UNITED STATES PATENT OFFICE

2,660,952

UNDERWATER FIRING MECHANISM

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Application December 14, 1944, Serial No. 568,189

7 Claims. (Cl. 192—16)

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

This invention relates to firing mechanism and more especially to improvements in safety means for firing mechanisms employed in submersible explosive bodies.

One of the primary requisites in the construction of explosive bodies is to so design the firing mechanism that it will not accidentally be set in operation to cause an explosion of the body prematurely, that is, while it is being handled preparatory to use and even more important, so that it will not be set in operation even though mishandled.

In the present instance, the invention is concerned specifically with an explosive device adapted to be used in minesweeping operations and upon contact with the cable of an opposing mine to explode, whereby to cut the cable and free the mine so that it will rise to the surface. Such devices receive rather rough handling while as yet un-submerged, that is, preparatory to use in the sweeping operation and while they are provided with safety pins which prevent operation of the firing pin mechanism unless withdrawn, there is no guarantee that the pin will not accidentally or unwittily be removed before the device is submerged, or that through falling from a height and striking the deck or other object the inertia of the firing pin itself will not be sufficient to cause penetration of the primer, thereby igniting it and causing serious injury to personnel.

It is an object of this invention to provide an explosive body, the firing mechanism of which will not cause an explosion of the body even though set in operation as long as the body is un-submerged, and of such construction that if dropped the inertia of the firing pin will not penetrate the primer.

This invention resides in a firing mechanism including a firing pin of very light weight, a firing plunger having a normally empty chamber therein associated with the firing pin and adapted telescopically to fit over an end of the firing pin without making contact therewith, and hence, without actuating the same as long as only air occupies the chamber, but adapted when liquid is trapped in the chamber between it and the firing pin to transmit the impulse of the plunger through the liquid to actuate the firing pin. More specifically, as illustrated herein, the mechanism comprises a hollow cylindrical body a plug having a reduced portion threaded into one end thereof having a central bore therein, a primer disposed in the bore, a firing pin disposed in the bore adjacent to the primer, a shear pin arranged to retain the firing pin in spaced relation to the primer, a plunger having a cup shaped head adapted to fit over the end of the reduced portion of the plug to form a closed chamber, means for limiting the movement of the plunger so that it does not contact the firing pin and will not transmit its motion thereto, except through the intermediary of the water trapped therein, a spring adapted to move the plunger toward the firing pin and a removable release pin arranged manually to restrain the plunger but upon removal to permit it to be driven toward the firing pin.

It is a further object of this invention to provide a firing mechanism which, when actuated, will bring about ignition of the primer even though it is saturated with water, that is, regardless of whether it is dry or wet.

In this aspect invention resides in means for causing the firing pin to penetrate the primer at high velocity, whereby to generate frictional heat between the firing pin and the primer charge to cause ignition of the primer even though it is saturated with water. As illustrated herein, this is attained by constructing the plunger so that it traps a volume of water between it and the firing pin, the area of the plunger being far in excess of the area of the firing pin, hence, multiplying the movement of the plunger and resulting in greatly magnifying the movement of the firing pin. Specifically, the ratio of the diameter of the plunger to that of the firing pin is about 2 to 1 which results in a ratio of 1 to 4 in the movement transmitted from the plunger to the firing pin. With an initial velocity of about 20 feet per second, produced by a spring adapted when released to drive the plunger toward the firing pin, by reason of the aforesaid multiplication of motion, the firing pin is caused to move approximately 80 feet per second into the primer.

The invention will now be described in detail with reference to the accompanying drawings, in which:

The single figure shows a section through my improved safety device.

Referring to Fig. 1, the safety firing mechanism indicated generally by reference character 10 comprises a hollow cylindrical body 12 having a chamber 14 therein which extends from one end throughout the greater portion thereof and a guide-way 16 forming a continuation of the chamber to the other end, the guide-way being of smaller diameter than the chamber. The chamber 14 is provided with internal threads 18 near the open end thereof, and into this open thread-end there is screwed a plug 20 having a reduced inwardly projecting extension 22.
plug 20 is provided with a longitudinal bore 24, the inner portion of which is enlarged at 26 so that the shoulder 28 is formed substantially midway between the ends of the bore 24. In the enlarged portion 26 of the bore, there is disposed a primer 30 which is seated against the shoulder 28 and a firing pin 32 which is spaced inwardly from the primer and is retained in a spaced relation thereto near the inner end of the bore by a shear pin 34 passing through it and the walls of the extension 22. The firing pin is made light in weight so that it has little inertia and hence is insensitive to a sudden change in the motion of the device. This feature adds to the safety of the device since the firing pin will not be caused to back away if the device is dropped, even though as much as thirty or forty feet. A plurality of radially disposed passages 36 are formed in this portion of the cylindrical body 12 extending from the outward side thereof inwardly through the walls and through a portion of the plug 20, the passages terminating in the enlarged portion 26 of the bore between the primer 30 and the firing pin 32. All passages 36 are inclined downwardly. There is also disposed in the chamber 14 inwardly of the extension 22, a plunger 38 having an enlarged head 40 formed in the head 40, which is adapted to fit the inside of the chamber 14 and to slide longitudinally therein, the head being guided in its longitudinal movement by the close fit of the plunger in the guide-way 16. The head 40 of the plunger is recessed at 41 and the inside diameter of the recess 41 is adapted telecscopically to fit over the inwardly projecting extension 22. The movement of the plunger is limited by contact of the peripheral edge 42 of the head with a peripheral shoulder 44 formed near the base of the extension 22. The depth of the aforesaid recess is such that when the plunger has reached the aforesaid limit of movement the bottom of the recess will not engage the end of the firing pin 32. To make doubly sure that there will be no such contact between the bottom of the recess and the end of the firing pin, the firing pin preferably is disposed at some little distance inwardly in the bore 26 formed in the extension 22. The plunger 38 is urged toward the extension 22, and hence the firing pin, by a coiled spring 48 which is disposed about the body of the plunger 38, between a shoulder 50 formed at the rear side of the head 40 and a shoulder 52 formed between the intersection of the chamber 14 with the guide-way 16. The plunger 38 is held in a retracted position with the spring 48 compressed by a removable release pin 54 which is passed through diametrically disposed openings 56 formed near the end of the body 12 and a diametrical passage 58 formed near the end of the plunger. To admit water to the chamber 14 when the device is submerged, an opening 43 is provided in the wall of the body 12.

In underwater firing mechanism, it is as a practical matter, difficult to keep the primer dry, and when the primer is damp or wet, a misfire will result upon actuation of the firing mechanism. In such cases the firing pin may penetrate the primer mixture, but because of its comparatively low velocity and the moisture present, no ignition takes place. However, if a firing pin is driven into a primer mixture with sufficiently high velocity, heat is developed in sufficient quantity to cause ignition of the primer even though it is saturated with water. While the required velocity could be attained by use of mechanical means such as the spring 48 shown in Fig. 1, a spring of the strength required to impart the necessary velocity would be large, and hence, it would make the device bulky. Moreover, it would be hard to handle a spring of such strength and stiffness in assembling the device. To avoid this, and yet to attain the desired velocity, the hydraulic means consisting of the plunger 16 and its head 40, together with the firing pin 32 and bore 26 is so designed that the movement of the plunger is greatly magnified through the intermediary of the water trapped between the recess 41 in the head 40 and the firing pin to impart the high velocity to the firing pin. As shown herein, the ratio of the diameters of the recess 41 in the plunger to the diameter of the bore 26 and hence of the firing pin is about 2 to 1. Specifically, the diameter of the recess 41 is ½ inch and the diameter of the firing pin is ¼ inch. With the spring 48 designed to impart a velocity of 20 feet per second to the plunger and a ratio of 2 to 1 described, the firing pin will be caused to travel at a speed of 80 feet per second. This speed is great enough to cause the firing pin to penetrate the primer with sufficient velocity to ignite the primer even though it is wet. While a somewhat smaller ratio of diameters may be employed with success for the ignition of present primer, it is best to employ a ratio which will give sufficient velocity to the firing pin to cause penetration of the primer, and simultaneously, generation of frictional heat of sufficient intensity to cause ignition under the most adverse conditions. In this invention, the invention contemplates ratio which will give a speed up to about 500 feet per second to insure ignition even when the primer has been exposed for long periods, to sea water.

In normal use, the safety pin 54 is inserted in place to hold the plunger retracted during assembly and is left in the device when it is submerged for a minesweeping operation. A line is attached to the pin which will be caused to withdraw the pin when an opposing mine cable comes in contact with the device thereby to release the plunger. It is obvious, however, that in preparation for using the device this pin may accidentally be removed and if this should happen the plunger 38 would be driven forward by the action of the spring 48 with considerable force. As constructed, if this happens, the recess 41 will slide over the end of the extension 22 and as long as the device is unsubmerged, and only air is present in the recess after it begins to move over the end of the extension 22, the compression of the air which results from the piston-like action between the extension 22 and the head 40 will not be sufficient to shear the shear pin 34 and drive the firing pin into the primer 30. This, it is obvious, will, therefore, insure against accidental firing of the device as long as it is unsubmerged even though the release pin is accidentally or otherwise removed. As soon as the device is submerged, however, water flows into the body 12 through the opening 43, filling the chamber 14. If now, the release pin 54 is removed, the recess 41 of the head 40 in its forward movement traps a body of water between it and the extension and the resultant pressure developed and hydraulically transmitted through the intermediary of the water to the end of the firing pin, is sufficient to shear the shear pin 34 and to drive the firing pin 32 at high velocity into the primer 30, and hence, to explode the body, even though the primer is saturated with water. In order to prevent pressure between the firing pin and the primer and to permit the water therein ready to escape,
there is provided the radial passages 36, heretoefore described. The invention described herein may be manu factured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereo.

What is claimed is:

1. In a firing mechanism, a hollow cylindrical body, a firing pin slideably mounted in a tubular plug having a reduced end and positioned near one end of the hollow body, a plunger in said body for sliding movement in said cylindrical body toward the firing pin, a spring normally urging said plunger toward said firing pin, a removable release pin restraining the plunger from movement, a cup shaped head on the plunger adapted to slide over the reduced end of the tubular plug, upon longitudinal movement thereof when said means for restraining the plunger is removed, without contacting said firing pin, and adapted to transmit its motion to the firing pin only when a liquid is trapped in the cup formed between said cup shaped head and the reduced end of said tubular plug slideably holding said firing pin.

2. In a firing mechanism, a hollow cylindrical body, a plug threaded into one end thereof, said plug having a central bore therein, a primer in said bore, a firing pin adjacent thereto, a plunger mounted for sliding movement in said cylindrical body toward the firing pin, a spring normally urging said plunger toward said firing pin, a removable release pin restraining the plunger from movement, a cup shaped head on the plunger adapted to fit over the inner end of the plug to form a closed chamber to trap air or water between it and the firing pin, said chamber being so designed that if said release pin is withdrawn while the mechanism is as yet unsubmerged the pressure created by the compression of the air between the head and the firing pin will not actuate the same.

3. A firing mechanism for an explosive cutter, comprising a body having a chamber therein one end of which is open, a firing pin slidably mounted in a tubular plug having a reduced end and positioned in the open end of the chamber, a plunger in said chamber behind the firing pin adapted to slide longitudinally thereof and the firing pin, means for urging the plunger toward the firing pin, removable means for restraining the plunger, a cup-shaped head on said plunger adapted to slide over the end of the reduced end of said tubular plug having the firing pin therein, upon longitudinal movement thereof when said means for restraining the plunger is removed, without contacting said firing pin and adapted to transmit its motion to the firing pin only when a liquid is trapped between it and the end of the firing pin in the space formed by the cup shaped head and the reduced end of said plug.

4. A firing mechanism for an explosive cutter employed in mine sweeping comprising a body having a chamber therein, one end of which is open, a firing pin and means for movement of the same in the open end of the chamber, said means including a tubular plug fitting over said firing pin and having a reduced end, a plunger in said chamber behind the firing pin adapted to slide longitudinally thereof toward the firing pin, means for guiding the plunger in its movement, means for urging the plunger toward the firing pin, removable means associated with the guiding means for restraining the plunger, a cup shaped head on said plunger adapted to slide over the reduced end of said tubular plug fitting over the firing pin, upon longitudinal movement thereof when said means for restraining the plunger is removed, without contacting said firing pin and adapted to transmit its motion to the firing pin only when a liquid is trapped in the cup between it and the end of the tubular plug.

5. A firing mechanism for an explosive cutter, comprising a body having a chamber therein, one end of which is open, said chamber having an aperture in its wall to admit water therethrough, said body being submerged, a plug having a central bore therein connected to the open end of the chamber, a primer in said bore, a firing pin adjacent to said primer, a plunger mounted for sliding movement in said chamber toward said firing pin, a spring normally urging said plunger toward said firing pin, a removable release pin restraining the plunger from movement, a cup shaped head on the plunger adapted to fit over the inner end of the plug to form a closed chamber to trap air or water between it and the firing pin, said head being so designed that if said release pin is withdrawn while the body is as yet unsubmerged the pressure created by the compression of the air between the head and the firing pin will not be sufficient to impart movement to said firing pin.

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