Dec. 7, 1948. H. J. NICHOLS 2,455,603

FUSE

Filed April 14, 1943 2 Sheets-Sheet 1

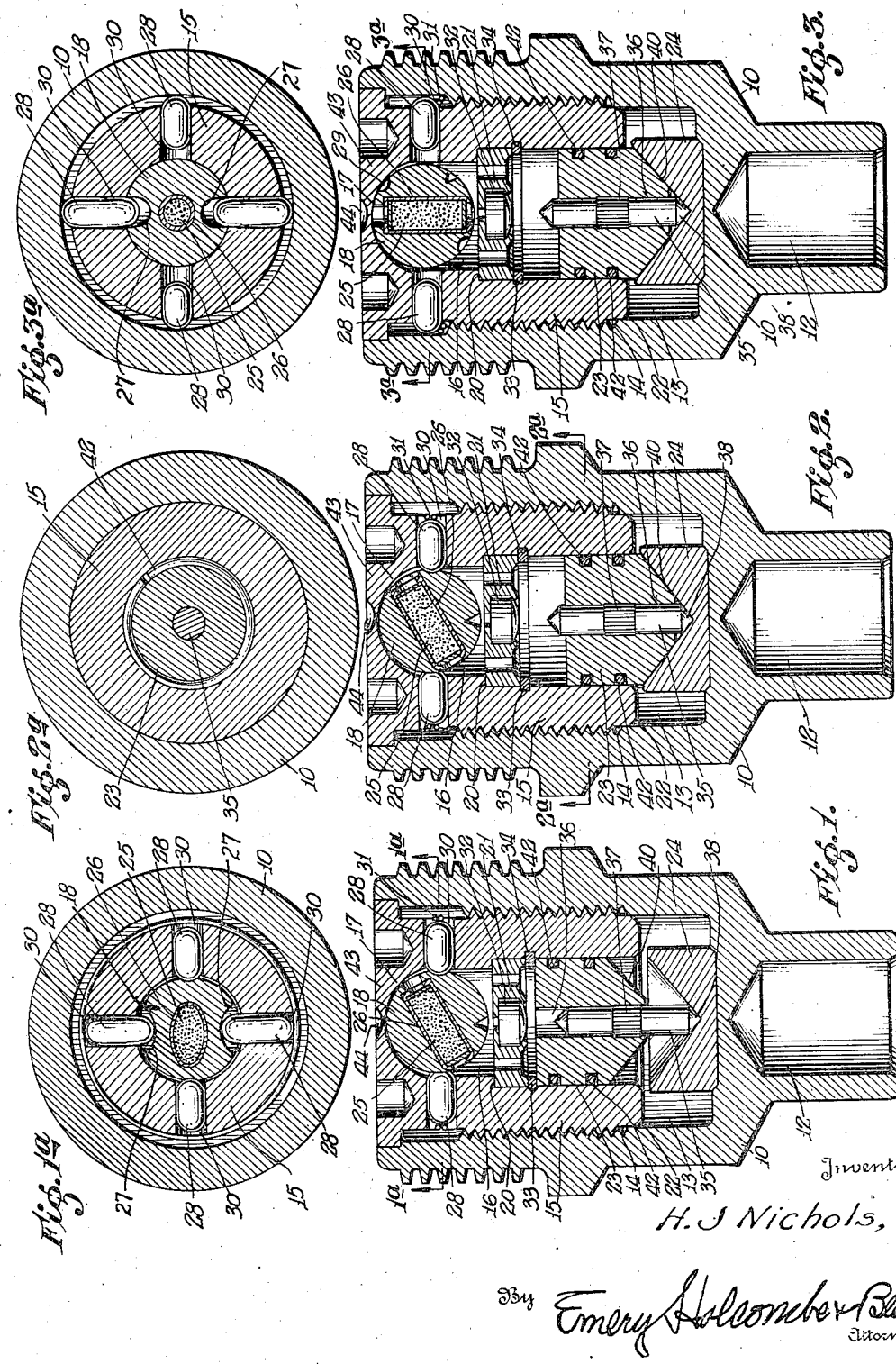


Fig. 3a

Fig. 3.

Fig. 2a

Fig. 2.

Fig. 1a

Fig. 1.

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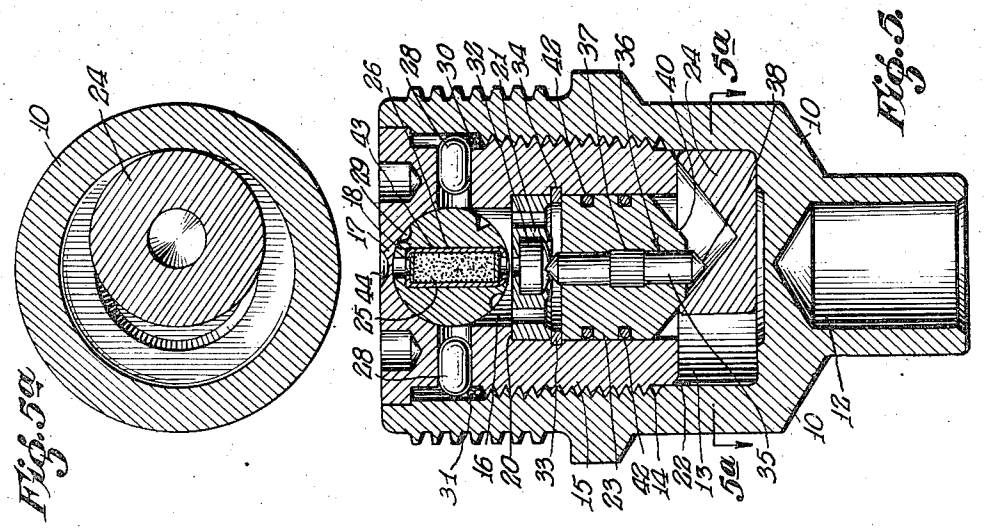


Fig. 5a

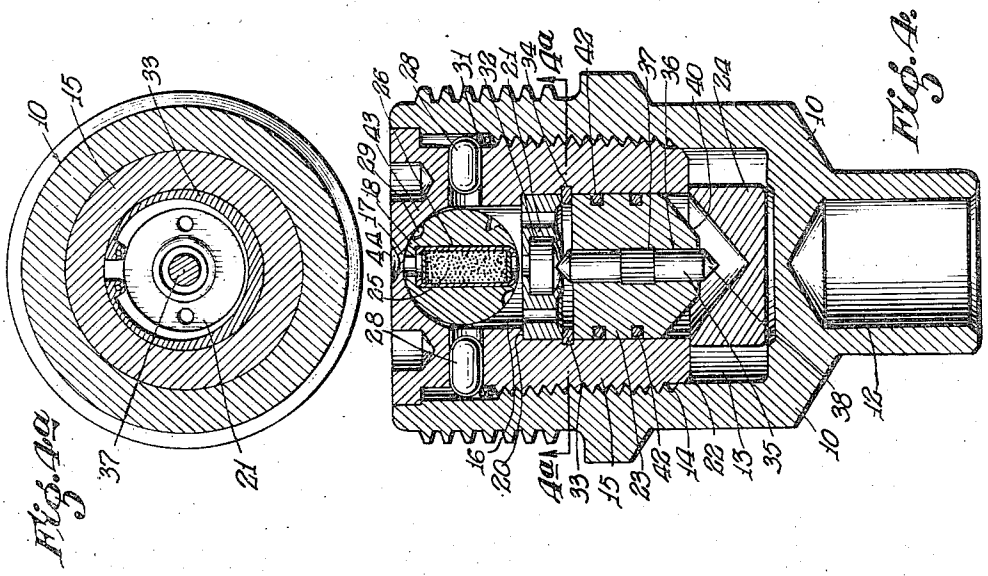


Fig. 4a

Fig. 4.

Fig. 5.

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2,455,603

FUSE

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Application April 14, 1943, Serial No. 483,028

5 Claims. (Cl. 102—79)

1

This invention relates to base detonating fuses for armor piercing high-explosive projectiles, such as anti-tank projectiles.

The invention will accordingly be hereinafter described with relation to such application, but it is to be understood that without material modification many features are equally applicable to other types of fuses.

Detonating fuses for small armor piercing projectiles present particular difficulties because of the tremendous forces to which they are subjected in firing and during penetration of armor. They must contain a relatively large detonator capable of producing high-order detonation of relatively insensitive explosive shell-fillers, yet at the same time they must be entirely safe in storage, handling and firing, and reliable in action on impact.

In general, fuses of this type are required to be (1) simple in design and operation, (2) easy to manufacture and load, (3) free from deterioration in storage, (4) safe in handling and storage, and (5) certain in action.

In particular, the fuse of the invention meets these requirements and provides the additional features of short delay action on substantially normal impact, and graze action on striking a target at highly oblique angles where a percussion fuse of conventional design would fail to act through lack of sufficient axial retardation in relation to the transverse force of impact. The fuse is also adapted to carry a tracer in the base. The firing mechanism is detonator-safe, bore-safe, and muzzle-safe.

These features in combination make the fuse of the invention particularly useful for attacking tanks and their accompanying forces, armored cars and trains, pill boxes, and other armored or protected targets.

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

Other objects will be in part obvious and in part hereinafter indicated in the description of this embodiment of the invention.

In the drawing forming part of this disclosure and illustrating one of various possible embodiments, like characters of reference denote corresponding parts throughout the several views, in which—

Fig. 1 shows in enlarged longitudinal cross section a base percussion detonating fuse according to the invention, the mechanism being shown in unarmed or safe position;

2

Fig 1*a* shows in transverse cross section a view of Fig. 1 taken at the plane indicated by *a—a* in Fig. 1;

Fig. 2 shows the same fuse in the same section as in Fig. 1, the mechanism being shown in firing position, that is, while in the bore of the gun while being fired therefrom;

Fig. 2*a* shows the fuse of Fig. 2 in transverse cross section at the plane indicated by 2*a*—2*a*;

Fig. 3 shows the same fuse in the same section as in Fig. 2, but with the mechanism in the position of flight after firing;

Fig. 3*a* shows the same fuse as in Fig. 3 in transverse cross section at the plane indicated by *a—a* in Fig. 3;

Fig. 4 is another longitudinal cross section of the same fuse, the mechanism being shown in exploding position as a result of substantially normal impact with a target;

Fig. 4*a* is a section on line D—D of Fig. 4;

Fig. 5 is a further longitudinal section of the same fuse, the mechanism being shown in exploding position as the result of highly oblique or graze impact with a target; and

Fig. 5*a* is a section on line E—E of Fig. 5.

Referring now to these drawings and especially to Figs. 1 and 1*a*, the main structural member of the fuse is the body **10** of relative massive proportions and preferably of impact resisting alloy steel, with strong external screw threads **11** for assembly to the base of the projectile (not shown). The body is preferably bored out at the rear with respect to the base of the projectile to provide a blind cavity **12** in which a pyrotechnic tracer is adapted to be loaded, although this feature can be omitted without detriment to the fuse mechanism. The body **10** is also bored out from the front or inner end to provide an internal blind bore **13** in which the firing mechanism is assembled. The bore **13** is slightly recessed at the bottom for a purpose to be described later, and the front portion of the bore is threaded at **14** to provide a strong connection for the rotor housing **15** which is screwed therein. This housing **15** is bored out from the inner end almost to the outer end to provide a blind cavity **16** with a spherical seat **17** adapted to bear a round rotor **18** of the general type disclosed in my application Serial No. 303,294, filed November 7, 1939, now Patent No. 2,446,019. It is also counterbored to provide a shoulder **20** to support a primer holder **21**, and a cavity **22** to receive an inertia percussion plunger **23**. Rearwardly of the percussion plunger **23** is mounted in a special manner a "graze" disc **24**.

The rotor **18**, of general centro-symmetric round form, has a diametral bore containing a

detonator 25, preferably enclosed in a metallic capsule 26, and two similar torque increasing grooves or channels 27 extending on opposite sides of and parallel to the detonator bore. The rotor 18 is normally retained in unarmed position in which position the axis of the detonator 25 lies obliquely to the axis of the fuse and is therefore ineffective to produce detonation. The rotor 18 is held in unarmed position by four detents 28 working in diametral cross holes 30, the longer two of which extend into the torque increasing channels 27 to provide loose pivots for the rotor, and the shorter two into shallow recesses 29 at right angles, Fig. 1*a*, located diametrally opposite on the equator of the rotor 18. The detents 28 are elastically held in position of engagement with the rotor by a circlet spring 31 mounted in an annular groove in the rotor housing.

The primer holder 21 mounts a primer 32 in the axis of the fuse, and is retained in position on shoulder 20 by a retainer ring 33 partly recessed in a groove 34. A firing pin 35 having a firing point on its forward end is a slide fit in an axial hole 36 in plunger 23, except for the over-size knurled portion 37, which upon being forced partly in plunger 33 provides a connection therewith of predetermined strength. The conical rear end 38 of firing pin 35 seats in a conical recess 40 in graze disc 24 to maintain that disc in concentric relation to the axis of the fuse. Shallow recess 41 in the bottom of bore 13, as priorly mentioned, also aids in keeping the graze disc 24 concentric. The plunger 23 has a similar conical rear end to fit the cone 40 and is provided with a pair of grooves in which are seated expansion rings 42 respectively which act jointly as an anticreep device and also hold the plunger 23 firmly in the armed position during flight, preventing side-wise movement of graze disc 24 until impact.

Referring to the drawings in sequence, the operation is as follows:

In Fig. 1, which shows the mechanism in assembled position, which is also the safe, unarmed position, it is to be noted that the plunger 23 masks the firing point of pin 35 from primer 32; and firing pin 35 holds the graze disc 24 centered; and the detents 28 retain the rotor 18 in unarmed position.

In Fig. 2, which shows the relative position of the parts of the mechanism during firing from a gun, all parts tend strongly to move towards the rear due to their inertia while the projectile is being accelerated, this tendency being known as "set-back." The plunger 23 is driven rearwardly by set-back, unmasking the firing point 35 and seating itself in the conical seat in the graze disc 24. Simultaneously, circlet spring 31 slips backwardly as shown due to set-back, releasing detents 28. But due to set-back, detents 28 and rotor 18 are immobilized and cannot respond to any centrifugal force acting while the projectile is in the bore of the gun.

In the event the primer or the detonator should be set off by the force of concussion of firing, the detonator would explode harmlessly. And should the projectile encounter coppering or any other obstacle in the bore of the gun capable of momentarily reversing the acceleration of the projectile, the rotor 18 would be unable to arm the detonator while the projectile remained in the bore of the gun. Hence, it is evident that the invention provides adequate safe guards against premature explosion of the detonator, and the fuse can be properly termed "detonator-safe" and "bore-safe."

Referring to Fig. 3 which shows the position of the parts after the projectile leaves the muzzle of the gun, after the acceleration of the projectile ceases the detents 28 are thrown outwardly, freeing the rotor 18 which thereupon responsively to centrifugal force turns the detonator 25 into alignment with the axis of the fuse, completing the arming of the exploding mechanism. It is to be noted that the arming takes place in two stages, namely, the arming of the firing pin and the removal of the restraint of the circlet spring 31 on the detents due to set-back in the gun; and the lateral movement of the detents and the turning of the rotor to arm the detonator responsively to centrifugal force after the projectile leaves the muzzle of the gun. This latter stage in the arming is not complete until the projectile is fifty feet or more beyond the muzzle of the gun, hence it is evident that the firing mechanism of the invention is "muzzle-safe" as well as "detonator-safe" and "bore-safe."

Referring to Fig. 4, on striking a target the projectile will be suddenly checked in flight and the percussion plunger 23 will continue onward due to its inertia, thus plunging relatively forward and thereby striking the firing point against the primer 32, exploding same. The primer will after a very short delay ignite the detonator 25 which will instantly explode, breaking through the thin diaphragm 43 of the concentrator hole 44, thereby delivering an exploding blow to the explosive shell-filler (not shown) which fragments the projectile. It is to be noted that the intensification of the detonator force by the concentrator hole 44 enables the detonator to explode the shell-filler directly, thus eliminating the need for a booster charge which has heretofore been considered essential for fuses of this class. This novel feature of the invention enables the fuse to be made smaller and simpler, saves the cost of the booster explosive and the loading thereof, provides more room in small projectiles for shell-filler, and generally adds to the efficiency of the fuse as a whole.

It is also to be noticed that should the threads holding rotor housing 15 in body 10 be stripped due to the force of impact, the housing will hold the exploding mechanism intact, thereby enabling the fuse to function as designed despite such structural failure.

Referring now to Fig. 5, which shows the "graze-action" of the fuse, on striking a target at a highly oblique angle or on glancing from the ground, the projectile is exploded in the manner just described, except that the primary cause is not the forward thrust of the percussion plunger on striking the target, but is rather the transverse movement of the graze disc 24 due to its inertia relative to cross-forces resulting from the impact. The origin and manner of acting of cross-forces on oblique impact of projectiles with armor is described in detail in my U. S. Patent No. 1,656,361, dated January 17, 1928. For present purposes, it need only be considered that on oblique impact with armor the cross-force may exceed the axial retarding force, whereupon the usual percussion plunger will fail to act. But under such circumstances, the graze disc will be driven forcibly side-ways, and the conical, concave surface thereof will wedge the percussion plunger forwardly as shown, exploding the primer and starting the detonating train priorly described. Thus the graze disc improves

the performance of the fuse on oblique impact with armor and other targets, while the short delay burst increases the destructiveness of projectile against the target in well understood manner.

As a further example of the advantages provided by the invention, it may be cited that when a projectile fired at a tank misses its target, which happens in the great majority of cases, solid shot or conventionally fused projectiles usually glance off the ground back of the target and land in the rear beyond the theater of action without military result. But with the fuse of the invention, such "misses" will explode immediately after glancing from the ground, producing the effect of high-explosive shrapnel. Such graze action bursts are known to be highly effective against unsheltered troops, as for example the tank accompanying troops in desert warfare. Thus by means of the fuse of the invention, armor piercing anti-tank projectiles are made more efficient against other incidental targets, and their military value is enhanced.

To summarize, the novel fuse of the invention provides a burst after a short delay back of armor plate encountered at normal and oblique angles, and on glancing impact with the ground or other obstruction an air burst after a short delay, simulating shrapnel fire. These fuse characteristics enhance the military value of anti-tank projectiles, particularly with respect to their effectiveness against incidental troops. These advanced features are obtained with a safe, simple, reliable, and rugged mechanism, able to withstand the most severe impacts.

Without further analysis, it should be evident from the foregoing that the invention provides novel and advantageous features in fuses, and that the invention as a whole, while simple in form, meets the complex general and special requirements for fuses of this class in a highly efficient and practical manner.

I claim:

1. In a base detonating fuse for explosive armor-piercing projectiles for rifled guns, in combination, a cylindrical fuse body having an axial bore; and detonating mechanism therein comprising a substantially spherical centrifugally armed rotor mounted on the axis of the fuse at the forward end of said body, a detonator carried by said rotor in normal safe position, means for retaining said rotor in unarmed position, a percussion plunger carrying a firing pin and mounted axially slidable, a holder carrying a primer for igniting said detonator mounted between said rotor and said plunger, and transversely movable means mounted rearwardly of said plunger and having a wedging relation thereto for forcing said firing pin into exploding relation to said primer upon oblique impact with a target.

2. In a base detonating fuse of the class described, in combination, a cylindrical fuse body having an axial bore, and detonating mechanism therein comprising a substantially spherical centrifugally armed rotor mounted on the axis of the fuse at the forward end thereof and carrying a cylindrical detonator in normal safe position, said rotor having a pair of channels for increasing the centrifugal torque thereof, a holder carrying a primer for igniting said detonator mounted rearwardly of said rotor, and a percussion element mounted for axial movement relative to said holder and carrying a firing pin adapted to explode said primer on substantially normal impact with a target.

3. In a base detonating fuse of the class described, in combination, a cylindrical body having an axial bore and detonating mechanism therein including a centrifugally actuated rotor carrying a cylindrical detonator mounted diametrically therein, means for normally holding said rotor in unarmed position but removable by centrifugal force, and means for exploding said detonator including a percussion plunger and a firing pin, said plunger being adapted to slide longitudinally on said firing pin at set-back to arm said firing pin, said rotor being characterized by having a pair of channels for increasing the centrifugal torque thereof.

4. In a fuse for rotative projectiles, in combination, a substantially cylindrical body adapted for assembly with such projectiles and having an axially concentric bore, a housing structure assembled in said bore carrying a symmetrical rotor carrying a cylindrical detonator in safe position and mounted for rotation in said housing when released, said rotor being adapted to turn said detonator to armed position responsively to centrifugal force, means for normally retaining said rotor in unarmed position and for releasing same for rotation when said fuse is fired in a projectile; and firing means for said detonator when in armed position, including a cylindrical percussion element slidably assembled in said structure and having a coaxially extending firing pin, and an inertia element mounted for transverse movement in said body and adapted to wedge said percussion element axially towards said detonator upon oblique impact of said projectile.

5. In a base detonating fuse for rotative anti-tank projectiles, in combination, a hollow cylindrical fuse body adapted for assembly with such projectiles, and percussion firing mechanism therein characterized by multiple safety means and by being particularly adapted to provide reliable exploding action upon oblique impact with armor or grazing impact with the ground comprising a detonator, a symmetrical centrifugally actuated safety rotor carrying said detonator, safety means for normally retaining said rotor in safe position and for releasing it for rotation when the fuse is fired in a gun, safety firing means for said detonator including a percussion element having an axial bore with a normally masked firing pin therein, and oblique impact firing means including a transverse inertia element adapted to wedge said percussion element axially to cause firing of said detonator upon impact with a target or incidental obstruction at a greater angle of obliquity than will normally actuate said percussion element.

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