Aug. 11, 1964 C. YOUNG, JR 3,143,964

ARMING AND FIRING MECHANISM

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FIG.1.

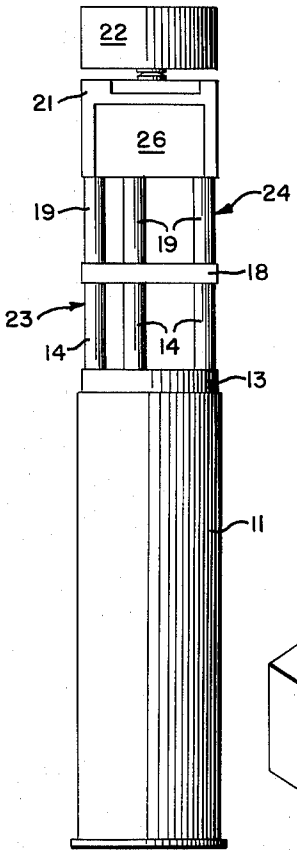


FIG.5.

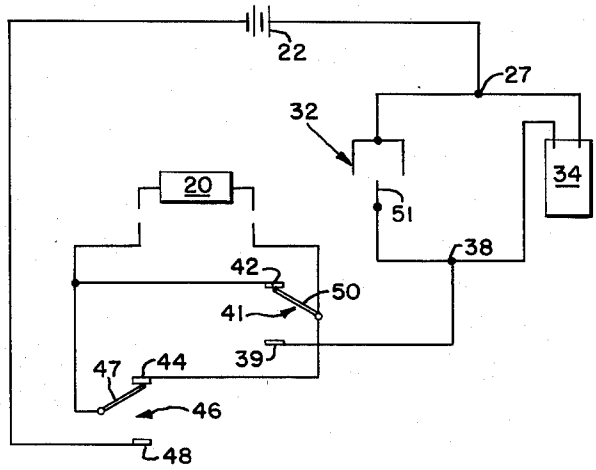
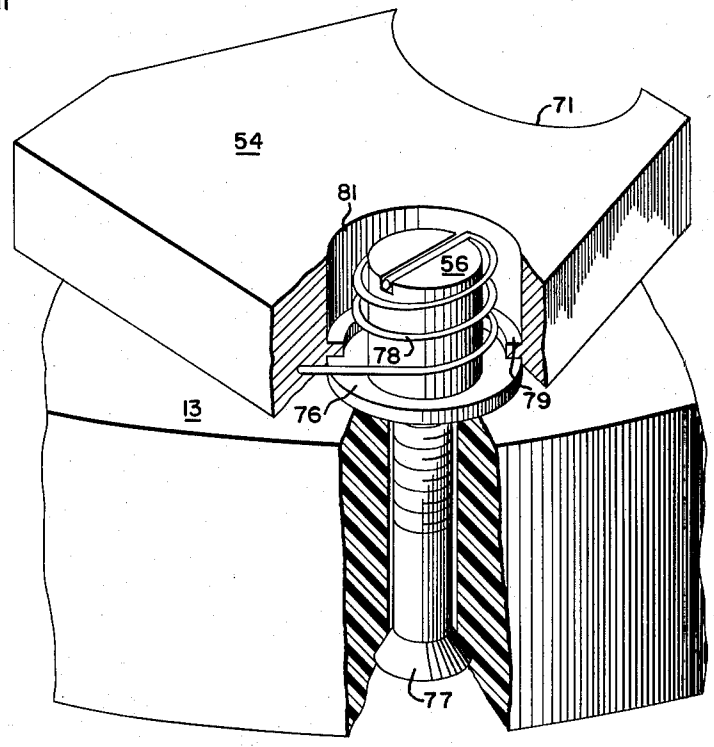


FIG.4.



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ARMING AND FIRING MECHANISM

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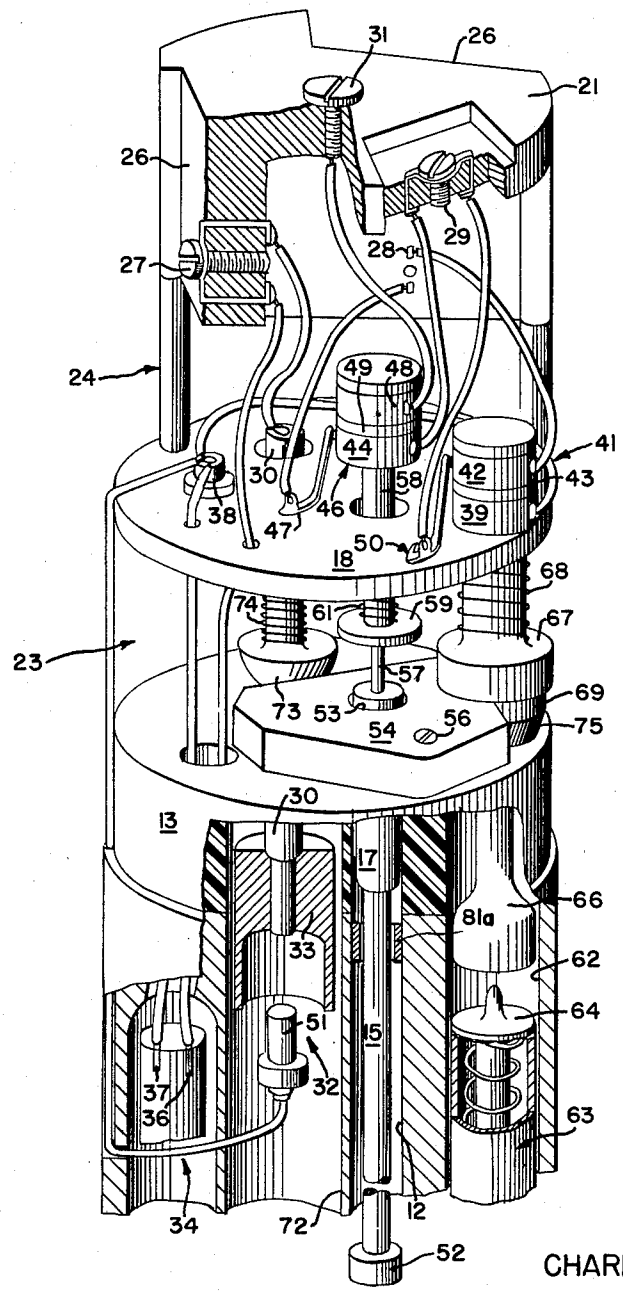
FIG.2.



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ARMING AND FIRING MECHANISM

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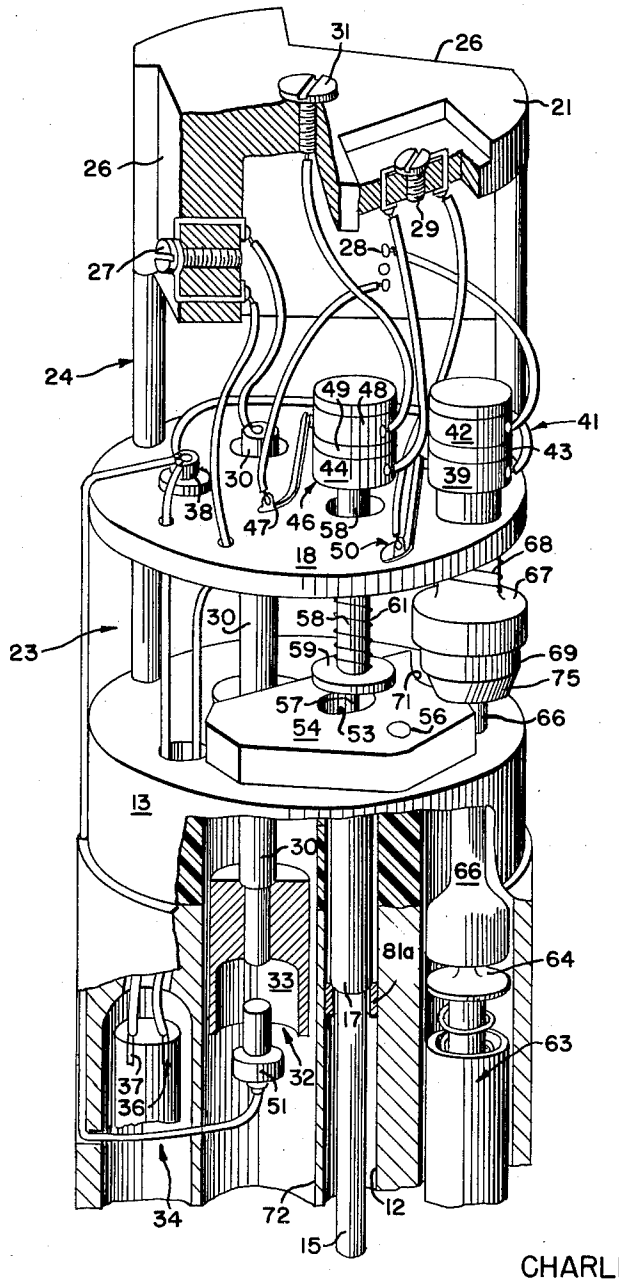
FIG.3.



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United States Patent Office 3,143,964 Patented Aug. 11, 1964

3,143,964

ARMING AND FIRING MECHANISM

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Filed Dec. 27, 1957, Ser. No. 705,721
11 Claims. (Cl. 102—16)
(Granted under Title 35, U.S. Code (1952), sec. 266)

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

This invention relates generally to a new and improved arming and firing mechanism for an ordnance device and more particularly to a mechanism of the type wherein the detonator is shorted by two switches which are connected in parallel when the detonator is in the unarmed condition and in series with respect to each other and the detonator when it is armed.

One object of this invention is to provide a new and improved apparatus for arming an ordnance device which requires the occurrence of two sequential or simultaneous arming events before the ordnance device becomes armed.

Another object of this invention is the provision of an arming and firing mechanism which is of rugged and simple construction and is adapted to be functionally integrated with standard demolition initiator components without requiring substantial modification of the components.

Still another object of this invention is the provision of a spring and cam powered switch mechanism having a new and improved locking arrangement of an arming cam to prevent premature accidental arming of the ordnance weapon and permit positive and reliable operation of the arming cam upon the occurrence of an arming event.

Yet another object is the provision of a new and improved firing mechanism for an underwater ordnance device such as a mine which is tamper proof and actuates the mine when an attempt is made to disarm the mechanism by an enemy.

A preferred embodiment of this invention relates to an arming and safety apparatus for underwater ordnance weapons such as mines, depth charges or the like. In this embodiment, a water soluble plug or washer supports a rod restraining a first double throw arming switch in the safe position. An explosive delay pencil of conventional design is adapted to arm a second double throw arming design which normally reposes in the safe position. Upon firing of the delay pencil and dissolving of the water soluble plug, both switches are armed and a normally restrained cam rotates to permit a normally inactive magnetic firing switch to be activated. A mercury firing switch is connected in parallel with the magnetic firing switch so that the actuation of either detonates the mine provided both arming switches are armed.

For a more complete understanding of the invention the following specification should be considered in conjunction with the accompanying drawings wherein like numerals designate like or similar parts throughout the various views and in which:

FIG. 1 is an elevation partly in section of a device embodying the principles of this invention;

FIG. 2 is an enlarged prospective view of a portion of the device of FIG. 1 with parts omitted for the sake of clarity and showing the arming switch in the safe position;

FIG. 3 is a view similar to FIG. 2 showing the switch in the armed position;

FIG. 4 is a greatly enlarged view of the cam shown in

FIGS. 2 and 3 partly broken away to more clearly show its construction; and

FIG. 5 is a circuit diagram of the device showing the switches in the unarmed condition.

Referring now with greater particularity to FIG. 1, it is seen that the arming mechanism is composed of a body portion 11 adapted to fit within an appropriate recess in the casing of an ordnance device [not shown]. Body 11 has a plurality of bores or cavities therein to provide protected internal passages for the electrical wiring and to house the mechanism disposed within the body. Lying upon the upper surface of body 11 is a bottom plate 13 composed of electrically non-conducting material and adapted to receive a plurality of threaded pillars 14 which screw into appropriate holes in the body 11 and bottom plate 13 to provide structural support for the apparatus. The opposite ends of pillars 14 are threaded and protrude through an electrically insulating plate 18 while a second set of pillars 19 are screwed onto the ends of pillars 14. The pillars 19 are secured at their opposite ends into a hollow terminal block 21 which provides the electrical connection to a firing battery 22. The device is divided by the plate 18 into a first section 23 housing all the mechanical elements and a second section 24 containing the wiring and switches.

As seen more clearly in FIGS. 2 and 3 there are formed in the walls of block 21 a plurality of indented portions 26 adapted to receive a plurality of electrical posts 27, 28 and 29; a fourth post 31 is formed at the surface of the terminal block. Posts 27 and 31 are electrically connected across the output of the battery 22 to provide initiation of the detonator at the proper moment. Posts 28 and 29 are connected exteriorly across the detonator 20 shown schematically in FIG. 5.

Interiorly, post 27 is connected to rod 30 which provides an electrical connection to a magnetic switch 32 which will be described in detail hereinbelow. Post 27 is also connected electrically to one terminal 36 of a mercury switch 34 disposed within an appropriate cavity in the main body 11. The primary purpose of this switch is to detonate the mine in the event it breaks loose from its mooring. However, this switch may also detonate the mine if it is disturbed in any manner after planting and arming. The other terminal 37 of mercury switch 34 is permanently connected via binding post 38 to contact point 39 of switch 41. A second contact point 42 of switch 41 is electrically separated from contact point 39 by insulator ring 43. When switch 41 is in the position shown in FIG. 2, contact point 42 is connected to a resilient contact member 50 of switch 41 which is secured to plate 18 and electrically connected to post 29.

Post 29, in turn, is permanently connected to the contact point 44 of a switch 46. A resilient contact member 47 of switch 46 is electrically connected to post 28 and is secured to plate 18 to cooperate with contact point 44 when the switch is in the position shown in FIG. 2. Another contact point 48 of the switch 46 is separated from contact point 44 by an insulating disc 49 and is electrically connected to a terminal of battery 22 via post 31. It should be noted that binding post 38 forms a common electrical point between contact point 39 of switch 41, terminal 37 of mercury switch 34 and the magnet contact 51 of the magnetic switch 32.

Disposed within a bore 12 of the body 11 is a rod 17 which is supported by a member 15 abutting a water soluble washer 52 which lies exteriorly of block 11. Rod 17 extends through a matching bore in the bottom plate 13 and a bore 53 in cam 54 which cam is pivotally supported by the arbor 56 in a manner described hereinbelow. The bore 53 in the cam is slightly larger than the diameter of the rod but it is not so much larger as to allow the cam to pivot around the arbor 56. Affixed to the

end of rod **17** protruding through cam **54** is a small diameter extension rod **57** of a length at least equal to the thickness of cam **54** and terminating in a plate **59**. A finger **58** fixed to the switch **46** passes through an appropriate hole in the top plate **18** and is fastened to the plate **59**. A compression spring **61** disposed about finger **58** urges the extension rod **57** away from plate **18**.

Disposed within bore **62** in body **11** is a delay firing pencil **63** of conventional design. This delay pencil may conveniently be the type described in detail by Army Field Manual FM5–25 and will not be described in detail herein inasmuch as it forms no part of this invention. Upon firing of the delay pencil **63**, striker **64** is driven against an actuating rod **66** moving it upwardly to lift it through bore **62** in body **11** and an appropriate aligned bore in bottom plate **13** to move the trip rod **67** against the force of the biasing spring **68**. The trip rod has a lower extension **69** which fits within an appropriate recess **71** formed in cam **54** to prevent rotation thereof and is fixed to the switch **41** so that movement of rod **67** moves contacts **39** and **42** of switch **41** upwardly from the position shown in FIG. 2 to the position shown in FIG. 3. The actuating rod **66** is of smaller diameter than extension **69** of trip rod **67** to permit some movement of cam **54** about arbor **56** when rod **66** is in the position shown in FIG. 3. In the event that rod **67** is accidentally moved to the position shown in FIG. 3 while switch **46** remains in the position shown in FIG. 2, a taper **75** is provided on the lower end of extension **69** to permit re-engagement of **69** with cam **54** and thus prevent arming of switch **41** prior to the firing of pencil **63**.

The magnetic switch **32** is disposed in a hole **72** formed in the body **11** and in bottom plate **13**. The magnetic contact **51** of switch **32** is fixed for operation within hole **72** while the iron sleeve **33** is normally disposed above this contact so that the magnetic switch may not be accidentally closed. Rod **30** is secured to the iron sleeve **33** of the magnetic switch and extends upwardly through bottom plate **13** and top plate **18** to provide an electrical contact to the magnetic switch as previously described. This rod **30** passes very close to cam **54** and has a hemispherical enlargement **73** which normally rests against the upper surface of this cam while a spring **74** tends to urge the rod downwardly to bring the iron sleeve **33** in operable relation about the magnetic contact **51** of switch **32**.

Referring now to FIG. 4 which shows in greater detail the construction of cam **54**. An enlarged collar **76** on arbor **56** abuts the surface of plate **13** and receives an internal shoulder **79** formed within bore **81** in cam **54** to support the cam slightly above plate **13** to minimize frictional impedance as the cam is rotated. A screw **77** extends through an appropriate hole in the bottom plate **13** and threads into the arbor **56** so that by tightening screw **77** the arbor is locked to the top plate **13** while a spring **78** coiled in the same sense as the threads of screw **77** is fastened at one end to arbor **56** and at the other end to cam **54**, so that rotation of the cam in the direction urged by spring **78** serves to tighten the arbor more securely against plate **13**. Thus, rotation of the cam without rotation of the arbor is assured.

Referring now to FIG. 5 which is an electrical circuit diagram of the apparatus it is seen that a firing battery **22** is connected across a detonator **20** upon closing of one of the switches **32** and **34** which are connected in parallel to one terminal of the battery. However, terminals **48** and **47** of switch **46** must be connected and simultaneously terminals **39** and **50** of switch **41** must be connected in order to fire the detonator **20** upon the closing of either switch **32** or **34**. If only one of the switches **41** and **46** is closed the detonator is not armed and remains shorted.

When the apparatus has assumed the position indicated in FIG. 2, the switch **41** is in the position indicated in FIG. 5 thereby maintaining the circuit to the detonator **20** open. It will be seen however that even though the

switch **41** may be reversed so that a path is provided through detonator **20** through one leg of the battery, the device is still in the unarmed condition since switch **46** is in the open position. Accordingly, it is obvious that unless both switches **41** and **46** are in the armed position the detonator remains unarmed and shorted and closing of either switch **32** or **34** will not initiate the detonator.

Operation

Reference should now be had to FIGS. 2 and 3 in order to follow the sequence of operation of this device. Preparatory to planting the mine, the delay firing pencil **63** is armed in the conventional manner which will not be described herein as the firing pencil forms no part of this invention. After the mine is planted in a body of water the soluble washer **52** dissolves thereby permitting member **15** and rod **17** to slowly move downwardly through cam **54**. This allows extension rod **57** to move downwardly so that it is disposed in the hole in cam **54**. When the rod **17** has completely cleared the hole in cam **54** and has bottomed on a stop **81***a* in bore **12** the small diameter rod **57** is disposed within this hole thereby removing one interference which would prevent the cam from rotating about its arbor **56**. As the extension rod drops, contact between contact member **47** and contact point **44** of switch **46** is broken and contact between contact member **47** and contact point **48** is established. After a predetermined delay, the delay firing pencil **63** fires; its striker **64** hits actuator rod **66** driving the trip rod **67** upwardly against the action of coil spring **68** a sufficient distance to allow the cam **54** to rotate beneath the bottom or lower end of the trip rod **67**. Upon sufficient rotation of the cam **54** so that it no longer abuts shoulder **73** on rod **30**, the rod and the soft iron sleeve **33** attached thereto drop toward the magnetic contact **51**. Simultaneously, contact between the contact member **50** and the contact point **42** of switch **41** is broken and contact between point **39** of the switch and the contact member **50** is established. The cam, of course, may only rotate a relatively small distance because the small diameter extension rod **57** fits within hole **53** and restricts its rotation. Also the actuator rod **66** protruding up through bottom plate **13** below trip rod **67** prevents excessive rotation.

Arming will occur if the delay firing pin discharges prior to the melting of the water soluble washer because when this occurs, the trip rod assumes the position shown in FIG. 3, but since the extension rod **57** is still within the center hole **53** of the cam **54** it is prevented from moving. When the soluble washer dissolves, the rod **17** moves out of the center hole of the cam onto the bottom plate allowing the cam to rotate as before and drop the rod **30** and lower the iron sleeve **33** into proximity with magnetic contact **51**.

It should be noted that when the cam is in the armed position shown in FIG. 3 the rod **17** is prevented from moving up because the cam has assumed a position such that its center hole is eccentric with respect to the rod in the bottom plate and any upward movement of the rod **17** is blocked by the lower surface of the cam. This prevents an enemy from pushing the rod **17** from the outside to disarm the switch. If sufficient force or shock is used against the rod **17** to break the cam, either of the switches **32** or **34** closes causing immediate detonation thereby destroying the device and the person attempting to disarm it. This booby trap feature is an important facet of this invention.

Although this invention has been described with reference to but one embodiment it should be apparent to those skilled in the art upon reading and understanding the foregoing that it is not so limited but is susceptible of many alterations and modifications departing from the scope thereof. Accordingly, this invention is to be construed as limited only by the appended claims.

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

1. A device for arming and firing an ordnance weapon having an electrically operated detonator and a voltage generating means adapted to be connected across said detonator which comprises; a body, an electrically insulating perforated plate spaced from said body and defining a housing for mechanical elements of said device therebetween, a terminal block spaced from said plate and defining an arming switch housing portion therebetween, a normally safe firing switch disposed within said body and having a movable contact and a fixed contact, a cam having at least one bore therethrough and supported by said body exteriorly thereof, biasing means urging said cam to rotate, a first normally safe arming switch disposed within the arming switch housing portion and including a fixed contact secured to said insulating plate and a pair of mechanically connected movable contacts cooperating with said fixed contact to arm and safe the switch, said arming switch being electrically connected in series between the detonator and the voltage generating means, a rod slideably disposed within said body and extending outwardly thereof through the bore in said cam thereby restraining rotation of said cam, means integral with the movable contacts of said arming switch and operatively connected to said rod for operation of said switch upon movement of said rod, a potentially disintegratable member disposed without said body supporting said rod and restraining said arming switch in the safe position, whereby disintegration of said last named member permits movement of said rod to arm said first arming switch and to withdraw said rod from the bore in said cam, a second normally safe arming switch disposed within the arming switch housing portion and including a movable member containing a pair of discrete contact points and a fixed member secured to said insulating plate adapted to electrically connect with each of the movable contacts alternately to arm and safe said second arming switch, said second arming switch being electrically connected in series with the voltage generating means and the detonator, means fixed to the movable member of said second arming switch and operatively connected to said cam to restrain movement thereof, an actuating rod operatively connected to said last named means for operating said means to release said cam and simultaneously arm said second arming switch whereby said cam is rotated when said first arming switch and said second arming switch are both armed, means operatively connected to the fixed contact of said firing switch and normally restrained by said cam to retain the fixed contact of said firing switch in inoperative relation with respect to said movable contact whereby said fixed contact is brought into operable relation with said movable contact upon rotation of said cam.

2. The device of claim 1 wherein the diameter of the bore through said cam is slightly larger than the diameter of said rod whereby said rod cannot be moved longitudinally through said bore subsequent to rotation of said cam and arming of the arming switches without closing the anti-tampering switch and firing the ordnance weapon.

3. A device for arming and firing an ordnance weapon which comprises; at least one firing switch, a first normally safe arming switch, a second normally safe arming switch serially connected to said first arming switch, whereby the weapon is armed only when both arming switches are armed, actuating means for arming said first arming switch, independent actuating means for arming said second switch, rotatable means operatively connected to each of said actuating means and normally disposed in a position to permit facile movement of said actuating means, biasing means urging said rotatable means to an actuating means blocking position, said rotatable means being normally restrained from movement to the actuating means blocking position by each of said actuating means when the respective arming switches are in the safe position, whereby said rotatable means is permitted to move to the actuating means blocking position only upon arming of both of said arming switches, locking means restraining said rotatable means in the actuating means blocking position thereby to prevent disarming of the weapon subsequent to the arming thereof.

4. The device of claim 3 wherein the firing switch comprises; a magnetic switch adapted to fire said ordnance device upon the movement thereof in an attempt to disarm the arming switches.

5. A device for arming and firing an underwater ordnance weapon having an electrically operable detonator and voltage generating means adapted to be connected across said detonator which comprises; a first normally open firing switch electrically disposed between the detonator and the voltage generating means, a normally inactive magnetic firing switch electrically connected in parallel with said first firing switch, and including a magnetic movable contact and an iron sleeve contact, a support body, a cam having at least one bore therethrough and rotatably supported above said body, spring means operatively connected to said cam to rotate said cam, a first normally safe arming switch including a pair of movable contacts and a fixed contact cooperating with each of the movable contacts alternatively to safe and arm said switch, said arming switch being electrically connected in series between the detonator and the voltage generating means, a rod slideably disposed within said support body and extending outwardly thereof through the bore in said cam thereby restraining said cam from rotation, a smaller diameter extension rod integral with said first rod and having a length at least equal to the thickness of said cam to permit limited rotation of said cam when it is disposed in the bore therethrough, said extension rod being operatively connected to said first arming switch to operate said first arming switch upon movement of said first rod, a water soluble plug supporting said first rod to restrain movement thereof whereby said first rod moves within said body to arm said first arming switch and position said extension rod within the bore in said cam upon dissolution of said plug, a second normally safe arming switch electrically connected in series between said detonator and said voltage producing means and including a movable member containing a pair of discrete contact points and a fixed contact adapted to electrically connect with each of the movable contact points alternately to arm and safe said second switch, a trip rod affixed to the movable member of said second arming switch and operatively connected to said cam to restrain movement thereof when said second switch is in the safe position, a movable actuating rod connected to said trip rod for moving said rod to release said cam and simultaneously arm said second switch, whereby said cam is rotated by said spring biasing means only when said first arming switch and said second arming switch are both armed, means fixed to the iron sleeve contact of said magnetic firing switch and having a collar normally restrained by said cam to retain said sleeve in the inoperative position with respect to said movable magnetic contact whereby said sleeve is brought into operative relation with respect to said magnetic contact upon rotation of said cam and release of said last named means.

6. The device of claim 5 wherein said means fixed to the iron sleeve of said magnetic firing switch prevents return of said cam to its initial position after the rotation thereof thereby preventing movement of said first rod through the bore in said cam to disarm its respective arming switch without jiggling at least one of the firing switches.

7. A device for arming and firing an ordnance weapon having an electrically operable detonator and a voltage generating means adapted to be connected across said detonator which comprises; a body having a plurality of bores therethrough, a normally open firing switch disposed within said body and electrically connected in series

between the detonator and the voltage generating means, a cam rotatably supported by said body externally thereof and having at least one through bore spaced from the axis of rotation, a first normally safe arming switch serially connected between the detonator and the voltage generating means and including a pair of movable contacts and a fixed contact adapted to alternately connect with each of the movable contacts to arm and safe said switch, a rod slideably disposed within a bore in said body and extending outwardly thereof through the bore in said cam thereby restraining said cam from rotation, an extension rod integral with said first rod having a length at least equal to the thickness of said cam and a diameter smaller than said first rod to permit limited rotation of said cam when said extension rod is wholly disposed therein, said extension rod being operatively connected to the movable contacts of said arming switch to operate said switch upon movement of said rod, releasable means disposed within the bore in said body supporting said rod to restrain said arming switch in the safe position whereby said first rod is moved to position said extension rod only within the bore in said cam and to arm said arming switch upon release of said last named means, a second normally safe arming switch serially connected between said detonator and the voltage generating means and including a fixed contact, an arming contact and a safing contact mechanically connected to said arming contact for movement therewith relative to said fixed contact, means releasably restraining said second arming switch in the safe condition and preventing rotation of said cam whereby said cam is free to rotate when said first arming switch and said second arming switch are both armed thereby misaligning the bore in said cam with respect to said first rod so that the rod may not be moved through the bore to disarm said first firing switch without detonating the weapon.

8. A device for arming and firing an ordnance weapon having an electrically operable detonator and a voltage generating means adapted to be connected across said detonator which comprises; a body having at least one bore therethrough, a normally open firing switch disposed between said body and electrically connected in series between the detonator and the voltage generating means, a cam having at least one bore therethrough normally aligned with the bore in said body and rotatably supported exteriorly of said body, biasing means urging rotation of said cam, a first arming switch serially connected between the detonator and the voltage generating means, a second arming switch serially connected between said voltage generating means and said detonator, a rod slidably disposed within said bore in said body and extending outwardly thereof through the bore in said cam thereby restraining said cam from rotation, an extension rod integral with said first rod having a length at least equal to the thickness of said cam and having a diameter smaller than said first rod whereby said extension rod permits limited rotation of said cam when it is disposed in the bore therethrough, said extension rod being operably connected to the first named arming switch to operate said switch upon movement of said rod, means operatively connected to said first rod for movement thereof upon the occurrence of an arming event, a trip rod operatively connected to said second arming switch and cooperating with said cam to restrain movement thereof, means operatively connected to said trip rod for urging said rod

to release said cam and to simultaneously arm said second switch, whereby said cam is rotated by said biasing means when the extension rod is wholly disposed within the bore in said cam and said trip rod is released thereby misaligning the bore in said cam with the bore in said body, whereby said first named rod may not be manually pushed through the bore in said cam to disarm the device without closing the contact of the firing switch and firing the weapon.

9. An anti-tampering mechanism for an electrically actuated ordnance device comprising; an ordnance firing switch, a normally safe arming switch electrically connected in series with said firing switch, means operatively connected to said arming switch and slideable between an arming switch safing position and an arming position, cam means rotatably operable between a first position permitting free movement of said slideable means and a second position restraining movement of said slideable means, means operatively connected to said cam and urging it to the second position, said cam being restrained in the first position by said slideable means when said slideable means is in the switch safing position, whereby said cam rotates to the second position when said slideable means moves to the switch arming position thereby preventing forced return of said slideable means to the safing position.

10. The mechanism of claim 9 wherein the cam has a bore therethrough and the slideable means is disposed in said bore only when said slideable means is in the arming switch safing position.

11. A switching arrangement for arming an underwater ordnance device including a source of electrical energy having two terminals, a detonator and at least one firing switch electrically connected between the source of electrical energy and the detonator which comprises; an arming switch including a first contact connected to a first terminal of the source of electrical energy, a second contact, a third contact connected to one end of said detonator and operable to alternately connect with said first and said second contacts, water soluble means operatively connected to said arming switch to maintain connection between the second and third contacts prior to water immersion, means urging said first contact and said third contact into electrical contact upon solution of said water soluble means, a second arming switch operable independently of said first arming switch and including a first contact connected to the firing switch for connection to a second terminal of said source of electrical energy upon closing of said firing switch, a second contact electrically connected to the third contact of said first arming switch, and a third contact connected to the end of said detonator opposite to the end connected to the third contact of said first arming switch and normally connected to the second contact of said second arming switch, and time delay means for urging the first and third contacts of said second switch into electrical contact, whereby the ordnance device is armed only when the third contact of each arming switch is connected to its respective first contact.

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