June 21, 1932. T. B. DOE 1,863,838

FUSE FOR ANTIAIRCRAFT PROJECTILES

Filed June 6, 1930 2 Sheets-Sheet 1

Fig. 2.

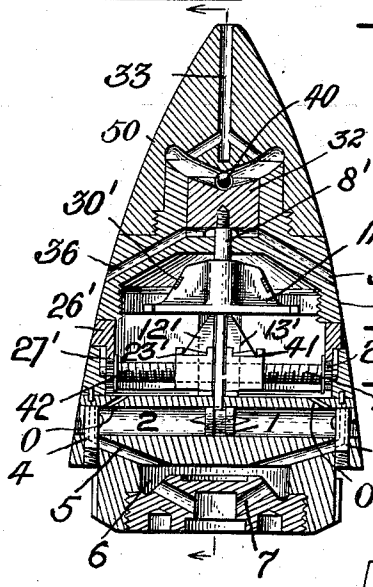


Fig. 3.

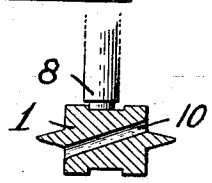


Fig. 4.

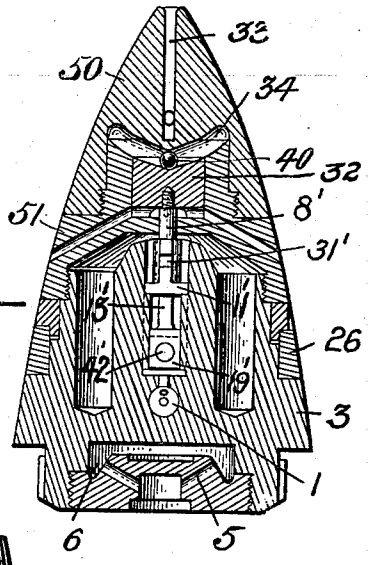


Fig. 5.

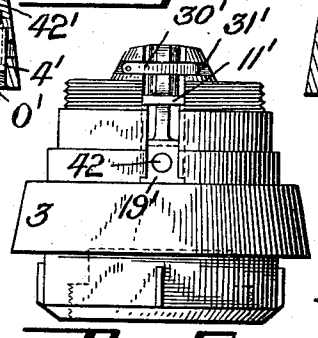


Fig. 1.

Fig. 6.

Fig. 7.

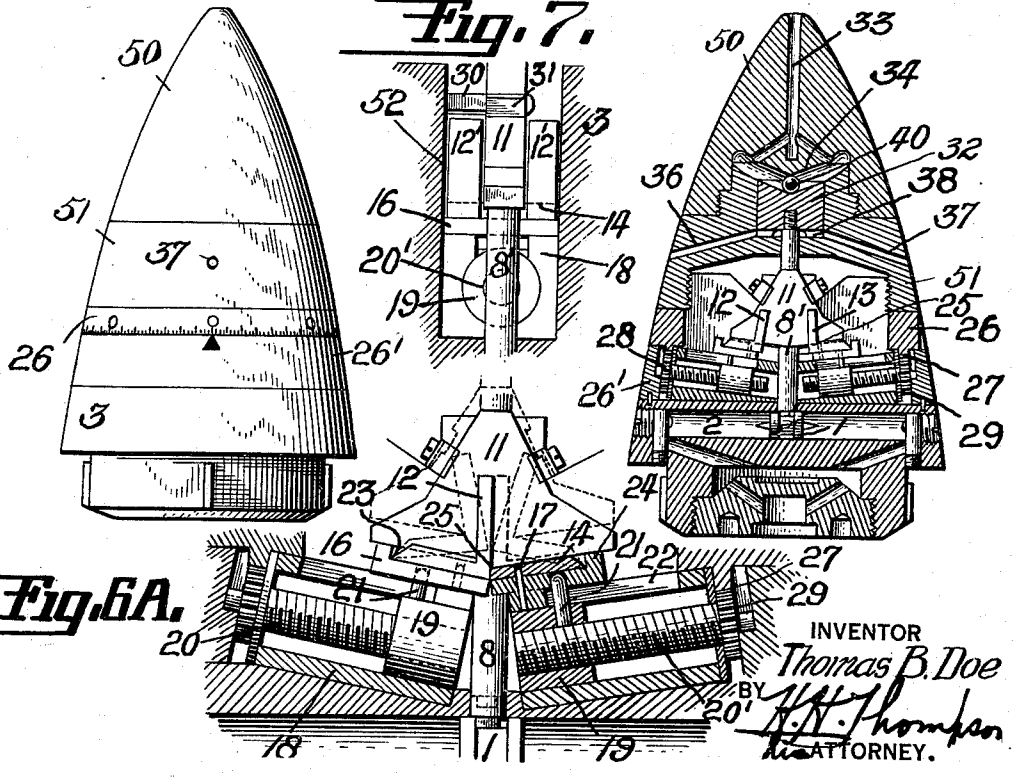


Fig. 6A.

INVENTOR
Thomas B. Doe
BY
H. N. Thompson
ATTORNEY.

June 21, 1932. T. B. DOE 1,863,838

FUSE FOR ANTIAIRCRAFT PROJECTILES

Filed June 6, 1930 2 Sheets-Sheet 2

Fig. 9.

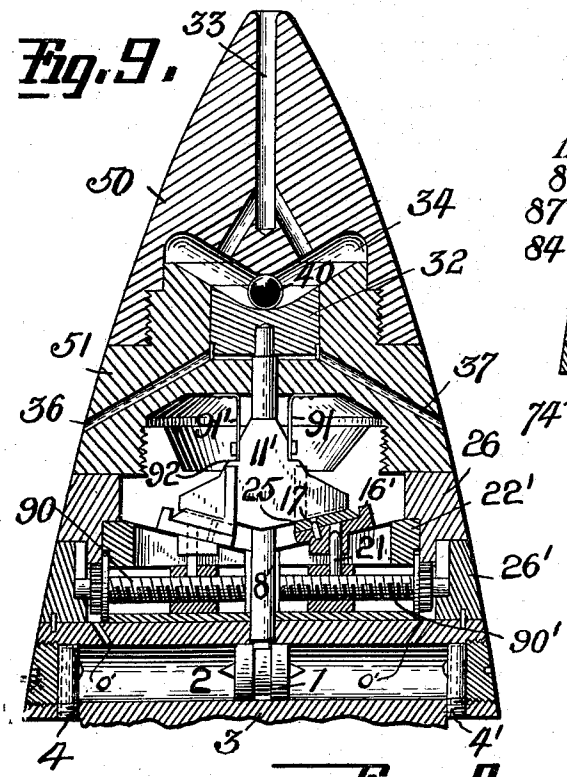


Fig. 10.

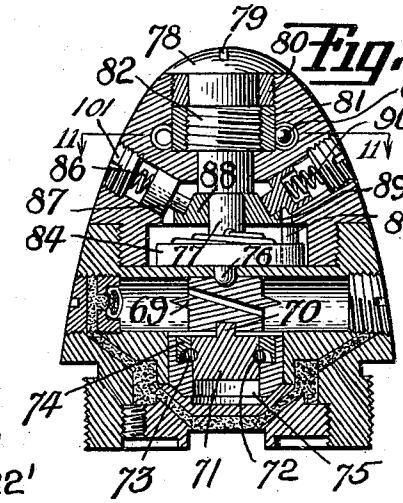


Fig. 11.

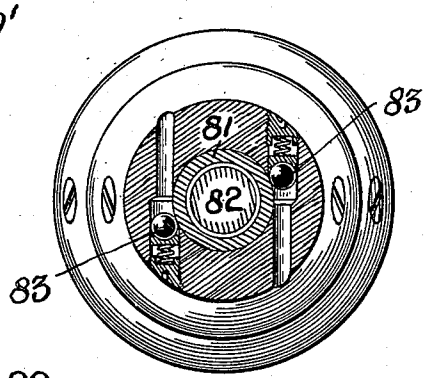
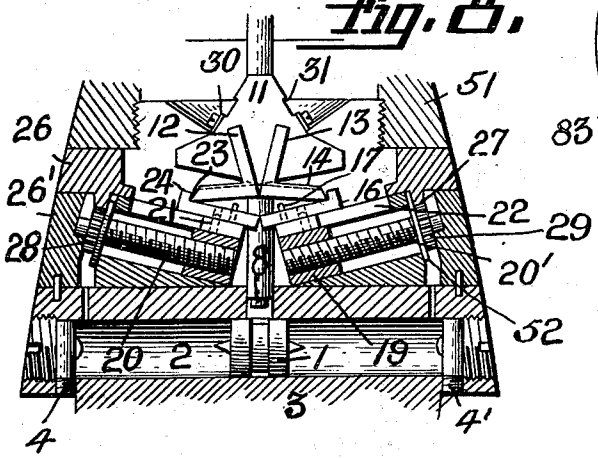


Fig. 8.



INVENTOR
Thomas B. Doe.
BY
Herbert H. Thompson
his ATTORNEY.

Patented June 21, 1932 1,863,838

UNITED STATES PATENT OFFICE

THOMAS B. DOE, OF NEW YORK, N. Y.

FUSE FOR ANTIAIRCRAFT PROJECTILES

Application filed June 6, 1930. Serial No. 459,556.

This invention relates to fuses for projectiles, particularly to the type of projectile which is detonated at a predetermined point in its flight. Such projectiles are largely employed in anti-aircraft gun fire. Usually such fuses are operated on the time principle, the projectile being detonated at a predetermined time after it is fired. By my invention, on the other hand, I propose to replace the costly and delicate timing mechanism now employed by a simple device which depends primarily on the velocity of the projectile and is operated by the pressure of the air on the nose thereof which, of course, is a function of the velocity. Since the velocity of the projectile at any given point in its flight is a function of the distance of the projectile from the gun, it is obvious that the air pressure at its forward end at any given point is also a function of the distance from the gun. It is, of course, necessary to take into account the height of the projectile, atmospheric conditions, etc., but such factors may all be taken into account in the setting of the fuses. The air pressure on the nose of the projectile may be balanced against any settable yielding means within the projectile, such as spring pressure or the like. I prefer to make use of the rotation of the projectile on its own axis (which is imparted by the rifling in the gun) to create the yielding force or a portion thereof which opposes the air pressure, by employing free or partially free masses within the projectile on which the centrifugal force acts. I provide a simple and reliable means within the projectile for opposing the air pressure means since the speed of rotation of the projectile is nearly a constant quantity, the rotation decreasing in velocity very slowly and at a known rate. This centrifugal force will overcome the force created by the air pressure on a portion of the nose of the projectile at a predetermined point in the flight of the projectile and is arranged, when that occurs, to trip a detent and release the hammer.

Other objects of the invention are to improve upon fuses of the above type by simplifying the same and rendering them absolutely fool proof so that the fuse can not be exploded prematurely. A further object of the invention is to so construct the fuse cap that it may be manufactured entirely separately from the detonator and other explosive charges so that the fuse may be manufactured in any machine shop without danger of explosion.

Referring to the drawings showing several preferred forms of the invention,

Fig. 1 shows a front elevation of my fuse cap ready to be applied to the main shell.

Fig. 2 is a vertical section of the same.

Fig. 3 is a detail of the hammer which explodes the detonator.

Fig. 4 is a vertical section taken at right angles to Fig. 2.

Fig. 5 is a side elevation of the lower portion of the fuse.

Fig. 6 is a vertical section showing a modified form of fuse.

Fig. 6—A is an enlarged sectional detail of a portion of the mechanism in Fig. 6 but with the parts shown in a slightly different position.

Fig. 7 is an enlarged sectional detail of a portion of this mechanism.

Fig. 8 is an enlarged view of the middle portion of Fig. 6, the parts being shown in a different position.

Fig. 9 is a vertical section of a slightly modified form of my invention.

Fig. 10 is a vertical section of a form of the invention using a spring means or a combination of spring and centrifugal means as the withdrawing force for the detent.

Fig. 11 is a horizontal section on line 11—11 of Fig. 10.

In the sectional figures a firing pin or hammer 1 is shown as slidably mounted in a transverse bore 2, the hammer being normally locked in its mid-position in the bore. Said bore preferably extends entirely through the main body 3 of the nose cap, the outer ends of the bore being threaded. Into these ends one or more detonator caps 4 and 4′ may be screwed after the fuse is completely manufactured and ready to be placed on the shell. Said caps communicate with powder-train channels 5 which lead downwardly through space 6 and channels 7 into the main

body of the charge in the shell (not shown). Preferably no other means are provided for actuating the hammer other than the centrifugal force due to the rapid rotation of the shell after being fired. The hammer need not be purposely weighted on one side or the other or purposely placed out of the center line of the shell, since in the ordinary course of manufacture the center of gravity of the same will always be enough out of line with the center of gyration of the shell to actuate the hammer in one direction or the other upon its release. In order that the hammer may explode the shell regardless in which direction it moves, I provide a detonator at each end of the channel.

This also has the advantage that the shell may be balanced about its longitudinal axis prior to the insertion of the firing pin and this balance will not be materially disturbed by the addition of the firing pin since it need not be purposely made heavier on one side in order to insure firing as explained above.

For normally locking the hammer in place I provide a detent 8 which engages in a annular channel in the periphery of the hammer. The hammer as shown in Fig. 3 is provided with a passage 10 therethrough so that an air cushion will not be formed as the hammer moves toward one of the detonators. For the same purpose, apertures 0, 0′ may be provided through the shell for by-passing the air around the hammer. The detent is preferably arranged to be withdrawn when the air pressure at the nose of the projectile falls below a predetermined amount.

In order to provide the withdrawing force I also prefer to make use of the rotation of the shell, the centrifugal force acting on adjustable masses within the shell to overcome the air pressure and lift the detent. In the form shown in Figs. 6 to 8, which represents the preferred form of my invention, there is mounted on the stem 8′ of the detent a flat triangular shaped member 11. The centrifugal masses appear in the side elevation as L-shaped members 12—13. Each of said members has a flat unitary base 14 which extends under the member 11. The upstanding portion of each member, however, is forked to form two ears 12′ and 12′, which extend to each side of the member 11 (see Fig. 7). Each centrifugal member is mounted on a base or plate 16 being normally held in place by the pin 17 extending upwardly from the plate and fitting loosely in a hole into the base 14. Each plate 16 is slidably mounted on a slotted member 18 and may be adjusted toward and away from the center of the shell by means of a nut 19 threaded on the screw 20. Each nut has a pin 21 extending upwardly therefrom through the slot 22 of member 18 and which extends into a hole in the plate 16 so that as the screw is turned the plate will be moved toward and away from the center of the shell carrying with it the centrifugal member 12 or 13. Fig. 8 shows such members at their innermost position, in which position the centrifugal force would be a minimum and, therefore, the shell would be set for maximum range. In Figs. 6 and 9, on the other hand, the corresponding members are shown as separated somewhat.

Under the action of centrifugal force acting on the upright forked ears 12—12′, each member 12—13 will be rotated about its tip end 23 of the base 14 which is shown as resting in an angle formed by lug 24 at the end of the plate 16 (see Fig. 8). As each member rotates about this point it will obviously raise the triangular member 11 as shown in exaggerated form in Fig. 8, thus withdrawing the detent 8 from the annular groove in the hammer. It should be noted that the point 23 about which each centrifugal member rotates lies in substantially the same horizontal plane as the inner edge 25 of the base 14, or in other words, the line of contact between the base 14 and member 11 as it tilts upwardly. This is for the purpose of securing the free disengagement of base 14 from pin 17 and maximum lifting effect on the member 11 at the start of the outward movement of the centrifugal members 12, 13, since once the lifting is started it will be continued by the rapid building up of the centrifugal forces due to the outward movement of the tops of the parts 12 and 13. To the same end the base may be longitudinally grooved to lower the member 11 and also hold it in place. In order to maintain this relationship between the toe 23 and the crotch 25, the member 18 is preferably positioned with its upper surface on a slant as shown. The screw 20 likewise may be shown slanted upwardly although this is not necessary as shown in Fig. 9. The adjustment of the screws is simultaneously effected by means of the range setting ring 26 which extends around the nose cap and is interiorly provided with teeth 27 meshing with pinions 28—29 on the ends respectively of the screws 20—20′. The graduations are read on a reference mark or marks M on a fixed ring 26′. The ready manner in which the parts may be assembled and disassembled is shown in Fig. 5. By unscrewing nose piece 50 and intermediate member 51, the graduated ring 26 and the reference ring 26′ may be slipped off, thus exposing the cross apertures 52, in which are placed the members 18 containing screws 20—20′.

While there is no force acting to release the detent until the shell is rotating at high velocity, I prefer to provide an additional safety locking means which I have shown as in the form of flat springs 30 which are pinned to the interior of the shell and normally lie in grooves 31 in the member 11. As long as said springs lie in said grooves it is obvious that member 11, and hence detent 8, cannot be

moved upwardly. When, however, the shell is rapidly rotated, the ends of flat spring 30, under the action of centrifugal force, move outwardly out of the notches 31 so as to unlock the member 11.

At its upper end the stem 8′ is provided with a piston-like member 32 shown as threaded on the stem and fitting closely into a bore in the body portion of the nose cap. The top of said piston is subject to the air pressure, the nose being provided with an axial bore 33, said bore being branched at the bottom and merging into a U-shaped channel 34. The air pressure hence builds up in this channel and exerts a pressure on top of the piston which opposes the action of the centrifugal force on the members 12—13. In addition I prefer to place rearwardly slanting channels 36—37 in the body of the nose which communicate with a space 38 under the piston. As the projectile rushes through the air, air will be drawn from the channels 36—37 to create a negative pressure in the space 38 and thus augment the positive pressure on the upper surface of the piston for the purpose specified.

Owing to the fact that during the interval that the shell is being expelled from the gun the air pressure on the nose may not be built up, I prefer to provide an additional safety device for preventing explosion during this interval. This preferably takes the form of a metal ball 40 or equivalent free object which normally lies at the lowest point in the U-shaped channel 34 and has a close but free fit in said channel. It is obvious that when the ball is in the position shown, i. e., with the shell sitting upright on its base that the detent cannot be raised. During the time that the shell is leaving the gun there is enormous acceleration of the shell and the inertia of the ball holds it in its center position in spite of the building up of a high velocity of rotation. This acceleration of the shell continues some distance beyond the muzzle as has been shown experimentally so that explosion of the shell within the gun or very close thereto is affectively prevented.

The form of the invention shown in Figs. 2 and 4 operates on a similar principle to that shown in Figs. 6 and 8. In this form the centrifugal members 12′—13′ are shown as triangular in shape and rest at their base as before in notched members 41 which are threaded on screws 42—42′. The tops of said members rest against the under-surface of the part 11′ secured to the stem 8′. Under the action of centrifugal force the tops of the triangular members will be thrown outwardly, rotating the members about their toes 23′ and thus lifting the member 11′ and the detent.

In order to maintain the proper relationship between the point of lift and the pivotal point of the centrifugal masses 12 and 13, it is not necessary to have the screws 20 and 20′ in an inclined position. Fig. 9 shows a construction in which the corresponding screws 90—90′ are placed horizontally and the aforesaid proper relationship maintained by making the slide-ways 22′, on which the pieces 16′ slide, of triangular shape so that the top surface thereof presents an inclined surface. Fig. 9 also illustrates a modified form of locking spring. In this form two springs 91 and 91′ are secured adjacent their tops to a fixed part of the shell with their free ends projecting downwardly to engage a flattened portion 92 on the member 11′. The springs may be weighted near their lower ends so that under the action of centrifugal force the lower ends will fly outwardly and release the member 11′. Otherwise the action of this form of the invention is the same as Fig. 8.

Instead of employing centrifugally operated means as a yielding force to release the detent, I may employ a spring means either with or without centrifugal action. One form of such means is shown in Figs. 10 and 11. In this form of the invention the hammer 69 is normally maintained locked in the retracted position by one or more detents or locking pins. One of said pins 70 is a safety catch which prevents all possibility of the shell being exploded prematurely. Said detent is on a mass 71 normally held in place by the split ring 72 which lies partly within a recess 73 in a nut 74 and partly in an annular recess in the mass 71. When the projectile is discharged from the gun, however, the inertia of said mass 71 is sufficiently great to snap it to the bottom of the bore 75 where it is held by the closure of the ring over the top thereof. The projectile is thus armed and ready to fire upon the release of the main detent or pin 76 from engagement with hammer 69.

Said pin projects downwardly from a stem 77 having a plurality of shoulders and threaded portions thereon. Said stem at its top is flared at 78 to form the nose of the projectile and may also be provided with a slot 79 for rotation by a fuse setter. The stem first passes through a locking ring 80 threaded in the projectile which holds in place a rotatably mounted nut or sleeve 81. Said ring is threaded interiorly, preferably with a left-handed thread, and engages corresponding threads 82 on the stem. Spring-pressed locking balls 83 (see Fig. 11) are placed in transverse bores in the shell and engage the exterior of said ring 81. Said balls serve to lock the sleeve 81 against rotation in one direction, i. e., clockwise rotation in Fig. 11, but permit the sleeve to be rotated in the opposite direction.

Secured adjacent the bottom of said stem is a flat coil spring 84. Said spring is preferably anchored at one end to the stem and at the other end to a pin 85. The spring is normally under more or less tension, i. e., is wound up so that it tends to rotate the stem

in a clockwise direction in Fig. 11. By turning the stem by means of a screwdriver or fuse setter in a counter-clockwise direction in Fig. 11, the spring will be wound up for a predetermined range extent. During such operation, however, the nut freely rotates with the stem, so that no axial adjustment of the stem takes place.

I also prefer to provide an auxiliary safety device for preventing the spring from prematurely unwinding and releasing the hammer. This device is preferably in the form of a pair of masses 86, each having a projection 87 thereon which engages a collar 88 threaded on stem 77 and having an annular shoulder 89. Said masses are normally pressed into engagement with said collar about said shoulder by springs 90 which press at their outer ends against threaded closures 101. As shown, I prefer to place each of said masses in a bore which extends transversely but at an angle to a transverse plane passing through the projectile. The centrifugal force tends to withdraw the masses as soon as the normal speed of rotation is approached, but due to the forward inclination of the bores in which they are placed, the centrifugal force is opposed by the inertia of the masses while the projectile is receiving its powerful accelerating impulse from the powder. Therefore, the masses will not be disengaged from the locking collar until the shell is well beyond the muzzle of the gun as in the other forms of the invention.

This form of the invention is set for range as follows: The parts are assembled in the position shown in Fig. 10, with the detent 76 engaging the hammer 69 and the spring under no or slight tension. The device is then set for range by turning the nose cap. The centrifugal masses 86 do not prevent this since no axial movement of the pin takes place and the nut 81 has a smooth periphery. This adjustment is effected by turning the stem counter-clockwise or to the left in Fig. 11 so that the nut rotates with the stem and no axial movement takes place. After the shell is fired, however, and the locking pins are all released, the spring will unwind the stem 77 and screw it outwardly through the nut 81 (which is locked in place against clockwise rotation) as soon as the air pressure on the nose falls below a predetermined amount.

The accuracy of my fuse depends, of course, somewhat on maintaining the muzzle velocity substantially constant. If the muzzle velocity is greater than anticipated, the fuse may be set off prematurely with the centrifugal method, as shown in Figs. 1 to 9 because the velocity of rotation of the shell will be more than correspondingly increased; while if the muzzle velocity and, therefore, the speed of rotation, is less than anticipated, the fuse will be set off too late. On the other hand, if a spring were employed which was uninfluenced by centrifugal forces, it would set off the fuse late where the muzzle velocity was greater than anticipated, and early if the muzzle velocity were less than anticipated. If these two methods are combined, however, the error due to change in muzzle velocity may be reduced to a very small amount. The form of spring shown in Fig. 10 is subject, to a certain extent, to centrifugal action. In other words, centrifugal forces acting on the helical coils tend to spread them and increase the twisting force exerted by the spring on the stem 77, especially if the spring is wound in the proper direction with respect to the direction of rotation of the shell. This form of the invention, therefore, really combines the spring and centrifugal methods and thereby reduces the error referred to.

In accordance with the provision of the patent statutes, I have herein described the principle and operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof, but I desire to have it understood that the apparatus shown is only illustrative and that the invention can be carried out by other means. Also, while it is designed to use the various features and elements in the combination and relations described, some of these may be altered and others omitted without interfering with the more general results outlined, and the invention extends to such use.

Having described my invention, what I claim and desire to secure by Letters Patent is:

1. In a fuse for projectiles, the combination with the hammer, of a detent for normally holding said hammer retracted, means subject to the air pressure due to the flight of the projectile for holding said detent in place, and yielding means opposing said other means for withdrawing said detent when the air pressure becomes a predetermined amount.

2. In a fuse for projectiles, the combination with the hammer, of a detent for normally holding said hammer retracted, means subject to the air pressure due to the flight of the projectile for holding said detent in place, yielding means opposing said other means for withdrawing said detent when the air pressure becomes a predetermined amount, a lock for preventing said yielding means from acting before the projectile has been discharged, said lock being subject to centrifugal force so as to unlock said means after the projectile is fired.

3. In a fuse for projectiles, the combination with the firing cap and hammer, of a detent for normally holding said hammer retracted, a movable member in the nose of said projectile and connected to said detent for holding it in place, and settable yielding means for withdrawing said detent when the

pressure on the nose falls below a predetermined amount.

4. In a fuse for projectiles, the combination with the firing cap and hammer, of a detent for normally holding said hammer retracted, a movable member in the nose of said projectile and connected to said detent for holding it in place, settable yielding means for withdrawing said detent when the pressure on the nose falls below a predetermined amount, centrifugally released locking means to prevent untimely withdrawing of said detent, the release of said locking means, in turn, being opposed by acceleration forces while the projectile is leaving the gun.

5. In a fuse for projectiles, the combination with the hammer, of a detent for normally holding said hammer retracted, means subject to the air pressure due to the flight of the projectile for holding said detent in place, movable masses within the projectile subject to the centrifugal force created by the rotation thereof for withdrawing said detent when the air pressure becomes a predetermined amount, and settable means for varying the effective force exerted by said masses on said detent for varying the range at which the shell explodes.

6. In a fuse for projectiles, the combination with the hammer, of a detent for normally holding said hammer retracted, yielding means tending to withdraw said detent comprising a pair of centrifugal members pivoted on opposite sides of said detent and adapted under the action of centrifugal forces, due to rotation of the projectile, to rotate outwardly and lift said detent, means for adjusting said masses toward and away from the axis of the projectile to vary the range, and means responsive to air pressure of opposing said withdrawing force.

7. In a fuse for projectiles, the combination with the hammer, of a detent for normally holding said hammer retracted, yielding means tending to withdraw said detent comprising a pair of centrifugal members pivoted on opposite sides of said detent and adapted under the action of centrifugal forces, due to rotation of the projectile, to rotate outwardly and lift said detent, and means responsive to air pressure for opposing said withdrawing force.

8. In a fuse for projectiles, the combination with the hammer, of a detent for normally holding said hammer retracted, centrifugally operated means for withdrawing said detent comprising a member mounted to one side of the axis of the projectile to pivot about the outer edge of its base under the action of centrifugal force and to raise said detent when so rotated, settable means for varying the distance of said member from the axis of said projectile to vary the range, and means for exerting an opposing force to the centrifugal action of said member on said detent.

9. In a fuse for projectiles, the combination with the hammer, of a detent for normally holding said hammer retracted, means subject to the air pressure due to the flight of the projectile for holding said detent in place, movable masses within the projectile subject to the centrifugal force created by the rotation thereof for withdrawing said detent when the air pressure becomes a predetermined amount, settable means for varying the effective force exerted by said masses on said detent for varying the range at which the shell explodes, and inertia operated safety locking means for preventing withdrawal of said detent until the projectile has left the gun.

10. In a fuse for projectiles, the combination with the hammer, of a detent for normally holding said hammer retracted, means subject to the air pressure due to the flight of the projectile for holding said detent in place, and combined spring and centrifugal means for withdrawing said detent when the air pressure falls below a predetermined amount.

11. In a fuse for projectiles, the combination with the firing cap and hammer, of a detent for normally holding said hammer retracted, a movable nose on said projectile connected to said detent for holding it in place, and settable spring means also subject to centrifugal forces for withdrawing said detent when the pressure on the nose falls below a predetermined amount.

12. In a fuse for shells, the combination with the firing pin and locking detent, of centrifugally operated means for withdrawing said detent comprising an L-shaped member adapted to pivot about its outer edge under the action of centrifugal force on its top, said pivoting edge being substantially on a line with the point of lift of said member on said detent.

13. In an air pressure fuse for projectiles, a detent for locking the firing pin, centrifugal means for withdrawing said detent, a centrifugally released spring lock for preventing accidental withdrawal of said detent, and an additional means for preventing explosion in the gun barrel comprising an inertia lock subject both to opposed translatory acceleration and centrifugal forces whereby said lock remains effective until the shell attains its maximum velocity beyond the muzzle.

14. In an air pressure fuse for projectiles, a detent for locking the firing pin, centrifugal means for withdrawing said detent, and an additional means for preventing explosion in the gun barrel comprising an inertia lock subject both to opposed translatory acceleration and centrifugal forces whereby said lock remains effective until the shell attains its maximum velocity beyond the muzzle.

15. In an air pressure fuse for projectiles, a detent for locking the firing pin, centrifugal means for withdrawing said detent, a centrifugally released spring lock for preventing accidental withdrawal of said detent, and means for preventing explosion in the gun barrel comprising a ball in a U-shaped channel disposed across the axis of the shell above said detent and adapted to prevent withdrawal of said detent while it lies near the bottom of said channel.

16. A fuse for projectiles, in combination with a nose cap, of a cross channel therethrough, a substantially symmetrical firing pin normally held therein at about the longitudinal axis of the projectile, and a percussion cap holder adapted to be detachably secured in each end of said cross channel whereby the shell is not materially unbalanced about its longitudinal axis by said firing pin.

17. A fuse for projectiles, in combination with a hammer, of a detent for normally holding said hammer retracted, a piston member connected to said detent for holding the same in place, the upper surface of said piston being subject to the air pressure at the nose of the projectile, and rearwardly inclined channels in said projectile leading to the under-surface of said piston whereby a negative pressure is created thereon, and yielding means for opposing said piston for firing the projectile when the effective pressure on the piston falls below a predetermined amount.

18. In a fuse for projectiles, the combination with the firing pin and locking detent, of means for withdrawing said detent at a predetermined point in the flight of the shell, and a safety lock for preventing premature release in the gun barrel comprising a U-shaped channel extending across the axis of the shell and above said detent, and a ball in said channel whereby inertia holds the ball over the detent during acceleration of the shell but centrifugal force displaces it as acceleration ceases.

19. In an air pressure fuse for projectiles, a detent for locking the firing pin, centrifugal means for withdrawing said detent, and means for preventing explosion in the gun barrel comprising a ball in a U-shaped channel disposed across the axis of the shell above said detent and adapted to prevent withdrawal of said detent while it lies near the bottom of said channel whereby inertia holds the ball over the detent during acceleration of the shell but centrifugal force displaces it as acceleration ceases.

20. In a settable fuse for projectiles, a detent for locking the firing pin, means within the projectile for withdrawing said detent at a predetermined point in the flight of the shell, and an additional means for preventing explosion in the gun barrel comprising an inertia lock subject both to opposed translatory acceleration and centrifugal forces whereby said lock remains effective until the shell attains its maximum velocity beyond the muzzle.

21. In a fuse for projectiles, the combination with the firing pin and locking detent, of means for withdrawing said detent at a predetermined point in the flight of the shell, and a safety lock for preventing premature release in the gun barrel comprising a cup on said detent and a ball in said cup which prevents lifting of said detent as long as the ball remains in the cup.

22. In a safety fuse for projectiles, the combination with the firing pin and locking detent, of means for preventing premature release of the detent including a cup on the detent, and a ball in said cup and normally held therein by gravity with the shell sitting on its base and by inertia during the acceleration of the shell in the gun barrel but expelled therefrom by centrifugal force as acceleration ceases.

In testimony whereof I have affixed my signature.

THOMAS B. DOE.