

Aug. 23, 1955

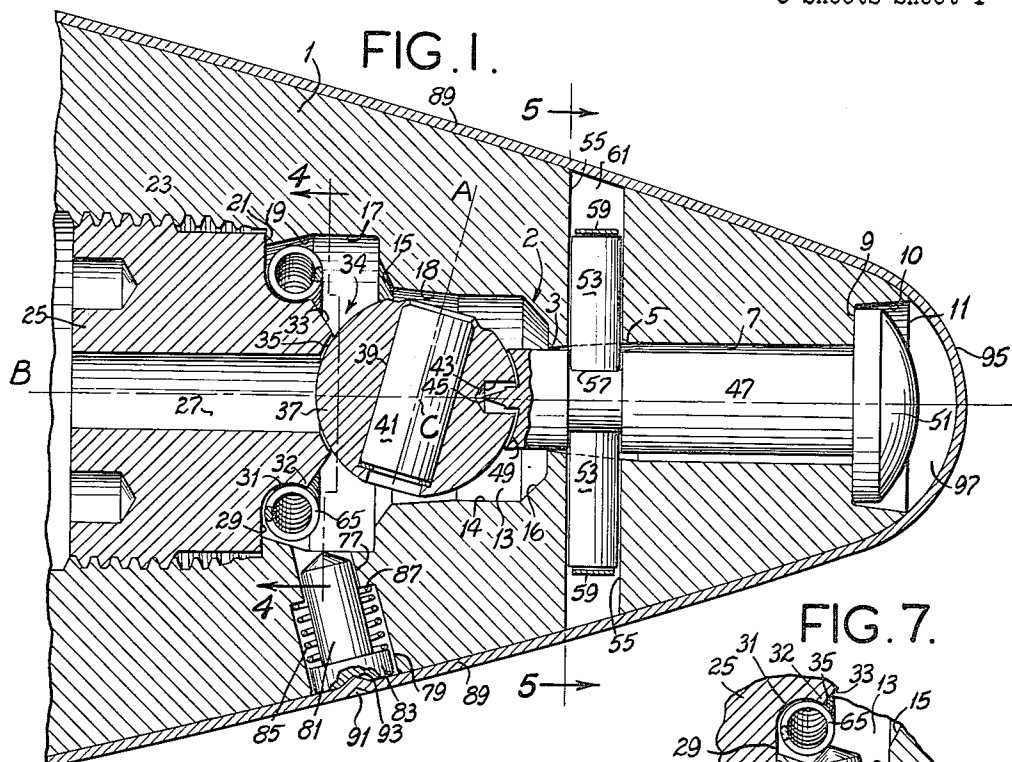
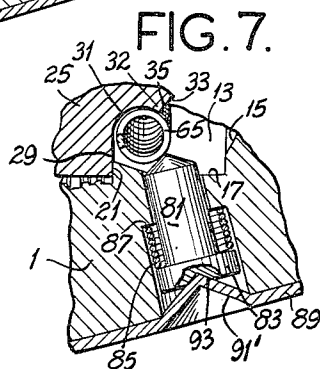
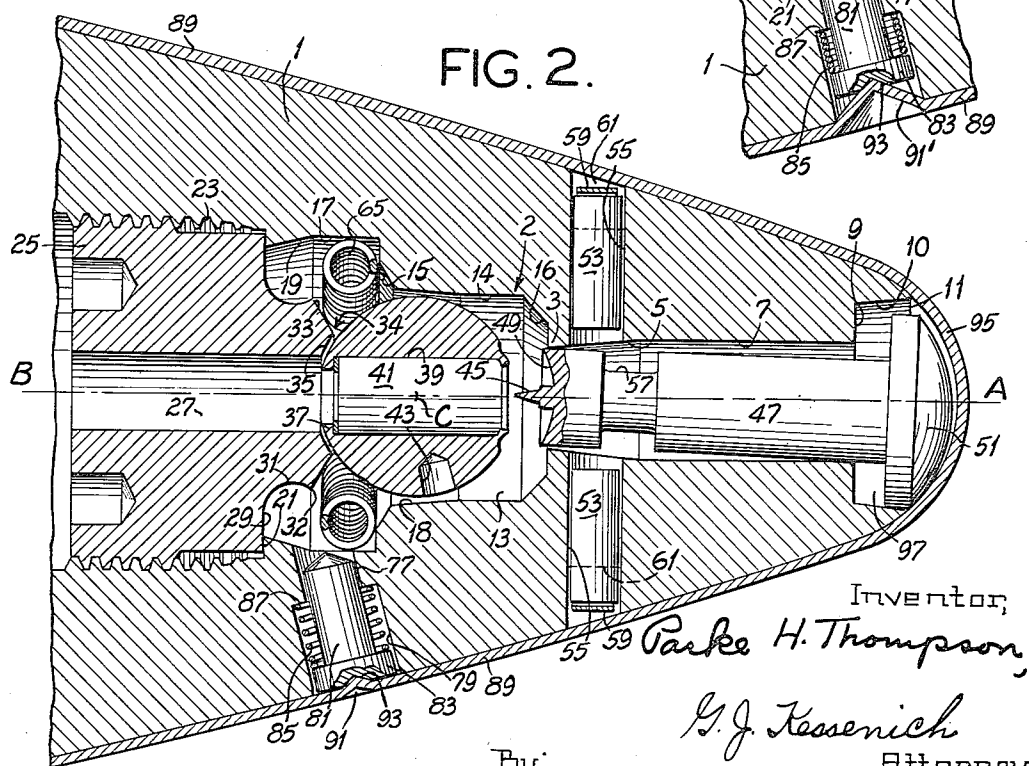
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2,715,873

FUZE

Filed Jan. 25, 1950

3 Sheets-Sheet 1



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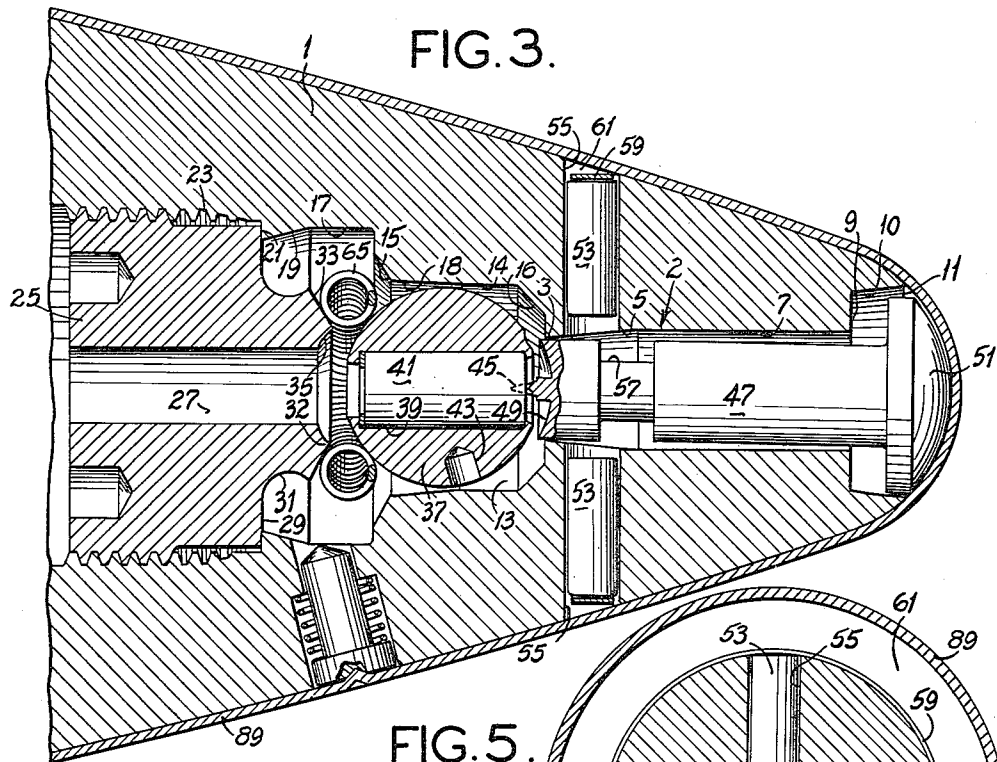
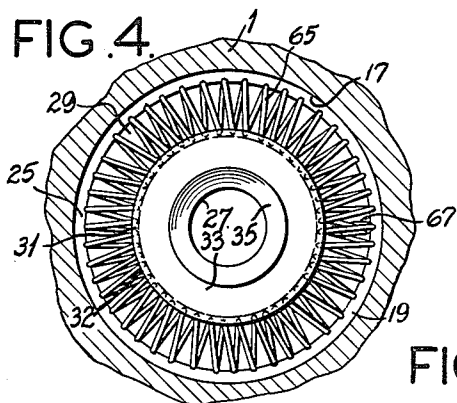
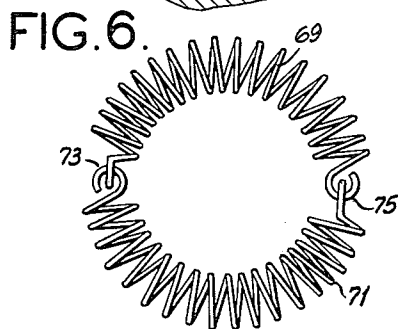
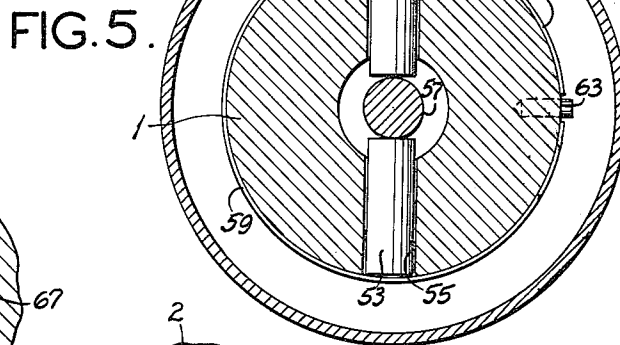
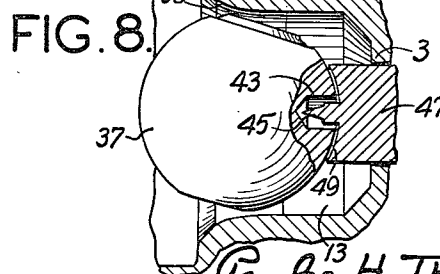
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FUZE

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3 Sheets-Sheet 2



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3 Sheets-Sheet 3

FIG. 9.

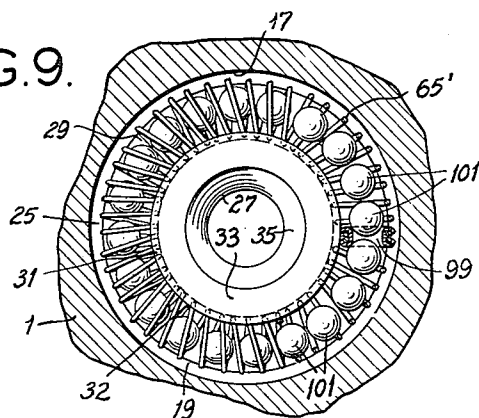


FIG. 10.

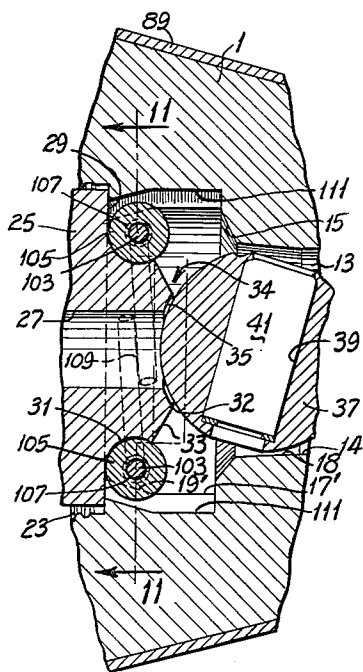
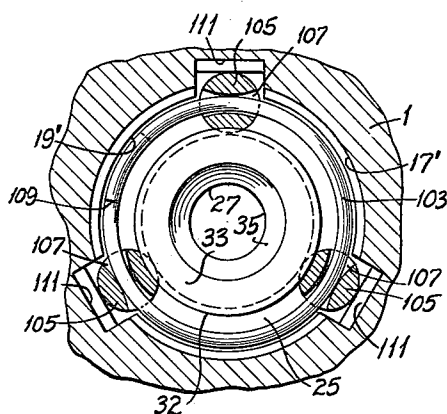


FIG. 11.



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2,715,873

FUZE

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Application January 25, 1950, Serial No. 140,454

17 Claims. (Cl. 102—71)

This invention relates to fuzes for rotary projectiles, and more particularly to fuzes for selective self-destruction of ammunition to which they are applied.

The primary object of the invention is to provide a simple fuze for rotary ammunition of the point-detonating type which, as desired, prior to firing may be selectively adjusted for subsequent self-destruction or for immobilization of the latter feature. Another object is to perform the selective adjustment or setting for self-destruction or immobilization without breaking into the fuze cover. Another object is to prevent self-destruction under creep conditions within the fuze prior to striking an intended target, while at the same time making an arrangement such that creep conditions may be developed upon ricochet to initiate detonation. Other objects will be in part apparent and in part pointed out hereinafter.

Briefly, the invention is carried out by the employment of a ball rotor type of detonator holder which is held in unarmed position by an interlock provided by a firing pin, the firing pin being held in interlocking position by a second centrifugal interlock. Upon spin due to firing, the second centrifugal interlock releases the firing pin, which is arranged for positive forward movement, into point-detonating position. This releases the interlock for the ball rotor with the result that the ball rotor precesses into arming position. The arrangement is such that upon point contact with a target, the firing pin will be driven back to the ball rotor to detonate.

A simple expansible and contractible annular spring member is seated in a safe position behind the ball rotor when the fuze is unarmed. As the fuze spins upon firing, this annular member under spin conditions and centrifugal force leaves its seat radially and is axially guided into position by the form of surrounding parts, so that upon subsequent deceleration of spin and the resulting contraction, the annular member contacts the rear of the armed rotor to project it forward into engagement with the firing pin. This causes self-destruction of the ammunition even though no target has been engaged. Immobilization is accomplished by a normally retracted lock pin which, when pushed inward by deformation of the fuze cover, prevents movement of the annular member forward and into ultimate engagement with the ball rotor.

The invention accordingly comprises the elements and combinations of elements, features of construction, and arrangements of parts which will be exemplified in the structures hereinafter described, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings, in which several of various possible embodiments of the invention are illustrated,

Fig. 1 is a longitudinal section of a fuze embodying the invention, showing it in unarmed, mobilized safety condition;

Fig. 2 is a view similar to Fig. 1, showing a mobilized armed condition of parts;

Fig. 3 is a view similar to Fig. 2, showing the condi-

tion of parts at the moment preceding self-destruction;

Fig. 4 is a cross section taken on line 4—4 of Fig. 1;

Fig. 5 is a cross section taken on line 5—5 of Fig. 1;

Fig. 6 is a view of an alternative form of annular spring member removed from the fuze;

Fig. 7 is a fragmentary view of certain parts of Fig. 1 but shown in immobilized safety position;

Fig. 8 is a fragmentary view of certain parts of Fig. 1, showing an alternative form of ball rotor pocket;

Fig. 9 is a view similar to Fig. 4, showing a loaded form of annular spring member, parts of the spring being shown in section;

Fig. 10 is a fragmentary view similar to Fig. 1, but showing another form of loaded spring member; and

Fig. 11 is a cross section taken on line 11—11 of Fig. 10.

Similar reference characters indicate corresponding parts throughout the several views of the drawings.

The term ammunition as used herein comprehends rotating missiles of all types, including those that receive their spin due to rifling, jets, air vanes and the like.

Referring now more particularly to Fig. 1, there is shown at numeral 1 a tapered fuze body of external ogive form, through which is formed a central axial opening 2. Starting more or less centrally, this opening has a shoulder 3 determining the least diameter of any part of the opening. To the right of the shoulder 3 is a flaring taper 5, then a cylindric portion 7 terminating in a forward enlarged seat 9 in a conical cup 10, ending in a truncated portion 11 of the body 1.

To the left of the shoulder 3 is a pocket 13 connected with a counterbore 17 by an outwardly flaring bevel portion 15. This pocket has a front cylindric section 14 bottomed by a bevel 16 and has a conical rear section 18 flaring to the rear. On the left side of the counterbore 17 is a bevel portion 19 constricting leftward, which forms a seat 21 at the bottom of a threaded cup 23. Threaded into the cup 23 is a plug 25 having on its axis a flash channel 27. The inner end of this plug 25 has a shoulder 29 engaging the seat 21 and adjacently formed as a toroidal seat 31. In section the seat subtends an arc of approximately 120° forming a lip 32. To the right of the toroidal seat 31 is a conical portion 33.

Between the flash channel 27 and the conical portion 33 is a spherical seat 35 for a metal ball rotor 37 located in the pocket 13. This rotor is provided with an axial bore 39 in which is a detonator 41 of lower specific gravity than the remainder of the rotor. The rotor 37 is recessed as shown at 43 for interlocking reception of the firing tip 45 of a firing pin 47. The rear end of the firing pin is of spherical form 49. The radii of the rotor 37, seat 35 and form 49 are all approximately the same so that the ball is snugly contained thereby under unarmed conditions.

The firing pin 47 has a mushroom head 51 which bears upon and is aligned in the seat 9 when the pin is in its Fig. 1 position. It is so held by radially positioned interlock pins 53. These pins are in radial passages 55 and their inner ends interlock with a groove 57 in the pin. The outer ends of the pins are surrounded by a C-shaped spring 59 which lies in a peripheral groove 61. The spring 59 is prevented from rotating in the groove 61 by a plug 63 in the bottom of the groove located between the separated ends of the spring. The diameter of the pin 47 is less than that of opening 7 and only slightly less than that of seat 3. If released from pins 53 it may rock on seat 3 as shown in Fig. 2.

From the above it will be seen that under static conditions the pins 53 are pressed inward by the spring 59 to hold the firing pin 47 in a position wherein the tip 45 is in interlocking position with the recess 43. This holds the ball rotor 37 in unarmed position, with the axis A of

the cylindric detonator 41 lying crosswise of the axis B of the fuze as a whole, the rotor being held between the seats 35 and 49.

Surrounding and engaging the toroidal seat 31 is a toroidal expandible member 65 which in the present example is in the form of a toroidal spring. The ends of this spring are fastened together, as by soldering its ends such as indicated at numeral 67 in Fig. 4; or a holding clip could be used at this point. The annular mean diameter of this spring is such that when placed on the seat 31 it is under some tension, so as safely to maintain its position on the seat behind lip 32 under unarmed conditions. If desired, the spring may be made up as shown in Fig. 6, having two equal sections 69 and 71, the ends of which are hooked together as shown at 73 and 75, or otherwise suitably fastened. Such a construction has the advantage of providing substantial dynamic balance if the hooks 73 and 75 are the same in form and the lengths of sections 69 and 71 are equal. There is some dynamic unbalance of acceptable value in the case of the soldered construction shown in Fig. 4, or one in which a single clip is used for making the connection. It is to be understood that a hook-forming connection may be employed in the case of Fig. 4.

At numeral 77 is shown a passage having a counterbore 79 forming a seat 87. This passage communicates from the outside of the body 1 to the counterbore 17. In it is a pin 81 having a head 83. A spring 85 reacts from the seat 87 to the head 83 and biases the pin outward. The head is biased against an adjacent portion of a protective cover 89 which is employed over the body 1. The small indentation 91 in the cover registers with a small indentation 93 in the head 83. When desired, the pin 81 can be forced inward against the bias of spring 85 by enlarging the indentation 91, as indicated at 91' in Fig. 7. This enlargement is accomplished by forcing the cover with a suitable tool such as a conical punch. The enlargement of the indentation from the form shown at 91 to the form shown at 91' does not break the cover 89. As shown at 95, the cover is of spherical form where it arches over the head 51 of the firing pin, thus leaving a space 97. This spherical part 95 is crushed when a target is engaged after firing.

Operation is as follows:

The fuze assembly located on the front of a shell or the like (not shown) is as indicated in Fig. 1. It may be tumbled about under ordinary transportation conditions with complete safety, since the spring-held pins 53 hold the firing pin 47 with the tip 45 interlocked with recess 43, thus holding the ball rotor 37 in its safe angled position between seats 35 and 49. The constrictive tendency of the annular coil spring 65 holds it on its toroidal seat 31. There is little tendency of the spring to leave the seat 31. Hence it remains in safe position though the pin 81 is in the Fig. 1 outward mobilizing position.

Assume now that the ammunition carrying the fuze has been loaded and is fired. The gun rifling or other means employed for spinning the ammunition accelerates it both angularly and linearly. Set back force holds rotor 37 on seat 35. When a predetermined angular velocity is reached, the pins 53 move out by centrifugal force, expanding the spring 59 (see Fig. 2). This releases the firing pin 47 which, due to rotation and the fact that its diameter is less than that of the opening 7, has a conical spinning action which positively forces it forward (in addition to the ordinary forward creep action to which it is subjected), as indicated in Fig. 2. The conical action is assured by reason of the constraining action of the shoulder 3 at one end of the pin, the loose fit of its other end in bore 7 and the conical form of the cup 10 around head 51. Ultimately the mushroom head 51 engages the spherical portion 95 of the cover. This withdraws the point 45 from the recess 49, thus opening the interlock between the firing pin and the rotor 37. Since the rotor

partakes of the angular velocity of the body 1 and a component of this angular velocity may be assigned around axis A as gyroscopic spin (the rotor in effect being a gyroscopic body mounted with three degrees of rotary freedom), it will, under applied torque around axis B precess about an axis C normal to and passing through the intersection of axes A and B until axes A and B are coincident, as indicated in Fig. 2. Axis C, being viewed on end, is indicated by a point. Temporary spiral nutation about axis B involved in this gyroscopic precessing process delays the time of alignment between axes A and B, thus rendering the fuze safe for some distance beyond the muzzle of the gun, or beyond its starting point if it is a spinning rocket.

Any tendency for the rotor 37 to creep forward of its own inertia, due to air friction decelerating the ammunition, is offset by the fact that the rotor, due to centrifugal force, bears against the conical surface 18. The resulting reaction from surface 18 is one tending to hold the rotor back against the seat 33. The amount of this force is a function of the angle of the cone 18 which is designed to prevent the creep tendency.

If and when the ammunition strikes the target in the condition of Fig. 2, the cover will be collapsed at 95, forcing the firing pin back into the detonator 41, which directs its explosion down the flash channel 27 to whatever booster or similar charge is used in the ammunition behind the head 1.

Assume now that the ammunition misses its target, pin 81 remaining as shown in Fig. 2. During angular and linear acceleration, the spring 65 will have partaken of the angular velocity of the fuze and by centrifugal force of its own mass spinning at high speed will expand away from the seat 31 and exteriorly contact the cone 19, being forced axially forward in the process, as shown in Fig. 2. The surrounding walls of the pocket 17 prevent further enlargement of the spring annulus. This brings the expanded spring into position surrounding the rear of the rotor 37, which with cone 33 forms an annular notch 34 within the spring. As the ammunition proceeds beyond its missed target, air-friction decelerating forces will reduce its angular velocity to a point at which the annular spring 65 will collapse into notch 34, as shown in Fig. 3. This occurs rather rapidly at a critical point during the decay of angular velocity, so that the spring collapses with more or less of a snap action. This is because the spring rate of the spring involves a substantially linear function, whereas the decay of the centrifugal involves a square power function. Thus the contractive force of the spring and the centrifugal force applied to the spring are not in equilibrium for any substantial amount of time at the critical point which results in the stated snap action. In other words, on a suitable chart, the spring rate line (spring deflection vs. applied force) would sharply (as distinguished from gradually) cross the centrifugal decay curve (centrifugal force vs. angular velocity).

When the spring 65 snaps from the Fig. 2 to the Fig. 3 position it engages the ball rotor 37 and pushes it forward with a rapid motion against the reactive force due to the cone 18, so that the detonator engages the point 45 and explodes back into the flash channel 27 to destroy the ammunition before it reaches the end of its trajectory. The timing of the destruction is determined by the selection of the spring constants such as spring length, spring diameter, wire diameter, number of coils and characteristic spring material employed, in relation to the angular velocities involved in a particular piece of ammunition. These are matters of selection determined by well known methods of spring design.

Sometimes conditions are such that a ricochet hit is made at a point somewhere on the ogive of the body 1 or elsewhere behind the nose part 95 of the cover. This under the conditions of Fig. 2 might prevent the firing pin 47 from being driven back and thus prevent point-induced detonation. However, with the present construc-

tion, detonation nevertheless occurs almost immediately because the resulting axial deceleration of the ammunition will result in the rotor moving forward to contact the point 45 for detonation even before the spring 65 collapses from the Fig. 2 to the Fig. 3 position. This action occurs against the restraining action of the rotor against its seat 35 by reason of the rearward reaction from cone 18 under conditions of spin. In fact, any ricochet contact tends to reduce the spin rate, thus weakening the rearward reaction induced at cone 18. Thus the ammunition detonates reliably regardless of how (within reasonable limits) the target is struck.

In Fig. 8 is shown another form of the pocket 13, in which there is substituted for the cone 18 in Fig. 1 a bell-mouthed portion flaring rearwardly with increasing outward slope. This is numbered 96 in Fig. 8. In this form of the device the reactive force tending to hold the rotor 37 to seat 35 is essentially greater, but when this force is once overcome upon initial contact at 95 or ricochet contact, this force deteriorates rapidly as the rotor 37 moves forward. Thus the rotor after once starting will accelerate in its movement toward the point 45 and induce a desirable sudden detonating contact between the detonator 41 and the point 45.

Self-destruction of ammunition is mainly desirable under circumstances such as firing at targets over friendly territory upon the surface of which it is not desired to explode ammunition that has missed its mark. Under other circumstances self-destroying ammunition is neither needed or desired, such as, for example, when firing against an enemy shore. Under the latter circumstances it is desirable to immobilize the self-destruction features. This is done in the present construction before loading by inserting a punch in depression 91 in the Fig. 1 condition and deforming the cover 89 to the condition shown at 91' in Fig. 7. This locks the end of the pin 81 behind a portion of the spring 65. Thereafter, although the spring may tend to expand, it cannot move forward throughout its entire periphery into the pocket 17. Consequently, it never reaches the position shown in Fig. 2 and upon subsequent contraction it again seats on the toroidal seat 31 and, assuming that the ammunition has missed its original target, it proceeds to destruction only upon reaching the end of its trajectory. While there is some tendency for the side of the spring 65 opposite pin 81 (when in immobilizing position) to move forward, this is not sufficient to carry the entire spring forward. It will also be seen that, if desired, additional immobilizing pins 31 could be used around the periphery of the body 1, such as, for example, in the case of large ammunition with a large annular diameter of the spring 65. One immobilizing pin is sufficient for smaller sizes. Of course if the ammunition has found its target before reaching the end of its trajectory it will detonate in the manner already described, independently of the position of the spring 65.

It is to be understood that instead of the more desirable conical motion for a forward movement of the firing pin 47 (when released by centrifugal latch pins 53), this pin 47 may be mounted for ordinary, forward sliding movement under ordinary creep conditions or under bias of a spring, as is common in the art, without affecting the remaining principles of operation of the invention.

For some designs, particularly those for ammunition or missiles of relatively lower angular velocities of spin, it may be desirable to make the wire of the spring smaller (instead of its coil larger) in order to obtain the proper spring deflection rate in response to centrifugal force. Since the centrifugal force is a function of the spring weight itself, this would introduce contradictory design factors. In order to make these factors independent, the alternate constructions of Figs. 9-11 may be used.

In Fig. 9 (as in Fig. 4) is shown a toroidal spring 65' resting on the seat 31, as already described. The ends of this spring are shown as being joined by an eyelet 99. Within the spring are loading steel balls 101. These have

the effect of providing weight for increasing the centrifugal expanding force applied to the spring 65', without the necessity for strengthening the spring and reducing its spring rate, as would be the case if the weight of the spring were increased (by increasing its wire diameter) in order to provide the additional desired centrifugal force.

In Figs. 10 and 11 is shown another method for accomplishing independence of centrifugal force and spring characteristics. In this case an expansible circular spring 103 is provided, upon which are strung several (three in the present case) ball-like beads 105. These have hour-glass openings 107 through them, through which the spring is threaded. The ends of the spring overlap between two of the beads, as shown at 109. Each bead is located in a groove 111 of the pocket walls surrounding the seat 31. These walls are designated 17' and 19' in Figs. 10 and 11. In this form of the invention, centrifugal force of the beads 105 (primarily) and that due to the weight of the spring 103 (secondarily) causes expansive action with removal of the beads from the circular seat 31. They and the spring may then move forward, as already described in connection with the toroidal springs 65 and 65'. In moving forward the beads retain their positions in the grooves 111 until retractive force of the spring 103 results in the beads 105 being driven in between seat 33 and rotor 37, thus forcing the latter forward.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As many changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. A fuze for projectiles which spin comprising a body having an axial pocket having a first rearward seat, a precessive detonator rotor in the pocket engageable with said first seat, a firing pin having a safety position wherein it extends rearward into the front of the pocket and is adapted to hold the rotor in a safe position on the seat, said pin being adapted to assume a forward arming position retracted from the rotor to release it to precess into armed position, a second seat behind the first seat, a resilient ring member embracing the second seat and expansible from embracing position in response to spin to leave the seat, and means for forcing said ring member after leaving the seat into a position forward of said second seat wherein it may shrink in size upon decay of spin to engage the rotor to force it forward against said pin said means comprising a conical flaring portion forming in part at least the wall of said pocket and radially aligned with said second seat.

2. A fuze made according to claim 1, wherein there is a third conical seat between the first and second seats adapted in connection with the rotor to be wedgingly engaged by the ring member when said decay of spin occurs whereby the armed rotor is pushed against the firing pin.

3. A fuze made according to claim 1, including an interlock member normally biased away from the ring member but adapted to be positioned to prevent its effective axial removal from the second seat under any conditions.

4. A fuze made according to claim 1, wherein there is a third conical seat between the first and second seats adapted in connection with the rotor to be wedgingly engaged by the ring member when decay of spin occurs, said third seat being of a form providing a holding lip in connection with the second seat, and wherein said ring member is a toroidal spring.

5. A fuze for projectiles which spin comprising a body having an axial pocket having a first rearward

seat, a precessive detonator ball rotor in the pocket engageable with said first seat, a firing pin having a safety position wherein it extends rearward into the front of the pocket and is adapted to hold the rotor in a safe position on the seat, said pin being adapted to assume a forward arming position retracted from the rotor to release it to precess into armed position, a second seat behind the first seat, an expansible toroidal ring member embracing the second seat and expansible from embracing position in response to spin to leave the seat, and a forwardly conical flaring portion within the body outside of the ring member and radially aligned with said second seat adapted to force said ring member after leaving the seat into a position forward of said second seat wherein it may shrink in size upon decay of spin to engage the rotor to force it forward against said pin.

6. A fuze made according to claim 5, wherein there is a third conical seat between the first and second seats arranged to provide a lip to hold the ring member on the second seat and adapted, after the ring member has left the second seat and shrinks, to form with the ball rotor an annular wedge into which the spring member moves.

7. A fuze made according to claim 1, wherein there is a locking pin which is movable with respect to the ring member when on the second seat and which pin is movable from a first position locking the ring member on its seat or to a second position clearing the ring, a cover for the body, a spring biasing the locking pin into a position adjacent the cover and clearing the expansible ring member, and wherein there is a deformable part in the cover adapted upon deformation to move the adjacent locking pin from its ring-releasing to its ring-holding position.

8. A fuze comprising a body having a first pocket and a larger second pocket therebehind, a first seat in the second pocket, a precessive detonator rotor in the first pocket and extending into the second pocket and adapted to rest on said seat, a conical portion around said seat, a toroidal second seat behind said conical portion, a toroidal spring member tensioned to engage and hold on said second seat, said second pocket having a forwardly flaring form around the spring member adapted in response to expansion of the spring member from its seat under spin to move the spring member axially into position around said conical portion and the portion of the seated rotor adjacent thereto, said spring upon shrinking in its last-named position being adapted wedgingly to force the rotor forward from the first seat.

9. A fuze made according to claim 8, including a movable locking pin adapted to be positioned to assume a first position away from the spring member on the second seat and into a second position adjacent the spring member preventing any effective axial movement of the spring away from the second seat.

10. A fuze for projectiles which spin comprising a body having an axial pocket having a rearward seat, a precessive detonator rotor in the pocket engageable with the seat, a firing pin having a safety position wherein it extends rearward into the front of the pocket and is adapted to hold the rotor in a safe position on the seat, detent means comprising at least one pin urged into a groove in the said firing pin and removed there-

from in response to projectile spin, the body having an opening so formed around the said firing pin that the pin may spin conically when released so as positively to move forward in a direction of normal creep to an arming position retracted from the rotor to release the latter, a second seat behind the first seat, a resilient ring member engaging the second seat and expansible in response to spin to leave the seat, and a forwardly flaring portion outside of said ring member adapted to force said ring member after leaving the seat into a position wherein it may shrink in size upon decay of spin to engage the rotor to force it forward against said pin.

11. The invention according to claim 10 including a movable locking pin adjustable from the outside of said body from a position clear of said ring when on the second seat to a position adapted to prevent effective movement of the ring from said second seat.

12. A fuze for projectiles which spin, comprising a body having an axial pocket in which is a rearward seat, a precessive ball rotor detonator in the pocket engageable with said seat, a firing pin having a rearward safety position wherein it extends into the front of the pocket and into said rotor, a centrifugal mechanism adapted to release the firing pin from the rearward position and to permit its movement to a forward arming position allowing the rotor to precess into armed position, a second seat in said body, a resilient ring member embracing said second seat and expansible in response to spin, a forwardly flaring portion formed in said pocket around said second seat adapted to force said ring member after leaving said second seat into a position wherein it may shrink in size upon decay of spin to engage the rotor to force it forward against said pin.

13. A fuze made according to claim 12 wherein said resilient ring member comprises a toroidal coil spring.

14. A fuze made according to claim 12 wherein said resilient ring member comprises a toroidal coil spring containing weights within its coils.

15. A fuze made according to claim 12 wherein said resilient ring member comprises a toroidal coil spring containing separate spherical weights within its coils.

16. A fuze made according to claim 12 wherein said resilient ring member comprises a circular spring, and weight members having openings therethrough threaded on said circular spring.

17. A fuze made according to claim 12 wherein said resilient ring member comprises a circular spring and weight members having openings therethrough threaded on said circular spring, said pocket having grooves formed therein for guiding said weight members.

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