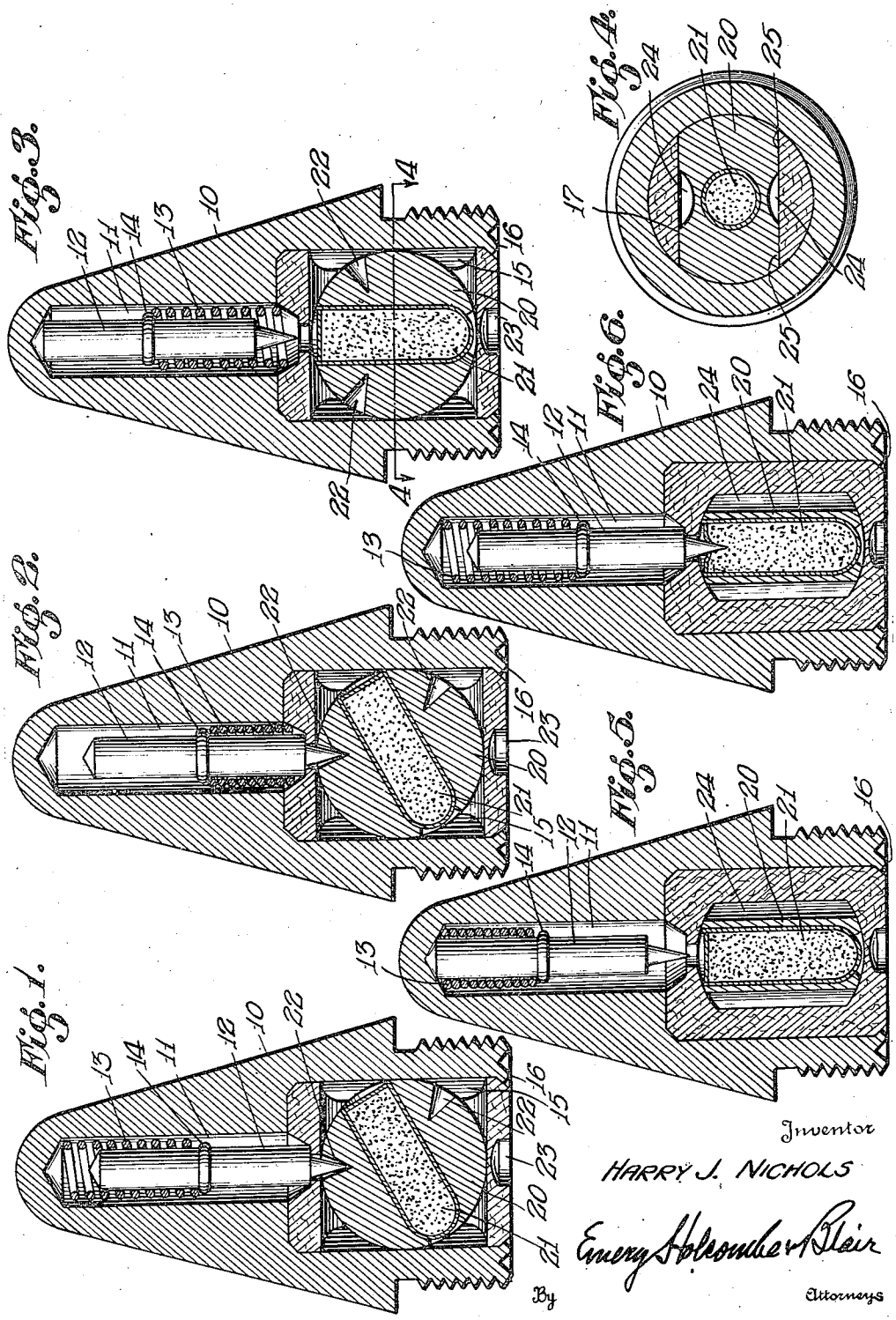
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FUSE

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FUSE

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This invention relates to point detonating fuses especially designed for small aircraft and anti-aircraft projectiles for automatic cannon, 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 projectiles for automatic cannon, in calibres of 20 mm. to 40 mm., inclusive, present particular difficulties because of their small size and the great accelerating and centrifugal forces to which the mechanism is subjected when fired in the gun, during flight, and on impact with the target. They must contain a relatively large detonator capable of producing high-order detonation of relatively insensitive explosives, yet at the same time they must be entirely safe in storage, handling, and firing.

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 using, and (5) certain in action.

In particular, because of the great force of acceleration or "set-back" on firing, amounting to approximately 75,000 times the weight of any component fuse part in the case of 20 mm. cannon, the detonator may be exploded by this great force of concussion. This possibility makes a "detonator-safe" feature highly desirable. This feature assures that in the event the detonator is exploded by heat or accident before firing or in the bore of the gun on firing, the explosion will be so limited as not to disrupt the fuse, nor to cause break-up nor explosion of the projectile.

Since a relatively strong retarding force due to the air resistance acts on the projectile as it emerges from the muzzle of the gun, and also since the projectile may simultaneously strike a weather seal or other light protective cover, or even some part of the plane in some cases, a "muzzle-safe" feature is also highly desirable. In other words, the fuse must be so constructed that it will be safe against exploding while in the gun and for a short distance beyond the muzzle of the gun.

During flight, the projectile rotates at great speed, exceeding 100,000 R. P. M. in the case of 20 mm. cannon. Therefore, each component of the fuse should be dynamically balanced with respect to the axis of rotation in order to avoid unbalance which might cause failure of the fuse to function, or destroy the ballistic stability of the projectile in flight.

Whereas prior to World War II anti-aircraft

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fuses were generally required to be highly sensitive so as to explode instantly on striking the flimsiest part of an airplane or even the fabric of a balloon, the great increase in the size of airplanes and the introduction of aircraft armor, often in multiple layers, has necessitated a fuse action which differentiates between light and heavy obstacles, and which usually produces a slight delay in the burst, so as to produce the greatest effect behind any protective covering or against the skeletal parts of the airplane.

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

A further object is to provide a fuse of the above character having relatively few parts which may be inexpensively manufactured and assembled.

A further object is to provide a fuse of the last-mentioned character which will be detonator-safe, bore-safe and muzzle-safe.

A further object is to provide a fuse of the above character adapted to function or explode the main charge at different relative times with respect to the nature of the target being hit.

Other objects will be in part obvious from the annexed drawings and in part hereinafter indicated in the description of this 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 longiudinal cross-section enlarged several times, a point-impact detonating fuse especially for 20 mm. projectiles illustrating one embodiment of the invention, the mechanism being shown in unarmed position, that is, normal safe position;

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 during firing therefrom;

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

Fig. 4 is a transverse cross section of the fuse shown in Fig. 3, the section being taken at the plane indicated by 4—4 in Fig. 3;

Fig. 5 is a longitudinal section of the same fuse, but with the mechanism in the position of impact with a relatively light target; and

Fig. 6 is a longitudial section of the same fuse with the mechanism in the act of exploding the detonator.

Referring now to these drawings, and particularly to Fig. 1, the main structural member of

the fuse is the body 10 of conical contour and with external screw threads for assembly to the projectile (not shown).

The forward portion of the body 10 is provided with a cylindrical bore 11 in the axis of which the firing pin 12 is retained in the position shown by a bodily movable helical combined safety and firing spring 13 which bears against a small circular bead or detent means 14 formed near the mid-section of the firing pin 12. In the base of the body 10 is a main cylindrical bore adapted to receive the rotor housing 15 which is securely held in place at assembly by a spun-over lip 16 formed from the body as shown, or by a threaded connection if desired.

The rotor housing 15 has a rectangular cross-slot 17 which rotatably supports edgewise therein a round safety rotor 20, shown in transverse section in Fig. 4, so that its axis of rotation crosses the axis of the fuse at right angles. This rotor 20 has a diametrical bore in its equatorial plane adapted to receive a detonator 21 (preferably sealed in a thin metal capsule), and one or more small tapered holes 22 located on the equator at an angle of say 60° to the axis of the detonator hole. The point of the firing pin 12 extends into one of the tapered holes 22 to retain the rotor so that the detonator 21 is normally positioned obliquely, so as to be masked from the firing pin 12 and in safe relation to the lead-out hole or recess 23. The rotor is of special centro-symmetric form, that is, the rotor is substantially symmetrical with respect to its center of gravity and to the axis of the diametrical bore. The preferred form is a sphere with two diametrically opposite and equal, parallel ends. The rotor thus has a form and structure which makes the detonator axis a principal axis passing through its center of gravity, so that while it is virtually statically balanced as it lies obliquely in the housing, it is dynamically unbalanced with respect to the axis of the fuse which is also the axis of rotation of the projectile. But when the detonator is rotated into alignment with the axis of the fuse as in Fig. 3, the rotor is dynamically balanced with respect to that axis. The rotor can also take the form of a short cylinder.

Referring to Fig. 4, it is seen that a diametrical channel 24 is formed in each end of the rotor, these channels extending substantially parallel to the axis of the detonator hole 21. Equal diametral centrifugal masses 25 are thus provided on each end of the rotor which masses upon rotation of the fuse about its axis produce a centrifugal torque-couple tending to rotate the rotor 20 counter-clockwise to bring the detonator 21 into alignment with the axis of the fuse. There may also be a minor centrifugal torque due to a difference in specific gravity of the detonator and the rotor metal which it displaces, but this minor torque is generally ineffective to turn the rotor if there is any eccentricity of rotation, such as occurs due to the yaw of the projectile in flight. The torque-couples due to the centrifugal masses tend automatically to compensate for minor eccentricity in flight due to yaw. Hence, the centrifugal masses may be considered to produce the torque effect which turns the detonator into armed position as shown in Fig. 3. Once in this position, the torque-couples combine to hold the rotor in a dynamically stable condition with the detonator in alignment with the fuse axis. Thus, when the rotor turns into armed position in response to centrifugal force, the same force and the restraint of the rotor housing positively maintains it in armed position against displacement by any extraneous force or forces. The need for rotor locking detents and the like, typical of prior art, is thus avoided, and the rotor is in effect self-locking in armed position.

Referring again to Fig. 1, the firing spring 12 is assembled partly compressed between the end of the bore 11 and the bead 14 on the firing pin, thus maintaining the point of the firing pin securely in the tapered hole 22 in the rotor 20, this being the same identical relative position to the fuse body as it is in exploding position, as shown in Fig. 6. Since the rotor normally has no particular tendency to turn out of position, the firing point suffices to hold the rotor 20 securely in position against accidental displacement, even when subjected to jolting and jumbling tests. Thus, it is evident that the invention provides a fuse arming mechanism of extreme simplicity but of great security.

Referring now to the figures in sequence, the operation of the fuse mechanism is as follows:

In Fig. 1 the parts are shown in the position in which they are assembled, and the detonator 21 is maintained in safe position as described above. On firing in a gun, the condition of the fuse mechanism becomes that shown in Fig. 2, in which set-back has caused the firing spring 13 to slide bodily downwards over the bead 14 on the firing pin to the opposite end of the chamber 11. The great force of set-back, which may amount to as much as 70,000 times the weight of the spring, fully compresses the spring 12 below the bead 14 as shown. It is to be noted that the same powerful set-back holds the firing point of pin 12 securely in the hole 22 in the rotor 20 preventing any possibility of the rotor turning the detonator into armed position while this force is acting. In the event of coppering or other obstructions in the bore of the gun capable of reversing the acceleration of the projectile, the firing pin 12 might be propelled forwards, but the effect of momentary reversal of acceleration on the rotor would be to hold it in unarmed position as shown.

When the projectile emerges from the muzzle of the gun, the firing spring 13 lifts the firing pin 12 forwardly, thereby freeing the rotor 20 which shortly thereafter turns about its axis to bring the detonator 21 into armed position as shown in Fig. 3. Meanwhile, before the detonator is completely armed, the projectile has proceeded many feet beyond the muzzle of the gun, thus clearing any nearby obstructions which might explode the projectile prematurely.

It will be evident from the above description of the functioning of the fuse during firing from the gun that the detonator does not become armed until the projectile has passed well beyond the muzzle of the gun, hence the fuse is "detonator-safe," "bore-safe" and "muzzle-safe."

During flight the fuse continues in the condition shown in Fig. 3 until an obstacle is encountered, whereupon the type of action will depend upon the solidity of the obstacle. First should this obstacle be thick armor, a heavy structural member, or like massive structure, capable of defeating the projectile, the point of the fuse will be driven inwardly, stabbing the firing pin 12 into the detonator 21 to produce an instantaneous burst of the projectile. As a second alternative, should the obstruction be of medium solidity penetrable by the projectile, such as thin armor or so-called "burster" plate, the firing spring 12 will slide bodily back over the ring or bead 14 into the position shown in Fig. 5, and

on emergence of the projectile after penetrating the obstruction, the then cocked firing spring 14 will drive the firing pin 12 into the detonator as shown in Fig. 6 to produce a short delay burst.

As a third alternative, should the first obstacle encountered be quite thin, such as the skin of a plane for example, then the percussion force acting on the firing spring will not suffice to cause the firing spring 12 to slip back over the ring or bead 14 and the spring will prevent the firing pin 12 from bouncing back due to the shock of impact, hence fuse action will not occur until a more substantial obstruction is encountered. This third alternative action is specifically designed to defeat the so-called "burster-plate" protection by delaying the fuse action until after penetration of the main armor.

To summarize, the triple action fuse of the invention provides first an instantaneous burst on heavy impacts likely to defeat the projectile; second, a burst after a short delay on medium armor and solid obstructions; and third, on very thin armor such as "burster-plate," fuse action is suppressed until a more substantial obstruction is hit. These three alternative fuse actions are obtained by a very simple mechanism, thereby avoiding the complex mechanisms of fuses of the prior are which provide automatic alternative action dependent upon the nature of the target.

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 fuse of the class described, a fuse body and safety arming and automatic delay action exploding mechanism therein comprising, in combination, an axially slidable firing pin normally mounted in exploding position, said firing pin having means near its mid-section for sustaining the thrust of a spring, spring means mounted co-axially with said firing pin for normally exerting pressure thereon to maintain said firing pin in exploding position, and for moving the firing pin to armed position after firing in a gun, a detonator, a centrifugal rotor carrying said detonator and normally maintained in unarmed position by said firing pin, and means including said spring and said firing pin for automatically delaying the explosion of said detonator until after penetration of armor defeated by the projectile, while permitting instananeous explosion of said detonator on encountering armor likely to defeat the projectile.

2. In a fuse of the class described, in combination, a fuse body adapted for mounting in the nose of a projectile including a firing pin bore and a rotor chamber; a substantially cylindrical firing pin having a point at one end and detent means near its mid-section positioned axially in said bore; a centrifugal rotor carrying a detonator in safe position rotatably mounted in said chamber; and a helical spring coiled about said firing pin and coacting with said detent means normally for holding said firing pin in safe position in retaining engagement with said rotor, and after set-back for moving said firing pin to armed position thereby releasing said rotor.

3. In a fuse of the class described, in combination, a fuse body adapted for mounting in the nose of a projectile and having a firing pin bore and a rotor chamber, a firing pin with detent means near its mid-section axially slidable in said bore, a centrifugal rotor with a detonator in safe position rotatably mounted in said chamber, and a helical spring coiled about the forward position of said firing pin and normally coacting with said detent means to hold said firing pin in unarmed position and adapted upon set-back to slide bodily over said detent means to the rearward portion of said firing pin thereafter to move said firing pin to armed position and upon impact with a target to return to its original position and thereafter to force said firing pin into exploding engagement with the detonator.

4. In a fuse of the class described, in combination, a fuse body adapted for mounting in the nose of a projectile and having a firing pin bore and a rotor chamber, a substantially cylindrical pointed firing pin axially slidable in said bore, a centrifugal detonator holder with a detonator in safe position mounted in said chamber, a helical spring coiled around the forward portion of said firing pin, and detent means positioned near the mid-section of said firing pin with which said spring coacts normally to hold said firing pin in unarmed position and over which said spring moves bodily at set back to a compressed position around the rearward portion of said firing pin.

5. In a fuse of the class described, in combination, a fuse body adapted for mounting in the nose of a projectile and having a firing pin bore and a rotor chamber; a pointed firing pin having detent means formed near its mid-section and axially slidable in said bore; a centrifugal rotor carrying a detonator rotatably mounted in said rotor chamber; and a helical spring coiled about said firing pin and coacting sequentially with said detent means for maintaining said firing pin in retaining engagement with said rotor until the fuse is fired in a gun, for thereafter moving said firing pin into armed position, and upon impact of the fuse with a target for causing said firing pin to explode said detonator after penetration of said target.

6. In a fuse of the class described having a fuse body adapted for assembly to a rotative projectile and detonating means housed therein, in combination, an axially slidable firing pin having a spring support member and a firing point adapted to explode a detonator, a cylindrical detonator, centrifugally actuated safety means for carrying said detonator normally in unarmed position with its axis oblique to the axis of the fuse body and for rotating said detonator into armed position after the projectile is fired in a rifled gun comprising a rotor carrying said detonator in a diametrical bore and having means for producing a centrifugal torque couple exceeding any rotary effect due to said diametrical bore, safety means for said rotor including said firing pin, and safety means for successively retaining, arming, and propelling said firing pin comprising a compression spring coacting with said support member carried by said firing pin.

7. In a fuse of the class described, in combination, a fuse body adapted for mounting in the nose of a projectile for rifled cannon, firing and detonating means in said body including an axially slidable detonator firing pin and a movable cylindrical detonator normally carried in safe position obliquely to the axis of the fuse body, centrifugally actuated detonator arming means comprising a rotor concentrically mounted in said body and carrying said detonator in said safe position in a diametrical hole therein; and combined safety, arming, and firing means operatively connected

with said firing pin, comprising a compression spring surrounding said firing pin in part and adapted to act thereon normally to hold said firing pin in detaining engagement with said rotor and after firing to arm said firing pin and after impact with a target to propel said firing pin into exploding relation with said detonator.

8. In a fuse of the class described, in combination, a fuse body and safety arming and delayed-action exploding mechanism therein comprising; an axially slidable firing pin having a spring support member and a firing point adapted to explode a detonator, said firing point being assembled in detonator exploding position in retaining engagement with a rotor; a firing spring mounted coaxially on said firing pin in compression between said support member and said body for retaining said firing point in detonator exploding position and for moving said firing pin to armed position after firing in a gun; a centrifugal rotor carrying a detonator normally held in unarmed position by said firing point and adapted to rotate said detonator into armed position after firing in a gun and upon release by said firing point; the aforesaid firing spring also being adapted to return said firing point forcibly from armed position to exploding position upon penetration of the target.

9. In a fuse of the class described, in combination, a fuse body adapted for mounting in the nose of a rotative projectile and having an axial firing pin bore and a rotor chamber, a firing pin having a detonator firing point and a bead near its mid-section mounted axially slidable in said bore, a centrifugally actuated rotor having a detonator mounted in a diametrical cavity therein rotatably mounted in said chamber and normally retained in unarmed position by said firing point, and combination safety and arming means for said firing pin comprising a compression spring coacting with the aforesaid bead to retain said firing pin in unarmed position, and characterized by being adapted to slide bodily over said bead when the projectile is fired and thereafter to move the firing pin to armed position.

10. In a point detonating fuse having a fuse body adapted for mounting in the nose of a projectile and detonating means therein; the combination of a firing pin having a firing point adapted to explode a detonator, a stem, and a spring supporting bead on said stem; and a combination safety, arming, and propelling compression spring adapted to coact with said bead on said firing pin normally to hold said firing pin in safe position, after firing to move said firing pin to armed position, and after penetrating a target to propel said firing pin to detonator exploding position.

11. In a point detonating fuse having a fuse body adapted for assembly to the nose of a projectile and firing mechanism therein, the combination of a firing pin having a stem with a spring detaining element thereon; and a compression spring mounted axially slidable on said stem so as normally to coact with said detaining element to maintain said firing pin in assembled position, on firing in a gun to slide bodily over said detaining element, and thereafter to move said firing pin to an operative position.

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