United States Patent

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[73] Assignee **The United States of America as represented by the Secretary of the Navy**

[54] UNDERWATER EXPLOSIVE FIRING MECHANISM

1 Claim, 2 Drawing Figs.

[52] **U.S. Cl.** **102/81,** 102/7, 102/16

[51] **Int. Cl.** **F42c 5/00,** F42c 15/08, F42c 15/10

[50] **Field of Search** 102/7, 16; 102/78, 81

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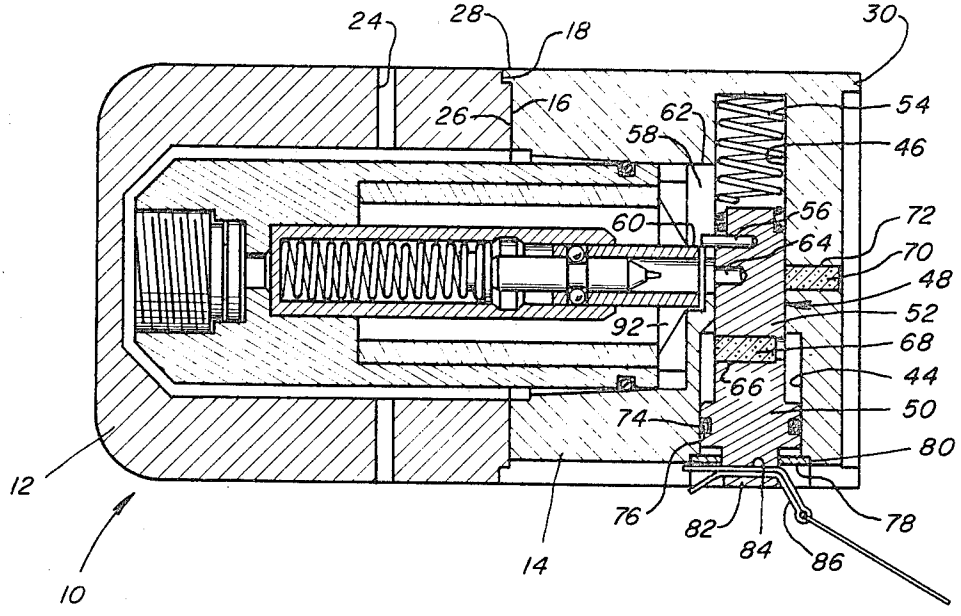
ABSTRACT: A fuze for an ordnance device having a cylindrical casing, a pressure responsive arming mechanism including a piston exposed to the ambient pressure, a precision calibrated coil spring urging against the piston, and explosive charge positioned in the piston, and a pin extending from the piston slidably mounted in a slot to prevent rotational movement and limit longitudinal movement; and a pressure responsive firing mechanism including a spring urged firing pin restrained by ball detents maintained by a sliding sleeve and a rupture disc sealing the sleeve from the ambient fluid pressure until the disc ruptures at a predetermined ambient pressure.



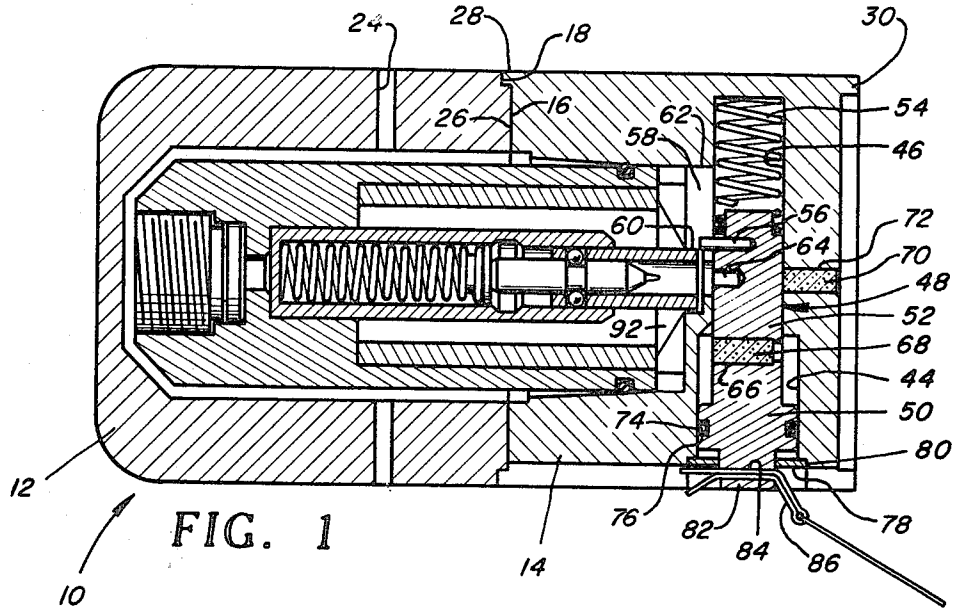


FIG. 1

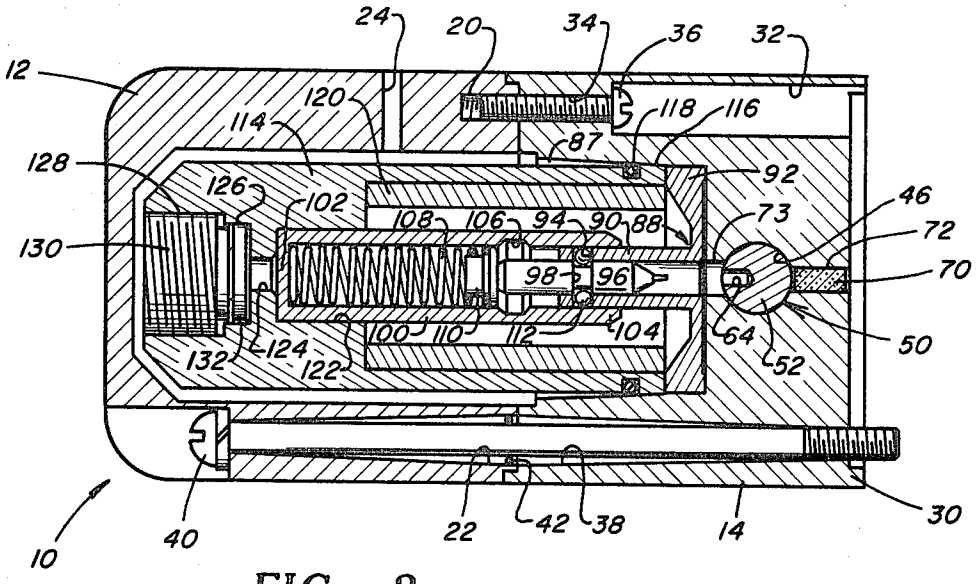


FIG. 2

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UNDERWATER EXPLOSIVE FIRING MECHANISM

BACKGROUND OF THE INVENTION

This invention relates generally to ordnance fuzes, and more particularly to an ordnance fuze which is armed and fired by predetermined diverse ambient pressures.

For a wide variety of military applications, a need has existed for many years for an ordnance fuze armable at a first predetermined ambient pressure and firable at a second greater predetermined ambient pressure. Although, in general, the prior art devices have performed satisfactorily, numerous shortcomings have been realized. The prior art ordnance fuzes are, generally, structurally complex with a resulting low reliability, expensive to manufacture, and heavy in weight.

SUMMARY OF THE INVENTION

Accordingly, one object of the invention is to provide a new and improved ordnance fuze responsive to ambient pressure.

Another object of the invention is the provision of a new and improved pressure responsive ordnance fuze of simple construction.

Still another object of the present invention is to provide a pressure responsive ordnance fuze having a high degree of reliability.

Another still further object of the instant invention is the provision of an inexpensive pressure responsive ordnance fuze.

Still another further object of the instant invention is to provide a pressure responsive ordnance fuze which is light in weight.

Briefly, in accordance with one embodiment of this invention, these and other objects are attained by providing in an ordnance fuze a firing pin axially restrained by a plurality of detents, a close ended sleeve circumscribing the detents and firing pin and slidably mounted with respect thereto, an uncalibrated coil spring positioned in the closed end of the sleeve and urging against the firing pin, and a rupturable device preventing the exposure of the sleeve to the ambient pressure until a predetermined pressure has been reached.

BRIEF DESCRIPTION OF THE DRAWING

A more complete appreciation of the invention and many of the attendant advantages thereof will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

FIG. 1 is a plan view, partly in section, of the fuze of the present invention, and

FIG. 2 is an elevation view, partly in section, of the fuze of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings wherein like reference characters designate identical or corresponding parts throughout the several views, the fuze of the present invention is indicated generally by reference numeral **10**. Fuze **10** comprises a generally cylindrical, cup-shaped, blunt nosed end housing **12** and a generally cylindrical cup-shaped body housing **14**. End housing **12** terminates at one extremity thereof with a substantially flat lip **16** disposed in a plane perpendicular to the axis of the end housing. An annular recess or groove **18** is provided in the outer surface of end housing **12** at the extremity thereof adjacent lip **16**. A plurality of internally threaded closed ended bores **20** are provided in end housing **12**, extending perpendicularly through lip **16** and terminating in the side walls of the end housing. A plurality of smooth, tapered, through bores **22** are also provided in end housing **12** extending parallel to the fuze axis from lip **16**, through the side walls, to the blunt nosed end of the end housing very slightly tapering inwardly in the direction recited above. Another plurality of smooth through bores **24** are provided in end housing **12** extending radially through the side walls thereof.

Body housing **14** terminates at one extremity thereof with a substantially flat lip **26** disposed in a plane perpendicular to the axis of the body housing. An annular rib or shoulder **28** is provided along the outer edge of lip **26**. Shoulder **28** and groove **18** are suitably shaped, illustrated herein with square cross sections, to matingly engage one another. The base extremity of body housing **14** is substantially flat with an annular rib or shoulder **30** shaped to matingly engage an annular groove or recess (not shown) in the body of an ordnance device (also not shown). A plurality of smooth bores **32** having a diameter substantially greater than that of threaded bores **20** are provided in body housing **14**, extending perpendicularly through the base extremity thereof and through a portion of the side walls thereof, one such bore **32** being positioned coxially with each threaded bore **20**. A plurality of smooth through bores **34** having a diameter at least as great as that of threaded bores **20** but smaller than that of smooth bores **32** are provided in body housing **14**, one such bore **34** being positioned coaxially with each threaded bore **20** and extending from the extremity of smooth bore **32** through lip **26**. End housing **12** and body housing **14** are fixedly secured to each other by means of a plurality of cap screws recessed in bores **32**, extending through bores **34**, and threadly engaging threaded bores **20**. In this manner groove **18** and shoulder **28** matingly engage one another so as to provide a contiguous smooth outer surface.

Body housing **12** has a plurality of smooth tapered through bores **38** extending from lip **26**, through the side walls, to the base extremity of the body housing, tapering inwardly in the direction recited above; one such bore **38** being positioned coaxially with each tapered bore **22**. An elongate bolt **40** extends through bores **22** and **38** for engagement with an internally threaded bore (not shown) of an ordnance device (also not shown) to thereby provide convenient means of attachment of the fuze of the present invention with such an ordnance device. A conventional sealing means, such as O-ring **42**, is provided in bore **22** between end housing **12** and bolt **40** so as to effectuate a fluid tight seal therebetween.

The pressure responsive arming system for the fuze is located in the base extremity of body housing **14** between the firing system to be described hereinafter and an ordnance device (not shown). The base extremity of body housing **14** has provided therein a close ended lateral passageway comprising a smooth wide bore **44** extending radially from the outer surface of the body housing through a minor portion thereof and a close ended smooth narrow bore **46**, having a diameter smaller than wide bore **44**, extending coaxially with respect to the wide bore from the base thereof through the body housing over a major portion thereof.

A generally cylindrical piston **48**, having an enlarged portion **50** of approximately the same diameter as wide bore **44** and a reduced elongate portion **52** of approximately the same diameter as narrow bore **46**, is slidably positioned in the lateral passageway and bears against an outwardly biased resilient device, such as compressed coil spring **54**, which is positioned in the closed end of the lateral passageway. A narrow raised portion of piston **48** extends within the coils of spring **54** so as to keep the assembly in alignment. A pin **56**, secured to piston **48** in any conventional manner and extending radially therefrom, is slidably disposed within a lateral slot **58** in body housing **14** to prevent rotation of piston **48**. Pin **56** and slot **58** further serve as a stop means to constrain piston **48** from further outward movement in its initial position thereby resisting the force exerted by spring **54** and from further inward movement in its armed position thereby resisting forces hereinafter described, as by the bearing engagement of pin **56** with ends **60** and **62**, respectively, of slot **58**. A close ended bore **64** radially extending into piston **48** is positioned therein so as to be coaxial with the axis of fuze **10** when the piston is in its initial position. A smooth through bore **66** radially extending through piston **48** is positioned therein so as to be coaxial with the axis of fuze **10** when the piston is in its armed position. In the armed position, an explosive charge **68** positioned in bore **66** is coaxially aligned with an explosive charge **70**

positioned in a smooth through bore 72 in the base extremity of body housing 14 and with another through bore 73 in the base extremity of the body housing, each of the bores 66, 72 and 73 thereby being coaxially aligned with respect to fuze 10. A sealing device, such as O-ring 74, is positioned in an annular groove 76 in enlarged portion 50 of piston 48 to provide a fluid tight seal in wide bore 44 between body housing 14 and the piston. A retaining device, such as centrally apertured washer 78, is positioned within an annular groove 80 in the side wall of the body housing. A raised portion 82 of piston 48 extends through the aperture in washer 78, and a small transverse aperture 84 is provided in that segment of the raised portion which extends through the washer. A retaining device, such as cotter pin 86, having an appropriate instructional tag attached thereto is inserted through aperture 84 to restrain piston 48 from any inward movement toward its armed position until the cotter pin is selectively removed thereby maintaining the fuze in its initial or "safe" or "unarmed" position, as will become more clear hereinafter, prior to utilization thereof.

The pressure responsive firing system for the fuze is located in a cavity 87 provided by the lip-to-lip engagement of cup-shaped end housing 12 and body housing 14. A guide member 88 having an elongate, generally cylindrical, hollow barrel portion 90 and a plurality of winglike or butterfly type, radially extending, projections 92 at one end thereof is positioned in cavity 87. The outer dimensions of projections 92 are approximately equal to the inner dimensions of body housing 14 at the base extremity so that barrel portion 90 of guide member 88 is coaxially aligned with the fuze. Barrel portion 90 of guide member 88 has a plurality of radially extending through bores 94 in the other extremity thereof. An elongate, generally cylindrical firing pin 96, having an annular groove 98 in the central portion thereof, is slidably disposed within barrel portion 90 of guide member 88. An elongate, generally cylindrical, hollow inner sleeve 100, having a closed end 102, an open end 104, and an inside diameter approximately equal to the outside diameter of barrel portion 90, is slidably mounted about the barrel portion. An internal annular groove 106, having a depth at least as great as that of annular groove 98 in firing pin 96, is provided near the central portion of inner sleeve 106 in the inside surface thereof. An initially uncompressed coil spring 108 having a stopper 110 secured to one end thereof is positioned within inner sleeve 100 and bears against closed end 102 of the inner sleeve and one end of firing pin 96. In the prefired position of the fuze, as illustrated, a plurality of detents, such as balls 112, are secured in bores 94 in barrel portion 90 and in annular groove 98 in firing pin 96 by inner sleeve 100 thereby restraining the firing pin from longitudinal movement in either direction. A generally cylindrical cup-shaped outer sleeve 114, positioned within cavity 87, is secured in place by conventional means, such as press-fitting with the inwardly tapering side walls of body housing as at 116. It should be understood that outer sleeve 114 might also be held in place by bearing against a projected portion (not shown) of end housing 12 on the interior of the base thereof. A conventional sealing device, such as O-ring 118, is positioned between the outer surface of outer sleeve 114 and the inner surface of body housing 14 thereby providing a fluid tight seal therebetween. The side walls of outer sleeve 114 may be given additional strength by press fitting therein a hollow, generally cylindrical insert 120 made of a high strength alloy. Although outer sleeve 114 and insert 120 are illustrated as two-piece, it should be understood that they might be integrally formed. Outer sleeve 114 has centrally formed therein a smooth bore 122 of approximately the same inner diameter as the outer diameter of inner sleeve 100 extending from the interior of the base of the outer sleeve through a minor portion thereof. Closed end 102 of inner sleeve 100 extends into bore 122 in outer sleeve 114 and is slidably disposed therein, a layer of grease being provided therebetween to take up the clearance and reduce the friction. It should be noted that inner sleeve 100 bears against the base of bore 122 in outer sleeve 114 so that the outer sleeve thusly constrains the inner sleeve from transverse movement away from body housing 14 due to the force which might be exerted by spring 108 if it were compressed when in the unfired position; inner sleeve 100 is nevertheless free to slide longitudinally toward the body housing save for the force exerted by spring 108. A through bore 124 of a diameter smaller then bore 122 is centrally formed in the base of outer sleeve 114. A close ended bore 126 of a diameter larger than bore 124 is centrally formed in the base of outer sleeve 114 extending from the exterior surface thereof through a minor portion thereof. An enlarged portion 128 of bore 126 is internally threaded so as to accommodate an externally threaded hollow plug 130 thereby securing a rupture disc unit 132 in bore 126. Rupture disc unit 132 fluidly seals off bore 124 from the ambient but is designed to rupture when the ambient pressure reaches a predetermined valve, thereby exposing bore 124 to the ambient fluid environment.

In operation, fuze 10 is positively maintained in its unarmed position by cotter pin 86 which is manually removed when the fuze is to be utilized. After the cotter pin has been removed, washer 78 may or may not fall away, but in either case the position of piston 48, between the limits imposed by slot 58 and pin 56, is determined by the ambient pressure to which the piston is exposed. Spring 54 tends to resist the inward movement of piston 48 by a force which increases linearly with the inward movement of the piston. However, once a first predetermined ambient pressure is reached and/or surpassed, piston 48 will be positioned so that explosive charges 68 and 70 are coaxially aligned with firing pin 96.

Simultaneous with the inward movement of piston 48, the ambient fluid enters bores 24, fills cavity 87, passes through hollow plug 130, and is exposed to rupture disc unit 132. Upon reaching a second predetermined ambient pressure greater than the first predetermined ambient pressure, rupture disc unit 132 bursts, and the ambient pressure passes through bore 124 and is exposed to closed end 102 of inner sleeve 100. Spring 108 need not be finely calibrated, but it should be selected to be fully compressible at a pressure equal to or less than the second predetermined ambient pressure. In this manner, the ambient pressure will cause inner sleeve 100 to slide forward compressing spring 108 until annular groove 106 becomes aligned with bores 94, annular groove 98, and balls 112. At this point balls 112 are cammed outwardly by firing pin 96 which is urged inwardly by spring 108. Thusly released, firing pin 96 slides inward due to the force exerted by spring 108 until it strikes and sets off explosive charge 68 which sets off charge 70, which in turn sets off a booster charge (not shown), causing a main charge (also not shown) to detonate.

It should be noted that the fuze of the present invention is readily adaptable to a plurality of environments. The selection of the first predetermined ambient pressure may be made by varying spring 54, although it should be apparent that, if a sufficiently low first predetermined ambient pressure is selected, the fuze may be fired over a very wide range of higher ambient pressures by simply changing the rupture disc unit. The fuze of the present invention is adaptable for use in a wide variety of environments, but it is particularly useful as a hydrostatic fuze for use with either depth charges or depth responsive underwater sound signals. The features of the present invention have been found to be extremely advantageous in modifying a large stockpile of heretofore obsolete hydrostatic fuzes which modifying intended for a maximum depth of 800 feet. The fuze of the present invention is operable at depths from 1000 through 18,000 feet, weighs approximately 6.8 pounds which is approximately one-half of the weight of the present hydrostatic fuze for these depths, and may be produced at an approximate monetary savings in excess of 50 percent.

I claim:

1. A firing mechanism for detonating an underwater explosive at a predetermined depth in a high pressure fluid environment comprising in combination:

a housing having an elongated chamber centrally disposed therein and having first and second bores cut through the walls thereof at either end of said chamber such that each bore communicates both with said chambers and with the exterior of said housing, said first bore being adapted to permit the ambient fluid pressure experienced by said housing to be applied to one end of said chambers as said underwater explosive descends in said fluid environment; and

a spring-actuated firing pin assembly accommodated within said chamber, said assembly including a spring under compression and a firing pin, one end of which firing pin is in abutting relationship with one end of said spring, said pin being in alignment with said second bore and biased in a direction towards the said second bore by said spring; detent means in locking engagement with said pin for maintaining said firing pin in a cocked position relative to said housing; and piston means mounted for reciprocation within said chamber, coacting both with the other end of said spring and said detent means and confronting said first bore from position within said chamber for further compressing said spring in response to the application of fluid under pressure acting on the head thereof and for releasing said detent means from locking engagement with said pin when said fluid under pressure causes said piston means to move a predetermined distance towards said second bore; and

a thin disc positioned in said first bore and normally preventing said ambient fluid under pressure from acting on said piston head, said disc being adapted to rupture at said predetermined depth due to the ambient fluid pressure thereat such that whenever said underwater explosive reaches said depth said disc is ruptured and a fluid pressure pulse is suddenly delivered to said piston head causing said piston means to rapidly compress said spring and thereafter release said detent means from locking engagement with said firing pin, thereby allowing said spring to propel said pin through said second bore at a velocity sufficient to detonate any explosive charge adjacent the open end thereof.