Oct. 4, 1949. H. J. NICHOLS 2,483,555

FUSE

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Fig. 1.

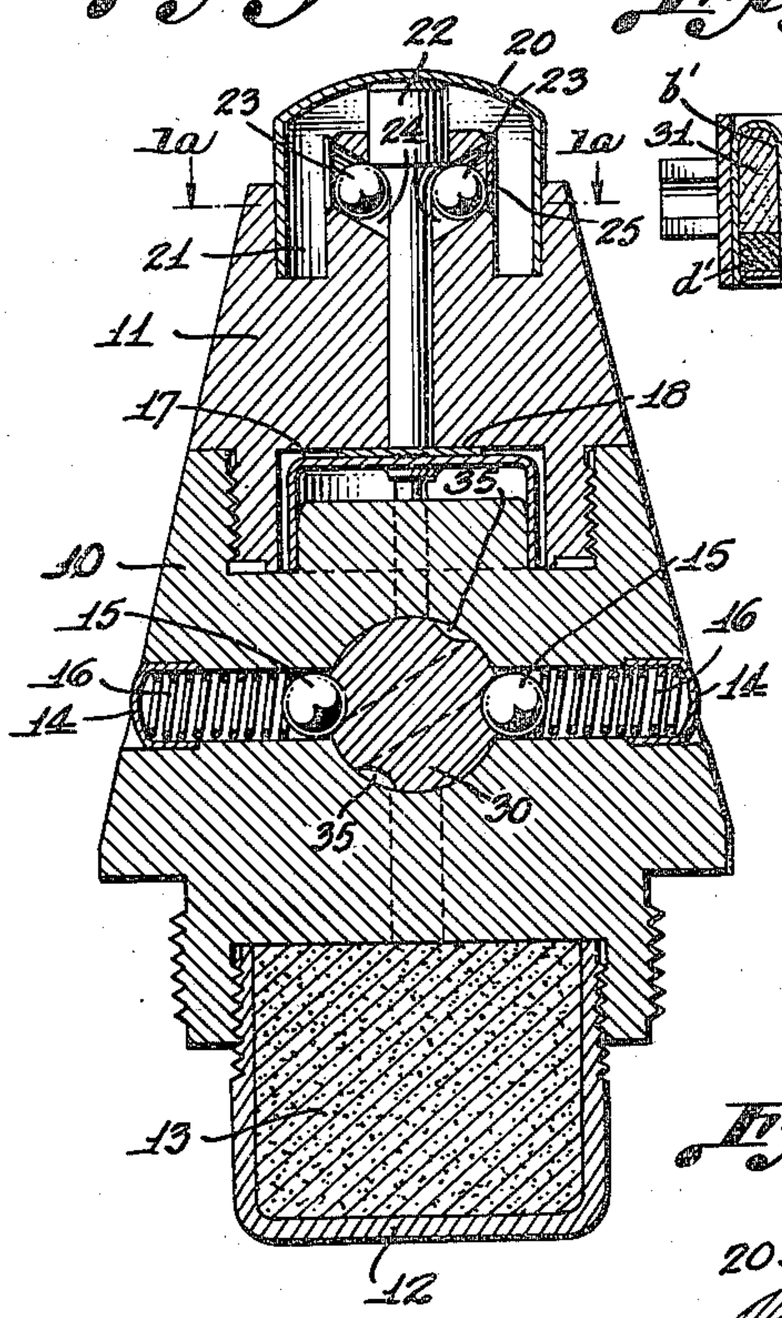


Fig. 2a.

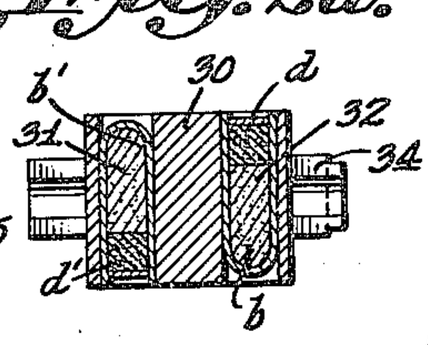


Fig. 2.

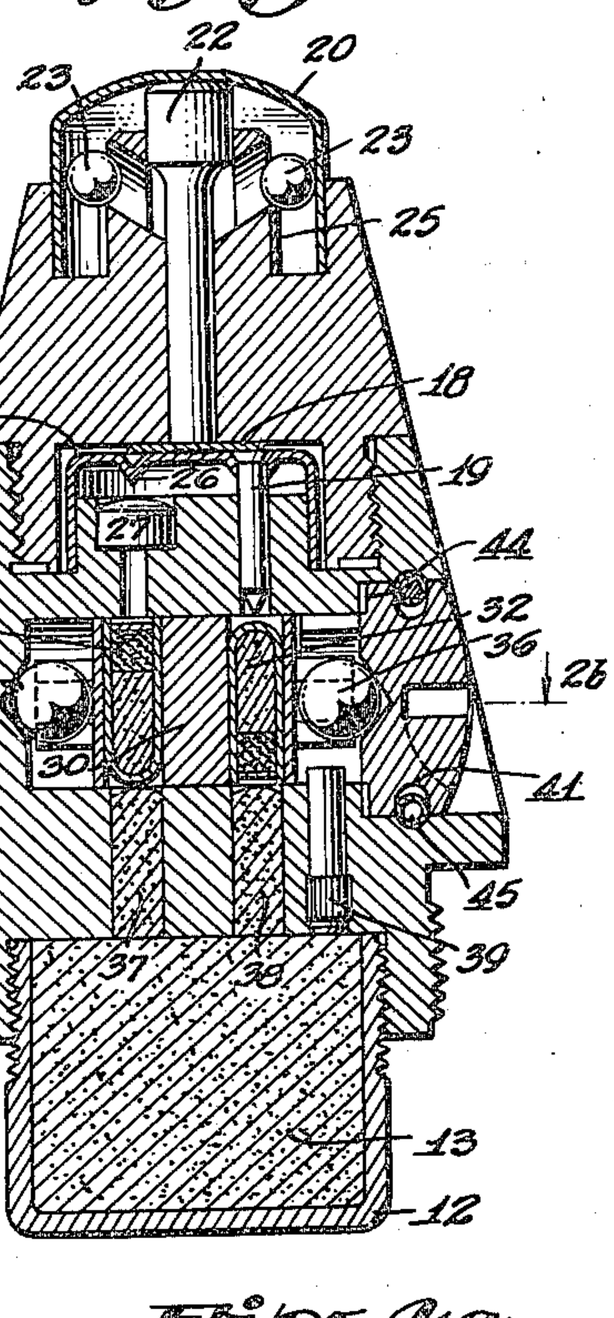


Fig. 1a.

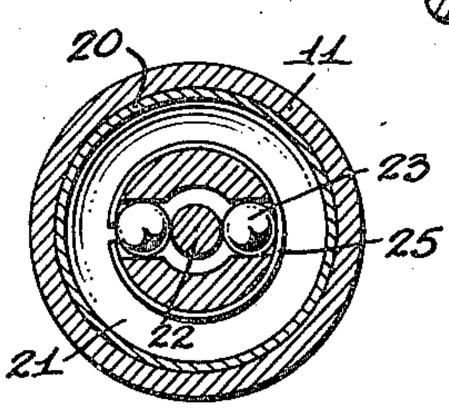


Fig. 2a.

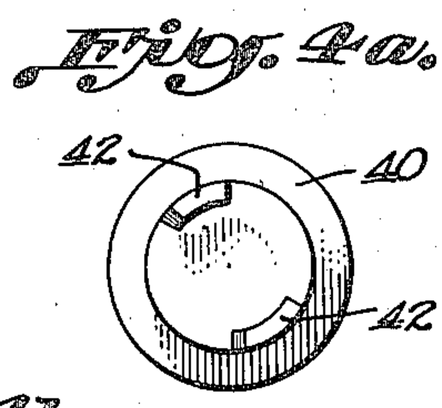


Fig. 2b.

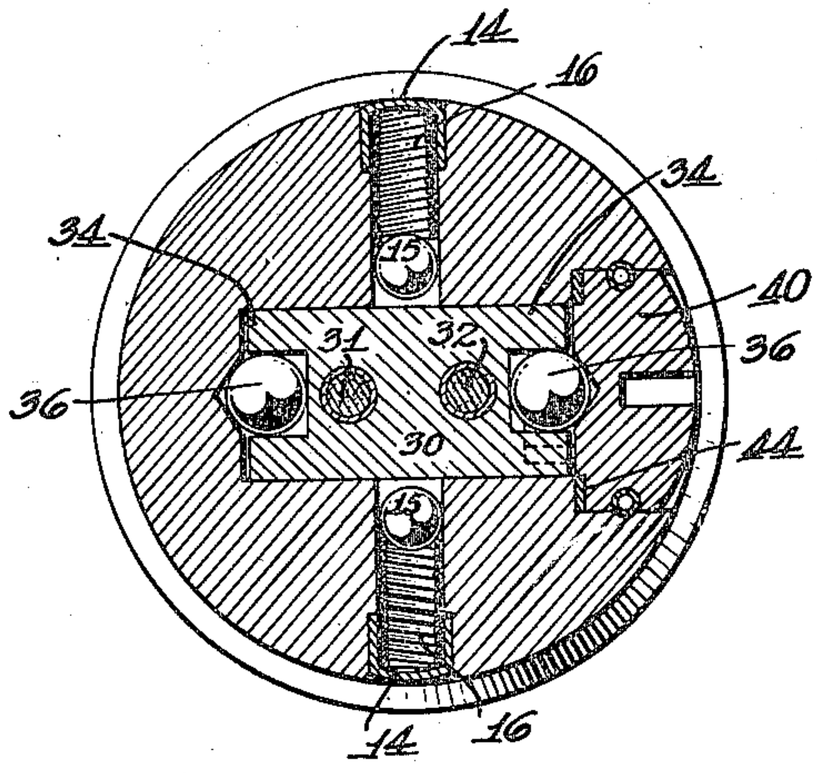


Fig. 4b.

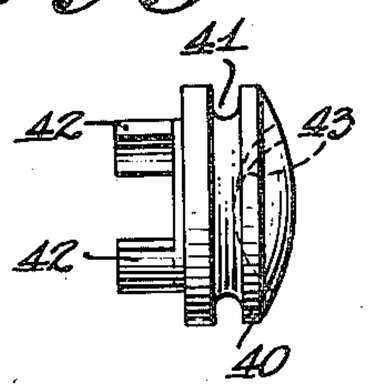
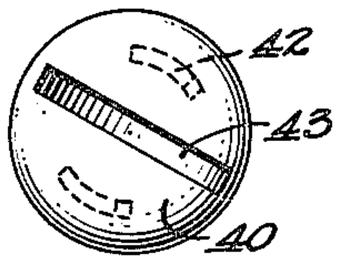


Fig. 4c.



Inventor

HARRY J. NICHOLS

By Emery, Holcombe & Blair

Attorneys

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FUSE

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Fig. 3a.

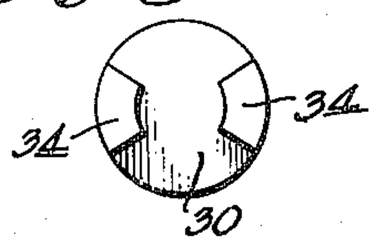


Fig. 3b.

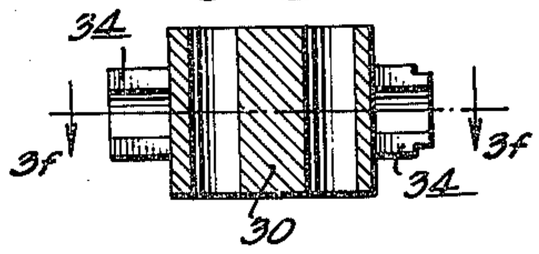


Fig. 3c.

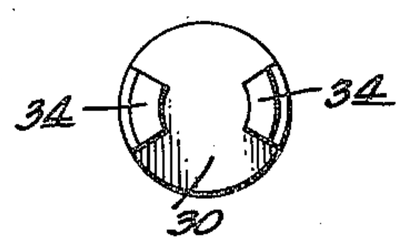


Fig. 3f.

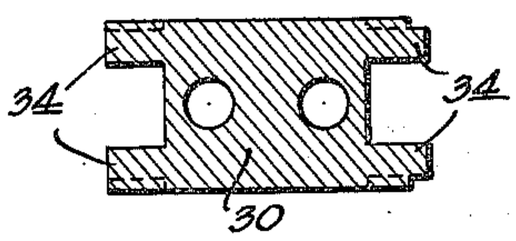


Fig. 3d.

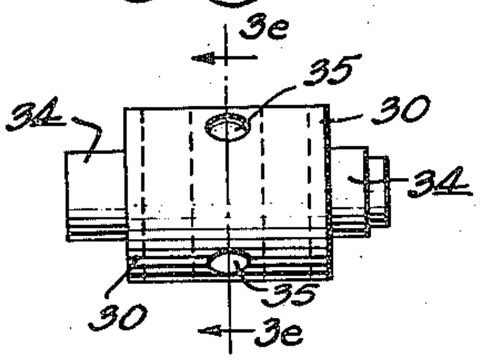


Fig. 3e.

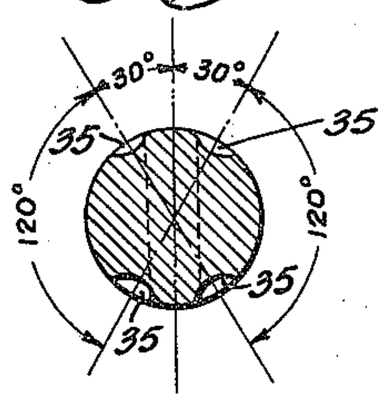


Fig. 5a.

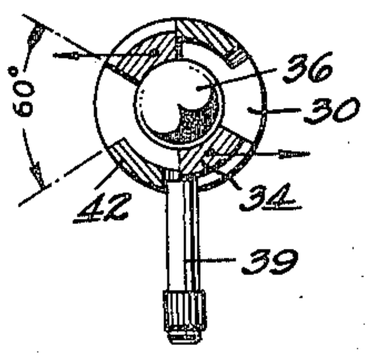


Fig. 5b.

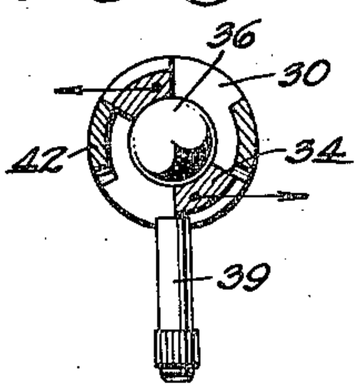


Fig. 5c.

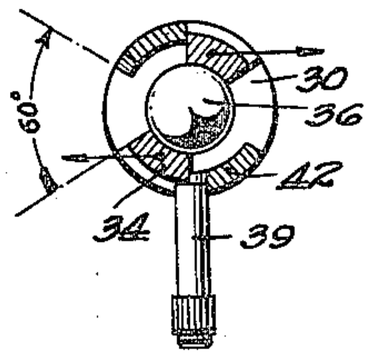


Fig. 5A.

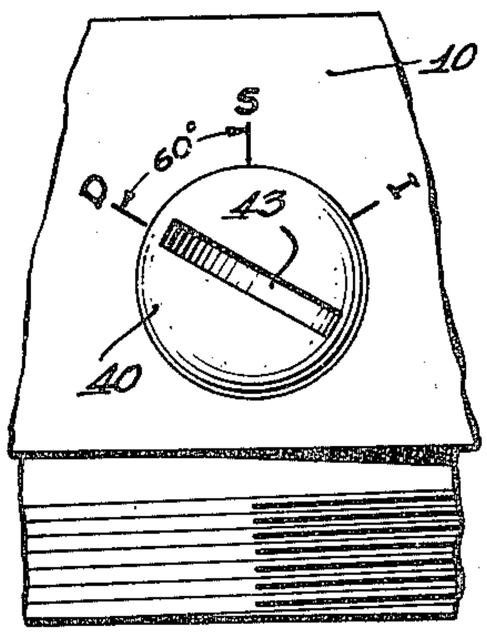


Fig. 5B.

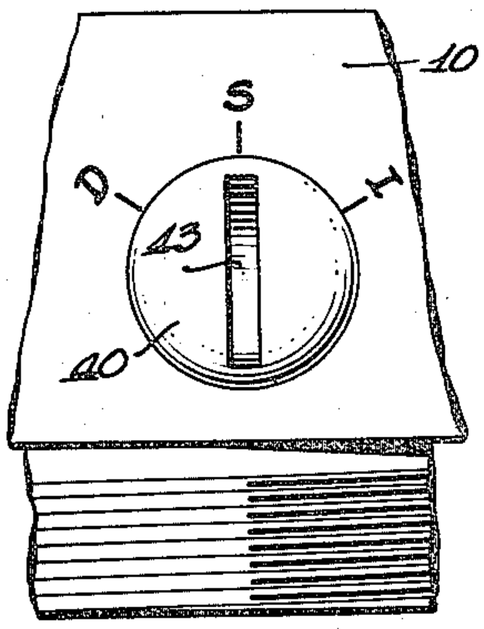
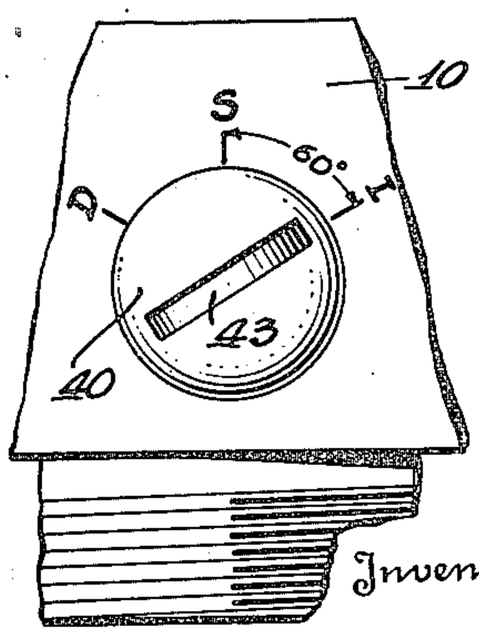


Fig. 5C.



Inventor

HARRY J. NICHOLS

By Emery, Holcombe & Blair

Attorneys

Patented Oct. 4, 1949 2,483,555

UNITED STATES PATENT OFFICE

2,483,555

FUSE

Harry J. Nichols, New York, N. Y.

Application June 17, 1943, Serial No. 491,199

10 Claims. (Cl. 102—74)

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This invention relates to point detonating fuses and especially those provided with a selective delay feature whereby one of two delay actions can be preset manually before firing. The invention will accordingly be hereinafter described with reference to such application but it is to be understood that without material modification various features are equally applicable to other types of point detonating fuses.

Examples of pre-selective delay fuses in the prior art have been characterized by complex mechanism, weak structure, and complicated setting, loading, and manufacturing.

Further, most of these fuses have not been fully automatic in arming, requiring the manual removal of safety pins, cotters, tapes, or the like before firing. This naturally has slowed down the rate of fire under combat conditions. Others have had safety pins which flew sideways as the projectile emerged from the muzzle of the gun, endangering the gun crew and others in the proximity of the gun. Still others have been of inadequate strength to withstand the shock of impact with solid targets, breaking up on impact before exploding, thereby producing duds.

Furthermore, these fuses have usually had one or more openings from the exterior to the interior of the fuse casing, and through these openings moisture enters to deteriorate the fuse mechanism and explosive components during storage and transportation. Or, if the fuse were dropped in water or mud at the front, the explosive components were likely to be wet and the fuse consequently to become a dud.

Accordingly, it is one of the principal objects of the present invention to overcome the objections and limitations recited above, and to provide a fuse which is relatively simple and rugged in construction, easy to assemble and load, fully automatic in arming, certain and safe in action, and entirely waterproof.

Another object is to provide a fuse particularly adapted for low cost manufacture in large quantities.

Other objects will be in part obvious from the annexed drawings and in part hereinafter indicated in connection with the following analysis of the invention.

In the drawings forming part of this disclosure, like characters of reference denote corresponding parts throughout the several views in which:

Fig. 1 shows in longitudinal cross-section a point detonating fuse according to the invention, the mechanism being shown in unarmed position, that is normal, safe position.

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Fig. 1*a* is a transverse cross-section of the fuse of Fig. 1 substantially at plane *a*—*a*.

Fig. 2 shows the same fuse as in Fig. 1, but rotated 90° and with the rotor armed in condition for producing delay action upon impact.

Fig. 2*a* shows the alternative position of the rotor of Fig. 2 when set for instantaneous action.

Fig. 2*b* shows the same fuse in transverse cross-section at plane *b*—*b* of Fig. 2.

Figs. 3*a*, 3*b*, 3*c*, 3*d*, 3*e* and 3*f* are a group of orthographic views of the detonator rotor showing the details thereof.

Figs. 4*a*, 4*b* and 4*c* show three views of the setting plug of the invention showing the details thereof.

Figs. 5*a*, 5*b* and 5*c* and Figs. 5A, 5B and 5C show in two groups three fragmentary positional views illustrating the manual setting arrangement for manually preselecting the desired action of the fuse, and three views indicating the corresponding relations of the setting plug and rotor for these settings.

Referring to the drawings in detail and particularly to Fig. 1, the main structural element of the fuse is the body **10** of truncated conical form with external screw threads for assembly to the projectile (not shown), and having a threaded recess at the front for receiving the nose piece **11** and another at the base for receiving the booster cup **12** containing booster charge **13**, of tetryl or the like.

The body **10** has a cross-bore in which is housed rotor **30**, to be described in detail later, and at right angles thereto two radial cross-holes closed by cups **14** and housing centrifugally actuated ball detents **15** therein pressed towards rotor **13** by springs **16** as shown. The body **10** also mounts at its forward end a drawn cap **17** surmounted by a disc **18** welded thereon, these parts being part of the firing mechanism.

The nose piece **11** houses the novel impact mechanism consisting of a dome **20** pressed partly into an annular recess **21** in nose piece **11** to provide a moisture tight closure of the point of the fuse. An impact element or striker **22** is slidably mounted in an axial bore of the nose-piece **11**, and two or more balls **23** are mounted in inclined holes **24** sloping downwards towards the axis of the fuse. A split band **25** serves to retain the balls **23** in position under the head of striker **22**.

Referring now to Fig. 2 which shows the same fuse as Fig. 1 but after firing and with the section taken at right angles to Fig. 4 and with the rotor **30** in armed position. Also further details of the firing mechanism are disclosed. The firing pin cap **17** is provided with an eccentric firing

point 26 aligned with primer 27 which in turn is aligned with delay detonator 31, and opposite thereto cap 17 is recessed to suspend a firing pin 19 aligned with instantaneous detonator 32 (when these detonators are in armed position).

Referring now to Fig. 2 and the group Fig. 3 disclosing details of the centrifugal rotor 30, which is one of the vital elements of the invention, the rotor 30 is of general cylindrical form with two diametrical holes equally spaced from the axis of the fuse, these holes being adapted to receive delay detonator 31 and instantaneous detonator 32 respectively, each enclosed in a waterproof capsule as shown. These detonators are of composite type, being composed of a bottom charge *b* of relatively insensitive booster explosive, such as tetryl, and a top layer *d* of sensitive detonating explosive such as fulminate or azide. (See Fig. 2*a*.) It should be noted that these detonators are assembled in the rotor in opposite directions, so that the bottom of one detonator lies opposite the top of the other. Thus, as shown in Fig. 2 when the rotor is in position for producing delay action, the sensitive end of detonator 31 is opposite firing pin 19. When the rotor is in position for producing instantaneous action, the positions of the detonators are reversed, as shown in Fig. 2*a*. Stabbing or heating the sensitive end of either detonator will produce detonation thereof, but similar treatment of the insensitive end will be ineffective to produce detonation.

The fuse of the invention is shown as providing a slight delay due to the primer 27, since only a slight delay is usually required of this type of fuse. But it will be apparent to those skilled in the art that more delay can be obtained by having a top layer of delay composition in detonator 31, or by a delay pellet inserted between primer 27 and detonator 31, or both.

Referring to Figs. 2 and 3, the cylindrical centrifugally actuated rotor 30 has at each end two symmetrical projections 34, in the form of arcuate segments, which are positioned perpendicular to the axis of the detonators. When the fuse is rotated about its axis, as in flight after firing from a rifled gun, these segments provide a torque couple tending to rotate the detonators from any oblique position to a position parallel with respect to the axis of rotation. The rotor is also provided at its mid plane with four spherical recesses 35 symmetrically arranged at angles of 30° to the axis of the detonators, as shown in Fig. 3*e*. These recesses are adapted to receive the centrifugal ball detents 15 when the rotor is in unarmed position to retain the rotor against movement from such position. (See Fig. 1.) When the rotor is assembled in the fuse body, a pivot ball 36, Fig. 2*b*, is placed at each end of the rotor in the recess formed by segments 34 to assure free turning of the rotor. This mounting of the rotor, being virtually frictionless, enables the rotor to turn reliably at a low rate of spin, such as that of trench-mortar and other low velocity projectiles.

Referring now to Figs. 2, 4 and 5, the fuse of the invention is provided with a novel selective setting arrangement enabling the fuse to be preset for safety, instantaneous action, or delay action. The setting plug 40, Fig. 5*a*, is rotatably mounted in a counterbore in body 10 by means of a snap ring 45 carried in groove 41 in the perimeter of the plug, and a corresponding internal half-groove cut in body 10. A gasket 44 is mounted under compression between the shoulder of plug 40 and the rim of the counterbore (see Fig. 2) to provide a moisture-proof seal at that point, thus preventing entrance of moisture into the interior of the fuse. The plug 40 is provided with a pair of concentric arcuate segments 42 and a transverse slot 43 cut perpendicular to the axis of the segments. (See Fig. 4*c*.) The plug segments 42 mesh with the rotor segments 34, permitting an angular movement of the rotor of 60°. The slot 43 is designed to receive the bit of a screw driver, or a small coin, such as a quarter, dime, nickel, or penny, which latter can be used in an emergency to set the fuse. A stop pin 39 is fixed in the body 10 to engage segments 42 on assembly, thereby properly limiting the rotation of plug 40.

Referring now to group Figs. 5 which illustrates the various settings, the lower figures represent the external view of the plug 40, while the upper figures represent the corresponding relations of the segments of the plug and those of the rotor.

Noting first Figs. 5A and 5*a*, when the slot 43 is inclined 60° to the left as indicated, so that the top of the slot aligns with mark "D" on body 10, plug segment 42 stops against pin 39 and the rotor segments 34 are positioned to permit a counter-clockwise rotation of 60° as shown. The rotor 30 is retained in that position by the ball detents 15 as shown in Fig. 1, in which the detonators are masked at both ends. After firing, the rotor turns centrifugally to align detonator 31 with primer 27 to produce delay action, as shown in Fig. 2.

Referring now to Figs. 5B and 5*b*, when the slot 43 is set vertically to align with mark "S" on body 10, plug segment 42 is rotated to the position which the rotor segments would have to occupy in order to arm the rotor, hence the fuse is incapable of detonating under all conditions. This safety position "S" is the one to which the fuse would be set during storage and transportation.

Referring next to Figs. 5C and 5*c*, when the slot 43 is turned to the right to align with mark "I" on body 10, the plug segment 42 moves rotor segment 34 clockwise to a position where rotor 30 can be turned clockwise by centrifugal force to a position where the sensitive end *d* of detonator 32 is brought into alignment with firing pin 19. (See Fig. 2*a*.) In this "I" position, rotor 30 is retained in unarmed position by ball detents 15 engaging the alternative pair of recesses 35.

Analysis will show that the rotor will always be brought to the proper position regardless of the order of setting, so the fuse can be set for any desired condition at will.

Referring again to Fig. 1, the operation of the fuse is as follows: Normally, the fuse is set at safety as above described. Just before firing, the plug 4 is turned to setting "D" or setting "I" as desired. The fuse is still perfectly safe because the rotor 30 is in any event held in safe position by detents 15 until after firing.

On firing in a gun, all parts tend to "set-back" because of their inertia during acceleration of the projectile. The striker 22 is supported in forward position against set-back by the balls 23, but the split band 25 slips over the narrow shoulder on which it is normally supported to the bottom of annular space 21 as shown in Fig. 2. The firing pin 19 and firing point 26 are supported by the cap 17, while rotor 30 remains frozen in position by set-back.

After the projectile leaves the muzzle of the gun, set-back ceases and centrifugal force becomes the dominant force. Responsive thereto, balls 23 move outwardly to free striker 22, and balls 15 move outwardly against the diminished force of springs 16 to free rotor 30, which there-

upon by reason of the torque-couples exerted by segments 34, as previously described, one or the other of the detonators is turned to armed position, according to the setting of plug 40. Assuming, that the fuse were set to the delay or "D" setting, the parts of the fuse in flight would be as shown in Fig. 2.

It is to be noted that since the rotor does not turn to armed position until after the projectile has left the muzzle of the gun, the fuse is "detonator-safe", "bore-safe", and "muzzle-safe", thus meeting the most advanced safety requirements.

A further novel safety feature is provided by the arming mechanism for striker 22. In the employment of trench mortars, which may be and often are used in a phase of warfare conducted in very wet weather, as in the tropics, in practice a danger arises from partially wet propellant charges discharging projectiles to a distance of only a few hundred feet from the gun position. Should such projectiles explode, as they will if fused with sensitive impact fuses heretofore employed, injury to friendly forces may result. Also, trench mortar projectiles are sometimes fired in action through brush or camouflage cover, in which case premature bursts of the projectile near the gun may occur, endangering friendly forces. The arming mechanism guards against such dangers in the following manner: Normally, the striker 22 is held from delivering a firing blow in the event the point of the fuse strikes an obstacle by the dome 20 and by the balls 23. In order for the balls 23 to escape from under the shoulder of striker 22, the split band 25 must slide over its supporting shoulder, and this action depends on set-back force. By designing band 25 for actuation by a certain degree of set-back, which set-back corresponds with the desired minimum operating range, the band 25 serves to discriminate automatically between shots where fuse action is desired, and shots where fuse action is not desired.

With respect to suppressing fuse action when firing through brush and other light obstructions, after the fuse is fired and balls 23 move out of the way, the dome 20 and cap 17 afford a resilient guard and support for the striker 22 unless a relatively solid obstruction is encountered. The strength of dome 20 and that of cap 17 is chosen with this requirement in view, so that the minor blows to the striker resulting from firing through brush, etc. are rendered ineffective to actuate the fuse.

Thus the novel firing mechanism of the invention is particularly adapted to regulate the conditions under which the fuse will explode, so that fuse action is properly suppressed in event of "short-shots" and premature action prevented when firing through brush and other minor obstructions. Those skilled in the fuse art will recognize that these features make the fuse of the invention particularly suitable for coping with the varied and unusual conditions of modern warfare.

Having been armed in flight in the manner and under the conditions described above, on impact with a substantial obstacle dome 20 is dished in and striker 22 driver inwardly, the blow from stroker 22 being transmitted by disc 18 to firing pin 19 and firing point 26, the former stabbing into instantaneous detonator 32, while the latter fires primer 27. If the sensitive end *d* of detonator 32 is aligned with the firing pin 19, detonator 32 is instantly exploded thereby initiating a detonating wave which is transmitted via passage 38 (filled with pressed tetryl) to booster 13 which amplifies the detonating wave and relays it to the shell-filler (not shown) to detonate same and fragment the projectile in well known manner. The chain of events described proceeds with such speed that the projectile travels only a few inches before the projectile is fragmented.

Alternatively, should the fuse have been preset for delay action, the insensitive end *b* of detonator 32 would be aligned with firing pin 19, and the blow thereof would be ineffective. Meanwhile, firing point 26 would have struck and fired primer 27 in well known manner, and after a short delay, the sensitive end *d* of detonator 31 would be ignited by the flash of the primer, exploding detonator 31 thereby initiating a detonating wave which is transmitted via passage 37 to booster 13, with consequent fragmentation of the projectile as before described.

The speed of the alternative chain of events is such as to permit the projectile to travel a few feet before the projectile is fragmented, thereby producing a burst within protected targets such as buildings, pill-boxes, etc.

It is to be noted that the rugged construction of the fuse, and the protection afforded by dome 20 against entrance on impact of mud or water into the interior of the fuse render the fuse particularly suitable for reliable delay action operation.

Without further analysis, it will be evident that the present invention provides a relatively simple, strong, and practical fuse overcoming the objections and meeting the requirements recited in the preamble of the specification.

Although only a single embodiment of the invention has been illustrated and described, it is to be expressly understood that the invention is not limited thereto, but that various changes and adaptations may be made therein. For example, the novel impact firing mechanism described may be employed with fuses having entirely different detonating arrangements than those shown, while the novel rotor and selective delay mechanism can be employed with fuses having an entirely different firing mechanism. Changes in the design and arrangement of parts may also be made without departure from the spirit and scope of the invention, as will now be understood by those skilled in the art. For a definition of the limits of the invention, reference will be had primarily to the appended claims.

What I claim is:

1. In a selective delay point detonating fuse for projectiles for rifled guns, a main body in the general form of a truncated cone having a nose piece assembled into the front end thereof and a booster container assembled in the base end thereof, a selective delay mechanism in said body including a centrifugally actuated cylindrical rotor carrying a pair of detonators mounted in diametrical holes therein, a rotatably mounted plug for engaging and setting said rotor in a position to obtain one of a plurality of predetermined actions on impact of the projectile with a target, and impact firing means in said nose piece including an axially slidable impact element and a cap assembled in said nose piece over said impact element.

2. In a selective delay point detonating fuse for projectiles for rifled guns, a main body in the general form of a truncated cone having a

booster container assembled in the base end thereof and a nose-piece assembled in the front end thereof, a selective delay mechanism assembled in said body including a centrifugally actuated cylindrical rotor carrying twin detonators and mounted for rotation in said body, a plug member assembled in said body for selectively setting said rotor in one of a plurality of angular positions, centrifugally actuated safety means for normally retaining said rotor in safe position, means for firing said detonators assembled in said body including a firing pin, an impact element slidably mounted for axial movement in said nose piece for actuating said firing means, and a closure assembled in said nose piece and covering the head of said impact element.

3. In a selective delay point detonating fuse for projectiles for rifled guns, a main body in the general form of a truncated cone having a booster container assembled in the base end thereof and a nose piece assembled in the front end thereof, a selective delay mechanism assembled in said body including a centrifugally actuated cylindrical rotor rotatably mounted in said body and carrying a plurality of detonators, rotatable means assembled in said body for setting said rotor in one of a plurality of angular positions, safety means for normally retaining said detonators in safe position, and means for exploding said detonators including a firing device individual to each detonator, and an impact element mounted for axial movement in said nose piece for actuating said firing devices upon impact of the fuse with a target.

4. In a point detonating fuse of the class described, means for preselecting the type of fuse action desired to result from impact of the fuse with a target comprising a centrifugally actuated cylindrical rotor carrying a plurality of detonators mounted diametrically therein, individual means for firing each of said detonators after differing time intervals, and rotatable means settable to alternative angular positions for conditioning said rotor for rotation upon firing in a gun to a predetermined angular position, thereby to present one of said detonators for firing by its associated individual means upon impact of the fuse with a target.

5. In a point detonating fuse of the class described, settable exploding means for preselecting one of a plurality of predetermined time intervals from impact of the fuse with a target to explosive action of said fuse comprising a centrifugally actuated cylindrical rotor carrying a plurality of detonators mounted diametrically therein, individual means adapted to explode each detonator after predetermined differing time intervals, rotary manually settable means for preselecting which one of said detonators is to be exploded by its associated individual exploding means, and impact actuated means for energizing said individual means thereby to explode the preselected detonator.

6. In a point detonating fuse of the class described, settable preselection means for causing explosive action after one of alternate time intervals from impact of the fuse with a target comprising, a centrifugally actuated cylindrical rotor carrying a pair of detonators mounted diametrically in parallel therein, means for delaying the explosive action of one of said detonators, individual means for firing each detonator, and manually settable means operatively associated with

said rotor for preselecting one of said detonators for firing on impact of the fuse with a target.

7. In a point detonating fuse of the class described, settable combination means for causing explosive action after a preselected time interval from impact of the fuse with a target comprising a centrifugally actuated cylindrical rotor carrying a pair of detonators mounted diametrically therein, centrifugally releasable safety means for normally maintaining said rotor in unarmed position, individual means for firing each detonator, and settable means operatively associated with said rotor for selecting one of said detonators for firing on impact of the fuse with a target, said individual means for firing each detonator including percussive means for firing one detonator, and igniting means for firing another detonator.

8. In a point detonating fuse of the class described, settable means for causing explosive action after a preselected time interval from impact of the fuse with a target comprising a centrifugally actuated cylindrical rotor carrying twin detonators mounted diametrically therein, each detonator having a sensitive end and an insensitive end positioned oppositely in said rotor, centrifugally releasable safety means for normally maintaining said rotor in unarmed position, individual means for firing each detonator, and settable means operatively associated with said rotor for selecting one of said detonators for firing on impact of the fuse with a target.

9. In a point detonating fuse of the class described, means for preselecting the type of fuse action desired to result from impact with a target comprising a rotatable cylinder carrying a plurality of detonators, means for delaying the exploding action of at least one of said detonators, manually rotatable means settable to a plurality of angular positions for preselecting which one if any of said plural detonators is to be exploded upon impact, means adapted to explode each of said detonators individually when preselected by said settable means, and impact actuated means for energizing in common said means for exploding said detonators individually.

10. In a point detonating fuse of the class described, in combination, a cylindrical rotor carrying twin detonators, percussive means for firing one detonator, igniting means for firing the other detonator, and rotary settable selecting means for predetermining which of said detonators shall be fired upon impact of the fuse with a target.

HARRY J. NICHOLS.

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