Nov. 1, 1960 A. H. SELLMAN ET AL 2,958,281

HYDROSTAT MECHANISM

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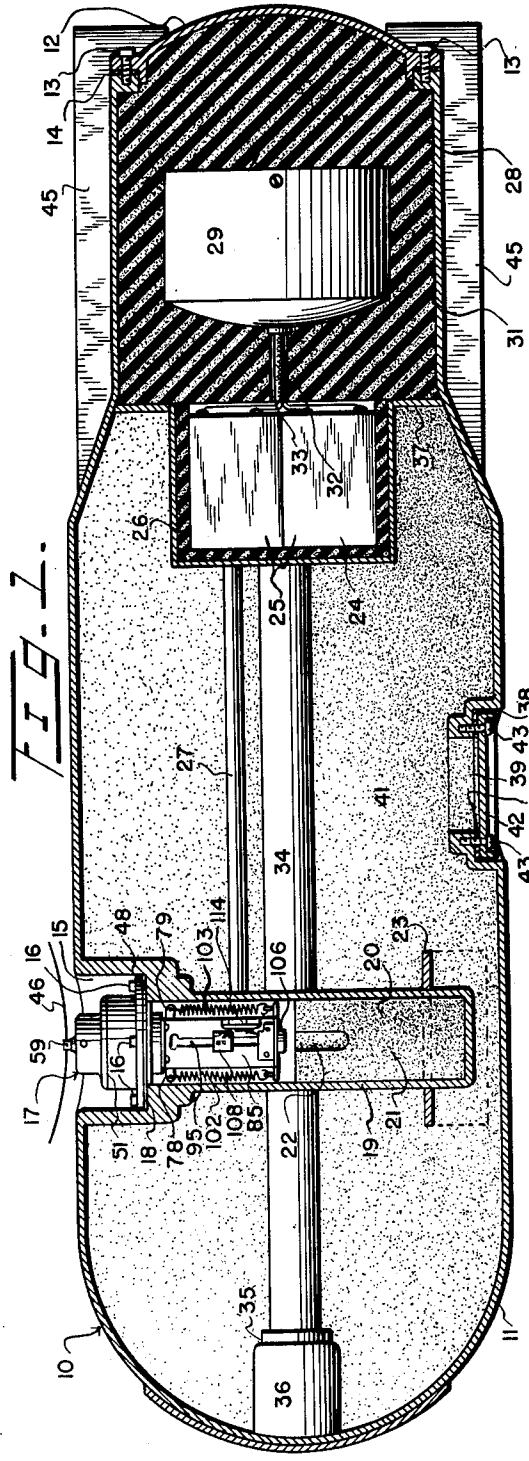

FIG. 1.

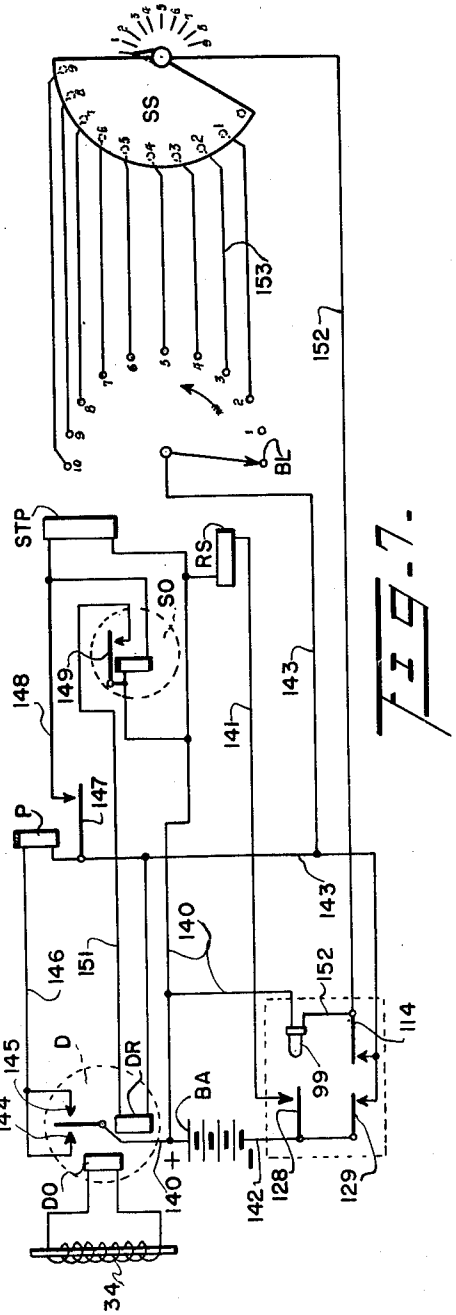

FIG. 7.

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HYDROSTAT MECHANISM

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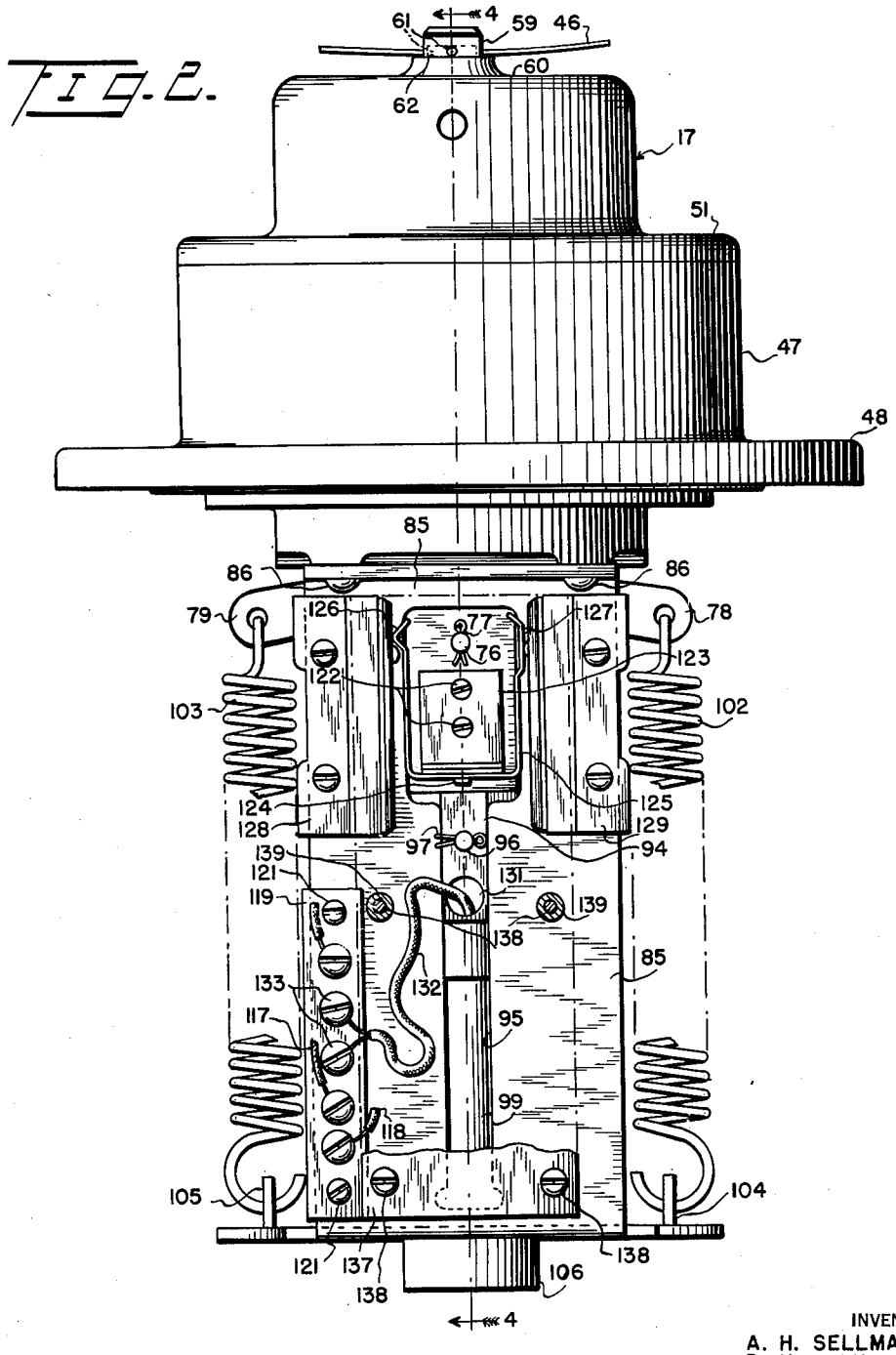
Fig. 2.



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HYDROSTAT MECHANISM

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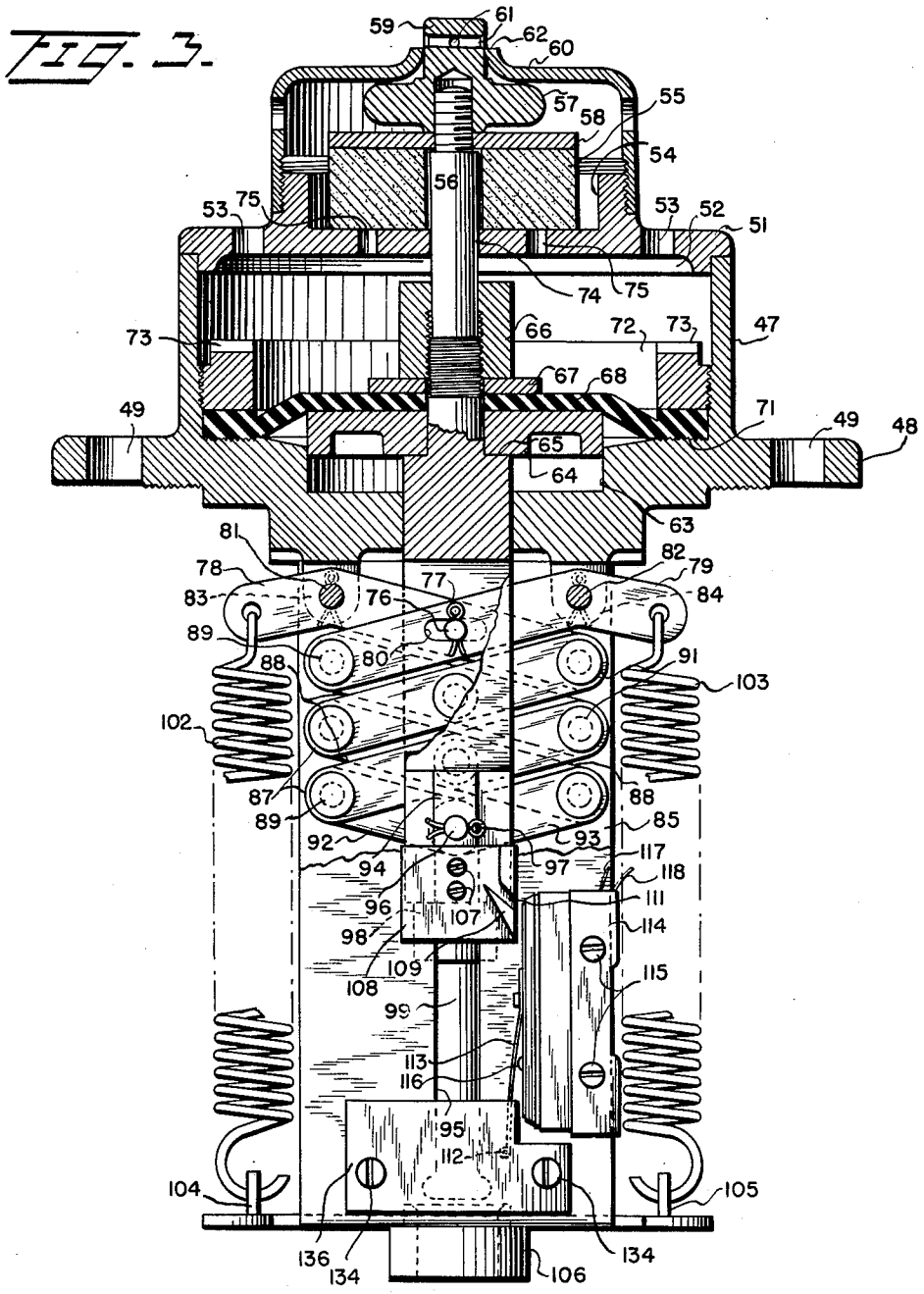
Fig. 3.



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HYDROSTAT MECHANISM

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FIG. 4.

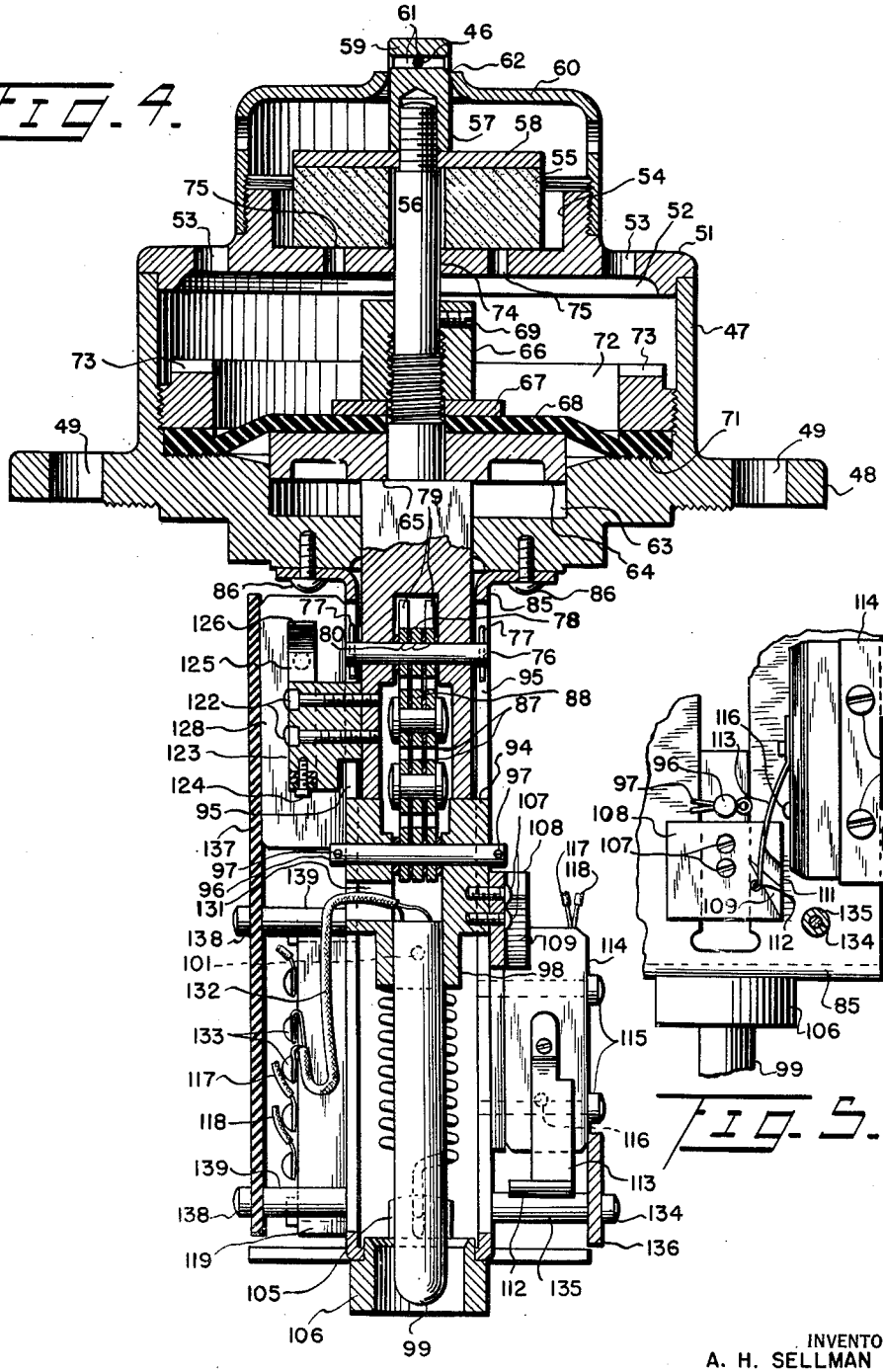

FIG. 5.

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HYDROSTAT MECHANISM

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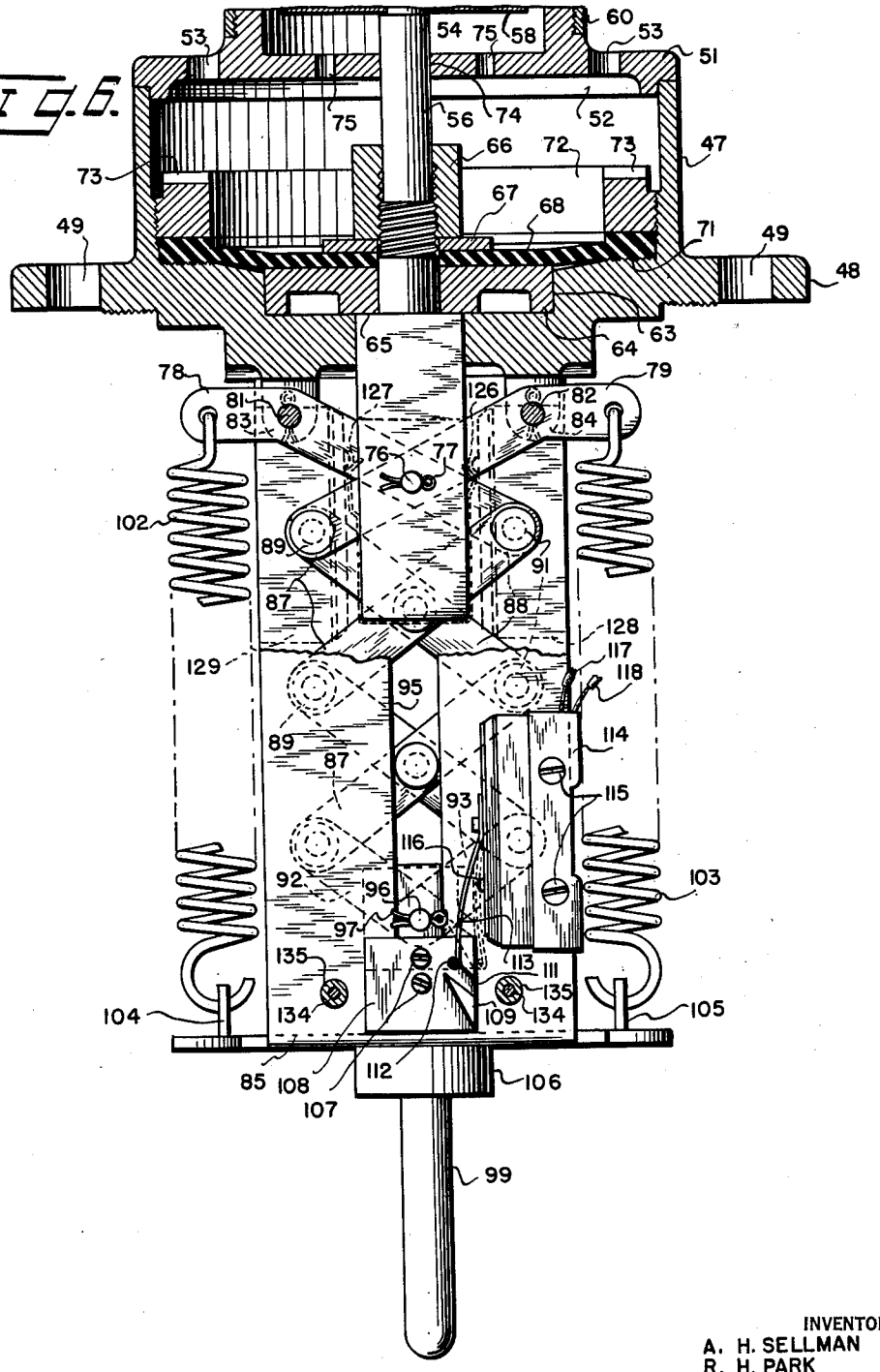
FIG. 6.



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2,958,281

HYDROSTAT MECHANISM

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Filed Feb. 26, 1942, Ser. No. 432,454

11 Claims. (Cl. 102—18)

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

This invention relates to submarine mine firing and control devices in which the mine is armed when a predetermined period of time has elapsed after the mine has been planted within a body of water and in which the mine is automatically destroyed when the mine is raised toward the surface of the water. More specifically, the present invention relates to mine firing control mechanisms in which a detonating device is moved into operative relation with respect to an explosive charge by the operation of a hydrostat in response to the pressure of the water within which the mine is arranged, the hydrostat also controlling the operation of certain switching devices in predetermined order of sequence thereby to energize certain control circuits whereby the mine is armed and caused to explode in response to the passage of a predetermined number of vessels within the vicinity of the mine in accordance with the setting of a selection device.

In systems heretofore proposed for controlling the firing mechanism of a submarine mine in which the firing of the mine is accomplished electrically by current from a source of electrical energy dispoesd within the mine, it is the general practice to perform the several switching operations necessary for energizing the various circuits by means of a clock mechanism having means provided therein for performing the various switching operations. Such systems require a rather expensive and complicated clock mechanism for performing the necessary switching functions and are not wholly reliable under all conditions of service for the reason that the clock may fail to start because of the storage of insufficient mechanical energy within the prime mover thereof or by reason of the failure of the starting mechanism to operate. Furthermore, the clock may stop in certain cases, before the cycle of operations thereof has been completed as the result of the formation of rust or the presence of foreign matter within the gear train or escapement mechanism or by reason of thickened lubricant or damage to the clock mechanism during the handling, transportation and planting of the mine.

In the system of the present invention the detonator is actuated preferably by a lazy tongs arrangement in which a relatively small movement of the flexible diaphragm of a hydrostat is multiplied sufficiently to actuate the detonating device through a considerable distance and cause the detonating device to be arranged initially at a safe distance from the booster charge and inserted well within the charge as the hydrostat operates. The hydrostat device is also provided with means adapted to operate a plurality of contact devices in predetermined sequential order thereby to close a plurality of electrical control circuits in predetermined time relation during the operation of the hydrostat and to render an additional switch device effective to fire the detonator and to explode the mine in the event that the hydrostat is actuated toward the initial position from the operated position thereof. The hydrostat is also provided with a soluble washer adapted to prevent the operation of the hydrostat until the device has been planted within the water for a predetermined period

of time sufficient to cause the soluble washer to dissolve or soften. There is also provided a lock nut secured to the hydrostat having an aperture therein within which is disposed a removable rod or wire, hereinafter referred to as an arming wire, thereby additionally to prevent movement of the hydrostat until the arming wire has been withdrawn from the nut.

The hydrostat device of the present invention is adapted to control a mine firing mechanism, preferably of the type in which the mine is fired electrically by a change in the magnetic field adjacent the mine such, for example, as may be caused by the approach of a steel vessel or other preponderous mass of iron or steel within the vicinity of the mine and in which the firing of the mine is delayed until a predetermined number of such signals have been received.

One of the objects of the present invention is the provision of new and improved means for inserting a detonating device within an explosive charge and for closing a plurality of control circuits in predetermined sequential order concurrently therewith.

Another of the objects is the provision of new and improved means for initiating a cycle of operations of a mine firing mechanism concurrently with the insertion of a detonating device into an explosive charge.

Still another object is the provision of means for exploding a mine in response to the withdrawal of the detonator from the explosive charge.

A still further object is the provision of an arming and control mcehanism for a submarine mine which is simple in operation, economical to manufacture, and which possesses all of the qualities of ruggedness and reliability in operation.

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

Fig. 1 is a view partly in section of a submarine mine in accordance with the present invention;

Fig. 2 is a view in elevation partly broken away of the hydrostat extending and switching mechanism employed with the mine of Fig. 1;

Fig. 3 is a sectional view partly broken away of the device of Fig. 2;

Fig. 4 is a sectional view taken substantially along the line 4—4 of Fig. 2;

Fig. 5 is a view of one of the control switches and actuating means therefor;

Fig. 6 is a view partly in section of the device in a fully operated position, and;

Fig. 7 illustrates in diagrammatic form a complete system suitable for use with the present invention.

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 thereof on which is shown a submarine mine indicated generally by the numeral **10** comprising a casing **11** adapted to be sealed by a cap **12** secured thereto by the bolts **13**, a suitable gasket **14** being provided preferably between the cap and the casing to insure a watertight joint therebetween. The casing is provided with a well **15** to which is secured as by the bolts **16** a hydrostat device indicated generally by the numeral **17**. A gasket **18** is provided preferably between the hydrostat device and the bottom of the well to prevent the seepage or leakage of water within the casing. The well is continued downward as at **19** thereby to form a chamber **20** within which is arranged a booster charge **21** having an aperture **22** therein adapted to receive a detonating device as the hydrostat **17** operates. The portion **19** of the well is preferably braced to the casing **11** as by the member **23** secured thereto.

There is also provided a chamber **24** within the casing

of the mine adapted to receive and support the battery 25, a suitable pad or cushion 26 of material suitable for the purpose such, for example, as sponge rubber or the like preferably being arranged between the battery and the walls of the chamber to prevent injury or damage to the battery as the device is launched within the water. A cable duct or tube 27 is provided between the chamber 24 and the chamber 20 within which is disposed a plurality of electrical conductors whereby an external electrical circuit is established to the switches controlled by the hydrostat 17. The casing is also provided with a chamber 28 adapted to receive and support a mine firing mechanism 29, a suitable pad or cushion 31 being provided between the mine firing mechanism and the walls of the chamber 28 to prevent damage or injury to the mine firing mechanism during the handling, transportation and launching of the mine. The cushion 31 is provided with an aperture 32 within which is disposed a cable 33 comprising a plurality of electrical conductors for establishing an external circuit to the mine firing mechanism 29.

There is also provided within the casing an induction or pickup coil 34 comprising a large number of turns of fine wire wound about an iron rod or a rod composed of material known in the art as Permalloy having a composition of substantially 12½ percent iron and 87½ percent nickel, the induction coil being suitably supported at each end thereof by a flexible cushion or pad 35 arranged within a suitable well within the member 36 secured to the casing of the mine and a similar well or recess secured to the partition 37 within the mine.

The casing 11 is provided with a recessed portion 38 having an aperture 39 therein for the induction of an explosive mixture 41 within the casing, a cover 42 secured thereto as by the bolts 43 being provided to seal the aperture. A gasket 44 may, if desired, be provided between the cover and the bottom of the recessed portion 38 of the casing to prevent the entrance of water or moisture within the casing of the mine. There is also provided preferably a plurality of fins 45 secured to the mine casing in any convenient manner thereby to direct and steer the mine both in the air and in the water along a predetermined line of flight when the mine is launched from a craft such, for example, as an aircraft, vessel or the like.

When the mine is launched from an aircraft in flight an arming wire 46 having one end secured to the aircraft and the other end thereof passing through an aperture within the hydrostat device is employed preferably to prevent the possibility of the premature operation of the hydrostat until the mine has fallen free of the aircraft.

The hydrostat device 17 employed with the present invention comprises a support 47, Figs. 2 and 3, having a flanged portion 48 provided with a plurality of apertures 49 adapted to receive the bolts 16, Fig. 1, whereby the hydrostat is securely clamped to the casing of the mine at the lower portion of the well 15. The support 47 has secured thereto, in any suitable manner, a cap 51 thereby forming a chamber 52 to which water is admitted by a plurality of apertures 53 within the cap. There is also formed within the cap 51 a recess or well 54 adapted to receive and support a soluble washer 55 of material suitable for the purpose such, for example, as a composition of salt, glycerine, glue and the like having an aperture therein within which is arranged the plunger or shaft 56. The end of the shaft 56 is preferably threaded and provided with a wing nut 57, a suitable washer 58 being arranged between the wing nut and the soluble washer to prevent movement of the plunger 56 inwardly until the soluble washer has dissolved. The wing nut is provided with a cylindrical projecting portion 59 adapted to project from an aperture within the cover 60 secured to the cap 51 in any suitable manner as by threading the parts together. The cylindrical portion 59 of the nut is provided with a plurality of apertures 61 adapted to receive the arming wire 46, Fig. 1, and additionally prevent movement of the plunger or rod inwardly until the arming wire has been withdrawn from the wing nut by reason of a shoulder 62 provided on the cover 60 in substantial abutting relation with the apertures 61 when the wing nut is in the position shown on the drawings.

The plunger 56 is bifurcated at the lower portion thereof and slideably supported within the support 47 and prevented from rotative movement with respect thereto by reason of a square or oblong aperture within the support 47 within which the member 56 is slideably fitted. The support 47 is provided with a cylindrical portion 63 within which a piston 64 is arranged, the piston 64 being supported by a shoulder 65 on the plunger rod 56. Secured to the piston 64 as by the nut 66 and washer 67 is a flexible diaphragm 68, a screw 69 being provided within the nut 66 thereby to maintain the nut securely in a clamped position. The outer edge of the flexible diaphragm 68 is clamped in sealed relation to a shoulder 71 within the support 47 as by the clamping ring 72 threaded therein, a plurality of slots 73 being provided within the clamping ring for receiving a suitable clamping tool during the assembly of the device. The cap 51, it will be noted, is provided with an aperture or bearing support 74 within which the plunger 56 is adapted to slide and a plurality of apertures 75 adapted to allow the passage of water therethrough from the chamber 52 to the soluble washer 55. The lower end of the bifurcated portion of the member 56 is provided with a pin 76 passing therethrough and retained in the assembled position as by the cotter pins 77. The pin 76 also passes through the arms 78 and 79 at the slotted portion 80 thereof, the arms being pivotally mounted upon the support 47 as by the pins 81 and 82 respectively, suitable projections 83 and 84 being provided for this purpose. There is also provided a U-shaped member 85 secured to the support 47 as by the screws 86 within which the bifurcated portion of the rod 56 is adapted to move. There is also provided a plurality of levers or links 87 and 88 operatively connected to the lever arms 78 and 79 as by the bearing pins 89 and 91, the links 87 and 88 being connected together in the manner shown on the drawing to form a lazy tong arrangement in which the links 92 and 93 are employed to complete the connection between the lazy tongs and the member 94 slideably mounted within the slotted portions 95 arranged within the U-shaped member 85 on opposite sides of the lazy tongs, a suitable pin 96 maintained in assembled position by the cotter pins 97 being employed preferably to transmit the motion of the lazy tongs to the member 94. The member 94 is provided with a cylindrical portion 98 adapted to receive a detonating device 99 secured thereto as by the screw 101.

The detonator is held in the retracted position by the springs 102 and 103 secured to the arms 78 and 79 respectively, the other end of the springs being in engagement with the turned up portions 104 and 105 of the lower end of the member 85.

By employing relatively long springs 102 and 103 connected to the arms 78 and 79 in the manner illustrated on the drawings, the movement of the spring is less than the degree of movement of the flexible diaphragm 68 and because of the relatively long springs and the small degree of movement thereof the pressure applied to the member 56 by the springs is substantially uniform throughout the range of operation of the device. Furthermore, by employing two springs in the manner illustrated the member 56 may be moved inward or outward, as the case may be, without excessive friction or binding of the parts and thus an arrangement is provided in which the device is invariably reliable in operation

in response to predetermined variations in the pressure of the water within which the device is submerged.

The lower end of the member **85** is provided preferably with a projecting collar **106** secured thereto in any suitable manner and having an aperture therein of sufficient size to permit the passage of the detonator therethrough as the detonator is moved to the extended position.

The member **94** has secured thereto in any suitable manner as by the screws **107** a cam member **108** having an inclined portion **109** raised therefrom and a slotted portion **111** adapted to engage the projecting end **112** of a spring **113** secured to the switch device **114**. The switch **114** is secured to the U-shaped member **85** in any suitable manner as by the screws **115** and provided with a pair of contacts adapted to be moved into engagement with each other when a plunger **116** is actuated inwardly by the spring member **113**. The switch is provided with a pair of conductors **117** and **118** for establishing an external electrical connection between the switch contacts and a terminal block **119**, Figs. 2 and 4, secured to the member **85** as by the screws **121**. There is also secured to the plunger **56** as by the screws **122** a support **123** having a screw **124** by means of which the U-shaped spring **125** having raised portions **126** and **127** thereon is affixed thereto and adapted to engage the plungers of the switches **128** and **129** respectively. The switch **128** is adapted to close a pair of contacts momentarily in response to the engagement of the plunger thereof by the raised portion **126** of the spring **125** as the plunger **56** begins to move the detonator into operative relation with respect to the booster charge.

The switch **129** has a pair of normally closed contacts maintained in the open position by the raised portion **127** of the spring **125** when the hydrostat is unoperated and adapted to cause the contacts thereof to be moved to closed position after the plunger switch **128** has been actuated and released by the raised portion **126** of the spring **125** during the movement of the hydrostat to the operated position thereof. The switches **114**, **128** and **129** are connected together by suitable conductors in the manner illustrated on Fig. 7, the electrical connections to the switches including preferably terminals of the connecting or terminal block **119**. The member **94**, it will be noted, is provided with an aperture **131** within which is disposed a pair of electrical conductors within the insulating sleeve or cable **132** for establishing an electrical connection between the detonating device **99** and the terminals **133** on the terminal block **119**. The cable **132**, it will be noted, is of sufficient length to permit the movement of the detonating device from the initial to the final position thereof without interfering in any way with the operation of the device.

There is also secured to the U-shaped member **85** as by the screws **134** and studs **135** a plate or guard **136** thereby to effectively prevent damage or injury to the switch **114** and spring member **113** thereof during the assembly and testing of the device. A similar plate or guard **137** preferably of insulating material is provided on the opposite side of the U-shaped member **85** and secured thereto as by the screws **138** and studs or spacers **139** thereby to protect the switch mechanisms **128** and **129** and the electrical connections of the terminal block **119** from injury or damage during the assembly of the device.

The firing mechanism **29** comprises, among other elements, a sensitive detecting relay D, Fig. 7, having an operating coil DR adapted to reset the tongue of the relay to an initial position intermediate a pair of contacts. There is also provided within the firing mechanism **29** a slow releasing relay P controlled by the relay D and adapted to actuate the stepping magnet STP of a rotary stepping switch which may be of any type suitable for the purpose, in which the wiper is advanced successively into contact with a plurality of switch terminals selectively in accordance with the number of operations of the stepping magnet. The switch comprises also a reset magnet RS adapted to restore the wiper thereof to an initial position upon energization of the reset magnet. The terminals of the switch are wired to contacts of a selector switch SS having a contact member settable at will to any desired position thereby to establish an electrical circuit to a predetermined contact thereof.

The operation of the device will best be understood by a consideration of Fig. 7 which shows in diagrammatic form a system comprising an arrangement of circuits and parts therefor suitable for use with the device of the present invention and in which the switch contacts **114**, **128** and **129** are employed for controlling the operation of the firing control mechanism. Let it be assumed, by way of example, that the mine **10**, Fig. 1, has been launched from an aircraft in flight over a body of water and that the arming wire **46** is withdrawn from the hydrostat element thereof as the mine falls away from the aircraft, the mine continuing its downward movement along a predetermined line of flight by reason of the fins **45** secured thereto and that the mine has come to rest on the bed of the body of water. When the mine has been planted for a length of time sufficient to cause the soluble washer **55** to dissolve or soften to such a consistency that the pressure of the water against the flexible diaphragm **68** causes the plunger **56** to be moved inward, the raised portion **126** of the spring **125** momentarily actuates the switch **128**. When this occurs, a circuit is closed from the positive terminal of the battery BA, conductor **140**, winding of reset magnet RS, conductor **141**, switch contacts **128**, conductor **142** and thence to negative battery thereby causing the reset magnet RS to operate and restore the wiper of the stepping switch to the blank or normal position thereof in the event that the wiper had been previously moved from the blank position. An arrangement is thus provided in which the wiper of the stepping switch is invariably resting on the normal or blank position prior to the arming of the mine. As the hydrostat continues its movement inward the raised portion **126** of the spring member **125** moves away from the plunger of the switch **128** thereby opening the switch contacts and interrupting the circuit to the release magnet RS. The release magnet releases and the stepping switch is in readiness to start a cycle of stepping operations.

As the hydrostat continues to move inward the raised portion **127** of the spring **125** moves away from the plunger or switch **129** thereby causing the switch contacts to move into engagement with each other and apply negative battery to conductor **143**.

Relay D, it will be recalled, is a sensitive relay adapted to be operated in response to the electromotive force generated within the pickup coil **34** by reason of the current flowing through the winding DO thereof. The armature or tongue of the relay is preferably adapted to remain in any position in which it has been set and it may be assumed, for the purpose of description, that the armature has been moved into engagement with one of the contacts associated therewith as a result of the handling, transportation or planting of the mine. The manner in which the moving element or armature of relay D is restored to an initial position intermediate the contacts of the relay will now be described.

As negative battery is applied to conductor **143** by the operation of the switch **129**, the following circuit is completed: positive terminal of battery BA, conductor **140**, armature and contact **144** or **145** of relay D, as the case may be, conductor **146**, winding of relay P, conductor **143**, contacts of switch **129**, conductor **142** and thence to the negative terminal of battery BA thereby causing relay P to operate and at armature **147** thereof apply negative battery to conductor **148** from whence the circuit is continued by way of the stepping magnet STP of the stepping switch, conductor **140** and thence to positive

battery. The stepping magnet is energized thereby causing the switch wiper to be advanced to terminal 1 of the switch bank.

The operation of relay P also closes a circuit from positive terminal of battery BA, conductor **140**, winding of the slow operating relay SO, conductor **148**, make contact and armature **147** of relay P, conductor **143**, contacts of switch **129**, conductor **142** and thence to the negative terminal of battery BA thereby causing relay SO to operate. Relay SO, by reason of the provision of a certain delay mechanism such, for example, as a copper slug arranged on the core of the electromagnet of the relay does not move the armature **149** thereof into engagement with its make contact until a predetermined period of time has elapsed after the operating circuit to the relay has been completed thereby to insure that the wiper of the stepping switch will be advanced to the next succeeding terminal of the switch bank before the operate circuit thereto is interrupted. As armature **149** of relay SO moves into engagement with the make contact thereof, a circuit is closed from positive terminal of battery BA, conductor **140**, armature **149** and make contact of relay SO, conductor **151**, winding of the reset magnet DR of relay D, conductor **143**, switch contacts **129**, conductor **142** and thence to the negative terminal of battery BA. The operation of the reset magnet DR causes the armature of relay D to be moved to a position intermediate the contacts **144** and **145** thereby interrupting the operate circuit to relay P and causing relay P to release. Relay P, it will be noted, is a slow release relay and for this reason, armature **147** thereof is not disengaged from its make contact until a predetermined period of time has elapsed after the operate circuit thereto has been interrupted.

As armature **147** of relay P moves away from its make contact, negative battery is removed from the stepping magnet and the winding of relay SO thereby causing the stepping magnet to be deenergized and relay SO to release. As armature **149** of relay SO moves away from its make contact positive battery is removed from the reset magnet DR thereby removing the restraint from the armature of relay D and causing relay D to be responsive to signals detected by the pickup or induction coil **34**. The mine is now in a partially armed condition with the wiper of the stepping switch resting on contact 1 of the switch bank.

Let it be assumed, by way of example, that the selector switch SS is set in position 2 whereby the first signal received by a passing ship or sweep wire, as the case may be, is ineffective to cause the mine to be exploded. The passage of a ship, for example, within the vicinity of the mine causes a disturbance in the magnetic field adjacent thereto sufficient to generate an electromotive force within the pickup coil **34** and cause the relay D to operate. When this occurs, a circuit is closed from the positive terminal of battery BA by way of conductor **140**, armature and contact **144** or **145**, as the case may be, of relay D, conductor **146**, winding of relay P, conductor **143**, switch contacts **129**, conductor **142** and thence to the negative terminal of battery BA thereby causing relay P to operate and at armature **147** and make contact thereof apply negative battery to the stepping magnet STP and the winding of relay SO in parallel, the circuit being continued by way of conductor **140** to the positive terminal of battery BA. The stepping magnet STP operates and advances the switch wiper to terminal 3 of the switch bank. Relay SO operates and at armature **149** thereof closes an operate circuit to the reset magnet DR thereby resetting relay D to an initial unoperated position and causing relay P to release. The release of relay P at armature **147** thereof interrupts the operate circuit to the stepping magnet STP and relay SO thereby deenergizing the stepping magnet and causing relay SO to release. As armature **149** of relay SO moves away from the make contact thereof, the reset magnet DR releases and relay D is again rendered responsive to signals detected by the pickup coil **34**. The mine is now in an armed condition.

As a second ship approaches the mine the signal picked up by the induction coil **34** is sufficient to energize the operate magnet DO of relay D and move the armature thereof into circuit closing position thereby applying battery from positive terminal of battery BA by way of conductor **140**, armature and make contact of relay D, conductor **146** and thence to the winding of relay P, the circuit being continued by way of conductor **143**, contacts of switch **129**, conductor **142** and thence to the negative terminal of battery BA. Relay P operates and at armature **147** thereof closes a circuit from positive terminal of battery BA, conductor **140**, winding of the stepping magnet STP and relay SO in parallel, conductor **148**, make contact and armature **147** of relay P, conductor **143**, contacts of switch **129**, conductor **142** to the negative terminal of battery BA. The stepping magnet STP operates thereby advancing the switch wiper to terminal 3 of the switch bank. When this occurs, a circuit is closed from positive terminal of battery BA, conductor **140**, detonator **99**, conductor **152**, wiper of switch SS and contact **2** thereof, conductor **153**, terminal 3 and wiper of the stepping switch, conductor **143**, contacts of switch **129**, conductor **142** and thence to negative terminal of battery BA, thereby causing the detonator to operate and explode the mine.

Whereas in the example assumed, the mine is exploded in response to the passage of a second ship within the vicinity of the mine it will, of course, be understood that the mine may be arranged, if desired, to explode in response to the approach or passage of the first ship within the vicinity of the mine, it being merely necessary to set the switch SS to position 1. The number of ships required to pass the mine before the mine is exploded is predetermined in accordance with the setting of the switch SS.

The manner in which the mine is caused to explode in response to movement of the mine toward the surface of the water will now be described with reference to Figs. 3 to 7 of the drawings. Referring particularly to Fig. 5, it will be noted that the cam member **108** has a raised inclined portion **109** adapted to engage the spring **113** and move the spring outwardly from the switch **114** as the detonator moves into the fully extended position within the booster charge. This movement of the spring **113**, as illustrated on Fig. 5 is caused by the engagement of the extended portion **112** of the spring **113** with the inclined portion **109** of the cam member **108** at the lower cam surface thereof. As the limit of travel of the detonator **99** within the booster charge is reached the extended portion **112** of the spring **113** is disengaged from the inclined portion **109** of the cam member, and the spring moves somewhat inward by reason of the resiliency thereof to the position shown in solid outline on Fig. 6. As the mine is moved upward toward the surface of the water the pressure of the water against the flexible diaphragm **68** is reduced sufficiently to cause the member **56** to be moved outward by the springs **102** and **103** thereby causing the cam member **108** to be moved to the position shown in dashed outline on Fig. 6 and the spring **113** to be moved to the position shown in dashed outline by reason of the engagement of the projecting portion **112** thereof with the upper cam surface of the inclined raised portion **109**. When this occurs the plunger of the switch **114** is moved inward thereby operating switch **114** and closing a circuit, Fig. 7, from positive terminal of battery BA by way of conductor **140**, detonator **99**, conductor **152**, contacts of switch **114**, the circuit being continued by way of contacts of switch **129**, conductor **142** and thence to negative terminal of battery BA thereby causing the detonator to oeprate and explode the mine.

Briefly stated in summary, the present invention contemplates the provision of a new and improved hydrostat-

ically operated device adapted to maintain a detonating device at a safe distance from a booster charge and insert the detonating device within the booster charge and close a plurality of switching elements and control circuits in predetermined sequential order concurrently therewith, in which the arrangement of parts and the combination of instrumentalities employed is such as to insure reliable operation of the device and in which the mine is caused to be self-destructive when the mine is raised toward the surface of the water sufficient to cause the pressure of the water against the hydrostat to be reduced to a predetermined value, thereby to prevent discovery of the operating mechanism of the mine by unauthorized persons.

While there is shown and described herein a certain specfiic embodiment of the invention especially suited for uses in the system of a submarine mine, many other and varied forms and uses will present themselves to those versed in the art without departing from the invention, and the invention is, therefore, not limited either in structure or in use except as indicated by the terms and scope of the appended claims.

The invention herein disclosed and claimed may be manufactured and used by and for the Government of the United States of America for governmental purposes without the 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 device of the character disclosed adapted to be arranged within a body of water, the combination of a casing, a flexible diaphragm secured to said casing having one side thereof in communication with the water, a member connected to said diaphragm and movable therewith, a pair of lever arms pivotally connected to said casing and adapted to move said movable member outwardly to a predetermined initial position, means including a pair of springs connected respectively to each of said lever arms for yieldably urging said movable member and diaphragm outwardly to said predetermined initial position, a motion amplifying device operatively connected to said lever arms, a detonating device adapted to be moved to an extended position by said motion amplifying device in response to the pressure of the water against said diaphragm, a pair of normally open switch contacts secured to said casing, and means adapted to close said switch contacts momentarily during the movement of said detonating device by said motion amplifying means.

2. In a device of the character disclosed for controlling the firing of a submarine mine, the combination of a hydrostat, motion multiplying means, a pair of levers interposed between the hydrostat and the motion multiplying means, said levers having long and short arms with each of the long arms connected to the motion multiplying means and to said hydrostat, and a pair of elongated springs each fixed at one end respectively and connected at the opposite ends to the short arms of said levers for yieldably causing the levers to urge said hydrostat and motion multiplying means into an initial position, a detonating device operatively connected to said motion multiplying means and adapted to be moved thereby from said initial position to a moved position, an explosive charge arranged within the path of travel of said detonating device and at a safe distance therefrom when the detonating device is in said initial position, a control circuit, and means for energizing said control circuit during the movement of said detonating device from said initial position to said moved position.

3. In a device of the character disclosed for inserting a detonating device within an exlosive charge, the combination of a hydrostat in communication with the water, means for multiplying the degree of movement of said hydrostat, detonating means adapted to be moved by said multiplying means from an initial position to a moved position within said explosive charge in response to a predetermined pressure of the water against said hydrostat, a plurality of mine firing control circuits, a selector switch, means in one of said circuits for resetting said switch, means in another of said circuits for arming said detonating means, a plurality of switch devices respectively connected in said circuits, and means adapted to be actuated by said hydrostat during the movement of the detonating means from said initial position to said moved position for operating said switch devices in succession, thereby to energize said control circuits in predetermined sequential order.

4. In a device of the character disclosed, the combination of a hydrostat having a flexible diaphragm in communication with the water adapted to move through a predetermined distance as the hydrostat operates, a pair of levers having long and short arms for yieldably maintaining said diaphragm in an initial position, a pair of elongated spring members respectively connected to the short arms of said levers and adapted to move through a lesser distance than the extent of movement of the diaphragm as the hydrostat operates, a detonating device, and means connected to the long arms of said levers for causing said detonating device to move through a greater distance than the extent of movement of said diaphragm as the hydrostat operates.

5. In a device of the character disclosed, the combination of a casing, a plurality of levers pivotally secured to said casing, a plurality of springs respectively connected to each of said levers for yieldably urging the levers toward an initial position thereof, a flexible diaphragm having one side thereof in communication with the water, a movable member secured to the central portion of said diaphragm and operatively connected to said levers, a motion multiplying device operatively connected to said levers and controlled thereby, a detonating device, means for operatively connecting said detonating device to said motion multiplying device whereby the detonating device is adapted to be moved variably in accordance with the degree of movement of said motion multiplying device, a mine firing control mechanism, means including a plurality of switch devices actuated by said movable member for rendering said mine firing control mechanism effective during the movement of said flexible diaphragm from an initial position to an operated position, and means including a pair of switch contacts controlled by said motion multiplying means for exploding said detonating device when said flexible diaphragm is moved by said springs from said operated position toward said initial position.

6. In a hydrostat device of the character disclosed, the combination of means for causing the hydrostat to operate when a predetermined period of time has elapsed after the device has been planted within a body of water, means including a plurality of levers operatively connected to said hydrostat device adapted to be actuated by the hydrostat, a plurality of spring members respectively connected to each of said levers for yieldably maintaining said hydrostat in an initial position, an electro-responsive detonating device, motion amplifying means operatively connected to said hydrostat and adapted to move the detonating device through a much greater distance than the degree of movement of the hydrostat, a source of electrical power, means for closing a circuit during the operation of said hydrostat device in response to a predetermined pressure of the water, means effective when the pressure of the water has been decreased to a predetermined degree for closing a pair of contacts as the hydrostat is reversely actuated by said spring members, and means including said circuit closing means for causing the detonating device to be operated by said source of electrical power in response to the closure of said pair of contacts.

7. In a device of the character disclosed, the combination of a flexible diaphragm having one side thereof in communication with the water, a movable member secured to said diaphragm, a pair of levers operatively connected to said movable member, each of said levers hav-

ing a spring secured thereto for yieldably urging the diaphragm against the water, lazy tongs operatively connected to said levers, a detonating device, means operatively connected to said lazy tongs for supporting said detonating device whereby the supporting means and detonating device are adapted to be moved by the lazy tongs to a fully extended position through a much greater distance than the degree of movement of said flexible diaphragm, a source of power, a cam element secured to said supporting means, a switch device adapted to be engaged by said cam element as the detonating device is moved to said fully extended position, and means including a plurality of electrical connections for causing the detonating device to be fired by said source of power when the switch device is operated by said cam element in response to the movement of said supporting means from said fully extended position.

8. In a submarine mine, the combination of a hydrostat having a flexible diaphragm in communication with the water, a member secured to said diaphragm and movable therewith, a casing having means for slideably supporting said movable member, a soluble washer in contact with the water and disposed about said movable member, said washer being adapted to prevent movement of the member and diaphragm until the washer is dissolved, means including an arming wire operatively connected to said movable member for additionally preventing movement of the movable member and the diaphragm until the arming wire has been withdrawn from the movable member, a pair of levers operatively connected to said movable member and pivotally mounted on said casing, said levers having relatively short projecting arms, a pair of retractile springs respectively secured to each of said arms and said casing, said springs being of sufficient length to cause the flexible diaphraghm to be yieldably urged against the water with a substantially uniform degree of pressure throughout the movement of the diaphragm, a motion multiplying device operatively secured to said levers, a detonating device controlled by said motion multiplying device, said detonating device having an initial retracted position and an extended position, a plurality of switching devices, means secured to said movable member for operating said switching devices in predetermined sequential order during the movement of said detonating device to said extended position, a switch device including a pair of firing contacts adapted to fire the detonating device, means effective when said detonating device has been moved to said extended position for establishing a control connection between said switch device and the motion multiplying device, and means actuated by said motion multiplying device for causing said firing contacts to be moved to closed position and fire the detonating device concurrently with the movement of the detonating device from said extended position.

9. In a hydrostat device, in combination, a support, a flexible diaphragm secured to said support and having one side thereof in communication with a body of water, means including a pair of levers for yieldably urging said diaphragm against the water, a movable member secured to said diaphragm and operatively connected to said levers, said movable member being slidably supported within said support, a U-shaped member secured to said support on opposite sides of said movable member and having a slotted portion in each side thereof, means secured to said lever arms for multiplying the degree of movement of said movable member, a supporting member slideably supported within said U-shaped member at the slotted portions thereof, means for operatively connecting said sildeable member to the motion multiplying device whereby the slideable member is adapted to be moved by the motion multiplying device through a much greater distance than the degree of movement of the diaphragm, a detonating device secured to said slideable member and movable therewith, said detonating device being normally arranged within said U-shaped support when the flexible diaphragm is unoperated by the pressure of the surrounding water, and an annular member secured to said U-shaped support within the path of travel of the detonating device and coaxially therewith for additionally guiding and supporting said slideable member when the slideable member and detonating device have been moved to a fully extended position by the pressure of the water against the flexible diaphragm.

10. In a submarine mine, the combination of a hydrostat, lazy tongs operatively connected to said hydrostat, means including a plurality of elongated retractile springs for yieldably urging said lazy tongs to closed position, a detonating device secured to said lazy tongs and adapted to be moved thereby to an extended position as the hydrostat operates, a plurality of circuit closing devices adapted to be closed in predetermined sequential order during the actuation of said detonating device to said extended position, a terminal block supported by said hydrostat and having a plurality of terminal connections for establishing a plurality of electrical circuits to said circuit closing devices and to said detonating device respectively, a mine firing mechanism in electrical circuit with said terminal connections, and means included in said mine firing mechanism for exploding the detonating device in response to the approach of a vessel when the detonating device has been moved to said extended position by said motion multiplying means.

11. In a device of the character disclosed, the combination of a flexible diaphragm having one side thereof in communication with the water, a movable member secured to said diaphragm, a pair of levers, each of said levers having a slotted portion therein, means for pivotally supporting said levers with the slotted portions thereof in substantial alinement with each other, a bearing pin secured to said movable member and disposed within said slotted portions of the levers, a pair of springs respectively secured to each of said levers for yieldably urging the diaphragm against the water, lazy tongs operatively connected to said levers, a detonating device, means operatively connected to said lazy tongs for supporting said detonating device whereby the supporting means and detonating device are adapted to be moved by the lazy tongs to a fully extended position through a much greater distance than the degree of movement of said flexible diaphragm, a source of power, a cam element secured to said supporting means, a switch device adapted to be engaged by said cam element as the detonating device is moved to said fully extended position, and means including a plurality of electrical connections for causing the detonating device to be fired by said source of power when the switch device is operated by said cam element in response to the movement of said supporting means from said fully extended position.

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