J. H. WOODBERRY.

DELAY ACTION MECHANISM FOR FUSES.

APPLICATION FILED DEC. 10, 1918.

1,376,908.

Patented May 3, 1921.

4 SHEETS—SHEET 1.

Fig. 1.

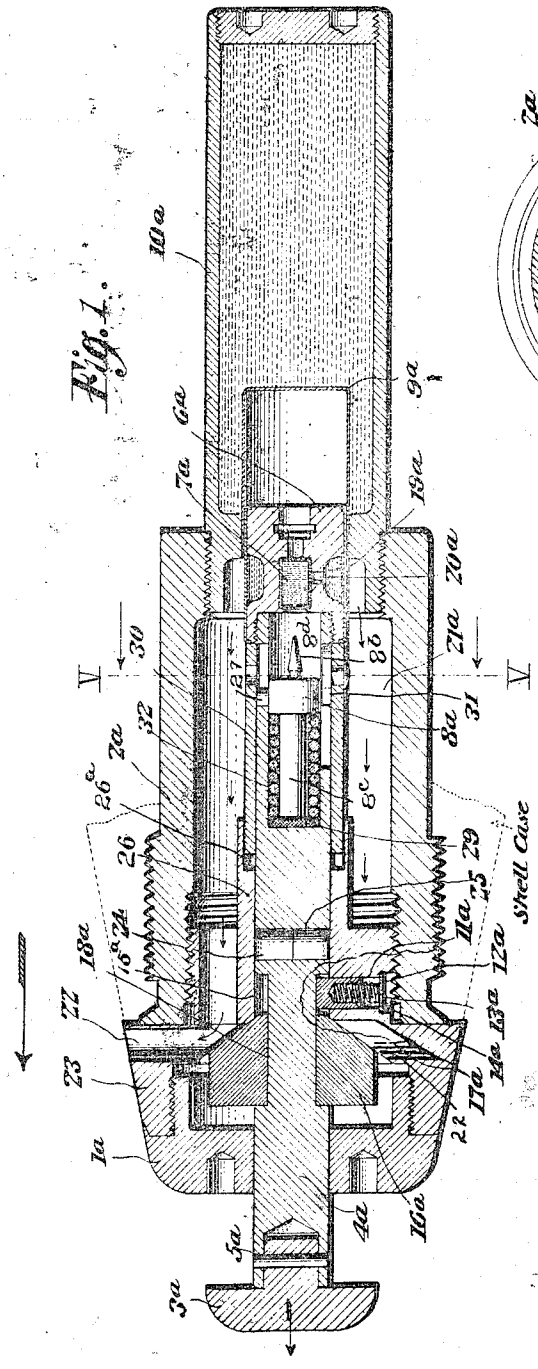


Fig. 5.

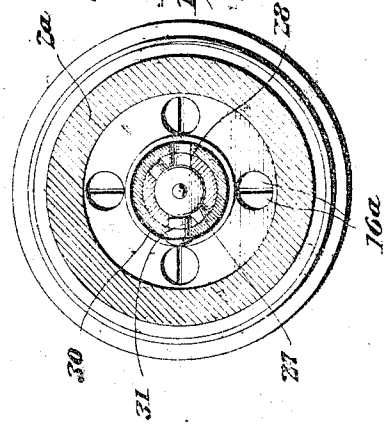


Fig. 4.

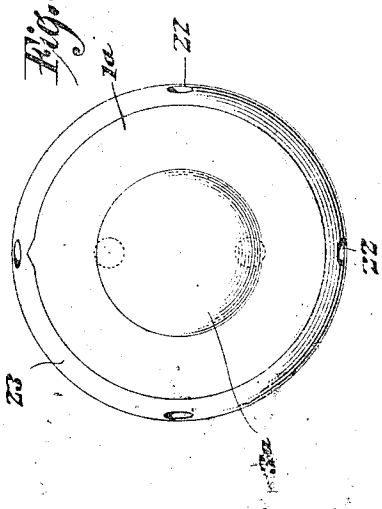
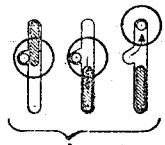


Fig. 10.



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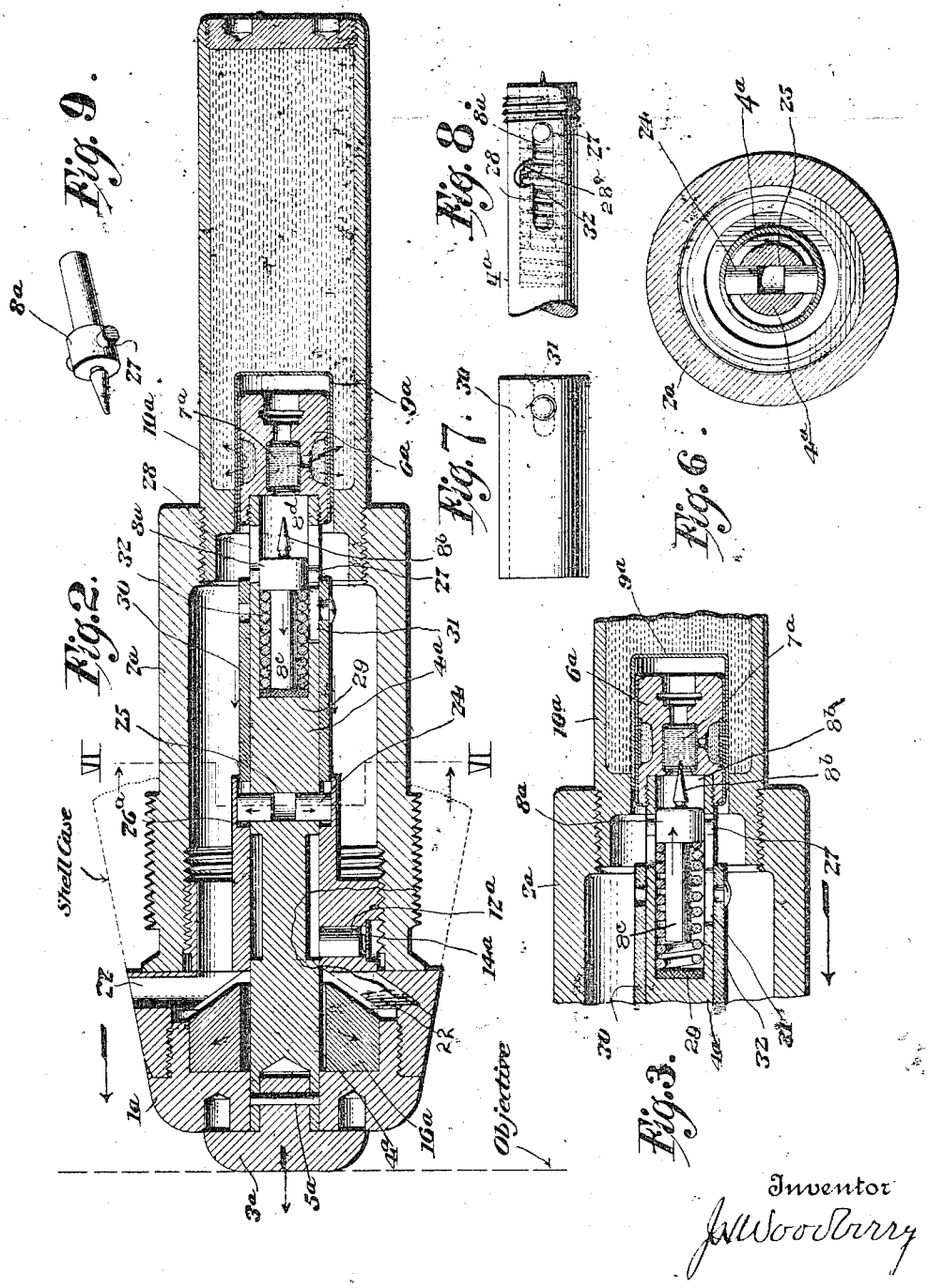
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4 SHEETS—SHEET 2.



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4 SHEETS—SHEET 3.

Fig. 11.

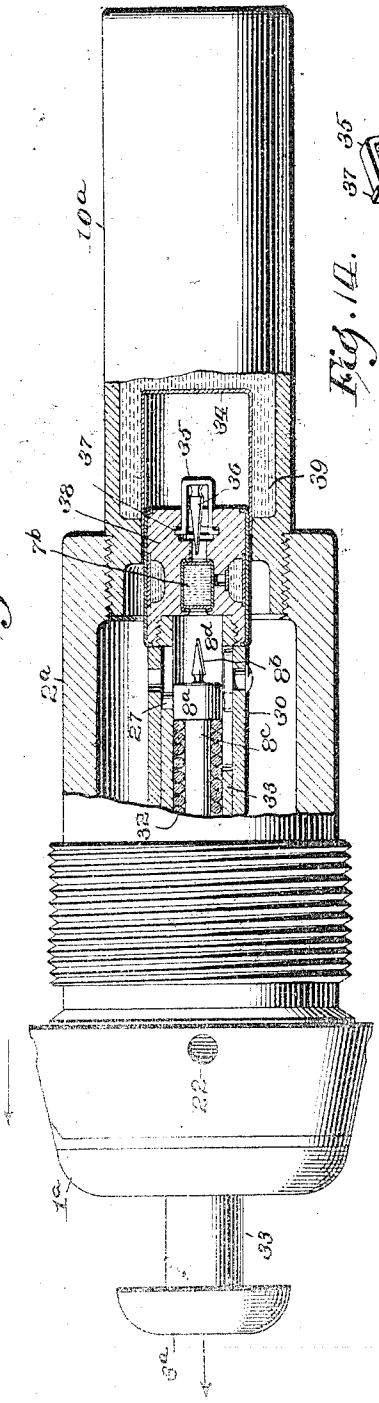


Fig. 14.

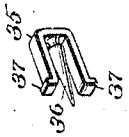


Fig. 13.

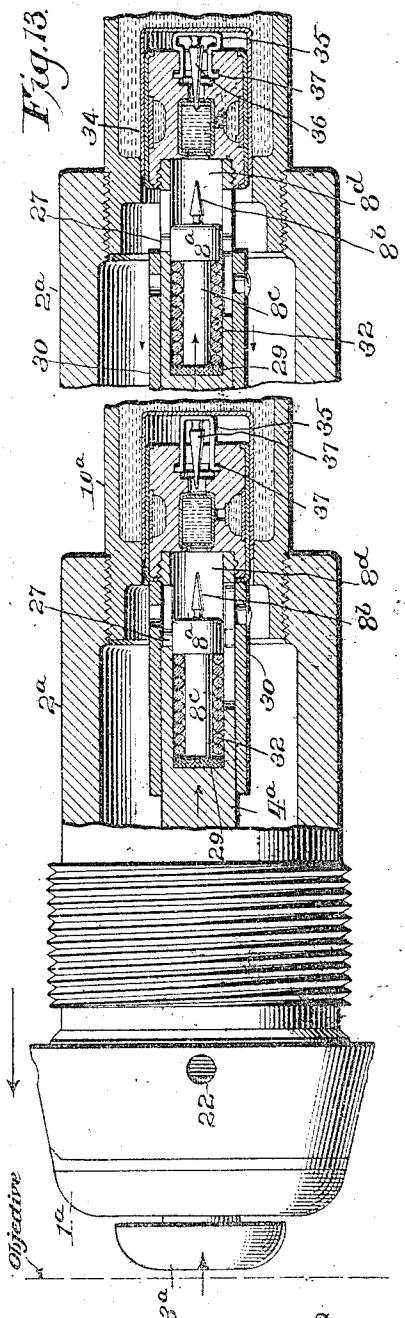


Fig. 12.

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4 SHEETS—SHEET 4.

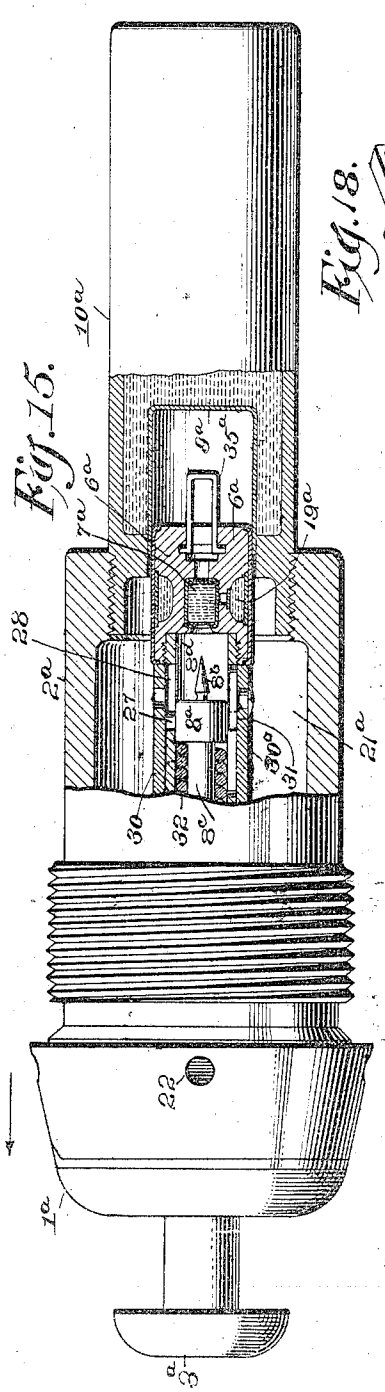


Fig. 15.



Fig. 18.

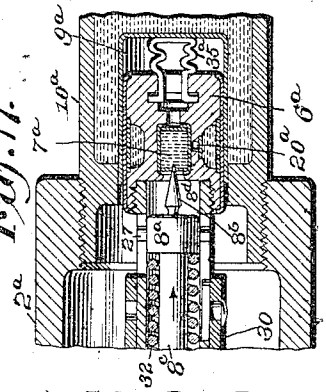


Fig. 17.

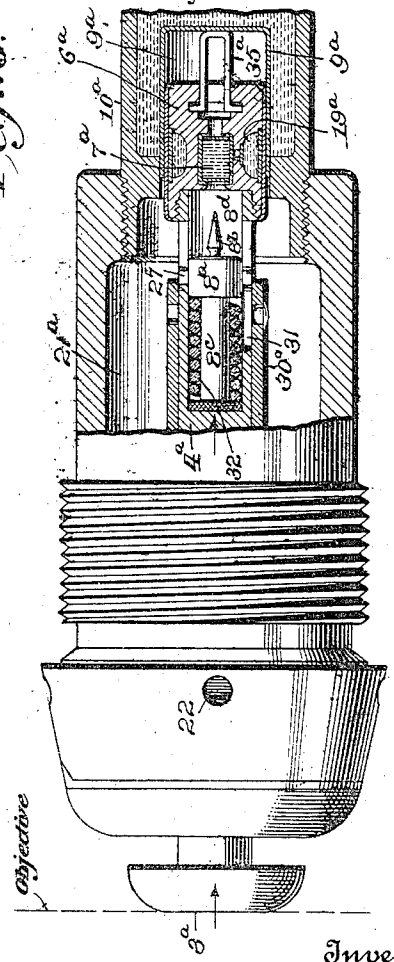


Fig. 16.

Objective

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UNITED STATES PATENT OFFICE.

JOHN H. WOODBERRY, OF THE UNITED STATES ARMY.

DELAY-ACTION MECHANISM FOR FUSES.

1,376,908. Specification of Letters Patent. Patented May 3, 1921.

Application filed December 10, 1918. Serial No. 266,145.

(FILED UNDER THE ACT OF MARCH 3, 1883, 22 STAT. L., 625.)

To all whom it may concern:

Be it known that I, JOHN H. WOODBERRY, major, Ordnance Department, United States Army, a citizen of the United States, stationed at Washington, D. C., have invented an Improvement in Delay-Action Mechanism for Fuses, of which the following is a specification.

The invention described herein may be used by the Government, or any of its officers or employees in prosecution of work for the Government, or by any other person in the United States, without payment of any royalty thereon.

The principal object of my invention is to provide a mechanical means for obtaining at will delay action in fuses.

A further object is to provide means whereby the battery commander, may readily at his will, obtain either a delay action proportional to the resistance which the projectile may encounter on impact, a constant delay action on impact, or a quick action of the fuse.

A still further object is to provide novel means, for insuring certainty of action in a spring actuated firing pin.

Other objects will appear as the specification proceeds and the nature of the invention is more fully defined.

The invention is graphically portrayed in the accompanying drawings, which show an illustratory embodiment capable of carrying out the underlying principles of the invention. Like reference characters indicate corresponding parts throughout the several views. The several views of the drawings may be briefly described as follows:—

Figure 1 is a central, vertical, longitudinal section through a fuse embodying my improvements, showing the position of the parts before the projectile carrying the fuse passes out of the bore of the gun, a slight portion broken away to show a centrifugal locking member;

Fig. 2 is a similar view, showing the position of the parts after the projectile carrying the fuse has struck the target, but before explosion has taken place;

Fig. 3 is a fragmentary, longitudinal sectional view of the fuse, showing the position of the parts when the primer is detonated by the firing pin;

Fig. 4 is a front elevation of the fuse;

Fig. 5 is a transverse sectional view on the line V—V of Fig. 1 looking in the direction of the arrows;

Fig. 6 is a transverse sectional view on the line VI—VI, Fig. 2, looking in the direction of the arrows;

Fig. 7 is a detached detail view, in side elevation, of the slidable sleeve carried by the plunger;

Fig. 8 is a fragmentary, detached, detail view, in side elevation, of the rear portion of the plunger;

Fig. 9 is a detached detail view, in perspective, of the firing pin;

Fig. 10 is a collective detail view, in the nature of a diagram, showing the plunger locking pin in section and the locking and unlocking positions thereof;

Fig. 11 is a view in side elevation, partly in section, showing a slightly modified form of fuse, in which the detonator carries a sensitive firing pin attachment, and showing the normal position of the parts;

Fig. 12 is a view in side elevation, partly in section, with the rear end of the booster broken away showing the position of the parts after air impact has driven the plunger rearward;

Fig. 13 is a fragmentary longitudinal sectional view, showing the position of the parts when the fuse encounters a resistance sufficient to crush the firing pin attachment;

Fig. 14 is a detached detail view in perspective of the firing pin attachment;

Fig. 15 is a view in side elevation, partly in section, showing a slightly modified form of fuse, in which the detonator carries an attachment operating to afford a short delay in exploding the primer, upon impact of the fuse with the objective, this view showing the normal position of the parts;

Fig. 16 is a view in side elevation, partly in section, with the rear end of the booster broken away, showing the position of the parts immediately after impact with the target;

Fig. 17 is a fragmentary longitudinal sectional view, showing position of parts when the fuse encounters a resistance sufficient to crush the firing pin attachment; and

Fig. 18 is a detached view in perspective of the attachment shown in Figs. 15 and 16.

Referring, now, in detail to the drawings, and first, to Figs. 1 to 10, inclusive,

The fuse stock 2^a is provided at its front end with a ring 23 closed by a cap piece 1^a, which has a screw threaded engagement with said ring.

Slidable axially of the fuse stock is a plunger 4^a provided with a head 3^a secured thereto by the pin 5^a. The rear inner end of the plunger carries the detonator 6^a, with primer 7^a, coöperating with the firing pin, which in this instance, comprises the firing pin proper 8^b axially carried by a head 8^a from which extends a shank 8^c. The firing pin device thus described is held in a longitudinally extending opening 8^d in the rear end of the plunger 4^a. The booster 10^a has a threaded engagement with the rear end of the fuse-stock 2^a, and is provided with a cup 9^a to receive the detonator.

The extension 26 of the ring 23 is provided with a transverse opening 11^a to house the centrifugally operated lug 12^a, which is normally urged toward the plunger by a spring 13^a seated between the lug and the disk 14^a closing the outer end of the opening 11^a. The lug 12^a, coöperating with shoulder 15^a obtained by providing plunger 4^a with the peripheral groove 18^a, normally renders the fuse safe during transportation and storage, and also prevents the locking sectors 16^a from being separated, due to any lateral shock.

The centrifugally-operable safety-locking sectors 16^a are seated on the oblique face 17^a of the ring 23, and normally engage in the groove 18^a to hold the plunger in unarmed relation.

The primer of the detonator 6^a communicates, through port 20^a, with the explosive material 19^a carried in a peripheral pocket of the detonator. As shown in Fig. 1, the whole detonator is normally in an air-chamber 21^a of the hollow stock. This air space may be vented to the atmosphere through openings 22 in the ring 23. The sliding fit between the detonator 6^a and the cup 9^a is made sufficiently tight, so that, if the detonator is prematurely exploded, the hot gas cannot reach and explode the booster charge. The centrifugally-operating locking members 24 are housed in a transverse opening 25 in the plunger 4^a, to coöperate with the shoulder 26^a toward the inner end of the fixed plunger-guide-sleeve 26 carried by the ring 23, when the released plunger is forced rearwardly by the air pressure on the head 3^a during flight. These members 24, prevent the plunger, together with the detonator, from again assuming the position shown in Fig. 1.

The delay action in this form of fuse is secured by providing the longitudinally movable and rotatable firing pin 8^a with diametrically oppositely disposed lugs, which function in the slots 28 in the plunger 4^a, and by providing the pin with the spring 32 coiled around the shank 8^c thereof and seated between the head thereof and a lead washer 29 in the forward end of the longitudinal opening 8^d in the plunger. The spring is normally compressed, and is prevented from propelling the pin by having the lugs 27 seated in the inclined sections or offset portions 28^a of the slots 28, and by having a sleeve 30 with an inward projecting piece or keeper 31 sliding in one of the slots 28 and normally disposed at the inner end of such slot. The keeper 31 is of such length, as to hold the adjacent lug 27 in the inclined section 28^a of the slot.

The operation of this form of fuse is as follows:—

The normal position of the parts is shown in Fig. 1, wherein the spring 32 is shown compressed, and the pin 8^a turned so that its lugs 27 are seated in the inclined or curved branches 28^a of the slots 28 and retained therein by the member 31 on the sleeve 30. During flight, the lug 12^a is moved, through centrifugal force, to the position shown in Fig. 2 and releases the plunger, with the detonator and firing pin remaining as shown in Fig. 1. When the centrifugal force acting on the quadrant sectors 16^a overcomes the inertia of these members, that is, when the positive linear acceleration ceases, they move outwardly, and the air resistance on the head 3^a causes the plunger to move inward, so that the detonator 6^a lies fully within the booster cup 9^a. The plunger is locked in this position by the centrifugally-operating bolts 24 engaging the shoulders 26^a, as shown in Fig. 2.

Immediately after the instant of impact, the position shown in Fig. 2 obtains. The projectile and fuse are retarded throughout the duration of the resistance encountered. The tendency of all parts on the interior of the fuse is to move forward through the force due to inertia of these parts. The sleeve 30, being no longer prevented from moving forward, does not experience this retardation and consequently slides forward as shown in Fig. 2, so that its locking lug 31 uncovers the inclined branch 28^a in which the corresponding lug 27 of the firing pin is engaged. So long as the resistance is such as to cause the inertia of the firing pin and spring to produce a force greater than and counter to the force of the spring, the firing spring remains compressed. When the resistance becomes insufficient to keep the firing spring 32 compressed, the spring extends itself with a force equal to the difference between the force due to the inertia of these parts and the force of the spring. If the cessation of the resistance is sufficiently sudden, the firing pin will be projected into the primer, exploding the fuse.

If, however, the resistance should cease

gradually, the firing pin spring would also extend gradually and consequently the firing pin may not have sufficient force to fire the primer. To obviate such an occurrence, means are provided for retarding the extension of the spring until sufficient force is accumulated therein to fire the primer when the spring extends. The retardation of action is obtained by cutting the inclined branches 28^a, in which the firing pin lugs 27 rest, at such an angle to the slots 28 that it will require a force sufficiently great to fire the primer to overcome friction between the lugs and said offset portions 28^a to drive the lugs into the longitudinal slots 28. It is thus seen that a gradual cessation or decrease of resistance to penetration will not cause the spring to extend gradually, but with sufficient force, in all cases, to fire the primer. The lugs 27 of the firing pin rotate out of the inclined slots and then, with a longitudinal movement, the pin is propelled, under the action of the spring, against the primer.

The action of this fuse gives an automatic selective delay in firing, through mechanical means, the delay, in all cases, being proportional to the duration of the resistance encountered. With this design of fuse, in armor piercing shell, the shell explodes immediately after penetrating the armor. For ricochet action, the shell explodes immediately after the projectile bounces from the ground. For mining purposes, the shell, in high angle fire, will penetrate to its maximum depth and then explode, and, should a bomb proof, or other cavity, be encountered in its path through the earth, the explosion will take place in the cavity. In any case, the explosion of the shell will take place immediately after the resistance ceases or decreases sufficiently to permit the firing pin being driven, under the action of the firing pin spring, into the primer.

Referring, now, in detail to Figs. 11 to 14, inclusive:

In this form of fuse, a sensitive firing pin attachment is shown as detachably carried by the base of the detonator stock, so that, while in flight, the air pressure will drive the plunger 33 rearward into the firing position until the sensitive firing pin attachment rests on the bottom of the firing pin cup 34, as shown in Fig. 12. When the fuse encounters a resistance sufficient to crush the structure supporting the firing pin 36, the firing pin will be driven into the primer, as shown in Fig. 13, and the fuse will fire instantly. This attachment, therefore, affords an easy and simple means of obtaining quick action, thereby rendering the fuse universal in application. When it is desired to utilize this design of fuse for quick action, the firing pin attachment is snapped into position by hand prior to its assembly in the projectile. An enlarged view of the firing pin attachment is shown in Fig. 14, from which it will be seen that it comprises a substantially U-shaped member 35^a, of suitable material, which is easily distortible or crushable, such as soft and somewhat resilient metal, and a firing pin 36 carried by the base of said member and extending between the legs and projecting beyond the free ends thereof. The free ends of said legs are bent outwardly to form lugs 37, for an obvious purpose. The rear end of the detonator 38 carried by the rear end of the plunger 33 is provided with a recess 39 leading to the priming material 7^b, and the U-shaped member 35 is sprung into said recess, as shown.

Referring, now, in detail, to Figs. 15 to 18, inclusive:

It is desirable at times in artillery fire to obtain a short delay upon impact. In these figures there is shown a means for obtaining a very short delay upon impact. Fig. 18 shows an attachment 35^a similar to that shown in Fig. 14, except that the firing pin is removed. With this attachment placed in the base of the detonator, the plunger, when driven back by air pressure, assumes the position shown in Fig. 16. Subsequent impact tends to crush this attachment, as shown in Fig. 17, but, as the plunger has considerable momentum while in flight and the attachment 35^a offers considerable resistance to crushing, a short time will elapse before the plunger has moved sufficiently to the rear to permit the sleeve 30^a (which is the same member as is designated by the reference numeral 30 in Figs. 1 to 3) to unlock the firing pin. While the plunger is thus being retarded, the shell, not having come in contact with the resistance, does not experience any retardation until its penetration begins.

The shell in a short interval of time therefore overtakes the head of the plunger, and in doing so, imparts a positive linear acceleration to the plunger and detonator. The pin, having been previously unlocked from the plunger does not experience this acceleration and consequently is overtaken by the accelerated primer. The pin is also moved relatively rearward by the action of the spring, thus augmenting the force with which the pin encounters the primer. Just prior to the impingement of the shell against the head of the plunger, the spring is under compression due to the deceleration of its container, the plunger; but, when this deceleration changes to acceleration by the impingement of the shell, the spring is free to extend under its own force. With these combined forces acting on the pin and primer, the primer receives a forceful penetration, insuring its action.

In connection with the forms of fuses

shown in Figs. 11 to 18, inclusive, it will be understood that, except as described, the mechanism is precisely the same as is embodied in the form of the fuse shown in Figs. 1 to 10, inclusive.

While I have, in compliance with the letter and spirit of the patent laws, described, with great particularity, a specific structural embodiment of my invention, it is to be understood that various changes will suggest themselves to those skilled in the art to which the invention appertains, and that all of such modifications as come within the scope of the appended claims constitute no departure from my invention.

Having thus fully described my invention, what I claim as new and desire to secure as Letters Patent is:

1. The combination with a fuse of a plunger carried therein and normally held in forward position, and means normally disposed entirely within said plunger in the forward position of the latter and operable when the plunger is moved to rearward position to project therefrom automatically and lock the same against retrograde movement.

2. The combination with a fuse of a plunger carried therein and normally held in forward position, and locking bolts normally disposed entirely within said plunger in the forward position of the latter and operable when the plunger is moved to rearward position to project therefrom automatically and lock the same against retrograde movement.

3. In a fuse, the combination with the fuse stock of a plunger carrying at its rear end a detonator having a recess in its rear end, and a deformable member removably supported in said recess.

4. The combination with a fuse, of a detonator, means for firing the detonator, an auxiliary firing attachment removably carried by the detonator casing adapted to fire said detonator independently of the main firing means.

5. The combination with a fuse, having a safety-chamber, of a detonator normally in said safety chamber, and a member carried by the detonator casing and operable upon impact after movement of said detonator from said safety chamber, to determine the delay action of the fuse.

6. In a fuse, the combination, with a plunger having a longitudinally extending recess in its rear end, of a normally-restrained firing-pin disposed in said recess and releasable by an axial turning movement, and a spring also disposed in said recess for causing said movement and for moving said pin into firing position.

7. In a fuse, the combination, with a plunger having a longitudinally-extending recess in its rear end and longitudinally-extending slots communicating with said recess, said slots having offset portions, of a firing pin device movable in said recess, and having lugs normally seated in said offset portions of the slots to lock the firing pin in operative position, and means carried by said plunger for normally preventing such lugs from being moved out of said offset portions of the slots.

8. In a fuse, the combination, with a plunger having a longitudinally extending recess in its rear end and longitudinally extending slots communicating with said recess, said slots having offset portions, of a firing-pin device movable in said recess and having lugs normally seated in said offset portions of the slots to lock the firing pin in operative position, means, including a sleeve encircling said plunger, for normally preventing said lugs from moving out of said offset portions of the slots.

9. In a fuse, the combination, with a plunger having a longitudinally-extending recess in its rear end and longitudinally-extending slots communicating with said recess, said slots having offset portions, of a firing-pin device movable in said recess and having lugs normally seated in said offset portions of the slots to lock the firing pin in operative position, and a sleeve encircling said plunger and provided with a keeper sliding in one of said slots for normally preventing said lugs from moving out of said offset portions of the slots.

10. The combination, with a fuse, of a plunger carried therewithin and normally held in forward position, and centrifugally-operable means normally disposed entirely within said plunger in the forward position of the latter, and operable, when the plunger is moved to rearward position, to project therefrom and lock the same against retrograde movement.

11. A combination with a fuse, of a plunger carried therewithin and normally held in forward position, and centrifugally-operable locking bolts normally disposed entirely within said plunger in the forward position of the latter and operable, when plunger is moved to rearward position, to project therefrom and lock the same against retrograde movement.

12. In a fuse, the combination, with a fuse-stock, of a fixed plunger-guiding sleeve disposed within said stock, a plunger slidable in said sleeve and normally held in forward position, and centrifugally-operable means normally disposed entirely within said plunger in the forward position of the latter and operable, when the plunger is moved to rearward position, to project therefrom and engage said plunger-guiding sleeve to lock the plunger against retrograde movement.

13. In a fuse, the combination, with a fuse-stock, of a plunger carrying, at its rear

end, a detonator having a recess in its rear end, of a readily crushable, substantially U-shaped member, of spring material, removably held in said recess.

14. In a fuse, the combination, with a plunger carrying at its rear end a detonator having a recess in its rear end, of a readily crushable firing-pin support removably held in said recess, and a firing-pin carried by said support.

15. In a fuse, the combination, with a plunger carrying at its rear end a detonator having a recess in its rear end, of a readily crushable firing-pin support, comprising a U-shaped member removably held in said recess, and a firing pin carried by said support.

16. In a fuse, the combination, with a plunger carrying at its rear end a detonator having a recess in its rear end, of a readily crushable firing-pin support, of spring material, sprung into said recess, and a firing-pin carried by said support.

17. In a fuse, a combination with a fuse-stock, of a booster carried at the rear thereof, a stationary cup within said booster, a plunger carrying, at its rear end, a detonator and an independently longitudinally-movable firing pin, said plunger being normally held in a forward position with the detonator at the forward end of said cup, and yieldable means carried at the rear end of said booster and impingeable with said cup in the rearward movement of said plunger, to yieldingly resist further rearward movement of the plunger upon impact with the objective of the shell carrying said fuse.

18. In a fuse, the combination, with a plunger and a booster carrying a cup, of a normally restrained firing-pin carried by the plunger at the rear end thereof, means for locking said firing-pin in restrained position, a detonator also carried by said plunger and withdrawn from said cup in the forward position of said plunger, and yieldable means carried by the rear end of said detonator and impingeable with said cup in the rearward movement of said plunger to temporarily prevent unlocking movement of said firing pin locking means.

19. In a fuse, the combination, with a plunger and a booster carrying a cup, of a normally restrained firing-pin carried by the plunger at the rear end thereof, means for locking said firing pin in restrained position, a detonator also carried by said plunger and withdrawn from said cup in the forward position of said plunger, and a substantially U-shaped, yieldable member detachably carried by the rear end of said detonator, and impingeable with said cap in the rearward movement of said plunger to temporarily prevent unlocking movement of said firing-pin locking means.

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