May 13, 1947. H. J. NICHOLS 2,420,612

FUSE

Filed Nov. 14, 1939 2 Sheets-Sheet 1

Fig. 1

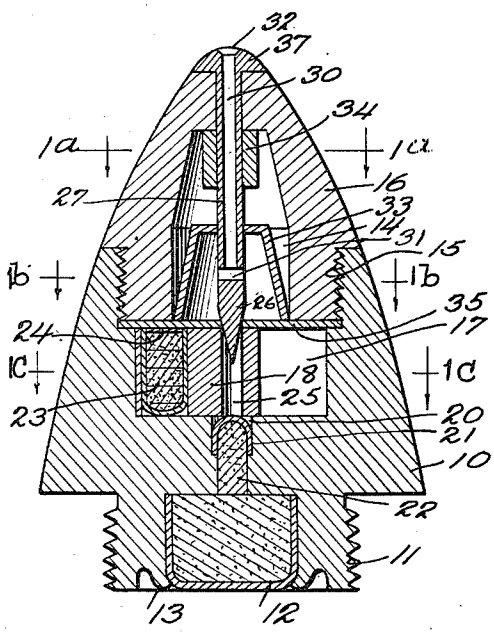


Fig. 3

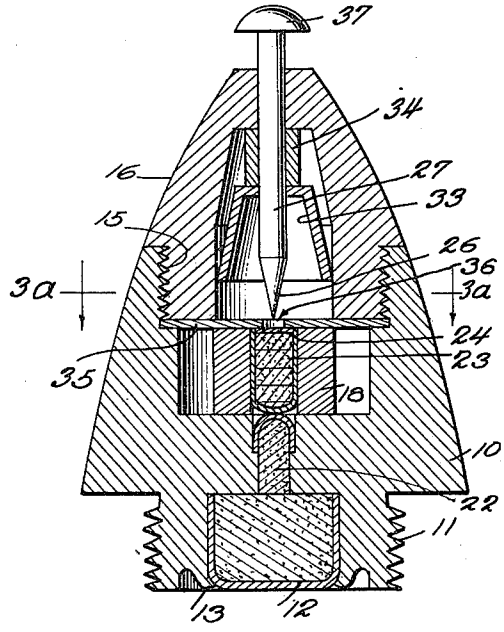


Fig. 2

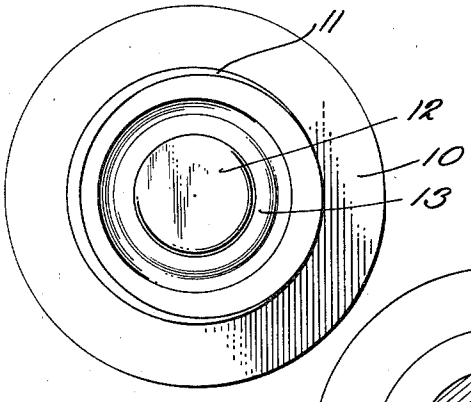


Fig. 1b

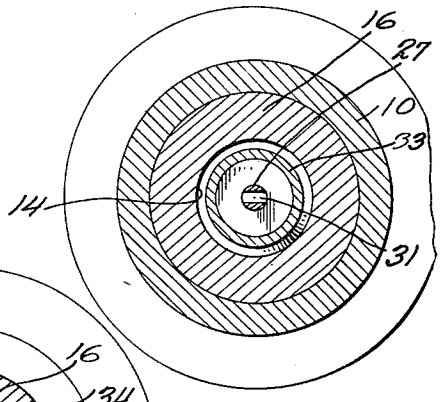
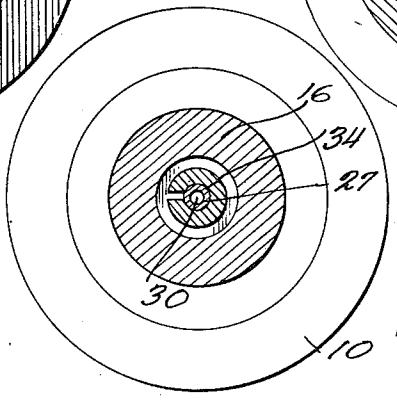


Fig. 1a



Inventor
H. J. Nichols
Blair Reisenger
Attorneys

May 13, 1947. H. J. NICHOLS 2,420,612

FUSE

Filed Nov. 14, 1939 2 Sheets-Sheet 2

Fig. 4

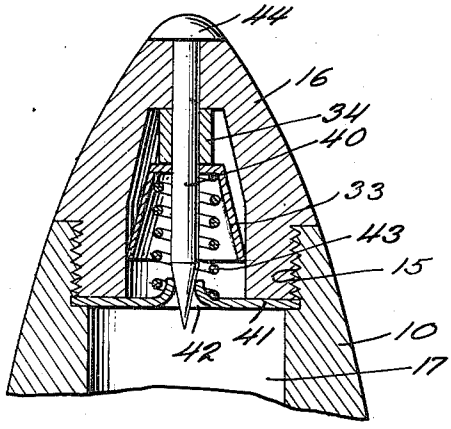
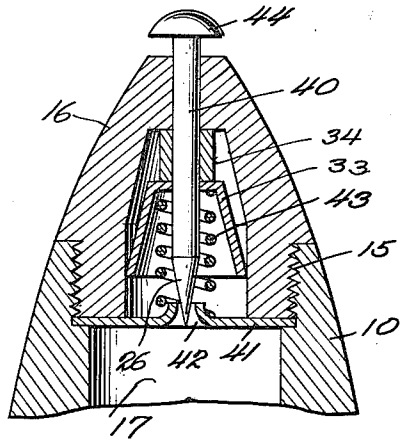


Fig. 5



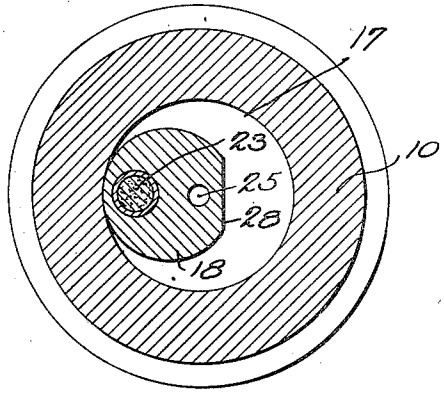


Fig. 1c

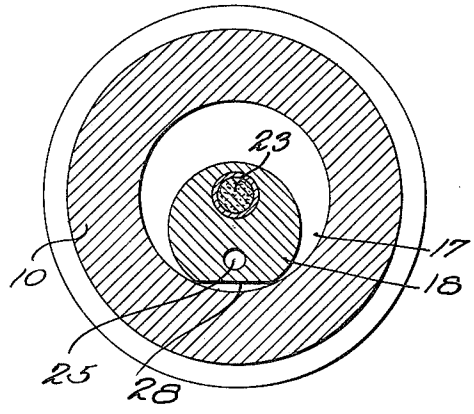


Fig. 3a

Inventor
H. J. Nichols

By Blair Kilbourne

Attorneys

Patented May 13, 1947

2,420,612

UNITED STATES PATENT OFFICE

2,420,612

FUSE

Harry J. Nichols, Binghamton, N. Y.

Application November 14, 1939, Serial No. 304,393

14 Claims. (Cl. 102—76)

1

This invention relates to point detonating fuses especially designed for anti-aircraft projectiles and the like, and will be described with relation to such application although it is to be understood that without material modification many features are equally applicable for other uses.

Detonating fuses for small anti-aircraft projectiles present particular difficulties because of their small size and the great accelerating and rotary forces to which the parts are subject in firing and in flight. It is essential that fuses for this purpose be extremely sensitive on impact yet at the same time be entirely safe in handling and firing. Because of the great force of "set-back" on firing, the detonator may be fired by concussion while the projectile is in the bore of the gun. This makes a "bore-safe" feature highly desirable. A fuse to be "bore-safe" must have adequate provisions against arming in the bore of the gun, and in the event the detonator is exploded by concussion due to the firing of the gun, the explosion must be so limited as not to disrupt the fuse nor to cause explosion or break-up of the projectile.

A further desirable feature is that the fuse be not completely armed until the projectile has travelled some distance beyond the muzzle of the gun, since a relatively strong retarding force acts on the projectile when it strikes the air on emerging from the gun, and if the sensitive firing elements can coact at that instant, premature detonation may result. This feature is usually termed a "muzzle-safe" feature. To ensure adequate sensitivity and quickness on impact with light targets, such as wing covering of aircraft, the impact element must be of light weight, and the design should be such that the impact element first strikes the target, and as this element is thereby retarded, the projectile drives the detonator into the firing pin, producing instantaneous detonation before the projectile has been sensibly retarded. This is termed "supersensitive" and "super-quick" action.

Finally, from the practical standpoint, fuses of this class should be simple in construction, easily loaded and assembled, and adapted to low cost manufacture in large quantity.

It is therefore one of the principal objects of this invention to meet in a highly efficient, reliable, and practical manner the general and special requirements above stated.

Another object is to provide simple and reliable arming means which utilize forces generated by the firing process.

2

Another object is to provide a novel and effective "bore-safe" feature.

Another object is to provide alternative means for extending the impact firing element after the projectile is in flight.

Another object is to provide means by which the distance at which the fuse becomes completely armed after the projectile has left the gun may be predetermined.

Another object is to provide a novel detonator arming means utilizing the retardation of the spin of the fuse in flight to arm the detonator, and centrifugal force to maintain the detonator in armed positioned.

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

This invention accordingly consists in the features of construction, combination of parts, and in the unique relation of the members and in the relative proportioning and disposition thereof, all as more completely outlined herein.

To enable others skilled in the art fully to comprehend the underlying features of this invention, that they may embody the same by the numerous modifications in structure and relation contemplated by the invention, drawings depicting two embodiments of the invention form a part of this disclosure, and in such drawings like characters of reference denote corresponding parts through the several views, in which—

Fig. 1 shows greatly enlarged and in longitudinal cross section a point-impact, detonating fuse illustrating one embodiment of the invention, the mechanism being shown in unarmed condition.

Figs. 1*a*, 1*b* and 1*c* are transverse sections of the fuse shown in Fig. 1, the sections being taken on the lines 1*a*—1*a*, 1*b*—1*b*, 1*c*—1*c*, as indicated in Fig. 1.

Fig. 2 shows a bottom view of the fuse shown in Fig. 1.

Fig. 3 shows the same fuse as that in Fig. 1, in similar section, the mechanism being in armed condition.

Fig. 3*a* shows in transverse section on the line 3*a*—3*a* the fuse shown in Fig. 3 illustrating the position of the rotor in armed condition.

Fig. 4 shows in fragmentary, longitudinal section an alternative embodiment of the invention with respect to the means for extending the firing pin or striker.

Fig. 5 is a similar view, showing the firing pin or striker extended.

Referring now to these drawings and particularly to Fig. 1, the main structural element of the fuse is the body 10, of rugged proportions, with external screw threads 11 at the base end for assembly to the projectile (not shown). At the base is a cylindrical cavity, called the booster cavity, adapted to receive the booster cup 12, the latter being filled with compressed tetryl or the like. The booster cup is held securely in place by a spun-cover lip 13 formed from the fuse body, as shown, or otherwise as desired. The forward portion of the body is provided with an internally threaded cylindrical cavity adapted to receive the threaded portion 15 of a nose piece 16. Rearwardly of the threaded cavity is a cylindrical, smooth cavity 17, called the rotor cavity, adapted to receive a rotor 18. Extending from the rotor cavity 17 to the booster cavity is a small diameter axial hole 20, counter-bored at the upper end to receive a small metal cup 21, called the cord protector cup. The interior of the cup and the axial hole are filled with tightly compressed tetryl or the like, this part of the detonating train being termed the detonating cord 22 for exploding the booster. The purpose of the protector cup 21 is to protect the end of the cord from moisture, and from hot gases likely to be generated in the event of premature explosion of the detonator.

The rotor 18 mounted in the rotor cavity 17 is of short cylindrical form and considerably smaller in diameter than the rotor cavity, and lies flat and eccentrically in the rotor cavity. The rotor has an off-center round hole to receive a cylindrical detonator capsule 23 located so that in one (the armed) position of the rotor 18 this hole becomes concentric with the axis of the fuse body (Fig. 3*a*). The detonator 23 is preferably a thin, drawn copper shell in which a highly compressed fulminate detonating charge is loaded by any suitable loading apparatus. The assembly of the detonator 23 is completed by covering the fulminate charge, loaded not quite to the top, by a thin disc 24 cemented in place by a water-proof cement. When the detonator capsule is assembled in the rotor 18, the capsule is preferably coated with a strong, adherent cement to hold it securely in place.

The rotor 18 is also provided with a second small off-center hole 25 adapted to receive the firing point 26 of an impact element or firing pin or striker 27, the hole being located so that when the rotor is assembled in unarmed position, the hole 25 can be rotated to lie at the axis of the fuse, Figs. 1 and 1*c*. The rotor preferably has a small flat cut 28 across the periphery of the cylindrical portion at right angles to the diameter connecting the detonator hole 23 and the firing pin hole 25. By referring to Figs. 1 and 1*c* it is seen that the construction described enables the firing point 26 when assembled in unarmed position to serve as a pivot around which the rotor 18 can freely revolve, but at the same time the firing point 26 restrains the rotor from moving into any such position that the detonator 23 will come into alignment with the detonating cord 22. Sufficient space is provided transversely between the detonator hole and the detonating cord that in event of premature explosion of the detonator 23, the detonating cord 22 will not be exploded. In this connection, it is to be noted that the least mass of the rotor is on the detonator side, and that considerable void space exists in the rotor cavity 17. These factors contribute toward rendering the detonator harmless when exploded in the unarmed, hence safe, position.

Referring again to Fig. 1, the nose piece 16 houses the striker 27 and the firing pin extender mechanism. In this embodiment, the striker 27, of steel and of the general form of an upholstery nail, is drilled axially at 30 from the head along most of its length, and cross-wise at the inner end 31 of the axial hole, to provide an air vent communicating from the point 32 of the assembled fuse to the cavity in a piston cup 33 in the nose piece. When in position in the nose piece, a small, tight-fitting split sleeve 34 is forced along the shank 27 of the striker until the latter is secured firmly in place as shown. The split sleeve 34 is designed in such manner that its effective weight at "set-back" (usually exceeding 20,000 times its normal weight) will overcome the frictional force holding it to the striker, and cause it to slip back until stopped by the piston cup 33, which latter is also a tight fit on the firing pin shank 27. The piston cup 33, of light strong metal and preferably of conical shape as shown, has the large diameter of such size as to fit but to slide easily in, the bore 14 of the nose piece. Between the nose-piece and the fuse body is assembled a thin but strong metal washer 35, termed the support disc, having an axial hole 36 of such size as to fit closely the taper point 26 of the striker. Figs. 1*a* and 1*b* show the transverse sections of the parts described at the planes indicated in Fig. 1.

Referring now to Figs. 1 and 3, the operation of the fuse is as follows: On firing, due to the set-back force, the set-back sleeve 34 slips down along the firing pin shank 27 until stopped by the piston cup 33. The firing point 26, supported by its head 37, remains in the hole 25 in the rotor 18, preventing the rotor from rotating relative to its own axis. When the projectile emerges from the muzzle of the gun, the point strikes the exterior "air-bank" and air under pressure due to the velocity of the projectile enters the vents 32, 30 and 31 in the firing pin and thence to the space inside the piston cup 33, which is virtually air tight. This air pressure causes the firing pin 27 to be extended as shown in Fig. 3, notwithstanding the air pressure on the head of the firing pin, because the effective area of the piston cup 33 is greater than the transverse area of the head 37, giving a differential pressure outward. In fact, even if the piston cup area were no greater than that of the head, some differential pressure would probably exist due to the curvature of the head, but in the interest of certain action, it is deemed preferable to have the cross area of the piston greater than that of the head.

Consider now the action of the rotor 18. When the projectile is in the bore of the gun, the set-back force on the rotor will exceed the torque force due to the angular acceleration of the projectile, hence the rotor will remain pressed against the base of the rotor cavity 17 and will take up the rotation of the projectile without slipping. Should the detonator 23 be exploded by the set-back force, the explosive gases will be vented into the voids in the fuse without disrupting the fuse or exploding the booster charge 12. Should the acceleration of the projectile be reversed in direction due to coppering or other obstruction in the gun bore, the rotor would tend to be thrown forward. If the striker were projected forward, before it could clear the rotor hole the rotor would be pressed against the front of the rotor cavity, holding the rotor in unarmed position in a man-

ner reverse to that at set-back. Hence it is evident that the firing point 26 cannot strike the detonator while in the bore of the gun.

As the projectile leaves the muzzle of the gun and the striker 27 is extended as before described, the rotor 18 is set free and due to the retardation of the spin of the projectile in flight will start rolling around in the rim of the rotor cavity 17. However, each time the rotor rolls over, the tendency to roll is curbed due to the centrifugal component and at some distance from the muzzle of the gun, the rotor will eventually stop in stable equilibrium as illustrated in Fig. 3*a*, in which position the detonator 23 is in alignment with the cord 22. It is to be noted that the force due to the retardation of the spin is minor compared to centrifugal force. Thus it is evident that the fuse is "bore-safe" and "muzzle-safe."

The fuse being completely armed, on striking the target, even though the target be a flimsy one such as wing fabric of an airplane, the head 37 of the striker will encounter substantial resistance and will be checked in flight. The projectile will then drive the detonator 23 into the firing point 26, instantly detonating the former. The wave of detonation will travel with great velocity from the detonator through the detonating cord and booster charge to the projectile burster charge, exploding same. It has been shown that under the conditions here described, the detonation proceeds so rapidly that a projectile having a high explosive burster charge is fragmented within a few inches of encountering the target.

Referring now to Figs. 4 and 5, which show another embodiment of the invention with respect to the means for extending the striker, the main parts of the fuse so far as shown are as previously described except that the striker 40 is not drilled, the support disc 41 is provided with an extruded and pierced central projection 42, and a striker extender spring 43 is added. The latter, a helical compression spring, is assembled inside the piston cup 33 around but clear of the striker shank 40 and is supported and centered at the lower end by the projection 42 of the support disc 41. The extender spring 43 is designed in such manner as to exert, when assembled, a force sufficient to extend the striker 40 against the head air-pressure in flight. By proper design of the spring in relation to the air pressure on the head of the firing pin, the approximate velocity or range at which the fuse is to arm can be predetermined, if desired. Thus, for example, assume that the projectile is fired with a muzzle velocity of 3000 f. s. and it is desired to delay arming until the velocity has decreased to approximately 2000 f. s. or at a range corresponding thereto. Application of known ballistic data and formulae enables the air pressure on the striker head 44 at the lower velocity to be calculated, and by designing the extender spring force to equal this pressure, arming at the approximate velocity or equivalent range can be predetermined as desired. Otherwise, the spring force is designed to exceed the pressure on the striker head 44 at the muzzle velocity, and the striker 40 is extended and the rotor freed for arming as before described. Owing to the action of the rotor, however, complete arming is delayed until the projectile has travelled some distance from the gun.

It will be evident from the foregoing that the invention provides novel and advantageous features in arming means for fuses, and adequately meets the general and special requirements for fuses of this class.

Without further analysis the foregoing will so fully reveal the gist of this invention that others can, by applying current knowledge, readily adapt it for various applications without omitting certain features that, from the standpoint of the prior art, fairly constitute essential characteristics of the generic or specific aspects of the invention, and therefore such adaptations should and are intended to be comprehended within the meaning and range of equivalency of the following claims.

I claim:

1. In a fuse of the class described, in combination, a fuse body formed with an axially concentric cylindrical rotor cavity and carrying a booster charge at the rear end and a detonating train communicating therewith, a cylindrical rotor pivotally in said cavity in such manner as to be free to revolve in a plane transverse to the axis of the fuse body and carrying a detonator adapted to produce detonation of said train and thence of said charge, a nose piece secured to said fuse body formed with an axial bore, an impact striker and arming means therefor mounted in said bore, said striker in the unarmed position acting as a pivot for said detonator rotor permitting said rotor to revolve thereabout, but restraining said rotor from rotating into such position as to make said detonator effective to produce detonation of the booster charge.

2. In a fuse of the class described, in combination, a fuse body with an axially concentric cylindrical rotor cavity, an impact firing pin having an impact head and a shank slidably mounted in the nose of the fuse, means frictionally mounted on said shank for holding the firing pin normally in unarmed position, means coacting with said holding means after firing in a gun to move the firing pin forwardly into armed position, a cylindrical rotor mounted in said cavity, said rotor carrying a detonator and being normally pivoted on said firing pin to maintain the detonator in safe position, said rotor being characterized by being so formed and proportioned that after firing in a gun and after the firing pin is armed, it will roll in said cavity to a stable position to arm the detonator.

3. A fuse of the class described including the combination of a fuse body with a central concentric rotor cavity and safety mechanism therein including an impact firing pin, safety means frictionally mounted thereon for holding the firing pin normally in unarmed position in said body and adapted on setback to release said firing pin preparatory to arming, kinetic means operatively associated with said firing pin and effective after the fuse is fired in a gun to advance the firing pin into armed position, a cylindrical rotor revolvably mounted in said cavity and normally restrained by said firing pin, but free to revolve thereabout, a detonator mounted eccentrically in said rotor, the combination being adapted to prevent the detonator from moving from safe position before or during firing in a gun, but to revolve the detonator into armed position a short interval after firing.

4. A fuse of the class described, including a body formed with a central concentric cylindrical rotor cavity and containing a bore-safe and muzzle-safe firing device comprising a head-striker firing pin, set-back actuated means frictionally mounted thereon normally holding said firing pin in unarmed position and on firing adapted to release said firing pin, a cylindrical rotor carrying an eccentrically mounted deto-

nator and normally pivoted freely on said firing pin, arming means coacting with said set-back means and effective after firing in a gun to extend said firing pin to armed position and simultaneously to release said rotor, and means residing in the form and proportions of the rotor and the rotor cavity to enable said rotor at an interval after firing in a gun to revolve said detonator from the safe to the armed position.

5. A fuse of the class described, including a fuse body having a cylindrical rotor cavity centrally located with its axis concentric with the fuse axis, a cylindrical rotor of materially less diameter than said cavity adapted to roll therein, a firing pin pivotally mounting said rotor and normally holding said rotor eccentrically in said cavity, a detonator mounted eccentrically in said rotor, said firing pin acting successively as pivot means for said rotor and as firing means for said detonator after firing of the projectile, and means for arming said firing pin.

6. A fuse as set forth in claim 5, including means inherent in the form and proportions of the detonator rotor for rolling the rotor to carry the detonator into alignment with the axis of the fuse body after the fuse has been fired in a gun and the arming means has acted.

7. A fuse of the class described including a fuse body formed with an axially concentric cylindrical rotor cavity, an impact striker assembled axially in said body, means for advancing said striker to armed position on firing, cylindrical rotor means carrying a detonator normally mounted eccentrically in said cavity and so formed and proportioned as to roll in said cavity thereby to carry said detonator into armed position in concentric relation to said cavity after firing, and means including said striker for restraining said rotor from rolling said detonator into armed position until after the fuse has been fired in a gun.

8. In a fuse as set forth in claim 7, including, in combination, a head-striker firing pin, frictional means adapted normally to hold said firing pin in unarmed position and on set-back to free said firing pin for arming, and arming means effective after firing for extending said firing pin to armed position.

9. In a fuse, a body structure having a central concentric rotor cavity and a cylindrical rotor eccentrically mounted therein carrying a detonator, said rotor being characterized by inherent means due to form and balance for utilizing the retardation of the spin of the fuse in flight to revolve the detonator from safe to armed position.

10. A rotor element as set forth in claim 9, including the said inherent means due to form and balance for utilizing centrifugal force to maintain said detonator in stable position after rotation into armed position.

11. A sensitive impact fuse for rotative projectiles, including a body part having an axially concentric cylindrical rotor cavity in the approximate center of said body part, a nose part with an axial bore assembled to said body part, firing mechanism assembled in said axial bore including an impact striker having a head, a shank, and a firing point, safety means frictionally mounted on the shank of said striker, kinetic means assembled in said axial bore for arming said striker, and a cylindrical rotor with a detonator mounted eccentrically therein and eccentrically positioned in said rotor cavity, said rotor being normally freely pivoted on said firing point.

12. In a fuse as set forth in claim 11 in which the striker is moved forwardly after firing to release the rotor to permit it to move in the cavity to carry the detonator into armed position.

13. A point detonating impact fuse comprising a body structure formed with an axially concentric cylindrical rotor cavity and carrying a booster charge at the rear end thereof, an impact striker having a firing pin and axially slidable in said body structure, safety means mounted on said striker, means for moving said striker to armed position, a cylindrical self-actuated safety rotor carrying a detonator and pivotally mounted on said firing pin in eccentric relation to said rotor cavity so that the detonator is safe from action by the firing pin and is harmless in the event of premature explosion of said detonator, said rotor being so mounted on the said firing pin as to be released from pivotal action upon movement of the striker to armed position and so formed and proportioned that after the fuse has been fired in a gun and the striker has moved to armed position the rotor will roll in said rotor cavity into armed position whereby the detonator is presented to the action of the firing pin and becomes effective to detonate said booster charge.

14. A fuse as set forth in claim 7 wherein said last named means acts as a pivot for said rotor.

HARRY J. NICHOLS.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
1,870,405	Doe	Aug. 9, 1932
1,561,687	Brayton	Nov. 17, 1925
1,342,652	Sullivan et al.	June 8, 1920
1,352,543	Schneider	Sept. 14, 1920
2,030,085	Woodberry	Feb. 11, 1936
1,774,043	Summerbell	Aug. 26, 1930

FOREIGN PATENTS

Number	Country	Date
127,924	Great Britain	June 19, 1919
145,829	Great Britain	June 28, 1920
505,055	France	Apr. 23, 1920
760,486	France	Dec. 14, 1933