization in said chamber differs from the value which is normal for the depth at which the torpedo is running.

10. In combination with a torpedo carrying an explosive charge, an ionization chamber sensitive to cosmic rays and means for exploding said charge when the ionization in said chamber differs from the value which is normal for the depth at which the torpedo is running and for the temperature which exists in the ionization chamber.

11. In combination with a torpedo carrying an explosive charge, an ionization chamber sensitive to cosmic rays and means for exploding said charge when the ionization in said chamber differs from the value which is normal for the depth at which the torpedo is running and for the pressure which exists in the ionization chamber.

12. In combination with a torpedo carrying an explosive charge, an ionization chamber sensitive to cosmic rays and means for exploding said charge when the ionization in said chamber differs from the value which is normal for the depth at which the torpedo is running and for the temperature and pressure which exists in the ionization chamber.

13. In a moving body, an explosive charge, means for detonating said charge, a primary ionization chamber for receiving cosmic rays, means controlled by said ionization chamber for operating said detonating means in response to a change in the intensity of the cosmic rays received by said ionization chamber, and a second ionization chamber adapted to compensate for variations in temperature and pressure in said primary ionization chamber.

14. In a moving body, an explosive charge, means for detonating said charge, an ionization chamber for receiving cosmic rays, means controlled by said ionization chamber for operating said detonating means in response to a change in the intensity of the cosmic rays received by said ionization chamber, and means, including a source of ionization carried by said body, for compensating for variations in temperature and pressure in said ionization chamber.

15. In a moving body, an explosive charge, means for detonating said charge, an ionization chamber for receiving cosmic rays, means controlled by said ionization chamber for operating said detonating means in response to a change in the intensity of the cosmic rays received by said ionization chamber and means, including a uranium rod carried by said body, to provide a secondary source of ionization for compensating for variations in temperature and pressure in said ionization chamber.

16. The method of operating a torpedo which comprises actuating a control thereon when the intensity of the cosmic rays received by said torpedo is changed due to the proximity of a foreign object.

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