Sept. 3, 1963 W. L. BECKWITH, JR 3,102,475

EXPLOSIVE DEVICE

Filed Feb. 13, 1961 3 Sheets-Sheet 1

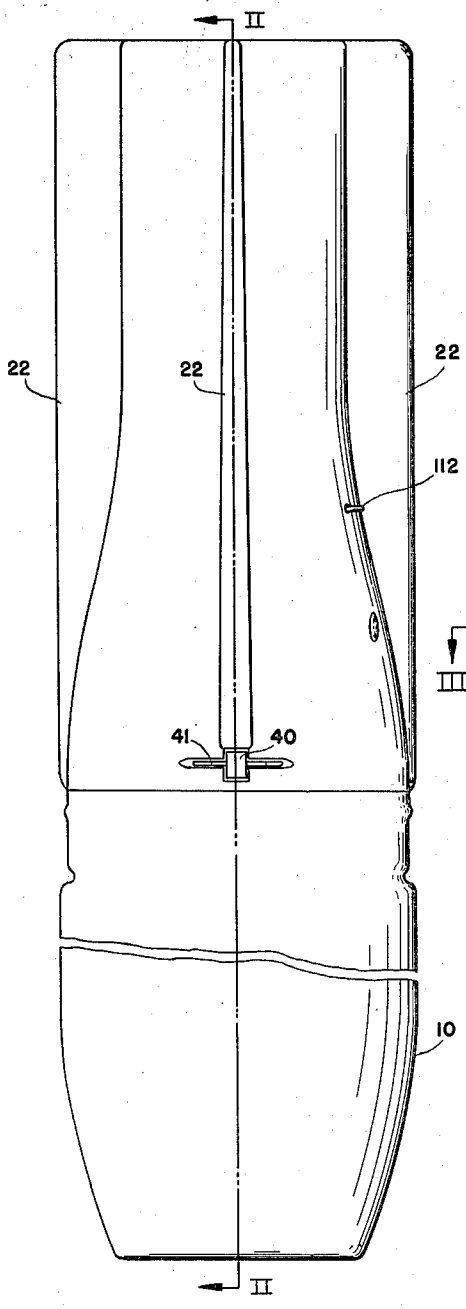


FIG. 1

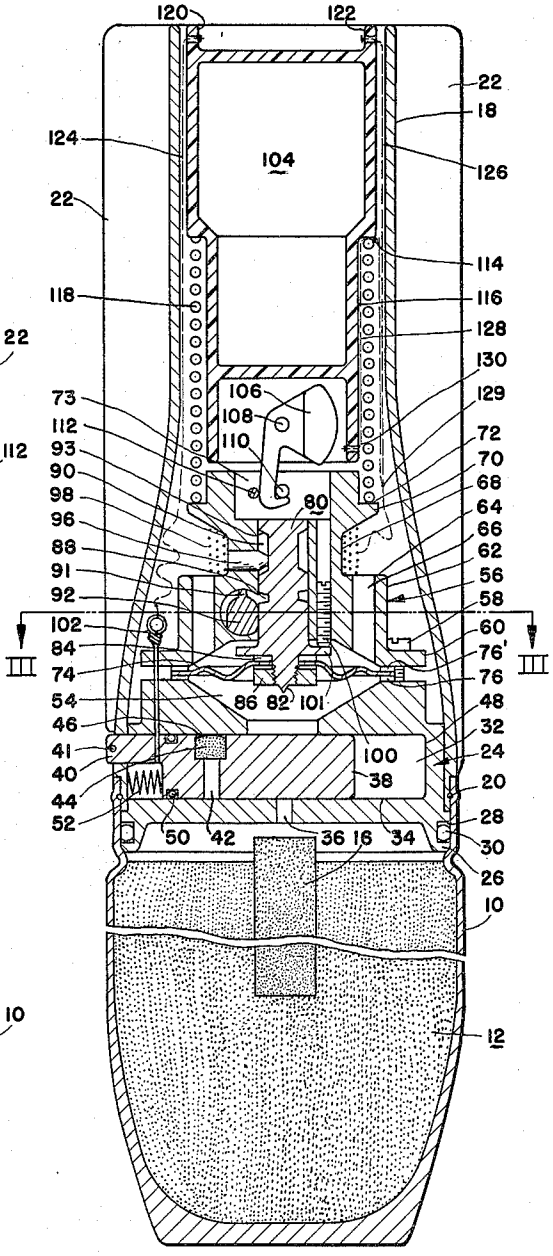


FIG. 2

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EXPLOSIVE DEVICE

Filed Feb. 13, 1961 3 Sheets-Sheet 2

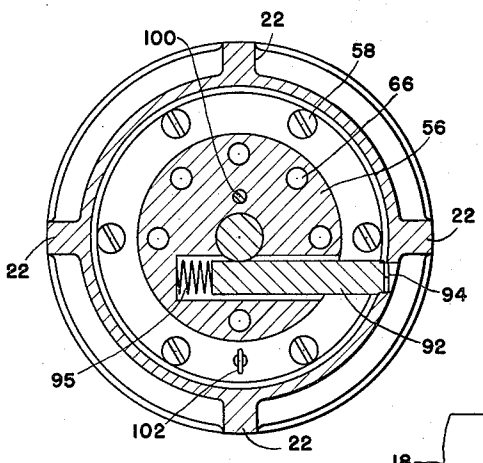


FIG. 3

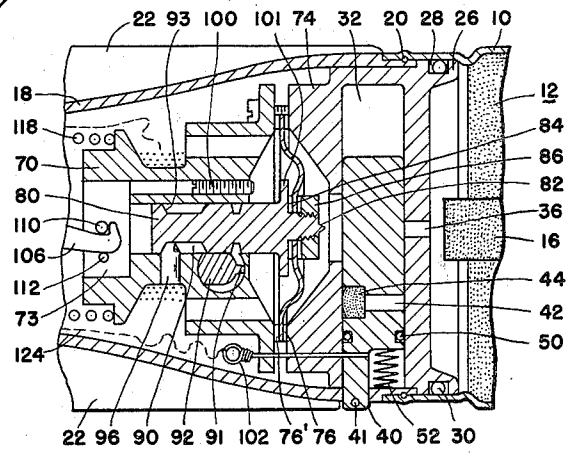


FIG. 4

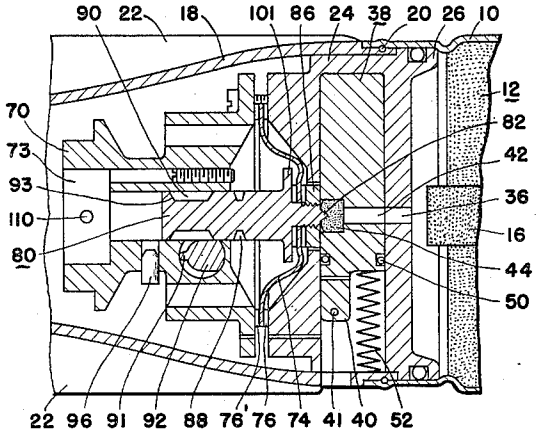


FIG. 5

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Sept. 3, 1963 W. L. BECKWITH, JR 3,102,475

EXPLOSIVE DEVICE

Filed Feb. 13, 1961 3 Sheets-Sheet 3

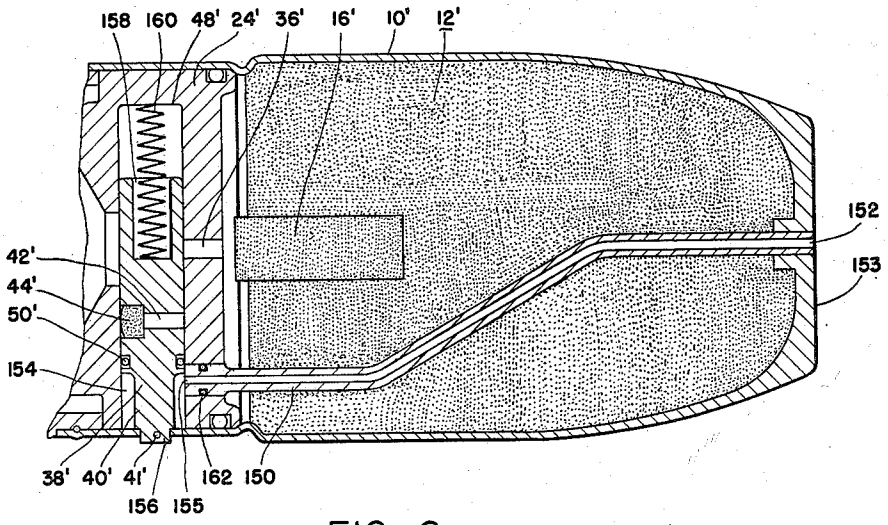


FIG. 6

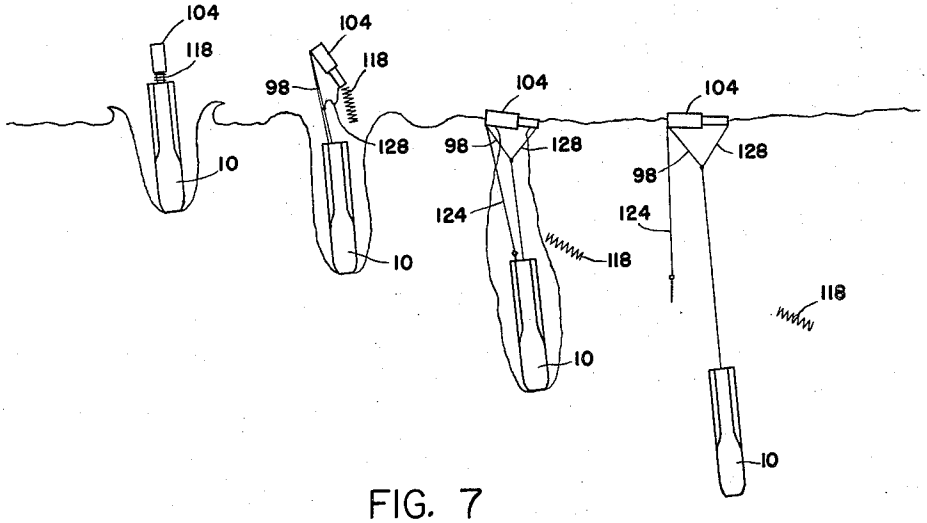


FIG. 7

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3,102,475

EXPLOSIVE DEVICE

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Filed Feb. 13, 1961, Ser. No. 88,953
10 Claims. (Cl. 102—16)

The present invention relates to an explosive device and more particularly relates to such a device capable of exploding at a predetermined depth.

A known technique for detecting undersea craft, such as submarines, involves detonating explosive charges at predetermined depths of submergence in a suspected area. These charges, rather than being planned to do direct damage to the craft, are intended to set up vibrational signals or "echoes" reflecting from the craft. In a known manner these signals may be recorded and a pattern plotted for determining the location of the craft.

Previously, underwater explosive devices of the foregoing type have been provided with means such as depth sensing diaphragms, rupture discs or timing units for selecting the detonating depth of the unit. Each of these methods presents serious limitations in use. For example, prior art depth sensing diaphragms are delicate and critical in operation and are susceptible to damage in handling and, particularly, from the impact when the device is dropped into the water from some height as from an airplane. Rupture discs, while being less sensitive than diaphragms, are difficult to produce with sufficient uniformity to meet critical depth firing requirements. Timing devices are seriously limited in their ability to explode at a predetermined depth since the time factor is necessarily related to sinking rate and, obviously, the sinking rate of the device will be directly affected by the height from which it is launched.

It is, therefore, one object of the present invention to provide an improved device arranged to explode at a predetermined depth beneath the surface of a body of water.

Another object of the present invention is to provide an underwater explosive device provided with means for detonating the device at alternative depths from which a preselected explosion depth may be chosen.

Another object of the present invention is to provide an underwater explosive device capable of being detonated at a predetermined depth of submergence unaffected by its acceleration upon entering the water or its rate of descent.

Another object of the present invention is to provide an underwater explosive device in which the firing mechanism is maintained inoperative until after the device has descended to a predetermined depth.

Another object of the present invention is to provide an underwater explosive device wherein the firing mechanism is initiated by mechanical means.

Another object of the present invention is to provide an underwater explosive device wherein the depth at which said firing means is initiated is regulated by a length of line.

Another object of the present invention is to provide an underwater explosive device wherein the firing mechanism is pressure controlled.

Another object of the present invention is to provide an underwater explosive device incorporating an improved means for selecting the depth at which detonation occurs.

Another object of the present invention is to provide an underwater explosive device incorporating improved means for moving the detonating charge from a safe to an armed position.

Another object of the present invention is to provide an underwater explosive device which is economical to manufacture, simple is operation, and durable and reliable in use.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the apparatus possessing the construction, combination of elements and arrangement of parts which are exemplified in the following detailed disclosure and the scope of the application of which will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention reference should be had to the following detailed description taken in connection with the accompanying drawing wherein:

FIG. 1 is an elevational view of the underwater explosive device of the present invention;

FIG. 2 is a sectional view taken along line II—II of FIG. 1, and showing the firing mechanism set in the deep depth firing position;

FIG. 3 is a sectional view taken along line III—III of FIG. 2;

FIG. 4 is a fragmentary sectional view similar to FIG. 2 but showing the firing mechanism set in the shallow depth firing position;

FIG. 5 is a fragmentary view similar to FIG. 2 but showing the firing mechanism in the fired position;

FIG. 6 is a sectional view showing a modified means for actuating the arming slide; and

FIG. 7 is a view diagrammatically illustrating in sequence the separation of the float and spring from the device during its movement into the water.

Generally stated, the present invention comprises a new and improved underwater explosive device wherein the explosive charge is detonated at a predetermined depth in a body of water by operation of a firing mechanism which is operatively connected with and which receives its firing impetus from a coned disc, or Belleville type, spring. The firing mechanism is engaged by a rotatable plug. By rotation of the plug the spring is deflected whereby it is selectively set away from its relaxed position to either a position where its coned surface is maintained forward of center, or to a position where its coned surface is deflected over center to an inside-out position. The spring is possessed of the stable characteristic whereby once it has been deflected inside-out it will not return to its normal or relaxed position without the assistance of an external load. However, once a sufficient load is applied against its exposed wall, the spring will respond to its elastic property to snap back to its normal position. For shallow firing the spring is flexed with its coned surface maintained away from its relaxed or normal position but, yet, forward of its center in which position a releasable pin serves to so maintain it. A detachable float, normally carried within the device is detached therefrom when the device strikes the water. A length of line attached to the float and coiled about the releasable pin is uncoiled as the device sinks downwardly from the float lying on the surface of the water. At a depth determined by the length of line the pin is released thereby allowing the spring and connected firing mechanism to snap forward and detonate the device.

For detonating the device at a deep depth the spring is deflected over its center. Due to the stable characteristic of the spring when in this position, the firing mechanism will not be actuated when the releasable pin separates therefrom. Rather, the device will continue to descend into the water until a depth is reached where sufficient hydrostatic pressure exists to snap the spring forward through its center whereby the firing mechanism is similarly snapped forward to detonate the device. Ad-

justment is provided for limiting the amount of over-center deflection of the spring and, hence, the value of water pressure necessary to snap the spring forward, thereby providing means for predetermining the point of deep depth firing.

Turning now to a detailed description of the present invention a casing **10** carries a charge of explosive **12** including a centrally positioned booster charge **16**. A hollow sleeve **18** is secured to casing **19** by means of a clamping wire **20** which encircles the sleeve and engages with the casing. Sleeve **18** etxends upwardly from casing **10** and mounts a plurality of fins or vanes **22** which extend longitudinally along the periphery thereof and radially outward therefrom at equidistant points and serve to provide aerodynamic stability to the device.

Situated generally within sleeve **18** and at the lower end thereof is a disc **24** having a downwardly extending lip **26** protruding into casing **10** and provided with a groove or channel therearound as at **28** which carries a seal or O ring **30** to establish a watertight connection between the disc and casing **10**. A passage **32** having bottom wall **34** and end wall **48**, extends diametrically across the greater width of disc **24**. The lower wall **34** of passage **32** is bored through as at **36** at a point midway across the disc and in alignment with booster **16**. An arming slide **38** is slidably carried within passage **32**. Slidable **38** has a tang **40** at one end of which is drilled through to receive a safety wire **41** and which protrudes out through sleeve **18** when arming slide **38** is in its "safety" position as will be more fully explained hereafter. A bore **42** is provided transversely through slide **38**, being positioned generally midway along its length and a percussion cap or detonator **44** is seated in counterbore **46** formed in the upper end of bore **42**. So located, counterbore **46** and bore **42** will be in alignment with bore **36** when arming slide **38** is resting against end wall **48**. A seal **50** is passed suitably around arming slide **38** between tang **40** and bore **42** to prevent passage of water into the area of the detonator **44**.

The positioning mechanism for slide **38** includes a compression spring **52** disposed in a recess in slide **38** adjacent tang **40** and which is compressed between sleeve **18** and arming slide **38**. The upper surface of disc **24** has a generally V-shaped axial cavity **54**, the lower section or apex of which presents an aperture somewhat larger in diameter than counterbore **46** giving access to passage **32** and slide **38**.

A hollow member **56** is secured to disc **24** by screws **58** which pass through rim **60** and secures spring **74** to disc **24** and slidably carries firing bolt **80** and firing pin **82**. Member **56** comprises cylindrical portion **62** which extends upwardly from rim **60** and terminates in the shoulder **64**. Member **56** continues upwardly in the length **68** having a reduced diameter and this length terminates in the tapered flange **70** the upper surface of which is provided with rabbet **72** and the axial recess **73**. A plurality of longitudinal openings or ports **66** are provided in the wall of cylindrical portion **62**.

An initially coned disc, or "Belleville" type, spring **74** is secured between disc **24** and member **56** to close cavity **54**. The joint between the edge of spring **74** and disc **24** and member **56** is sealed by gaskets **76** and **76'**.

The coned spring **74** as illustrated in FIG. 2 is in an "inside-out" position, that is to say, deflected over center away from normal or relaxed position. As will appear hereinafter, coned spring **74** is deflected to a lesser degree when the device is to explode at a shallow depth. The spring **74** may be modified by introducing corrogations into its surface which have the effect of reducing spring rate and increasing spring travel. Further, in accordance with the present invention, spring **74** should be constructed to be possessed of a stable characteristic when set in its "inside-out" position and, yet be elastic to snap to its relaxed position under the force of an external load thereon. With this characteristic of stability spring **74** will not return to its normal position from its "inside-out" position until some external load, as from water pressure, is introduced to the rearward surface of said spring. Thus, the spring will produce a snap-action as it returns to its normal position from a condition of over-center or "inside-out" deflection.

A firing bolt **80** extends longitudinally and concentrically through and in axial alignment with member **56** and has its lower end reduced in diameter and pointed to comprise a firing pin **82** which extends through the center of spring **74** and into cavity **54**. A washer **84** and nut **86** secure the bolt **80** to spring **74**. Bolt **80** is provided with a pair of parallel circumferential recesses or grooves **88** and **90**. Groove **88** is located generally midway along the length of bolt **80** and serves to receive the single tooth **91** of a rotatable selector plug **92** which is positioned radially in member **56** with its slotted head **94** exposed through sleeve **18** as best shown in FIG. 3. A compression spring **95** is provided to bear against the inner end of plug **92** for frictionally holding the bolt in position. It will thus be understood that bolt **80** and plug **92** function as a "rack and pinion" arrangement where rotation of plug **92** causes bolt **80** to be bodily shifted axially of member **56** between a first or shallow depth firing position where the bolt **80** is located in the lower of the two positions as illustrated in FIG. 4 and a second or deep firing position where the bolt **80** is in the upper of the two positions with spring **74** in its over center position.

Groove **90** has a width substantially equal to the height of length **68** of member **56** and is so positioned on bolt **80** that it is substantially even with said length **68** when firing bolt **80** is in the upper or deep firing position. A freely slidable pin **96** is positioned in a radial hole formed in the wall of member **56** with its innermost end being chamfered and seated in groove **90**. The upper wall **93**, which acts as a cam, of groove **90** is inclined at an angle substantially equal to the chamfer on pin **96** so that a downward force on bolt **80** will tend to cam said pin out of said radial hole. In order that the freely slidable pin **96** may be restrained with its inner end in groove **90** a plurality of coils of line **98** are wrapped around the length **68** overlying the outer end of said pin.

A set screw **100** is threaded in member **56** parallel to bolt **80** and diametrically opposite from plug **92**. The lower end of the set screw **100** engages flange **101** adjacent firing pin **82** on bolt **80** and functions to adjustably limit the upward movement of said bolt and thereby controls the amount of "inside-out" or over-center deflection. As will appear more clearly hereinafter, regulating the amount of over-center deflection of spring **74** regulates the lower depth at which charge **12** will explode.

To the end that the arming slide **38** may be maintained in a "safe" position until the device has sunk into the water some desired distance a pin **102** constituting a safety latch extends through aligned bores in rim **60** and disc **24** and into a hole extending vertically into the tang **40** of arming slide **38** as shown in FIG. 2. The hole in tang **40** is so located that when pin **102** is engaged therewith arming slide **38** will repose with detonator **44** spaced out of alignment with firing pin **82** and bore **36**, see FIG. 2, thereby preventing accidental discharge of the detonator after safety wire **41** has been removed.

Disposed upwardly of member **56** and aligned coaxially therewith is a float **104** preferably constructed of hollow plastic but which can be formed from any suitable buoyant material. Float **104** extends upwardly to be coterminous with the rearward end of sleeve **18**, the float being freely slidable therein. A shoulder **114** is formed midway along the outer diameter of float **104**, with a section **116** of reduced diameter extending downwardly therefrom. A compression spring **118** encircles section **116**, being compressed between shoulder **114** and the previously described rabbet **72** of member **56**. A weighted release latch

106 is pivotally mounted on post 108 in the lower end of section 116 and extends into recess 73 to engage stud 110. Stud 110 extends across and is secured to the wall of recess 73. A safety wire 112 also bridging the recess 73 is disposed to hold latch 106 in engagement with stud 110. Wire 112 extends outwardly through sleeve 18 for convenient removal prior to launching the device.

A pair of ears 120 and 122 extend upwardly from the uppermost section of float 104. Ear 120 has one end of line 124 secured thereto. The other end of line 124 extends inwardly between sleeve 18 and float 104 and is secured to the upper end of pin 102. The free end 126 of line 98 extends upwardly between float 104 and sleeve 18 and is fastened to ear 122. One end of line 128 is jointed fast to the lower edge of float 104 at point 130 and passes upwardly between said float and spring 118 and is connected to line 98 at point 129. As will be more fully explained hereafter, line 98 may be any predetermined length and such length fixes the upper firing depth. Obviously, line 124 is shorter than line 98 so that pin 102 will be withdrawn to insure that the arming slide 38 will be in its armed position prior to the freeing of pin 96.

The foregoing mechanism operates in the following described manner. Preparatory to launching the device is set to explode at either a first shallow depth or a second deeper depth in the water. This is accomplished by rotating plug 92 clockwise or counterclockwise to rock bolt 80 downwardly or upwardly by means of tooth 91 and groove 88. To set the device to explode at its shallow depth plug 92 is rotated clockwise, see FIGS. 2, 4 and 5, to move bolt 80 downwardly to engage the upper edge of groove 90 with pin 96. In this position spring 74 is deflected but its conical surface remains below its transverse plane as shown in FIG. 4. In this position spring 74 is restrained from snapping downwardly by pin 96 seated in groove 90.

To set the device to explode at its deeper depth plug 92 is rotated counterclockwise. By so doing, bolt 80 is shifted to an upper position as illustrated in FIG. 2 where spring 74 is deflected over center to an "inside-out" position. In this position spring 74 tends to force bolt 80 upwardly and requires external energy to deflect it downwardly over its center. Pin 96 is positioned away from the wall 93 of groove 90 and therefore does not act to restrain the bolt 80 in this deep firing position.

The explosive device of the present invention is intended to be launched from a height above the water as from the deck of a ship or from an airplane or the like. Preliminary to launching safety wires 41 and 112 are removed. The device may thereafter be released for free flight into the water, vanes 22 acting to provide aerodynamic stabilization to the device and guiding the nose of casing 10 into the water first. The instant the device strikes the water, it is subjected to deceleration which causes weighted release latch 106 to rotate clockwise, see FIG. 2, out of engagement with stud 110 to release float 104 which is ejected from sleeve 18 by spring 118. The force of spring 118 is preferably such that the upward velocity which it imparts to the float is approximately equal to the forward velocity of the device into the water, thus causing the float to arrive at and rest on the surface of the water. Spring 118 normally will be ejected from sleeve 18 with float 104 and will fall free into the water.

As the device descends into the water, lines 124, 98 and 128, attached to float 104 pass out of sleeve 18. Lines 98 and 128, being attached to opposite ends of float 104 act as a bridle to urge the longitudinal axis of the float to be parallel to the surface of the water, the float 104 thereby being impeded from falling into the cavity created by the device as it passes into the water. When the depth of submergence of casing 10 equals the length of line 124 pin 102 will be withdrawn thereby permitting arming slide 38 to shift under the influence of spring 52 to align detonator 44 and bore 42 with firing pin 82 and bore 36. Thereafter, as the device continues its downward movement the full length of line 98 will be drawn out of casing 10 freeing pin 96 for movement out of member 56. When the device is set to explode at the shallow depth, i.e., with bolt 80 in the lower position shown in FIG. 4 after the final warp of line 98 is uncoiled from length 68, pin 96 is cammed outwardly by the upper wall or cam 93 of groove 90 permitting bolt 80 to be driven downwardly immediately by spring 74 to strike detonator 44 and discharge explosive 12.

It will be recalled that the spring 74 is set in an "inside-out" position with bolt 80 in upward position in the event it is desired to fire the device at a deeper depth. In this position spring 74 is not free to snap downward upon release of pin 96 due to its stable characteristic whereby it is maintained in its over-center position. Rather, spring 74 will continue to hold the bolt 80 in its raised position until some external pressure is brought to bear on it. As the device sinks, water is permitted to flow through ports 66 to exert a pressure against the upper wall of spring 74. As this pressure increases due to an increase in depth it will eventually reach a value sufficient to snap spring 74 downwardly in the fashion of a pressure sensitive diaphragm whereupon the spring will be shifted to a position below its center or the plane of its rim to its relaxed position. This spring action will, in turn, drive bolt 80 and firing pin 82 downwardly to percussively strike detonator 44 to fire the device. Set screw 100 maintains spring 74 deflected to the point where decreasing amounts of force will move it through its center position. Therefore, the farther down screw 100 holds bolt 80 the less pressure will be required to move spring 74 through center and the shallower will be the depth at which the device will explode.

A modified form for actuating the arming slide is illustrated in FIG. 6. Here, a hollow tube 150 is utilized to form a passage through a disc 24' situated at the upper section of casing 10'. Tube 150 affords an opening as at 152 out of the nose 153 of casing 10' and an opening 155 into a cavity 154. Cavity 154 extends transversely the greater width of the disc 24'. An arming slide 38' is slidably positioned with the cavity 154 and presents a tang 40' which extends centrally from one end thereof. Tang 40' is reduced in size at its terminal end as at 156, this end being adapted to protrude out of casing 10' and being drilled transversely therethrough to receive a safety wire 41'. The end of arming slide 38' oppositely of tang 40' has a blind bore as at 158 penetrating through a portion of the length of the slide. Arming slide 38' is provided with a bore 42' midway therealong, the rearward section of which is counterbored to receive a percussion detonator 44'. The lower wall of disc 24' also has a bore 36' extending therethrough centrally thereof and aligned with primer 16'.

A compression spring 160 is seated within bore 158 and bears on wall 48' of disc 24' to normally bias slide 38' in a direction so that end 156 extends out of casing 10' and bore 42' is out of registration with bore 36'. An O ring 50' is positioned between bore 42' and the end 156 of slide 38' to prevent entrance of water into the area of detonator 44'. Similarly, an O ring 162 is seated around tube 150 adjacent cavity 154 to provide a watertight seal between disc 24' and the tube 150.

In operation, water is introduced into cavity 154 through tube 150 as the device descends into a body of water. Water pressure exerted against the cross slide 24' acts to overcome the pressure of spring 160 and urge the slide toward wall 48'. At the point when slide 24' abuts wall 48' bore 42' will be aligned with bore 36' and the detonator will be positioned to fire booster 16' and explosive 12'.

Since certain changes may be made in the above device without departing from the scope of the invention herein

involved, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. An underwater explosive device comprising in combination, a casing having an explosive charge disposed therein, detonating means for said charge, a firing means for exploding said detonating means, means biasing said firing means in a direction to explode said detonating means, a movable pin for releasably holding said firing means against movement to explode said detonating means, means including a cam for biasing said pin for movement in a direction to release said firing means, and means including a float and a line connected to said float, said line being operably associated with said pin for normally holding said pin against movement in said releasing direction and for releasing said pin at a predetermined depth of submergence whereby said firing means explodes said detonating means.

2. An underwater explosive device as set forth in claim 1 including a member for supporting said pin, said line being wound around a portion of said member to hold said pin against movement in said releasing direction.

3. An underwater explosive device as set forth in claim 1 including a latch adapted to release said float when said device strikes said body of water and a spring for ejecting said float from said device.

4. An underwater explosive device comprising in combination, a casing having an explosive charge disposed therein, detonating means for said charge, firing means for exploding said detonating means, biasing means associated with said firing means having a first position wherein said firing means is biased directionally to explode said detonating means and a second position wherein said firing means is biased in the opposite direction, selector means adapted to selectively set said biasing means in said first position or said second position, a movable pin for releasably holding said firing means against movement to explode said detonating means, means for biasing said pin in a direction to release said firing means, and means for normally holding said pin against movement in said releasing direction and for releasing said pin at a first predetermined depth of submergence whereby said biasing means can move said firing means to explode said detonating means when it is in said first position, said biasing means being adapted to move from said second position to said first position at a second predetermined depth of submergence.

5. An underwater explosive device as set forth in claim 4 wherein said means for biasing said pin in a releasing direction includes a cam.

6. An underwater explosive device as set forth in claim 4 wherein said means for holding and releasing said pin includes a float, a line attached thereto, said line being operably associated with said pin.

7. An underwater explosive device as set forth in claim 6 including a member for supporting said pin, said line being wound around a portion of said member to hold said pin against movement in said releasing direction.

8. An underwater explosive device as set forth in claim 7 including a latch adapted to release said float when said device strikes a body of water, and a spring for ejecting said float from said device.

9. An underwater explosive device as set forth in claim 4 wherein said biasing means is responsive to hydraulic pressure.

10. An underwater explosive device as set forth in claim 9 wherein said biasing means is a conical spring.

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