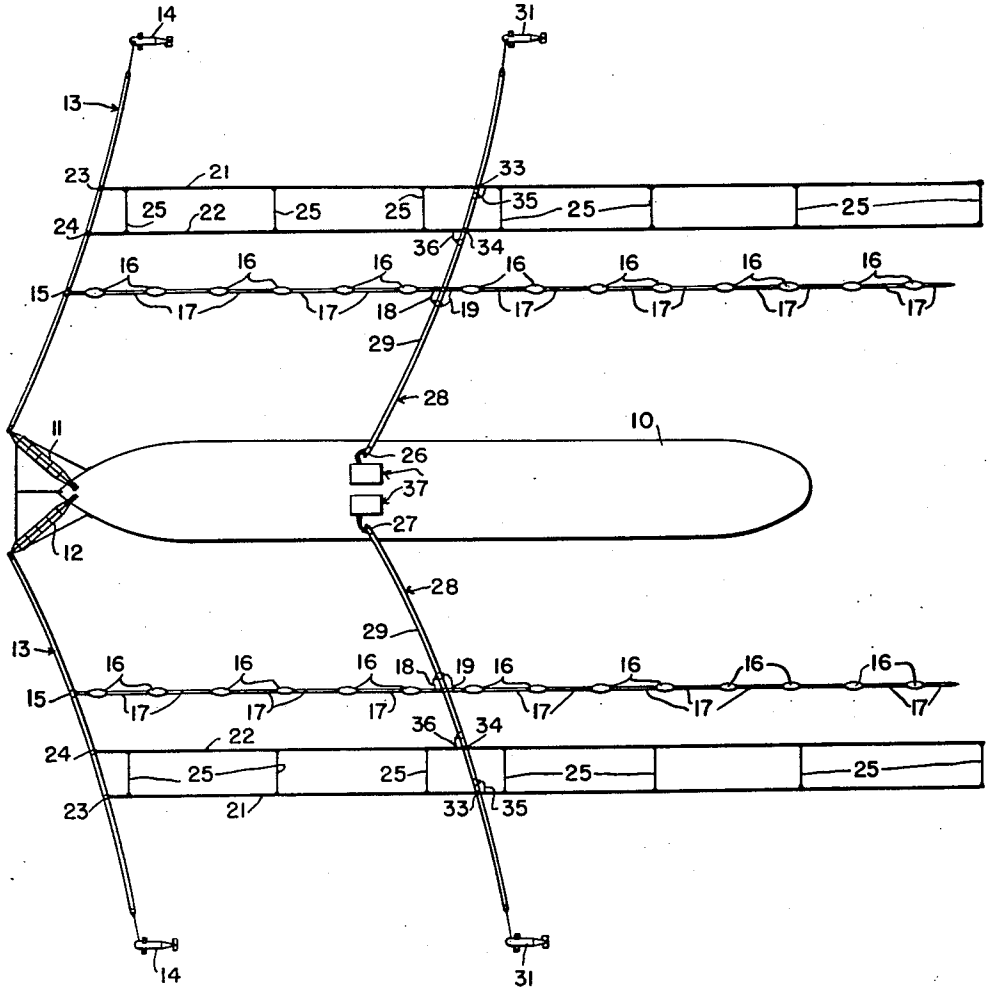
Jan. 10, 1961 C. S. LIVERMORE 2,967,506

ANTI-TORPEDO SYSTEM

Filed May 11, 1945 3 Sheets-Sheet 1

Fig. 1.



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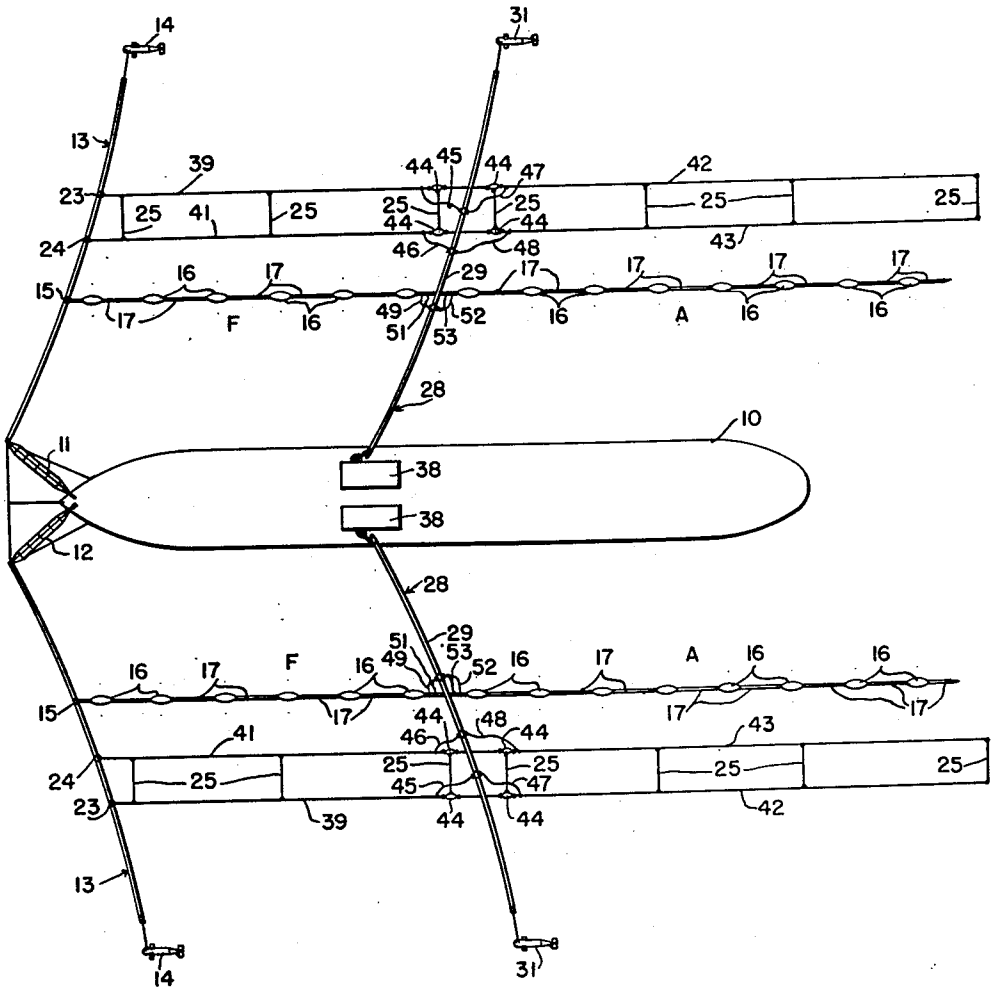
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ANTI-TORPEDO SYSTEM

Filed May 11, 1945 3 Sheets-Sheet 2

Fig. 2.



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ANTI-TORPEDO SYSTEM

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Fig. 3.

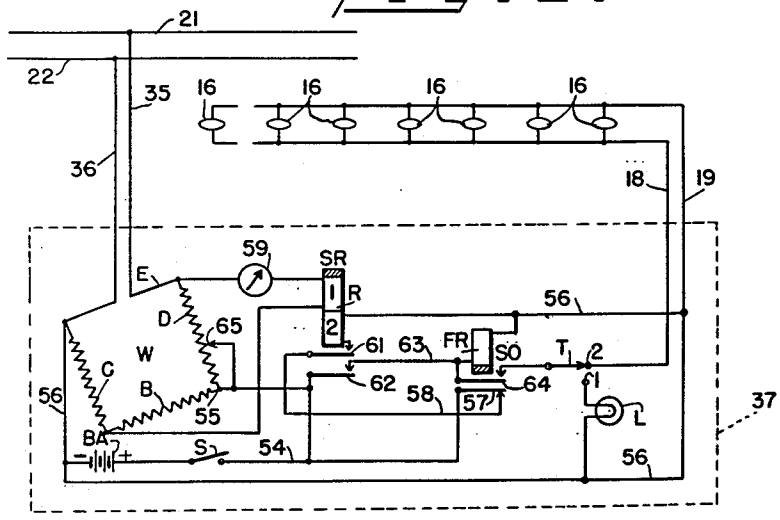
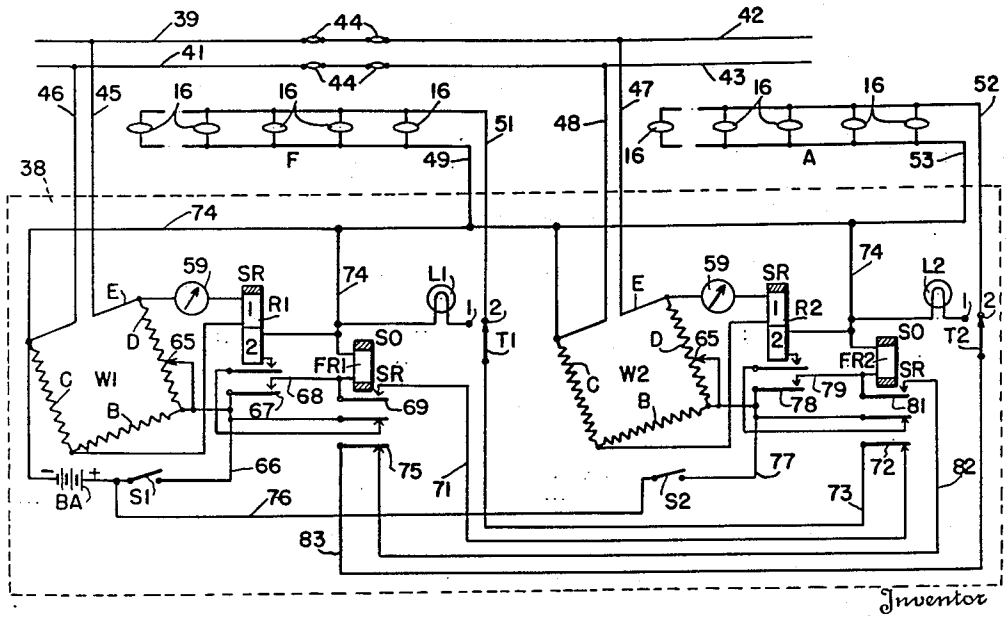


Fig. 4.



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2,967,506

ANTI-TORPEDO SYSTEM

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Filed May 11, 1945, Ser. No. 593,181

19 Claims. (Cl. 114—240)

(Granted under Title 35, U.S. Code (1952), sec. 266)

This invention relates generally to an anti-torpedo system for the protection of a vessel and more particularly to a system having a pair of devices arranged in predetermined spaced relation within the water at a distance from the vessel in which the conductivity of the torpedo or the electrical potential induced thereby is employed to set up a signal condition between the devices for detecting the presence of a torpedo thereby to fire a plurality of explosive charges when the moving torpedo has traveled to a position adjacent the charges.

Various devices have heretofore been proposed for protecting a vessel from the ravages of a torpedo, such devices comprising barriers composed of heavy plates, nets, chains, rods, springs, rotatable discs and the like, secured to the vessel by booms or similar mechanisms, other devices for preventing damage by a torpedo including compartments or "blisters" attached to or formed integrally with the hull of the vessel, or a copious quantity of resilient material attached to the hull of the vessel thereby either to deflect the torpedo or to absorb the shock of impact of the torpedo with the target, as the case may be.

Such devices have generally proved unsatisfactory in service by reason of the complicated mechanisms employed and the considerable reduction in the mobility and speed of the vessel with which the devices are associated, and for the additional reason that modern torpedoes have in recent years increased in size, rate of travel through the water and in firing power to such an extent that these devices are no longer regarded as completely effective in protecting a vessel against the modern torpedo.

In accordance with the present invention the anti-torpedo system comprises a plurality of explosive charges adapted to be towed through the water by a vessel and fired by the energization of a firing circuit extending to each of the charges. The firing of the charges is effected by the operation of a firing relay in response to a predetermined change in the resistance of an electrical path between two conductor electrodes as the torpedo moves into approximate position with respect thereto. The electrodes are maintained within the water in predetermined spaced relation with respect to each other and outboard of the explosive charges by suitable towing gear including at least one paravane.

The aforesaid conductor electrodes comprise one arm of a balanced Wheatstone bridge circuit in which the unbalance of the bridge caused by a change in the electrical character of the medium between the electrodes as the torpedo moves into a proximate position with respect thereto is employed to fire the explosive charges within the path of travel of the torpedo and destroy or deflect the torpedo from its target without physical contact of the electrodes with the torpedo. The invention provides means towed by a vessel for detecting a change in the electrical character of the medium between two conductor elements maintained in predetermined spaced relationship within the water and adapted to destroy the

torpedo by exploding a plurality of explosive charges in time delayed relation when the aforesaid change has reached a predetermined value.

One of the objects of the present invention is the provision of a pair of spaced electrodes arranged beneath the surface of the water transversely to the path of travel of the torpedo for firing a plurality of explosive charges in response to a predetermined decrease in the resistance of the fluid medium between the electrodes thereby to destroy the torpedo.

Another object is the provision of a pair of spaced electrodes arranged beneath the surface of the water transversely to the path of travel of the torpedo for firing a plurality of explosive charges in response to a predetermined change in the potential difference between the electrodes caused by the presence of the torpedo.

Another object is the provision of new and improved means for firing an explosive charge within the path of travel of a torpedo in response to a predetermined decrease in resistance of the fluid medium between the two lines of reference as the torpedo moves into predetermined spaced relationship with respect thereto.

A further object is to provide new and improved means responsive to an electrical signal received from the torpedo and effective at a distance therefrom for firing an explosive charge within the path of travel of the torpedo and adjacent thereto.

A still further object is to provide an anti-torpedo system for a vessel comprising a plurality of groups of explosive charges arranged within the water at a predetermined distance from the vessel in which new and improved means are employed for firing the groups of charges selectively as the torpedo moves into proximate relation with respect thereto and in which an electrical characteristic of the torpedo is employed to control the firing mechanism without physical contact with the torpedo.

Still other objects, advantages and improvements will be apparent from the following description taken in connection with the accompanying drawings, in which:

Fig. 1 is a plan view of a vessel provided with an anti-torpedo system in accordance with a preferred embodiment of the invention;

Fig. 2 is a plan view of a vessel provided with an anti-torpedo system in accordance with an alternative embodiment of the invention;

Fig. 3 shows in diagrammatic form an electrical circuit arrangement suitable for use with the system of Fig. 1; and

Fig. 4 illustrates in diagrammatic form a complete electrical circuit arrangement suitable for use with the system of Fig. 2.

Referring now to the drawings on which like numerals of reference are employed to designate like parts throughout the several views and more particularly to Fig. 1 therefore, there is shown thereon a vessel, indicated generally by the numeral **10** preferably having a pair of outriggers or booms **11** and **12** to which are respectively secured a pair of tow lines **13**, each of the tow lines having a paravane **14** connected thereto.

Secured to the tow line **13** as at **15** are a plurality of explosive charges or bombs **16** preferably streamlined and connected together in axial alignment with each other to form an array or train by a suitable strain member such, for example, as a plurality of lengths of steel cable arranged within the lengths of flexible tubing **17** whereby the explosive charges are adapted to be towed through the water in predetermined spaced relation with respect to the vessel, the depth of submergence of the charges being controlled by the setting of the paravanes **14**.

Each explosive charge includes an electroresponsive detonator, as is well known in the art, and adapted to fire

the charge in response to a firing potential applied to a pair of conductors 18 and 19 connected thereto.

There is also provided within the water a pair of electrodes comprising the flexible rods or conductors 21 and 22 connected to the tow line 13 as at 23 and 24 respectively. The electrodes are maintained in predetermined spaced relation with respect to each other within the water by a plurality of rigid spacing members 25 connected thereto and with respect to the explosive charges 16 and the vessel 10 by the tow line 13.

There is also connected to the vessel as at 26 and 27 a pair of tow lines 28 comprising a sheath or fairing 29 within which the conductors 18 and 19 are disposed and maintained in outwardly extending position from the vessel by the paravanes 31 respectively connected thereto. The tow line 28 is connected to the train or array of explosive charges 16 and to the flexible conductors 21 and 22 as at 33 and 34 respectively. The sheath 29 also encloses and protects a pair of conductors 35 and 36 for establishing an electrical connection between the conductors 21 and 22 and the firing control mechanism 37 on the vessel.

Referring now to Fig. 3, the firing mechanism 37 comprises a Wheatstone bridge W having electrodes 21 and 22 in one arm thereof adapted to cause a relay R to operate in response to the unbalance of the bridge as the torpedo moves into the zone of detection of the pair of electrodes 21—22. Means are provided for initially balancing the bridge whereby substantially no current flows through the winding of relay R until the bridge is unbalanced by a torpedo detected by the electrodes 21—22. A firing relay FR controlled by relay R is also provided for firing the explosive charges selectively in accordance with a predetermined unbalance of the bridge. The manner in which this is accomplished will become more clearly apparent as the description proceeds.

On Fig. 2 is shown the system of the present invention according to an alternative embodiment thereof, in which the explosive charges 16 are arranged in two groups respectively designated F and A and controlled by a firing control mechanism 38 whereby the groups of charges are fired selectively by signals received from the electrode conductors 39—41 or by the pair of electrode conductors 42—43, as the case may be. The electrodes 39—41 and 42—43 are electrically insulated from one another by the insulating devices 44. An external circuit connection is established between the firing control mechanism 38 and the electrodes 39 and 41 by the conductors 45 and 46 respectively connected thereto and, in like manner, the circuit connection between the firing mechanism and electrodes 42 and 43 is established by way of a pair of conductors 47 and 48 respectively connected thereto. The forward group of explosive charges F is fired by energization of the pair of conductors 49—51, and, in like manner, the aft group of explosive charges A is fired by energization of the pair of conductors 52—53.

The firing control mechanism 38 comprises a pair of balanced Wheatstone bridges W1 and W2 having the pairs of electrode conductors 39—41 and 42—43 respectively connected in one arm of each of the bridges. Each of the Wheatstone bridges controls the operation of a pair of relays including a firing relay similar to the arrangement of Fig. 3. An arrangement is thus provided in which a signal of predetermined strength detected by the pair of conductors 39—41 results in a predetermined unbalance of the bridge W1 and is adapted to cause the F group of explosive charges to be fired and, in like manner, a signal of predetermined strength detected by the pair of conductors 42—43 causes a predetermined unbalance of the bridge W2 and the firing of the A group of explosive charges.

Means are also provided for preventing the premature firing of the remaining group of explosive charges by the countermine effect of the explosion of the group of charges first to be fired. The manner in which this is accomplished will be more clearly apparent as the description proceeds.

The operation of the system of Fig. 1 will be best understood by reference to Fig. 3 on which is shown in diagrammatic form the complete circuit arrangement of the system. Let it be assumed, by way of example, that the electrode conductors 21—22 and the group of explosive charges 16 are being towed through the water substantially as shown in Fig. 1 with the electrodes 21—22 in predetermined spaced relation with respect to each other and with respect to the explosive charges.

The manner in which the Wheatstone bridge W is balanced will now be described. Switch T is moved into engagement with contact 1 thereof and switch S is closed. The closure of switch S completes a circuit from the positive terminal of battery BA by way of switch S, conductor 54, to terminal 55 of the Wheatstone bridge W, from whence the circuit is continued by way of arms B—C of the bridge, and conductor 56, to the negative terminal of battery BA, the arms D—E of the bridge being in parallel with the arms B—C. The arm E, it will be noted, includes the conductor electrodes 21—22 electrically connected to the bridge by the conductors 35 and 36 respectively and the closure of switch S, therefore, causes the electrodes 21—22 to be charged at a predetermined difference of potential applied thereto by the battery BA. Winding 1 of relay R is connected in the usual galvanometer circuit of the bridge between the arms B—C and D—E, the circuit including an ammeter 59.

Let it further be assumed that at the time of the closure of switch S, the bridge is sufficiently unbalanced to cause relay R to be operated. As armature 61 of relay R moves into engagement with its make contact, a circuit is closed from the positive terminal of battery BA by way of switch S, conductor 54, armature 57 and break contact of relay FR, conductor 58, armature 61 and make contact of relay R to winding 2 of relay R, from whence the circuit is continued by way of conductor 56 to the negative terminal of battery BA, thereby energizing the locking winding 2 of relay R.

As armature 62 of relay R engages its make contact, positive potential is applied by way of conductors 54 and 63 to the winding of relay FR, from whence the circuit is continued by way of conductor 56 to the negative terminal of battery BA thereby causing relay FR to operate. As armature 64 of relay FR moves into engagement with its make contact, a circuit is closed from positive potential on conductor 54 by way of armature 62 to make contact of relay R, conductor 63, armature 64 and make contact of relay FR, switch T and contact 1 thereof, and thence to the lamp L, thereby causing the lamp to light as an indication that relay FR is operated.

As armature 57 of relay FR moves away from its break contact the circuit to winding 2 of relay R is interrupted but relay R does not release at this time for the reason that the bridge W is sufficiently unbalanced to maintain a flow of current through the operating winding 1 of relay R of sufficient strength to prevent the release of the relay. This current, of course, causes a deflection of the ammeter 59 from the initial position thereof as an indication of the degree of unbalance of the bridge. The adjustable contact 65 of the bridge is now moved to a setting such that the bridge is balanced and no current flows through the meter 59 and winding 1 of relay R. Relay R now releases thereby interrupting at armature 62 thereof, the operating circuit of relay FR, and causing relay FR to release. As armature 64 of relay FR moves away from its make contact, the lamp L is extinguished.

Switch T is now moved into engagement with contact 2 and the system is in an armed condition, in readiness to fire the explosive charges 16 in response to a signal of

predetermined value received by the charged conductor electrodes 21—22 corresponding to a predetermined change in the electrical potential of the electrodes caused by a torpedo moving into proximate spaced relation with respect to the electrodes.

As the torpedo moves past the conductor electrode 21 the electrical potential between the electrodes 21 and 22 is changed, thereby changing the flow of current through arm E of the bridge W and causing the bridge to be unbalanced sufficiently for relay R to operate by current flowing through winding 1 thereof. When this occurs relay R locks over the following circuit: positive terminal of battery BA, switch S, conductor 54, armature 57, and break contact of relay FR, conductor 58, armature 61 and make contact thereof and winding 2 of relay R, conductor 56 and thence to the negative terminal of battery BA. As armature 62 of relay R engages its make contact, positive battery is applied to relay FR, thereby causing relay FR to operate and close the following firing circuit to the explosive charges: positive terminal of battery BA, switch S, conductor 54, armature 62 and make contact of relay R, conductor 63, armature 64, and make contact of relay FR, switch T and contact 2 thereof, conductor 18, to the detonating devices arranged within the explosive charges 16, from whence the circuit is continued by way of conductors 19 and 56 to the negative terminal of battery BA.

The firing relay FR is preferably slow operating, thereby to delay the firing of the explosive charges until the torpedo has traveled into proximate spaced relation with respect thereto whereby the explosive charges are effective to destroy the torpedo or deflect the torpedo sufficiently to miss the target in response to an electrical signal received from the torpedo by the electrodes 21—22. Relay R is slow releasing, thereby to maintain the firing circuit closed at armature 62 thereof for a length of time sufficient to insure firing of the explosive charges after the locking circuit to winding 2 of the relay is interrupted at armature 57 of relay FR.

The operation of the system of Fig. 2 will now be described with particular reference to the circuit arrangement shown on Fig. 4. Let it be assumed, by way of example, that the pairs of conductor electrodes 39—41 and 42—43 are arranged within the water in predetermined spaced relation with respect to each other and with respect to the groups of explosive charges F and A respectively associated therewith and that switches S1 and S2 are closed after the Wheatstone bridges W1 and W2 have been adjusted to a balanced condition generally in the manner of the adjustment of bridge W of Fig. 3. Let it further be assumed, for the purpose of description, that the system is armed with switches T1 and T2 in engagement with their respective contacts 2. Respectively associated with bridges W1 and W2 are pairs of relays R1—FR1 and R2—FR2. The operation of a pair of these relays in response to an electrical signal of predetermined value received by the pair of electrode conductors respectively associated therewith is generally similar to the operation of the relays R and FR associated with the bridge W of Fig. 3, and the operating circuit for these relays, therefore, will not be described in detail. Relays R1 and R2, however, are slow releasing relays and each of the relays FR1 and FR2 are preferably both slow operating and slow releasing.

The operation of relay FR1 in response to the operation of relay R1 caused by an electrical signal received from the torpedo by electrodes 39—41 causes a circuit to be closed from the positive terminal of battery BA by way of switch S1, conductor 66, armature 67 and make contact of relay R1, conductor 68, armature 69 and make contact of relay FR1, conductor 71, break contact and armature 72 of relay FR2, conductor 73, switch T1 and contact 2 thereof, conductor 51, thence to the detonating devices within the explosive charges 16 of group F from whence the circuit is continued by way of conductors 49 and 74 to the negative terminal of battery BA thereby firing the F group of explosive charges.

The premature firing of the explosive charges A at this time in response to variations in the resistance of the fluid medium between the pair of electrodes 42—43 resulting from the explosion of the charges of group F is prevented by including armature 75 and break contact of relay FR1 in the firing circuit for the detonators of the explosive charges of group A. Relay FR1, it will be recalled, is slow releasing and armature 75 thereof is not moved into engagement with its break contact until a predetermined period of time has elapsed following the explosion of the charges of group F sufficient for the pair of electrodes 42—43 to resume their predetermined spaced relation with respect to each other within the water in the event that the relative position of these electrodes should have been disturbed by the countermine effect of the explosion of the charges 16 of group F.

When a torpedo moves into sufficiently proximate relation to the electrodes 42—43 to cause an unbalance of the bridge W2 and effect the operation of relay R2, a circuit is closed from the positive terminal of battery BA by way of conductor 76, switch S2, conductor 77, armature 78 and make contact of relay R2, conductor 79, to the winding of firing relay FR2 from whence the circuit is completed by way of conductor 74 to the negative terminal of battery BA, thereby causing the firing relay FR2 to operate. As armature 81 of relay FR2 moves into engagement with its make contact a circuit is closed from positive terminal of battery BA, conductor 76, switch S2, conductor 77, armature 78 and make contact of relay R2, conductor 79, armature 81 and make contact of relay FR2, conductor 82, break contact and armature 75 of relay FR1, conductor 83, switch T2 and contact 2 thereof, conductor 52, and thence to the electroresponsive detonators of the explosive charges 16 of group A, from whence the circuit is continued by way of conductors 53 and 74 to the negative terminal of battery BA, thereby firing the explosive charges 16 of group A adjacent the torpedo.

In the event that the first torpedo to approach the vessel moved into proximate spaced relation with the electrodes 42 and 43 sufficient to cause the explosive charges of group A to be fired, the explosion of the charges of group F is prevented by reason of the interruption of the firing circuit to the detonators of group F at armature 72 and break contact of relay FR2. Relay FR2, it will be noted, is sufficiently slow releasing to prevent any possibility of premature closure of the firing circuit for the explosive charges 16 of group A until electrodes 39—41 are restored to an initial position within the water in predetermined spaced relation with respect to each other, in the event that the relative position of these electrodes was disturbed by the countermine effect of the explosion of the charges 16 of group A.

From the foregoing description it will be apparent that Fig. 4 discloses an arrangement for protecting a vessel from torpedo attack in which an electrical signal received by a pair of electrodes arranged within the water causes the firing of a group of explosive charges in predetermined time delayed relation with respect to the passage of a torpedo past the electrodes whereby the torpedo is destroyed or deflected from its course sufficiently to miss the vessel and in which the premature firing of another group of explosive charges protecting a different portion of the vessel and controlled by signals received by another pair of electrodes within the water is prevented.

Briefly stated in summary, the present invention contemplates an anti-torpedo system for protecting a vessel against attack from a torpedo in which the approach of the torpedo is detected by a change in the electrical character of the fluid medium between a pair of electrodes arranged in predetermined spaced relation within the water transverse the path of travel of the torpedo and in which the torpedo is destroyed or rendered ineffective

by exploding a plurality of explosive charges adjacent the torpedo under control of the torpedo detecting means and without physical contact of the torpedo with the detecting means. The present invention also contemplates the provision of a plurality of groups of explosive charges in predetermined spaced relation with respect to a vessel and adapted to be towed through the water in which the groups of explosive charges are fired adjacent the torpedo selectively under control of a pair of spaced electrodes arranged within the water transverse the travel of the torpedo and individual to each of the groups of charges, the firing means also including means for preventing the premature firing of the remaining groups of charges as a result of the countermine effect of the explosion of any of the groups of charges.

While the invention has been described with reference to two examples thereof which give satisfactory results, it will be understood by those skilled in the art, after understanding the invention, that various changes and modifications may be made without departing from the spirit and scope of the invention and it is my intention, therefore, in the appended claims to cover all such changes and modifications.

The invention herein described and claimed may be manufactured and used by or for the Government of the United States of America for governmental purposes without payment of any royalties thereon or therefor.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. In a system of the character disclosed for destroying a torpedo, a plurality of explosive charges arranged within a body of water, a pair of electrodes arranged within the water in predetermined spaced relation, means including said electrodes for detecting a torpedo, and means controlled by said detecting means for firing said explosive charges when the torpedo is adjacent thereto.

2. In a system for destroying a torpedo, a plurality of explosive charges arranged within a body of water and adapted to be towed by a vessel, means including a tow line for towing said charges at a predetermined distance from the vessel and in athwart relation thereto, a pair of elongated flexible electrodes secured to said tow line outboard of said explosive charges and in spaced relation therewith, means controlled by said electrodes for detecting a torpedo by an electrical change in the fluid medium therebetween caused by the torpedo, and means controlled by said detecting means for firing said explosive charges when the torpedo is adjacent the charges.

3. In a system of the character disclosed for protecting a vessel against attack by a torpedo, the combination of a pair of elongated flexible electrodes arranged in predetermined spaced relation within a body of water transverse the travel of the torpedo, a plurality of explosive charges arranged within the water, means for towing said electrodes and charges in predetermined spaced relation athwart the vessel with the charges intermediate the electrodes and the vessel, means for applying a predetermined electrical potential to each of said electrodes, and means controlled by said electrodes for firing the explosive charges adjacent the torpedo in response to variation in the potential of said electrodes induced by the torpedo as the torpedo traverses the electrodes without making physical contact therewith.

4. In a system of the character disclosed for destroying a torpedo, the combination of a plurality of explosive charges arranged within a body of water, means for firing said explosive charges, a pair of electrodes arranged within the water for operating said firing means selectively in accordance with a predetermined change in the electrical potential of the fluid medium between the electrodes caused by the moving torpedo, and means for maintaining said electrodes and explosive charges in predetermined spaced relation with respect to the vessel whereby the explosive charges are fired proximate the torpedo.

5. In a system for protecting a vessel from torpedo attack, the combination of a pair of charged electrodes arranged in predetermined spaced relation within a body of water, explosive means within the water disposed between said electrodes and the vessel, and means operatively connected to the electrodes for firing said explosive means in predetermined time delayed relation with respect to a predetermined change in the potential of said charged electrodes as the torpedo moves into proximate relation therewith.

6. In a system for protecting a vessel from torpedo attack, the combination of a pair of groups of explosive charges arranged within a body of water on opposite sides of the vessel and at a distance therefrom and adapted to be towed by the vessel, two pairs of elongated flexible electrodes arranged within the water, each of said pairs of electrodes being disposed outboard of said explosive charges, means for applying a predetermined difference of electrical potential to each of said pairs of electrodes respectively, towing means for maintaining said electrodes and explosive charges in predetermined spaced relation with respect to each other as the vessel moves through the water, and means controlled by said electrodes for firing one of said groups of charges adjacent the torpedo in response to a change in said difference of electrical potential of one of said pairs of electrodes caused by the torpedo moving into proximate relation therewith.

7. An anti-torpedo system comprising a plurality of explosive charges disposed within a body of water, and means including a pair of charged electrodes arranged within the water and controlled by the moving torpedo for firing said explosive charges without contact of the torpedo therewith.

8. An anti-torpedo system comprising a plurality of explosive charges arranged within a body of water, a pair of electrodes arranged within the water in predetermined spaced relation to said charges for detecting a torpedo as the torpedo moves into proximate relation therewith, and means operatively connected to the electrodes for firing said explosive charges adjacent the torpedo in response to an electrical signal received from the torpedo by the electrodes.

9. In a system of the character disclosed for prematurely exploding a torpedo, the combination of a plurality of explosive charges arranged within a body of water, a pair of elongated electrodes arranged in predetermined spaced relation transverse the path of travel of a torpedo, means including a Wheatstone bridge for applying an initial potential to said electrodes, a relay connected to said bridge and adapted to be operated in response to a variation in said potential caused by the torpedo, and means controlled by said relay for firing the explosive charges in predetermined time delayed relation with respect to said variation in potential.

10. In a system of the character disclosed for prematurely exploding a torpedo, the combination of a plurality of explosive charges arranged within a body of water, a pair of elongated electrodes arranged within the water adjacent said charges, means secured to a vessel for towing the electrodes outboard of said charges and in predetermined spaced relation with respect thereto, a Wheatstone bridge on the vessel having the electrodes included in one arm thereof, means for initially balancing the bridge, and means operatively connected to said bridge for firing said explosive charges in response to a predetermined degree of unbalance of the bridge caused by an electrical signal received from the torpedo by said electrodes.

11. In an anti-torpedo system of the character disclosed for prematurely exploding a torpedo, the combination of a plurality of sets of potentially charged electrodes arranged within the water, a plurality of groups of explosive charges respectively associated with said sets of electrodes, means controlled by the electrodes in response to a variation in potential caused by an electrical signal

received thereby from the torpedo for firing one of said groups of charges electrically when the difference in potential of the electrodes of one of said sets has reached a predetermined value, and means controlled by said firing means for preventing the firing of another group of explosive charges until a predetermined period of time has elapsed after the charges have been fired.

12. In an anti-torpedo system of the character disclosed for prematurely exploding a torpedo, the combination of a plurality of sets of potentially charged electrodes arranged within the water, a plurality of groups of explosive charges respectively associated with said sets of electrodes and arranged in predetermined spaced relation with respect thereto, means controlled by the electrodes in response to a variation in potential caused by an electrical signal received thereby from the torpedo for firing one of said groups of charges electrically in predetermined time delayed relation with respect to the response of said electrodes to said signal when the difference in potential of the electrodes of one of said sets has reached a predetermined value, and means controlled by said firing means for preventing the firing of another group of explosive charges until a predetermined period of time has elapsed after the charges have been fired.

13. An anti-torpedo system of the character disclosed comprising, in combination, electroresponsive explosive means for destroying an oncoming torpedo and arranged within the water transverse the travel thereof, a pair of charged elements disposed within the water and in predetermined spaced relation with respect to said explosive means and adapted to generate a voltage signal in response to a change in the conductivity of the water therebetween caused by the torpedo, and means operatively connected to said elements for firing said explosive means in response to said signal thereby to destroy the torpedo.

14. A system of the character disclosed for destroying a moving torpedo comprising, balanced circuit means including a pair of charged detector elements disposed within the water in predetermined spaced relation with respect to each other transverse the travel of the torpedo and constructed and arranged to unbalance said circuit means as the torpedo moves into predetermined spaced relation with respect to said detector elements, a plurality of explosive charges arranged in predetermined spaced relation to said detector elements, and electroresponsive means controlled by said circuit means for firing said charges when the circuit means is unbalanced.

15. An anti-torpedo system comprising a plurality of explosive charges disposed within a body of water, balanced circuit means including a pair of spaced detector elements, each of said elements having an initial potential applied thereto, said detector elements being disposed within the water along the travel of the torpedo and arranged in close proximity to said explosive charges, means including said detector elements for unbalancing said circuit means in response to the electrical potential induced by the torpedo on said detectors as the torpedo moves adjacent to said elements, and electroresponsive means for firing said charges in response to a predetermined unbalance of said circuit means.

16. A system of the character disclosed for destroying a moving torpedo comprising, in combination, a plurality of explosive charges arranged within the water transverse the travel of the torpedo, means including a pair of spaced electrodes disposed within the water and responsive to a change in the conductivity of the surrounding water caused by the torpedo for generating an electrical signal, and electroresponsive means controlled by said signal for firing said explosive charges as the torpedo moves adjacent thereto.

17. In a system for protecting a vessel against torpedo attack, the combination of a plurality of explosive charges, a pair of submerged devices for detecting the presence of a torpedo directed against the vessel by a change in the conductivity of the surrounding water caused by the torpedo, means for maintaining said explosive charges and said detecting devices within the water in predetermined spaced relation with respect to each other and with respect to the vessel, means operatively connected to said detecting devices and controlled thereby for generating a signal as the torpedo moves into proximity with the devices, and means controlled by said signal for firing said explosive charges when the signal has reached a predetermined strength.

18. An anti-torpedo system of the character disclosed comprising, in combination, electroresponsive explosive means for destroying an oncoming torpedo, means including a pair of spaced electrodes arranged within the water transverse the travel of the torpedo for generating a signal in response to a decrease in the conductivity of the water therebetween caused by the torpedo, and means controlled by said signal for operating said explosive means as the torpedo moves into proximity with respect thereto.

19. A system for protecting a vessel against torpedo attack comprising, in combinatiton, a pair of charged torpedo detection streamers arranged in predetermined spaced relation within the water and adapted to generate a torpedo signal in accordance with a change in the conductivity of the water therebetween as the torpedo moves into the vicinity thereof, means operatively connected to said streamers for generating an output voltage corresponding to said torpedo signal, an explosive array, means for maintaining said streamers in spaced parallelism with respect to said array and with respect to each other, and means controlled by said voltage for firing said explosive array when the torpedo signal has reached a predetermined value.

No references cited.