# United States Patent

[11] 3,608,493


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[54] **FUSE APPARATUS**
**3 Claims, 2 Drawing Figs.**


[52] **U.S. Cl.** ..... **102/78,** 102/70.2
[51] **Int. Cl.** ..... **F42c 15/28**
[50] **Field of Search** ..... 102/70.2, 78–80, 82



[56] **References Cited**

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| | | | |
|---|---|---|---|
| 2,712,791 | 7/1955 | Bleakney et al. | 102/70.2 |
| 2,971,463 | 2/1961 | Burrell | 102/70.2 |
| 3,102,480 | 9/1963 | Severance et al. | 102/78 |
| 3,415,190 | 12/1968 | Hart et al. | 102/70.2 |
| 3,500,747 | 3/1970 | Parker | 102/70.2 |

FOREIGN PATENTS

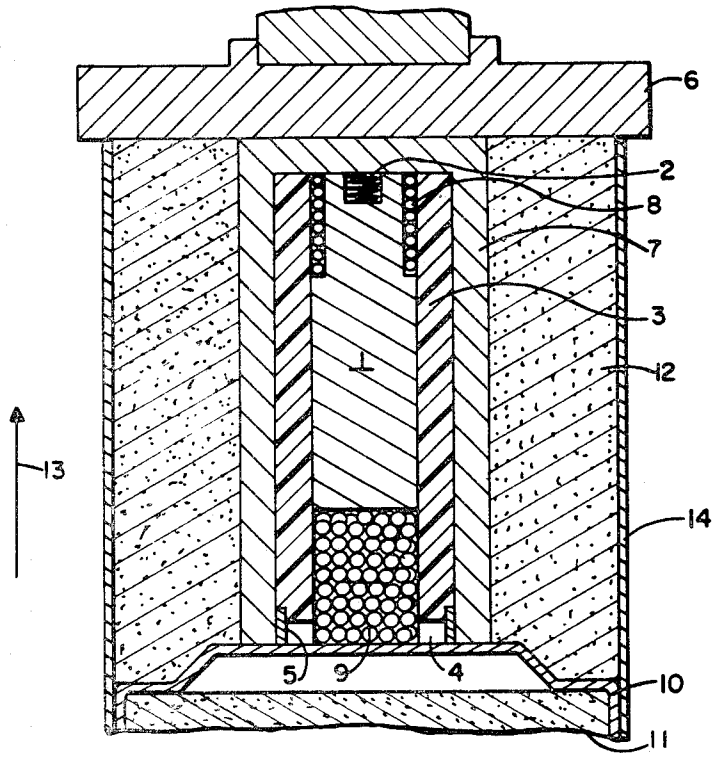
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| 17,795 | 1905 | Great Britain | 102/80 |



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**ABSTRACT:** A fluid barrier, delay arming, safing and arming mechanism utilizing a barrier material having flow characteristics to separate a detonator and acceptor explosive. The fuse is armed by causing the barrier material to flow out of its "safe" position between the detonator and acceptor explosive in a predetermined arming environment such as spin and/or setback. The invention provides a barrier material which may be used for safing as well as for determining a delay associated with arming.

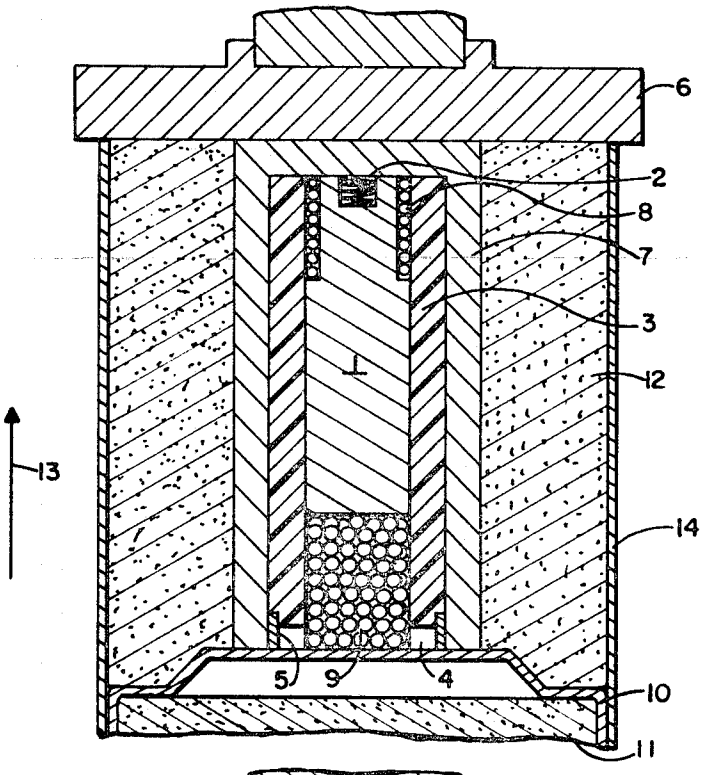



FIG. 1

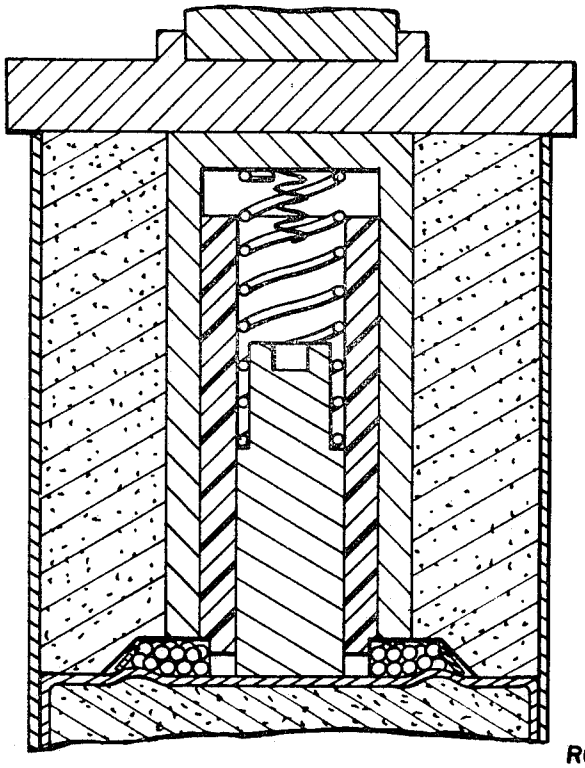


FIG. 2

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# FUSE APPARATUS

## BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention pertains to ammunition and explosive devices, and, more particularly, to fuses, primers and igniting devices.

2. Description of the Prior Art

It is often required in the fusing art to provide a barrier or "interrupter" for "safing" a detonator and acceptor explosive. Commonly these barriers have been metal plates which are of sufficient thickness to withstand actuation of the detonator without causing initiation of the acceptor explosive. Barriers of this type require some mechanization to allow movement of the barrier from between the detonator and explosive to arm the munition.

The prior art has also included delay devices wherein liquid, or granular materials having the flow characteristics of a liquid, are expelled through an orifice or other restricted passageway. A device of this type is shown in U.S. Pat. No. 2,971,463 where arming is achieved by allowing movement of a plunger to "open" a shorted detonator. The plunger motion is retarded by a flow of a quantity of small spherical pellets flowing through an orifice which is opened to initiate arming.

It is an object of the present invention to provide a fluid barrier safing and arming device which allows miniaturization without mechanical complexity.

## SUMMARY OF THE INVENTION

The present invention contemplates the use of a fluid material such as mercury, a mercury alloy, or a quantity of extremely small pellets having flow characteristics, for separation of a detonator and acceptor explosive lying along a common axis. A chamber is provided within the housing which has a frangible end section. A detonator is positioned within the chamber separated from the frangible end by a quantity of the fluid barrier material which will mitigate the shock wave generated by the detonator to prevent initiation of an acceptor explosive placed next to the frangible end of the chamber. To arm the fuse, the barrier material is expelled through orifices in the walls of the housing to open the area between the detonator and the frangible end next to the acceptor explosive. After expulsion of the barrier material, the detonator has a clear area to discharge into and consequently initiates the acceptor explosive through the frangible end section.

Another embodiment of the invention contemplates movement of the detonator along its axis as the liquid barrier material is expelled from a cavity. This provides a further safing feature in that the detonator is located at a greater distance from the acceptor explosive until the barrier material is expelled allowing the detonator output point to approach the acceptor explosive.

Opening of the orifice to allow the fluid barrier material to escape may be accomplished by means of a crushable sleeve which is moved in response to setback forces to expose the orifice. In addition, spin-arm dependency may be provided by a centrifugally actuated seal on the orifices. For example, a circular ring around the line of orifice openings may be designed to spin off in response to projectile spin.

The device of the present invention is equally suited for many types of detonators. The invention is contemplated for use in a projectile system which utilizes a piezoelectric power supply with an electrical impact switch. With an electrical detonator, it is also contemplated to provide a short across the detonator leads.

The short may provide a delay arming by requiring that a certain amount of the barrier material be expelled before the detonator can be actuated. The time delay may be controlled by orifice size barrier material spring pressure, etc.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross section of a fuse embodiment employing the present invention prior to arming.



FIG. 2 illustrates the fuse embodiment of FIG. 1 after arming.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, a cylindrical detonator 1 is positioned along the spin axis of a projectile. The detonator 1 is surrounded by a cylindrical plastic sleeve 3 having a plurality of orifices 4 located around the lower perimeter of the sleeve. Surrounding the lower portion of the sleeve 3 and closing the orifices 4 is a circular metalic ring 5. The plastic sleeve 3 is surrounded by an aluminum housing 7. A electrical contact 2 is secured to the housing 7 and contacts a terminal of the detonator 1. A spring 8, in compressed form, surrounds an extremity of detonator 1 having a reduced diameter tending to force the detonator 1 away from the aluminum housing 7. The detonator is restrained from axial movement by a quantity of a fluid barrier material 9 located within the cavity defined by the plastic sleeve 3 and the detonator I. The assembly is held against the bulkhead 6 by a booster cup 10 surrounding a booster 11. The booster cup 10 has a crushable bubble extending upward along the axis of the projectile holding the detonator, sleeve, and housing against the bulkhead. Surrounding the aluminum housing 7 is a quantity of high explosive 12, between the housing and the outer shell 14.

The flight of the projectile is in the direction of the arrow 13.

## OPERATION

Upon firing, the projectile experiences high setback forces in a direction opposite the direction indicated by arrow 13. These forces cause the crushable bubble on the booster cup 10 to be forced against the surface of the booster 11 due to inertia of the aluminum housing and detonator assembly. The aluminum housing, forced against the booster surface, creates a void between the top of the aluminum housing and the bulkhead 6.

As the projectile leaves the gun, setback forces are no longer present and the spring 8 extends, forcing the aluminum housing back 7 against the bulkhead 6 while the detonator 1 toward the rear of the projectile against the booster cup 10. As the housing slips over the plastic sleeve, the spin ring 5, due to high centrifugal forces created by projectile spin, is forced radially outward, uncovering the orifice outlets. The spring 8 and the centrifugal force acting on the barrier material 9 then forces the barrier material 9 downward and out through the orifices 4. After arming has been completed. the fuse is in the condition shown in FIG. 2.

An electrical arming delay is effected by the contact 2. The detonator is "shorted" by the spring 2 to the aluminum sleeve 7 until the detonator travels towards the rear of the projectile as the fluid barrier material is released.

The crushable bubble on the booster cup is of a frangible nature allowing the detonator output to actuate the booster explosive 11 in its armed position. Should the detonator by actuated before arming, the shock generated by the detonator output will be transmitted through the fluid barrier material and dissipated therein. Further mitigation of the shock wave will occur in the plastic sleeve surrounding the cavity wherein the barrier material is retained. The resulting shock at the surface of the booster 11 will be insufficient to cause detonation.

The invention provides a detonation safing and arming mechanism combination which may be fitted into a very small space, as required in projectile fusing applications. The need for complicated mechanisms to move an "interrupter" plate is obviated. Testing of the invention with both mercury and 440-micron-diameter tungsten ball barrier materials indicate that an overall size envelope of ¼
using a miniature detonator, is feasible.

The fluid barrier material must have flow characteristics and should be of relatively high mass to allow miniaturization. Liquid materials might be mercury or mercury alloys (such as mercury-thallium) and possible granular materials are small

diameter tungsten or copper balls. Successful embodiments of the invention have utilized 400-micron-diameter tungsten balls.

Modifications to the sleeve or housing surrounding the cavity are contemplated to mitigate the shock wave from the detonator. Such modifications include restrictions which are spin independent to enlarge upon a spin environment.

The housing material itself surrounding the cavity affects the mitigation of the shock front. Balsa, foam, and plastics are among the possible materials. A consideration with liquid barrier materials such as mercury is interaction of the barrier materials with the housing walls.

I claim:

1. Fuse apparatus for initiation of an acceptor explosive, comprising:

a housing member defining a longitudinal chamber, said member including a frangible partition closing one end of said member, said partition being crushable by the inertia of said housing member at setback, said member further defining at least one port connecting said chamber at a point near said partition to the exterior of said member;

detonator means disposed within said chamber, spaced from said partition, for initiating said acceptor explosive outside said chamber proximate said partition;

a fluid barrier material disposed within said chamber between said detonator means and said partition to prevent initiation of said acceptor explosive;

spring means said detonator against said barrier material and said partition; and

means for sealing said port until a predetermined warming environment is experienced, said material tending to flow out said chamber, whereby said material provides "-safing" until said environment causes expulsion of said barrier material over a time interval.

2. The apparatus of claim 1 wherein said detonator is an electric detonator having electrical contact means at the end distal proximate said partition, and including

electrical shorting means for shorting said electrical contact means until said barrier material is expelled and said spring moves said detonator toward said partition.

3. Fuse apparatus, comprising;

a detonator positioned along the spin axis of a projectile;

a sleeve surrounding said detonator, having orifices through the walls near one end;

housing means, surrounding said sleeve, for closing said orifices;

a booster explosive located to the rear of said housing means;

a booster cup surrounding said booster explosive said booster cup having a crushable bubble extending forward of said booster cup and against the end of said sleeve having orifices and against the end of said housing means;

a bulkhead located forward of said aluminum housing;

a fluid barrier material located within the cavity formed near said orifices by said detonator said crushable bubble, ans said sleeve; and

spring means urging said detonator along said axis of projectile toward said booster cup, through said sleeve, against said fluid barrier material,

whereby, upon setback, said housing member causes said crushable bubble to deflect, allowing said spring to open said orifices, said fluid barrier material being expelled whereupon detonator is in a position to actuate said booster explosive.

# UNITED STATES PATENT OFFICE
# CERTIFICATE OF CORRECTION

Patent No. 3,608,493 Dated September 28, 1971

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It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Claim 1, line 5, delete "member" and substitute --chamber--;

line 15, after "means" insert --urging--;

line 17, delete "warming" and substitute --arming--;

line 19, after "said" (second occurrence) insert --barrier--.

Signed and sealed this 21st day of March 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

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