Dec. 6, 1949 N. B. WALES, JR 2,490,389

QUICK ACTION FUSE

Filed Nov. 1, 1946 2 Sheets-Sheet 1

Fig. 1.

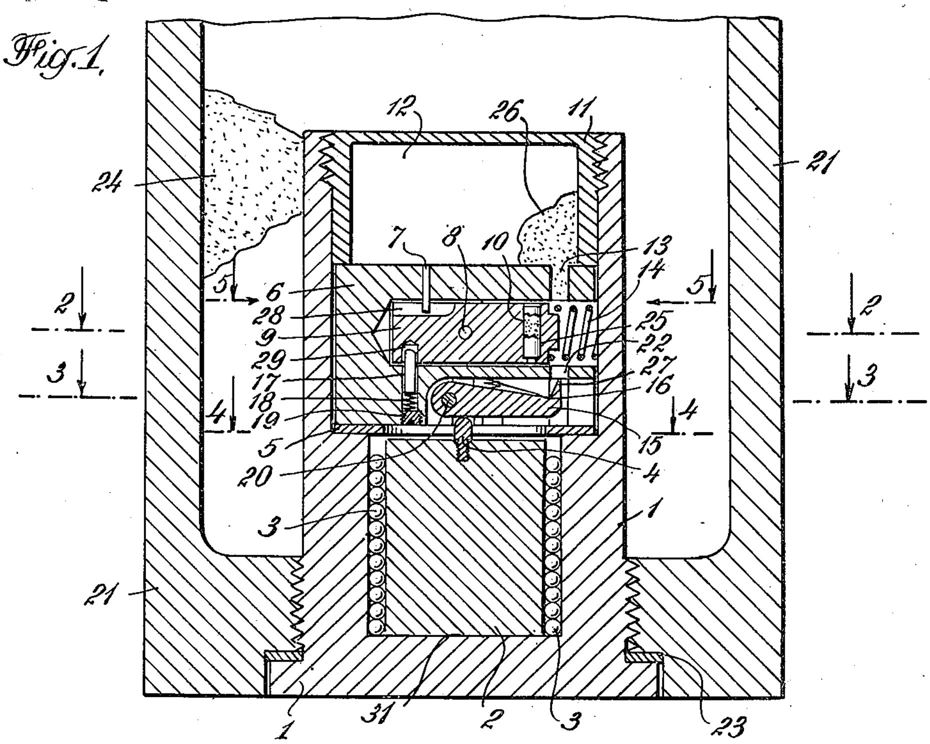
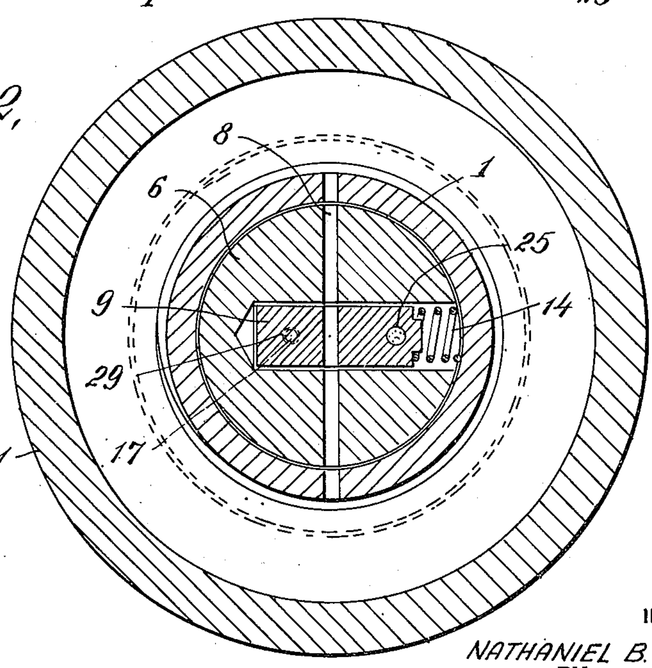


Fig. 2.



INVENTOR
NATHANIEL B. WALES, Jr.
BY
Pennie, Edmonds, Morton & Barrows
ATTORNEYS

Dec. 6, 1949 N. B. WALES, JR 2,490,389

QUICK ACTION FUSE

Filed Nov. 1, 1946 2 Sheets-Sheet 2

Fig. 3,

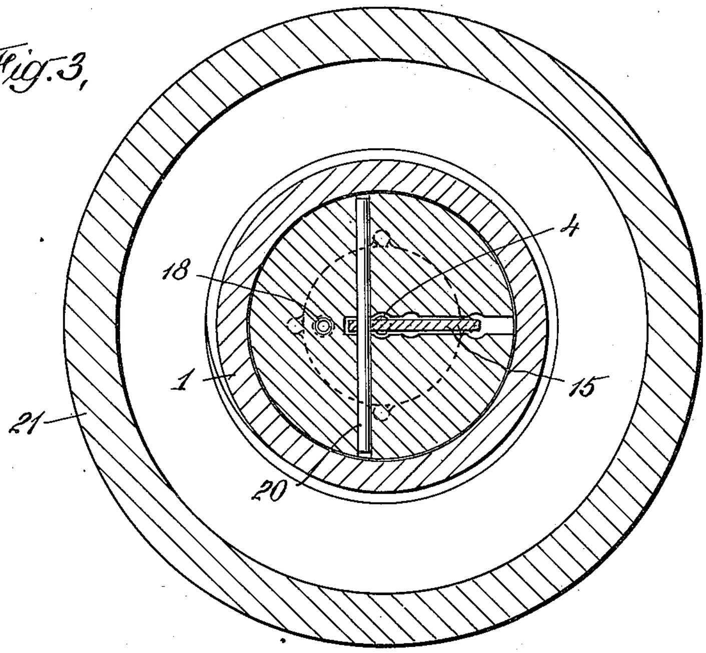


Fig. 4,

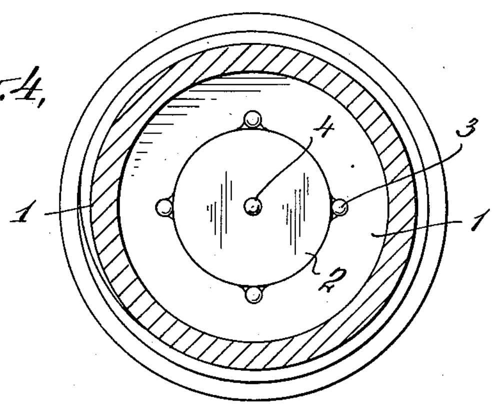
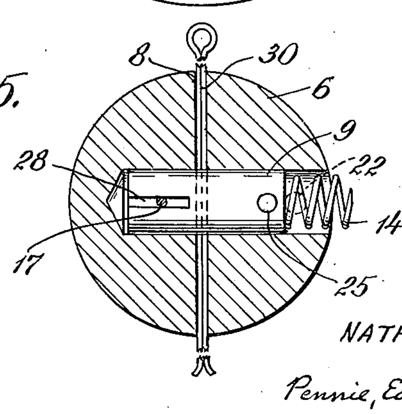


Fig. 5.



INVENTOR

NATHANIEL B. WALES, Jr.

BY

Pennie, Edmonds, Morton & Barrows

ATTORNEYS

Patented Dec. 6, 1949

2,490,389

UNITED STATES PATENT OFFICE

2,490,389

QUICK ACTION FUSE

Nathaniel B. Wales, Jr., New York, N. Y., assignor to United States of America as represented by the Secretary of the Army

Application November 1, 1946, Serial No. 707,173

1 Claim. (Cl. 102—80)

1

This invention relates to projectile fuzes of the inertia type, and more especially to those known as quick-action contact fuzes.

The fuze in accordance with this invention, while entirely safe previous to discharge of the projectile, is extremely sensitive to small deceleration, and is so rapid in its action that detonation may be caused to occur within about 200 microseconds of the initial impact. Briefly, the invention comprises an inertial mass consisting of a heavy slug arranged to move a very small distance when submitted to deceleration and a lever arm interconnecting the slug and a firing pin, such that the force derived from the moving slug causes the firing pin to move toward the detonator with much greater velocity than that with which the slug is caused to move by inertia.

It is well known that there is a critical velocity with which all pyrotechnic detonators must be struck in order to be detonated. One of the difficulties heretofore encountered in detonating shells and rockets, especially of the shaped charge type, has been to achieve detonation early enough to produce the most effective explosive force at the instant of impact of the projectile. This difficulty has resulted from the fact that a nose fuze is impracticable because it either is destroyed before it operates properly or else interferes with the effectiveness of the shaped charge, and from the fact that base fuzes of the inertia type previously proposed required an excessively long ogive in order to permit the firing pin to reach the critical detonating velocity at the instant of maximum effectiveness of the explosion. As above indicated, the simple and reliable mechanism provided by the present invention permits the fuze to be located in the base of the projectile so that the charge and ogive can be designed solely on ballistic principles, while providing ultra-rapid fuze action upon impact.

The nature of this invention will be clearly understood from the following description considered with the drawings, in which:

Fig. 1 is a longitudinal sectional view of a preferred embodiment of a fuze comprising the invention;

Fig. 2 is a transverse cross-sectional view taken along the line 2—2 of the fuze structure of Fig. 1;

Fig. 3 is a transverse cross-sectional view taken along the line 3—3 of Fig. 1;

Fig. 4 is a transverse cross-sectional view taken along line 4—4 of Fig. 1; and

Fig. 5 is a transverse cross-sectional view of the fuze chassis plug alone, taken along the line 5—5 of Fig. 1, looking in the direction of the arrows.

In Figure 1, a fuze body 1 is shown to be threaded in a shell 21 which may be assumed to form part of either an artillery shell or a spinning rocket. To make the joint tight it is customary to employ a gasket 23 of lead or copper between these two members. The explosive charge 24 which would usually fill most of the space between shell 21 and fuze body 1 would preferably comprise a so-called shaped charge, although the type of charge employed has no necessary relation to the present invention.

2

An inertial mass, in this case, slug 2 of any suitable heavy metal, is positioned in the shell base, as shown in Fig. 1, in a cavity 31 by means of linear ball bearings 3. Four such bearings, distributed at 90° intervals around the slug, as shown in Fig. 4, should ordinarily be sufficient, although more may be employed. The balls are retained in races or grooves formed on the inside surface of the cavity 31. The purpose of these ball bearings is to reduce the friction between slug 2 and the walls of cavity 31 in the event that the projectile strikes its target a glancing blow, viz., in an off-axis direction. In this event it is important that as much inertial energy as possible be available to provide a force in the direction of the longitudinal axis of the fuze. At the upper end of slug 2 a stud 4, which may be of hardened steel, is screwed into a hole threaded to receive it. This stud transmits the movement of slug 2 to a lever 15 positioned directly above it.

In the larger cavity located above the inertia plug 2 a fuze chassis plug 6 is retained by means of a booster cup 11 which is screwed down on top of the chassis plug, as illustrated. This chassis plug 6 contains the slider 9, detonator 10, firing pin 27, firing pin lever 15, and other components providing several safety features later to be described.

The lever 15 which may be of hardened steel, for example, is conveniently formed with an upturned firing pin 27 at its extreme end. The firing pin may, however, be formed separately from the lever, provided the pin is suitably actuated by movement of the lever. The ratio of the distance between the firing pin 27 and the center of shaft 20 and the distance between the axis of stud 4 and the center of shaft 20 constitutes the mechanical advantage of the lever arm 15. This mechanical advantage will necessarily differ in different specific designs of projectiles, but, as an example, I have found that a lever ratio of the order of at least 10 to 1 is desirable to provide sufficiently rapid detonation for shaped charge rockets, although tests with a 5 to 1 ratio gave results superior to any conventional inertia base fuze. From the well known fact that the velocity is a function of the square root of the acceleration it follows that if the mechanical advantage of the lever arm 15 is 5 to 1, the velocity of the pin 16 will be the square root of five times the acceleration of the mass 2, for example. Above lever 15 a small compression spring 16, known as a creep spring, is positioned normally to press down on the lever so as to hold the firing pin 16 away from detonator 10 until the intended moment of operation. Especially in the case of projectiles fired from a gun there is a moment of temporary deceleration which, without such a device as spring 16, might be sufficient to permit premature detonation. In the mentioned example, such deceleration occurs at the moment the shell emerges from the muzzle.

Slider 9 which fits into a hole bored horizontally in chassis plug 6 incorporates certain conventional safety features. These features are such that the fuze cannot be detonated unless it is simultaneously subjected to sufficient centrifugal force and sufficient set-back force. In the case of a rifle shell simultaneous existence of both of these forces can occur before the shell leaves the rifle barrel from which it is discharged. In the case of a rocket the projectile would of necessity be of the spinning type, and the simultaneous existence of the two necessary forces would probably not occur until a reasonable distance from the point of discharge or launching of the rocket. It is to be noted that although the disclosed safety features are designed for spinning projectiles it is evident that my lever action principle is in no way restricted by the arming safety devices used, and may be equally well employed in non-spinning projectiles.

As shown by Fig. 1 of the drawings, a centrifugal spring 14 normally maintains the slider 9 in the illustrated position at which point detonator hole 25 therein is out of alignment with firing pin hole 22 and lead hole 13 in the plug 6. Furthermore, it is locked in this position by set-back pin 17 which extends from plug 6 into hole 29 in slider 9. Set-back pin 17 is held in this locked position by compression spring 18, which is held in place by screw 19. It will be seen that when slider 9 is in the safety position, as illustrated, detonator 10 cannot be detonated even if firing pin 27 is actuated. However, when slider 9 moves to the right against spring 14, hole 25 comes into alignment with hole 22 so that actuation of firing pin 27 will detonate detonator 10.

During the initial moments of firing of a shell or a spinning rocket the set-back force due to acceleration is very great. This causes pin 17 to drop back against spring 18, unlocking slider 9 to permit it to move to the right, as shown in the drawing. At the same time the shell or rocket is spinning, and because most of the mass of slider 9 is to the right of the vertical axis of the projectile, as shown, the resulting centrifugal force will slide slider 9 against spring 14 and thus arm the fuze. The slider 9 will automatically be locked in the armed position just described at the moment when it is still spinning and the force due to set-back has decreased sufficiently to permit spring 18 to restore set-back pin 17 to its extended position, at which time the left-hand end of slider 9 will abut against pin 17. However, even if pin 17 is not arranged to lock the slider in its armed position, the centrifugal force due to rotation of the projectile should be sufficient to retain the slider 9 in armed position until the instant of impact. Guide pin 7 extends downwardly from plug 6 into the slot 28 cut in slider 9, as shown in Figs. 1 and 5, preventing rotation of the slider but permitting it to slide transversely of the axis of the projectile.

As a further safety precaution a hole 8 is drilled through the center of plug 9 of such size as to receive a suitable cotter pin 30 which is inserted at the time the fuze is assembled. This cotter pin prevents movement of slider 9 and is left in place until the occasion when the fuze is screwed into the base of the shell, rocket, or other projectile. This cotter pin 30 is shown in place in Fig. 5 which is a view of the chassis plug before it is assembled in the fuze body.

Operation

The mode of operation of the above described fuze according to this invention is as follows:

When the projectile is fired or launched the set-back force resulting from rapid acceleration causes set-back pin 17 to drop against spring 18 releasing slider 9 to move to the right, as shown in Fig. 1. Slider 9 will move to the right, as shown in Fig. 1, as soon as the centrifugal force due to the spinning of the projectile becomes sufficient.

When slider 9 moves to the right against spring 14, detonator hole 25 falls into alignment with firing pin hole 22, and lead hold 13, and this alignment is maintained until the instant of impact.

At the instant of impact, regardless of whether the projectile hits the target head-on or by a glancing blow, the sudden deceleration of the projectile will cause inertia slug 2 to move a short distance forward by its own force of inertia. Upon moving forward axially with respect to the projectile, as little as one- or two-thousandths of an inch, hardened stud 4 will transmit the resulting force to lever arm 15 causing it to swing forward on shaft 20. Firing pin 27 on the end of lever arm 15 will in the same time move forward a considerably greater distance than the stud 4. If the mechanical advantage of the lever is, for example 100 to 1, the velocity of the firing pin will be 100 times greater than that of stud 4. This velocity is more than sufficient to detonate the detonator 10 when it is struck by the firing pin 27. The flash from detonator 10 will pass through lead hole 13 to ignite booster charge 26 contained in the booster cavity 12, and the resulting explosion of booster charge 26 will detonate the principal charge 24. This entire chain of events can occur within the short period of a few ten-thousandths of a second so that the main force of the explosion will be developed substantially at the instant of impact.

Those skilled in the ordnance art will appreciate that the above described principles of this invention have wide and general applicability. It will, therefore, be understood that the foregoing description of a simple embodiment of the present invention comprises merely one useful application thereof and that the invention is limited only by the scope of the appended claim.

What is claimed is:

An inertia fuze for projectiles, comprising a body member longitudinally bored, a movable inertial mass within said bore, a fuze chassis plug fixed in said bore above said inertial mass, said chassis plug carring a centrifugally operated slider containing a detonator, an undercut in the surface of said chassis plug adjacent said inertial mass, a pivoted lever in said undercut having a firing pin formed on its free end, a creep spring resiliently spacing said firing pin from said detonator, said inertial mass having a stud positioned in the end adjacent said lever, said stud actuated by the motion of said inertial mass upon impact of said projectile and communicating the motion of said inertial mass to said lever at a predetermined point on said lever, said lever imparting to said firing pin a velocity greater than the velocity of said stud.

NATHANIEL B. WALES, Jr.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
972,034	Strange	Oct. 4, 1910
1,290,763	McCombs	Jan. 7, 1919
1,306,664	Hawken	June 10, 1919
1,689,470	Adalman	Oct. 30, 1928
2,379,784	Brand	July 3, 1945
2,398,718	Rasmussen	Apr. 16, 1946

FOREIGN PATENTS

Number	Country	Date
829,096	France	Mar. 14, 1938