June 17, 1969 J. A. DARE 3,450,049

UNDERWATER DELAY FUZE

Filed Sept. 9, 1966 Sheet 1 of 2

Fig. 1

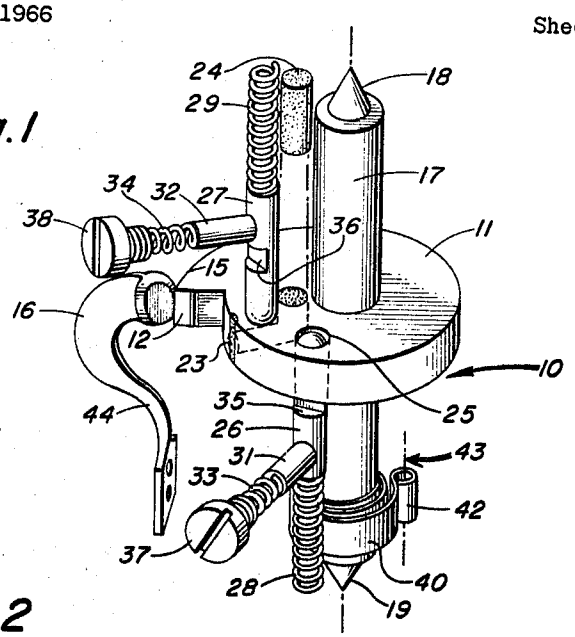


Fig. 2

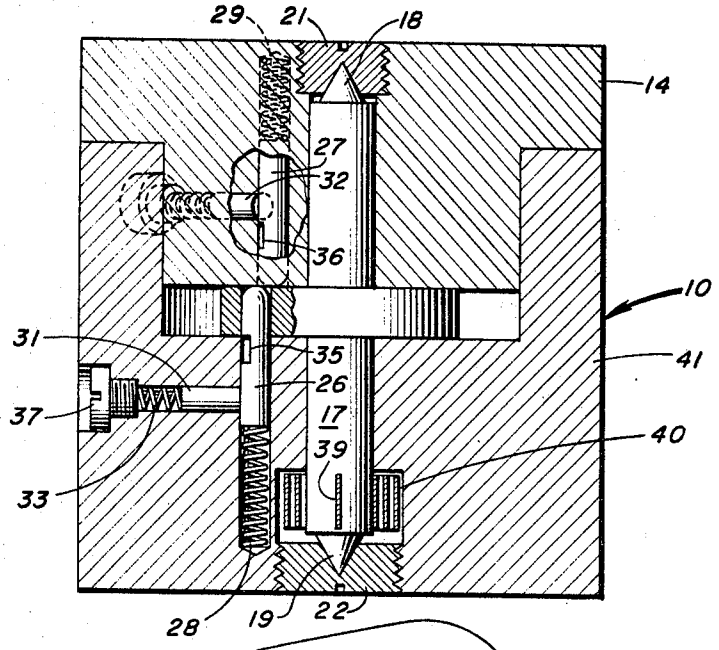


Fig. 6



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Fig. 3

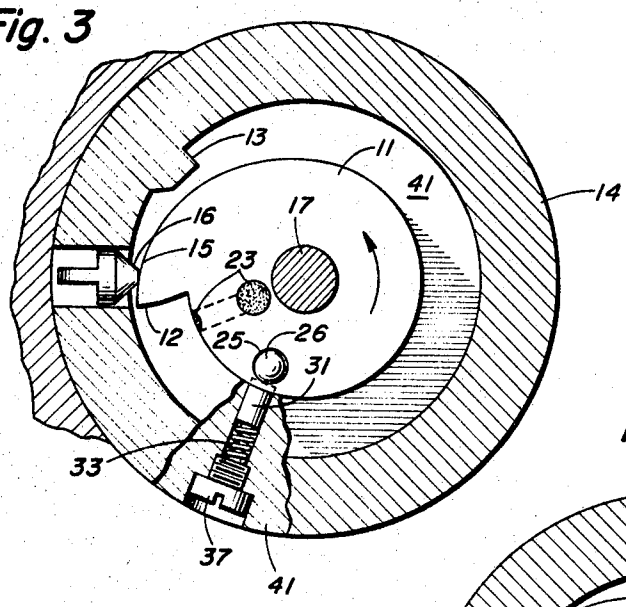


Fig. 4

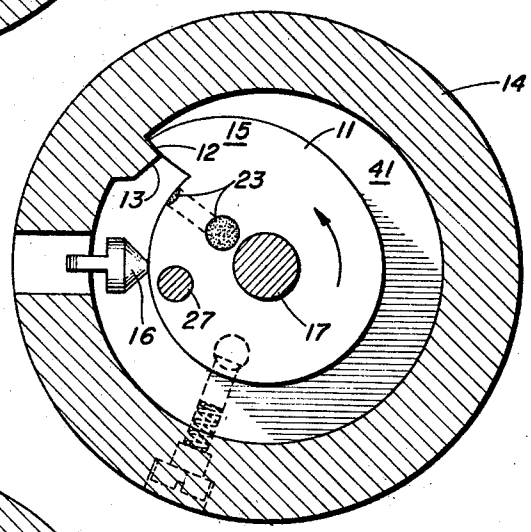
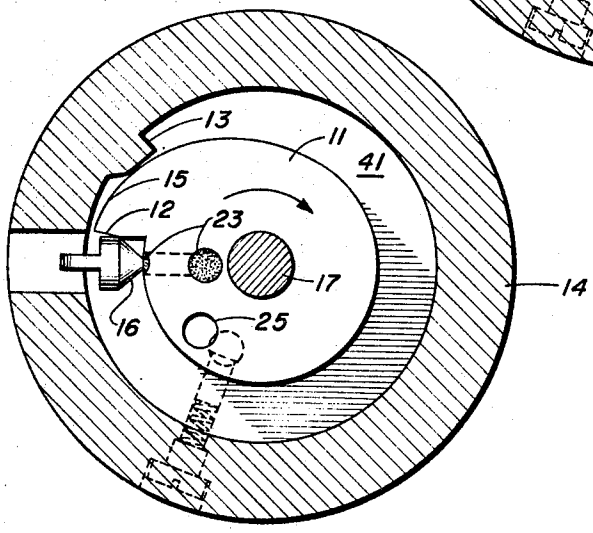


Fig. 5



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UNDERWATER DELAY FUZE

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U.S. Cl. 102—80 9 Claims

ABSTRACT OF THE DISCLOSURE

An underwater delay rotating fuze which utilizes setback, spin acceleration, impact and spin deceleration forces to arm, delay and fire the fuze. The fuze includes a preset rotatable cam, having a radial arm thereon, which is held against a position stop by a latch means. Upon impact with the surface of a body of water, the latch means is released thereby allowing the cam to be rotated by a deceleration spin force. The rotation of the cam stores energy in a firing pin which is biased against the cam. The firing pin is allowed to move inwardly after the radial arm of the cam passes thereby, and the inward movement causes the firing pin to strike a detonator element which detonates a projectile charge.

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

This invention relates generally to a fuze device and more particularly to an improved combination centrifugal and setback inerta type fuze mechanism.

More specifically the invention relates to a fuze device of a type adapted for use in a rotating projectile as a projectile fuze for controlling the arming of the fuze by such inherent conditions occurring during missile travel as setback, centrifugal force, deceleration, and predetermined combinations thereof, occurring in predetermined sequences, as developed at discharge from the gun or launching device for the projectile or missile, as the case may be, and with subsequent rotation of the projectile in flight along the air flight portion of its trajectory to the apogee thereof and further during subsequent deceleration at impact with and travel within a body of water.

This invention is advantageously adapted for utilization with an anti-personnel projectile for swimmer weapon purposes when the missile or projectile is projected from ships and boats by a suitable mechanism of a character well known in the art and including grenade throwing devices. The instant invention advantageously incorporates a plurality of devices for insuring reliability and a predetermined sequence of actuation of the various coordinated elements of the fuze to provide predetermined control with the cycle of actuation of the fuze from the time of firing until actuation of a booster charge occurring at a predetermined depth below the surface of a body of water.

The utilization of centrifugal forces and setback forces for actuation of arming devices and switch closure elements of fuze mechanisms is well known in and found in a variety of prior art devices. These prior devices generally incorporate certain types of biasing arrangements, utilized either directly or indirectly to maintain an electrical contact making member in an open position prior to switch actuation and may additionally incorporate spring elements to maintain a closed circuit relationship with the contacting member following application of centrifugal forces thereto. Other types of devices use combinations of setback and centrifugal forces to effect movement of various sized and shaped masses disposed within the fuze mechanism for effecting a desired sequence of operation. Additionally magnetically controlled inertia mechanisms have been incorporated in fuzing devices of the character utilizing setback and spin accelerations to arm the fuze. Such a device is shown in U.S. Patent 2,744,976 which issued to J. G. Black on May 8, 1956. The devices of the character of the aforementioned patent may be incorporated with fuze mechanisms which include additional sensing of impact or the presence of a target to fire the fuze. In instances in which an underwater burst is desired, the prior art devices generally incorporate a delay element which is disposed in series with the fuze firing mechanism. The fuze firing mechanism then functions on water surface impact and the main charge is fired after the delay element functions. The addition of a delay element adds at least one function and an additional mechanism in the fuze train which is generally disposed in series with the preceding fuzing elements or mechanism. The addition of such a delay element increases the cost and complexity of such fuzes while in many cases reducing reliability thereof. The instant fuzing mechanism of this invention differs from the prior arts types in that the fuze utilizes a first initial setback force for a first condition of arming, a spin acceleration in one direction for a second step in the functional sequence in the chain of arming actuations, impact with the body of water as a third function or condition for fuzing or arming and finally a spin deceleration in one of the mechanisms thereof to provide arming delay after impact and firing in a desired sequence.

It is therefore a feature of this invention to provide an improved air to water projectile fuzing mechanism for detonation of an explosive charge, upon elapse of a predetermined time interval after the occurrence of water entry wherein a predetermined period of delay time occurs after water impact and under precisely controlled condition and wherein the mechanism of the fuze is materially simplified and ruggedized as compared to fuze mechanisms heretofore or now in general use.

One object of the instant invention resides in the provisions of an ordnance fuze which incorporates a novel structure and relationship of elements thereof which are disposed to insure the deferment of registration of the initiation charge component of the explosive train with the firing pin mechanism or its equivalent until the ordnance device has been subjected to predetermined forces correlative to conditions synonomous with firing or launching of a projectile from a gun and including in a sequential order at least setback, centrifugal or rotational force, an additional setback force of a character ordinarilly developed therein only upon firing of the ordnance fuze from a gun and the subjecting of the fuze mechanism to water entry upon completion of an air flight trajectory.

Another object of the invention is to provide an improved ordnance fuze which employs a firing pin or actuation device for detonation of an explosive train, wherein the firing pin or actuation device is normally locked in a predetermined safe position with respect to the explosive train in the initial position thereof prior to firing, and in which position said pin or actuation device directly holds the moveable component of the firing pin or device out of alignment and away from a position permitting the possibility of engagement with elements of the train, in an unarmed or safe position whereby it is incapable of detonating the firing train upon accidental dropping of the ordnance item incorporating said fuze.

Another object of the instant invention resides in the provision of an improved ordnance fuze device which is initially inactive and which is adapted to be so maintained until after the application in sequence of a predetermined

setback force, a centrifugal force, a deceleration force and a subsequent rotational force combined in such order and imparted to the fuze mechanism with a sufficient degree of magnitude to effect a desired actuation.

Another object of the invention resides in the provision of an improved fuze mechanism characterized by simplicity of construction and ruggedness and adapted for mounting within a projectile or missile for control of arming and firing thereof in response to the application thereto of a predetermined sequence of forces characterized by a unique trajectory including water entry following air flight for effecting completion of arming only after the fuze penetrates the surface of a body of water and has descended to a predetermined depth therein.

A further object of the invention is to provide a fuze mechanism for an ordnance device wherein a firing mechanism incorporated therein is maintained in an unactuated condition with respect to an explosive train during all conditions of handling and flight through the trajectory of the ordnance device and is effective for ignition of the firing train only in response to the occurrence in predetermined sequential order of the plurality of forces to which the projectile or missile is subjected as the result of its being fired from a gun or gun-like device.

In correlation with the foregoing objects another object of the invention resides in the provision of an improved fuze mechanism assembly which is of relatively simple construction yet provides positive operation and the maximum of safety at all times prior to the application of a final influencing force to which the fuze is subjected during the terminal portion of its trajectory.

Other objects and many of the attendant advantages of the instant invention will be readily appreciated as the same bcomes better understood in connection with the accompanying drawings wherein:

FIG. 1 is a generally diagrammatic view in pictorial form showing the details of a typical fuze mechanism of a preferred embodiment of the instant invention;

FIG. 2 is an elevation view in vertical section of a fuze mechanism of FIG. 1 as incorporated in a housing assembly for the component parts;

FIG. 3 is a sectional plan view illustrating the position of various of the elements of the fuze mechanism in the initially unarmed condition thereof;

FIG. 4 is a sectional plan view similar to FIG. 3 showing the intermediate condition of certain of the elements thereof in an arrested and locked condition prior to full arming but following flight of the fuze mechanism through an initial portion of the trajectory of a missile incorporating therein a fuze of the instant invention;

FIG. 5 is a sectional plan view similar to FIGS. 3 and 4 which illustrates the fuze mechanism in the fully armed and firing condition thereof; and

FIG. 6 is a diagrammatic illustration of the forces to which the fuze of the instant invention is subjected during projectile flight.

Referring now to FIG. 1 of the drawings for a showing of an illustrative embodiment of the invention, a fuze mechanism generally indicated at **10** is shown sans the housing or body portion thereof, for purposes of clarity in illustrating the structural details of a typical device.

The instant fuze mechanism **10**, illustrated together with its housing in FIG. 2, comprises a cam-shaped rotor member **11** which is provided with a projection and flat portion at **12** for engagement with a stop portion or projection **13** disposed to project downwardly and inwardly from the upper housing member **14** upon a predetermined angular rotation thereof. The portion adjacent the stop or flat surface **12** of the cam rotor is configured to provide a cam lobe at **15** which engages the firing pin element **16**.

As shown in FIG. 1 this may be in the nature of a spring biased hammer. The hammer is of a metallic type material having spring characteristics suitable for lateral displacement of the hammer during cam rotation and which action in effect cocks and releases the hammer upon

rotation of the cam in a direction opposite to that rotation which permits engagement of the stop projection portion **13** with the stop projection flat **12**. The rotor is disposed on a shaft **17** having suitable bearing surfaces thereon at **18** and **19** which for purposes of illustration are shown as conical or of the pivot type. Either of the bearings **21** or **22**, but preferably the upper bearing **21** is mounted in a manner for adjustment at assembly to provide takeup of end play and limit as desired the degree of axial and lateral freedom of the shaft **17** relative to these bearings. The cam rotor element **11** is provided with an aperture indicated at **23**. This may be filled in any suitable manner, such for example as by casting, pressing, cementing or any other suitable technique, for retaining the ignition charge therein. The charge at **23** is located in a position immediately adjacent the periphery of the cam and disposed to project therethrough in a manner to permit engagement of this explosive or detonation charge by the hammer in its stroking action for firing thereof. Disposed in immediate adjacency to the initiation charge is a booster charge generally indicated at **24**. This charge in turn is disposed for actuation of the main charge of a projectile warhead (not shown). The cam rotor **11** is further provided with an aperture **25** disposed to receive respectively and in sequence during operation of the device, a first detent type plunger element **26** and a second detent type plunger element **27** on the opposite side thereof. The plunger elements are spring loaded by springs **28** and **29** respectively to establish and maintain a fixed relationship of the cam rotor **11** prior to release thereof and for a subsequent holding thereof following a predetermined rotation occurring during flight and in a manner that will hereinafter become more apparent as the description proceeds. Each of the plungers **26** and **27** are disposed to receive a detent type latch mechanism generally indicated at **31** and **32** of a spring loaded nature which provides for fixing of the plungers against relative movement after actuation of the plungers by forces to which the fuze is subjected during program portions of its trajectory. The springs **33** and **34** urge plungers **31** and **32** into notches **35** and **36** respectively in plungers **26** and **27**. Screws **37** and **38** are shown for purpose of illustration as retaining elements for the detent assemblies. The shaft **17** may advantageously incorporate a groove at **39** for reception of a helical spring **40** having an outer hook portion indicated generally at **42** for engagement with the housing **41** in a manner not shown. This spring **40** aids in providing rotation of the shaft **17** for effecting rotation of the cam rotor **11** relative to the housing **14**. The direction of rotation due to spring action is dependent upon the manner in which the spring **40** is disposed relative to the shaft **17** and the housing portions **14** and **41**. In the event the spring **40** is to be utilized for aiding rotation in a first direction it is disposed in the manner shown. In the event it is desired to use the spring to assist rotation of the shaft **17** and cam rotor **11** in the opposite direction and hence to some extent limit the rotation in the first direction, the spring may be inverted at assembly and staked or restrained in any suitable manner, such for example, as by a pin or slot not shown but disposed in restraining relationship to the hooked end **42** thereof at a position in lower housing **41** corresponding to that indicated by the centerline shown at **43**.

In the operation of the fuze mechanism of the instant invention and in a projectile, with respect to which an underwater burst is desired, the fuze firing mechanism functions to arm on water surface impact and thereafter the main charge is fired in response to ignition of the booster charge after the delay occasioned by the burning of the booster. In order to provide a better understanding of the operation of a fuze mechanism of the character of the instant invention, reference is made to FIG. 6 for an indication of the forces acting on the fuze mechanism during projectile trajectory flight. The initial setback force indicated at **46** in FIG. 6 effects a retracting of pin **26**

which latches in a rearward position by virtue of the action of the detent **31** engaging notch **35** in pin **26**. The spin force indicated at **47** to which the projectile is subjected immediately following the initial acceleration induces rotation of the housing relative to the rotor. This relative rotation induces a counterclockwise rotation about the axis thereof until the flat **12** on the radial lobe or cam surface **15** strikes the positive stop **13** on the upper housing. In this position the spin latch pin or plunger **27** engages the upper side of the same hole at **25** that latch pin **26** initially occupied on the lower side of cam rotor **11** before it was retracted. This prevents rotor movement during the air phase of the fuze and missile trajectory. This portion of the flight is characterized by small irregular spin forces acting on the fuze mechanism. On the occurrence of water impact of the fuze and the projectile or missile the impact force indicated at **48** in FIG. 6 causes latch pin **27** to move forward or outward from hole **25** to a position where it is retained by detent plunger **32** engaging latching notch **36**. At this time the cam rotor **11** is again free to be subjected to rotational forces which tend to rotate the rotor or to permit relative movement of the housing with respect thereto, wherein the fuze mechanism experiences or is subjected to the spin forces indicated at **49** in FIG. 6. The effective rotation in this instance may be considered as clockwise as indicated in FIG. 5, thereby storing energy in the firing pin or hammer **16** by distortion of the spring portion **44** until the radial cam surface of the lobe portion **15** passes the head of firing pin **16**. At this time the firing pin is permitted freedom to move forward in an inward radial direction until it strikes the projecting and exposed portion of the detonator element **23**. The detonator element then fires upon this impact and transfers the explosive detonation forces to the booster element **24** which in turn effects detonation of the main projectile charge.

As aforementioned the spring **40** may be, or may not be, utilized in the fuze, as desired. If it is incorporated in the assembly in the manner shown or the reverse torque applying manner it will function respectively as the case may be to obtain longer, or shorter, fuze function time after impact. It is considered apparent that the construction of the embodiment as illustrated is but one example of many possible configurations of the structural elements which may operate in accordance with the disclosed paths of movement indicated in FIGS. 3, 4 and 5 for effecting the overall control provided by the instant fuze mechanism.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings.

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

1. In a fuze, a firing mechanism comprising, a body member having a chamber adapted to receive a rotatable rotor mass:

a cam shaped rotatable rotor mass having a projecting lobe portion configured to provide a stop surface thereon for engagement with said body member,

a first latching means cooperatively engageable with said rotatable rotor mass and said body member for initially locking said rotor mass against motion of a nature inducing rotation relative to said body member until after the fuze has been subjected to a setback force,

a second latching means disposed to effect latching engagement with said rotor mass upon the occurrence of a predetermined relative rotation between said rotor mass, and following the application of the setback force to the fuze, said second latching means being responsive to inertial forces and adapted for release actuation with respect to said rotor mass upon the application to the fuze of decelerational forces applied in a manner and resulting from a condition corresponding to water impact of the fuze,

said rotatable member being disposed to be affected by centrifugal force influences occurring with fuze spin during an air flight portion of the trajectory thereof,

an explosive charge disposed in said rotor mass in adjacency to and in communication with the periphery thereof, and

means including a firing means for effecting ignition of said explosive charge upon a subsequent rotation of said rotary member in a direction contra to the direction of the initial relative rotation thereof.

2. The structure of claim **1**, wherein said firing means further comprises:

a spring cocked hammer disposed to be cammed into actuating condition by said lobe portion of said rotor mass only during the subsequent relative rotation thereof.

3. The structure of claim **2** further including spring means disposed in cooperative relationship with said rotor mass to effect biasing and/or aiding in the relative rotation thereof.

4. The structure of claim **1**, further comprising:

a first detent means for latching said first latching means after release actuation thereof.

5. The structure of claim **4**, further comprising:

a second detent means for latching said second latching means in an inoperative condition only upon release actuation of said second latching means.

6. The structure of claim **4**, wherein said firing means further comprises:

a spring cocked hammer disposed to be cammed into actuating condition by said lobe potrion of said rotor mass only during the subsequent relative rotation of said rotor mass.

7. The structure of claim **5** wherein said firing means further comprises:

a spring cocked hammer disposed to be cammed into actuating condition by said lobe portion of said rotor mass only during the subsequent relative rotation of said rotor mass.

8. The structure of claim **6** further including:

spring means disposed in cooperative relationship with said rotor mass to effect biasing and aiding in the relative rotational movement existant between said rotor mass and said body member.

9. The structure of claim **7** further including:

spring means disposed in cooperative relationship with said rotor mass to effect biasing in the relative rotational movement occurring between said rotor mass and said body member.

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