June 21, 1932. T. B. DOE 1,863,837

FUSE FOR PROJECTILES

Original Filed March 16, 1929

Fig. 1.

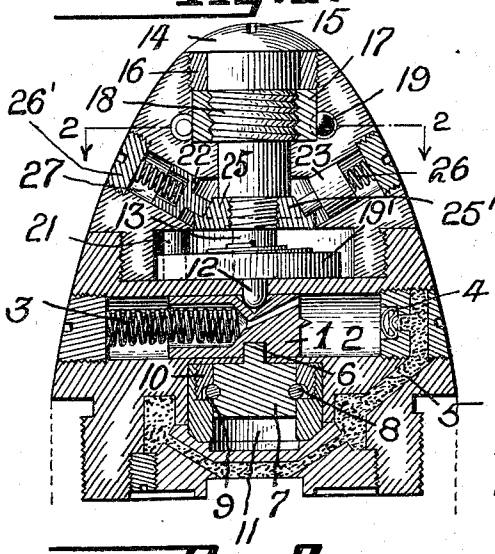


Fig. 2.

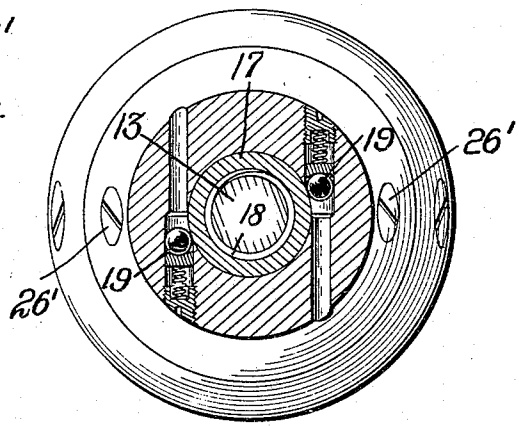


Fig. 3.

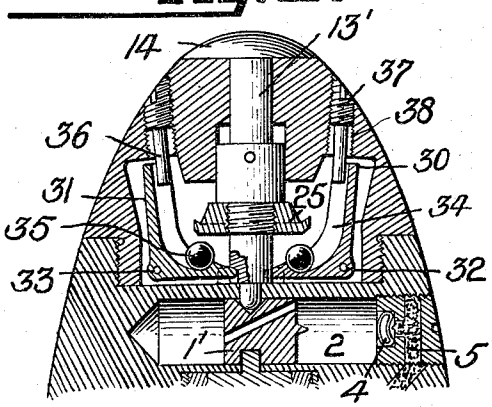


Fig. 4.

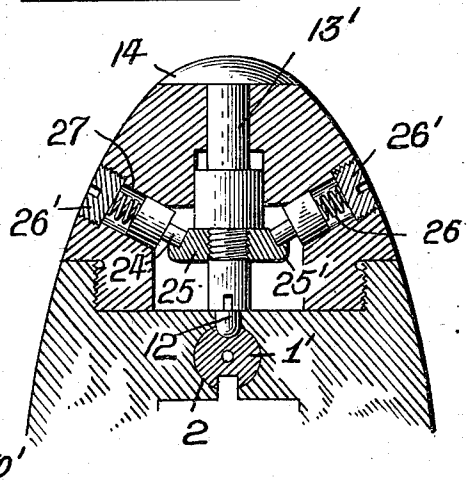
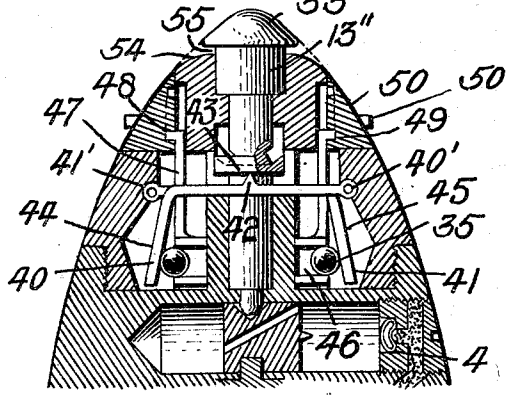


Fig. 5.



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

Patented June 21, 1932 1,863,837

UNITED STATES PATENT OFFICE

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

FUSE FOR PROJECTILES

Application filed March 16, 1929, Serial No. 347,491. Renewed November 7, 1931.

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 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.

Referring to the drawing in which several preferred forms of the invention are shown:

Fig. 1 is a vertical section through the form of the projectile utilizing a spring to oppose the air pressure means.

Fig. 2 is a transverse section thereof on line 2—2 of Fig. 1 looking downwardly.

Fig. 3 is a vertical section of a modified form of fuse in which centrifugal force is utilized.

Fig. 4 is a section taken at right angles to Fig. 3.

Fig. 5 is a vertical section of still another modification utilizing centrifugal force.

In the drawing, the forward portion of the projectile only is illustrated as this contains all of the firing mechanism. The firing pin or hammer 1 is shown as located within a transverse bore 2 in the nose of the projectile and is normally pressed forwardly by compression spring 3. When released, the hammer strikes the percussion cap 4 and fires the powder train 5 or fuse, leading to the main explosive charge in the lower part of the projectile. The hammer is normally maintained locked in the retracted position by one or more detents or locking pins. One of said pins 6 is a safety catch which prevents all possibility of the shell being exploded prematurely. Said detent is on a mass 7 normally held in place by the split spring ring 8 which lies partly within a recess 9 in a nut 10 and partly in an annular recess in the mass 7. When the projectile is discharged from the gun, however, the inertia of said mass 7 is sufficiently great to snap it to the bottom of the bore 11 where it is held by the closure of the ring 9 over the top thereof. The projectile is thus armed and ready to fire upon the release of the main detent or pin 12.

Said pin projects downwardly from a stem 13 having a plurality of shoulders and threaded portions thereon. Said stem at its top is flared at 14 to form the nose of the projectile and may also be provided with a slot 15 for rotation by a fuse setter. The stem first passes through a locking ring 16 threaded in the projectile which holds in place a rotatably mounted ring or nut 17. Said ring is threaded interiorly, preferably with a left-handed thread, and engages corresponding threads 18 on the stem. Spring-pressed locking balls 19 (see Fig. 2) are placed in transverse bores in the shell and engage the exterior of said ring 17. Said balls serve to

lock the sleeve 17 against rotation in one direction, i. e. clockwise rotation in Fig. 2, but permit the sleeve to be rotated in the opposite direction.

Secured adjacent the bottom of said stem is a flat coil spring 19′. Said spring is preferably anchored at one end to the stem and at the other end to a pin 21. 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. 2. By turning the stem by means of a screwdriver or fuse setter in a counterclockwise direction in Fig. 2, the spring will be wound up to a greater or less extent. During such operation, however, the nut 17 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 22—23, each having a projection 24 thereon which engages a collar 25 threaded on stem 13 and having an annular shoulder 25′. Said masses are normally pressed into engagement with said collar above said shoulder by springs 26 which press at their outer ends against threaded closures 26′. As shown, I prefer to place each of said masses in a bore 27 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, for it is well known that the shell continues to accelerate somewhat beyond the muzzle due to the following gases. I regard this as important because during this period the pressure on the nose of the projectile may not have built up sufficiently to hold the same against the unwinding action of the spring.

This form of the invention is set for range as follows: The parts are assembled in the position shown in Fig. 1 with the detent 12 engaging the hammer, and the spring under no or slight tension. The device is then set for range by turning the nose cap 15. The centrifugal masses 22 do not prevent this since no axial movement of the pin 13 takes place and the nut 23 has a smooth periphery. This adjustment is effected by turning the stem 13 counter-clockwise or to the left in Fig. 2 so that the nut 17 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 13 and screw it outwardly through the nut 17 which is locked in place against clockwise rotation as soon as the air pressure on the nose falls below a predetermined amount.

In the remaining figures of the drawing I make use of the centrifugal force due to rotation of the shell for opposing the air pressure. In this form of the invention the locking detent 12 is again held in place by the air pressure on the stem 13′ and similar auxiliary locking masses 22—23 may be provided. For withdrawing the detent as the air pressure falls below a predetermined amount, I have shown a pair of bell crank levers 30—31 pivoted at 32—33 on each side of the center line of the projectile. A channel or runway 34 is shown in each lever in which is placed a ball 35 or other free mass. Each ball normally rests in a pocket at the bottom of the levers shown in Fig. 3, but as the shell rotates the balls the action of centrifugal force will roll the balls up the runways until they rest against the adjustable stop-pins 36. Said pins are shown as having a portion 37 threaded in a bore 38 in the nose of the projectile so that they can be accurately adjusted for range. The distance of the ball in its outer position from the pivoted point 32—33 will determine the lifting force exerted thereby on the stem 13′ since the lever arm is altered by such adjustment. In the form shown in Fig. 3, the runways are also shown as inclined slightly outwardly so that the distance of the ball from the center of rotation is also increased with the increase in lever arm.

By providing a pair of balls on opposite sides of the shell I automatically take care of any out-of-balance that there may be in the shell. That is, if only a single ball were provided and the shell did not rotate about its geometric axis, the force exerted by the ball would be different from the calculated one because the radius of its path of rotation would not be the same as its distance from the center line of the shell. With my invention, however, if one ball is rotated about a slightly greater radius than it should, due to defect in the shell, the radius about which the other ball rotates will be correspondingly reduced so that the upward force exerted on the stem will remain the same.

It should also be noted that this form of the invention is self-locking to a certain extent, for, while the shell is leaving the gun, the inertia of the balls during such time will hold them in the position shown in Fig. 3 until the shell is well beyond the muzzle. Nevertheless I prefer to provide the additional locking weights 22, 23 as an additional safe-guard. In addition, I employ in this form no spring 3 to fire the hammer 1′ when it is released, but depend entirely on centrifugal force, the hammer having its center of gravity on the

primer side of the center of rotation of the shell.

In the form shown in Fig. 5 I also make use of the centrifugal force as a means to overcome the air pressure on the projectile. In this form the levers 40—41, which are engaged by the balls 35, are pivoted respectively at 40′—41′ and are each provided with a projection 42 bearing on a collar 43 on a stem 13″. The levers in this case are shown as provided with downwardly extending and outwardly flaring portions 44—45 against which the balls bear. The position of said balls along said portions and hence the force exerted thereby on the levers is adjusted in this instance by mounting the balls in a cage 46 which is adjusted upwardly or downwardly by means of upwardly extending arms 47 which are provided with lugs 48 engaging a coarse thread or a spiral groove 49 on the interior of the annular nose piece 50. Said piece is revolubly mounted near the nose of the projectile and may be rotated by engaging lugs 50′ thereon with a spanner wrench or the like to set the device for range.

In Fig. 5 I have also shown a somewhat different shape of head 53 on the stem 13″. In this instance the head or nose is normally spaced slightly from the end, proper, 54 of the projectile so as to leave a space 55. The nose is stream lined with respect to the rest of the projectile so that a negative air pressure exists within the space 55, thereby increasing the effective pressure of the air on the same. In addition, the nose is made more pointed than in the form shown in Fig. 1, so that the total air resistance on the shell is less.

From the foregoing, the operation of my invention should be readily apparent. Due to the safety locks it is impossible to cause a premature explosion of the projectile. As, however, the projectile is fired from the gun it is armed by the automatic withdrawal of the lock 10 as explained. Shortly thereafter as the acceleration ceases on the projectile the auxiliary locking devices 22—23 are withdrawn so that the projectile is completely armed and the pin 13 or 13′ is being pushed outwardly either by the unwinding spring action in Fig. 1 or by the centrifugal action of the balls in Figs. 3 and 5. No firing takes place, however, as long as the air pressure on the nose of the pin is sufficient to overcome the spring or centrifugal force. As soon, however, as the point in the path of the projectile is reached where the air pressure falls below a predetermined amount the detent is released and the projectile exploded. 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 will be set off prematurely with the centrifugal method, as shown in Figs. 3, 4 and 5, because the velocity of rotation of the shell will be correspondingly increased; while if the muzzle velocity and, therefore, the speed of rotation, is less than anticipated, the fuse will bet 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. As a matter of fact the form of spring shown in Fig. 1 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 13, 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 provisions 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. For instance, I employ the term air pressure herein in its broad sense of any pressure (positive or negative) different from atmospheric pressure, which is caused at any part of the projectile by and is a function of the velocity of flight of the projectile. 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 movable masses within the projectile subject to the centrifugal force created by the rotation thereof for withdrawing said detent when the air pressure falls below a predetermined amount, said masses also being subject to the acceleration of the projectile within the gun barrel whereby withdrawal of said detent is prevented before the projectile has cleared the muzzle.

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, and movable masses within the projectile subject to the combined centrifugal and acceleration forces created by the rotation thereof and by the acceleration of the projectile for withdrawing said detent when the air pressure becomes a predetermined amount but for preventing such withdrawal until the projectile is beyond the muzzle.

3. 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 levers pivoted on opposite sides of said detent, a mass movably mounted on each lever and adapted under the action of centrifugal force to exert through the lever a withdrawing force on said detent, means for adjusting the position of said masses along said levers to vary the range, and means responsive to the air pressure for opposing said withdrawing force.

4. 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 bell crank levers on opposite sides of said detent with one arm of each lever engaging said detent and the other arm extending forwardly, a mass movably mounted on each lever, said mass being normally held on the detent side of the pivot of each lever by the acceleration of the projectile in leaving the gun but adapted under the action of centrifugal force to move to the other side of said pivot when acceleration ceases, whereby a withdrawing force is exerted on said detent.

5. 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 lever pivoted to one side of said detent, a mass movably mounted on the lever and adapted under the action of centrifugal force to exert through the lever a withdrawing force on said detent, settable means for adjusting the position of said mass along said lever to vary the range, and means for exerting an opposing force to the action of said lever and mass.

6. 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.

In testimony whereof I have affixed my signature.

THOMAS B. DOE.