Feb. 18, 1947. P. W. ALLISON 2,415,804

FUSE FOR ANTIAIRCRAFT SHELLS

Filed May 10, 1943

Fig. 1.

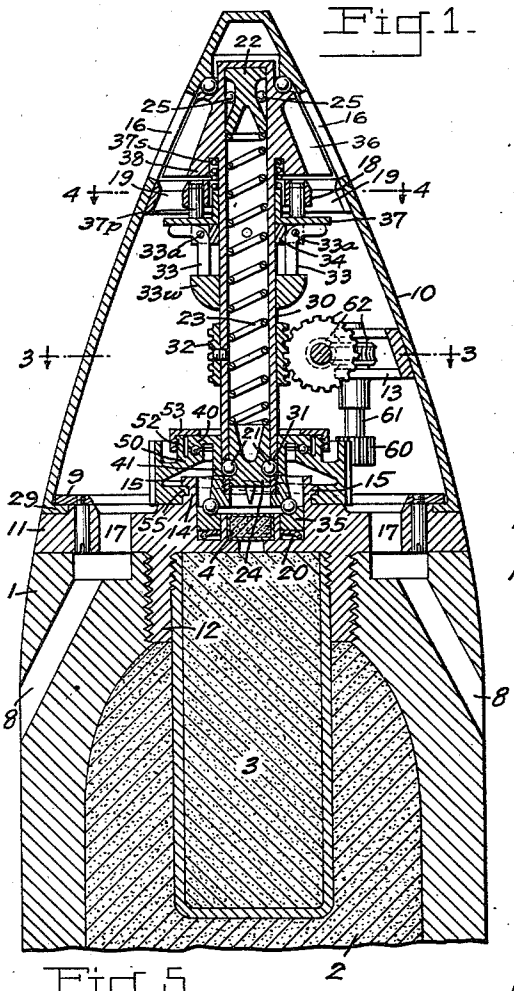


Fig. 2.

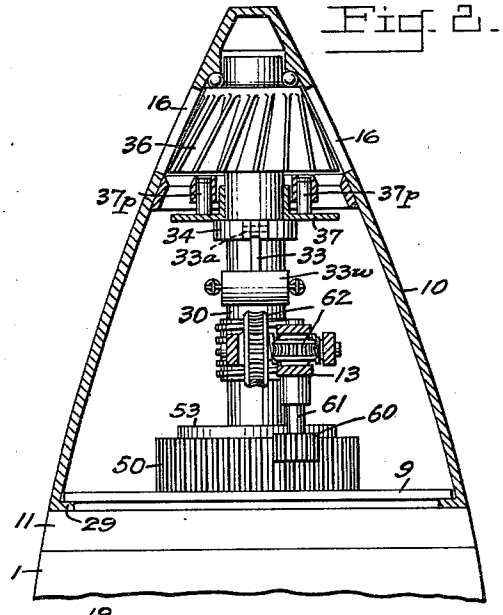


Fig. 4.

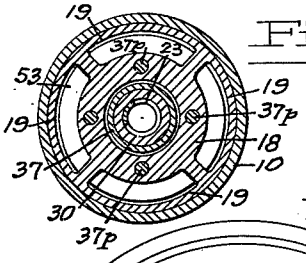


Fig. 3.

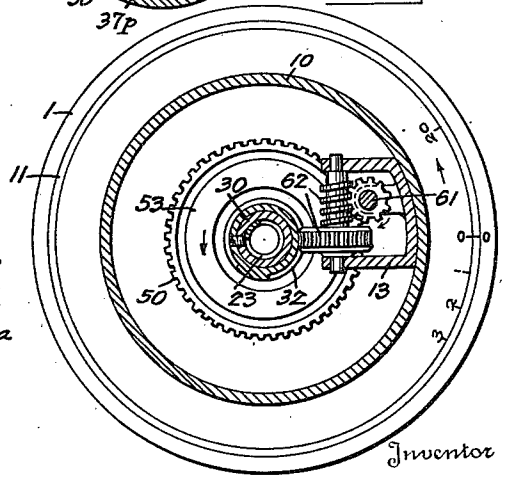


Fig. 5.

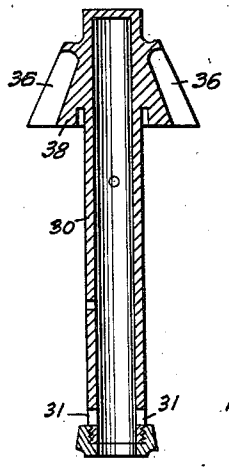


Fig. 6.

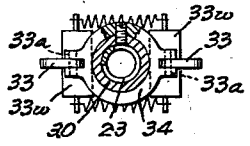
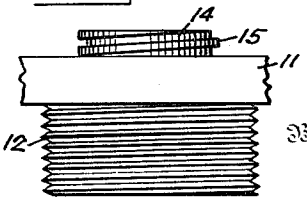


Fig. 7.



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FUSE FOR ANTIAIRCRAFT SHELLS

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14 Claims. (Cl. 102—86)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

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The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment to me of any royalty thereon.

This invention relates to the time fuse mechanism for shells and other explosive missiles which are designed to explode after a predetermined, and usually adjustable, interval of time after having been fired from a gun, thrown by hand or dropped from aircraft. For convenience the improved fuse will be described in connection with antiaircraft shells, although it is clear that the invention is not limited to this use.

The object of the invention is to devise a fuse which will obviate the necessity for clockwork now used in such cases and which by reason of its necessarily delicate mechanism is too easily subject to derangement by the shock accompanying the projecting of the shell and its flight. Allied with the object, other purposes include the devising of a fuse which will be reliable and foolproof in operation, and not costly to manufacture in quanties.

For the attainment of these and such other objects of invention as may herein appear or be pointed out I have shown an embodiment of my invention in the accompanying drawing, wherein

Fig. 1 is a sectional view of the improved fuse in elevation;

Fig. 2 is an elevational view thereof;

Fig. 3 is a sectional plan view taken as the line 3—3 of Fig. 1;

Fig. 4 is likewise a sectional plan view but taken nearer the tip of the fuse, on line 4—4 of Fig. 1;

Fig. 5 is a detail of the rotor;

Fig. 6 is a detail of the speed-of-rotation governor, and

Fig. 7 is a detail of the square external thread which is integral with, and uprising from, the fuse base.

The shell is shown in Figs. 1 and 2 of the drawing with the nose of the shell, or rather, of the fuse which occupies the forward nose end of the projectile, pointed upwardly, it being assumed that the shell is fired in this direction; hence in the following description "upward" also signifies "forward," the top of the fuse being its forward portion and the lower portion being in the rear.

The invention utilizes the rotation of the shell and the air-pressure on the nose to produce a constant differential speed of rotation between the shell itself and a rotor contained in the nose, and thereby operate a gear-train which will release a striker after a predetermined lapse of time. It has been found by experiment that, al-

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though the linear velocity of a shell decreases rapidly, due to air resistance and the gravity component, the rotational velocity remains practically constant throughout its flight. This principle of constant rotational velocity is utilized in the mechanical time-fuse now used in our armed services, where the centrifugal force of weights in the fuse is used to operate a clockwork mechanism. The fuse proposed herein will obviate the necessity for clockwork, with its necessarily delicate mechanism, subject to derangement by shock.

In the proposed mechanism, a rotor is mounted longitudinally in the fuse, on anti-friction bearings. Upon firing, the set-back seats this rotor firmly upon the fuse body, thereby permitting the rotor to acquire the same rotational velocity as the shell itself. When acceleration ceases, the rotor is freed. Air entering through holes in the fuse casing and impinging on inclined vanes in the rotor head causes an increased rate of rotation of the rotor. When this differenial rate of rotation reaches a certain value, a centrifugal governor on the rotor (similar to the touch-and-go governor on a phonograph) holds the rotor rotation to that speed, regardless of variation of air pressure. This constant differential rate of rotation between rotor and fuse body causes constant speed operation of a double-reduction set of worm gearing, which, after a predetermined time-interval (dependent upon initial setting) causes the tripping of a spring-operated striker in the rotor itself, the striker impinging upon a detonator and causing explosion of the shell.

The fuse casing 10 is rotatively mounted on the fuse base 11, as by means of a ring 9 which is fitted over an inwardly-turned flange 29 of the fuse casing and which is secured to the fuse base 11 as by screws shown. The fuse base itself is secured to the shell casing 1 by screwing a threaded nipple 12 depending from the fuse base 11, into the tapped mouth of the shell casing. The shell casing contains the usual high explosive filler 2, booster charge 3, and detonator 4. Detonator 4 is set off by primer point or striker 24 which is the lowermost element of a primer assembiage, the other elements of which are a follower member 22 and a compression spring 23 desposed between the striker 24 and the follower 22. The primer assemblage is contained within a tubular rotor 30, the follower being mounted within the said tubular rotor for an extent of sliding movement. Follower 22 is made in the form of a one-way ball clutch, and comprises a number of balls 25. Striker spring 23

is normally under only slight compression, in the position of the parts shown in Fig. 1. When the shell is fired from the gun, upwardly in Fig. 1, set-back causes follower 22 to move to the rear downwardly in Fig. 1, fully compressing the striker spring. Ball clutch 25 then becomes effective to hold the follower in the rearward position during flight of the shell, thereby keeping the striker spring fully compressed. The striker 24 is prevented from being moved rearwardly, downwardly, Fig. 1, under urgency of the said compressed striker spring by three steel balls 21, only two appearing in Fig. 1, which are contained in suitable pockets provided for them in the striker as clearly seen in Fig. 1. As seen in Fig. 1, portions of the balls 21 extend beyond the striker and are received in passageways 31 provided for them near the lower end of tubular rotor 30, see also the detail of the rotor in Fig. 5. Although passageways 31 are sufficiently large to permit the balls to pass through, the balls are held in place by a retainer ring 41 which in the normal position of the parts during flight, as shown in Fig. 1, blocks escape of balls 21, which are thus effective to prevent downward movement of striker 24.

Retainer ring 41 is elevated, at the instant the fuse is set to explode the shell, by the rotor 30 and the following parts associated therewith. The upper end of retainer ring 41 is provided with a flange 40 which rests on a ring gear 50, or rather, on ball-bearings between the two, as clearly seen in Fig. 1. The ring gear 50 is provided at its upper end with external threads 52 which receive a threaded cap 53 in a manner to hold flange 40 of the retainer ring between the cap 53 and the ring gear 50. The retainer ring 41 is thus caused to move with the elevational movement of the ring gear 50. The ring gear is mounted for a limited extent of vertical movement by the provision of an internal square thread 55 which makes a single or a partial convolution and which is received in the interdental space between a square thread 15 formed externally on a hub 14 uprising from the fuse base 11. The teeth of the wide-face ring gear 50 mesh with a pinion 60 secured at the lower end of a short vertical spindle 61 which is rotatively mounted in a bracket 13 secured on fuse casing 10. The bracket also mounts a double-reduction worm gear train 62 the last unit of which meshes with a worm 32 secured on the rotor 30.

The forward end, upward in the figures, of the rotor 30 is implemented with inclined vanes 36 upon which air impinges by passing through holes 16 in the fuse casing 10. The air escapes by passing through the hollow interior of the fuse and through holes 17 in the fuse base 11 and holes 8 in the shell casing 1.

The rotor is held against turning during the time of firing. For this purpose the forward end of the rotor is provided with an overhanging portion 38 which overlies an annular flange 18 secured within the fuse casing 10. Annular flange 18 is provided with a plurality of holes 19 for passage of the air entering fuse casing ports 15 and leaving the rotor vanes 36. In the normal position of the parts, as shown in Fig. 1, the rotor overhang 38 is raised so as to clear contact with the fuse flange 18. It should be mentioned that the rotor 30 is capable of a limited extent of vertical movement made possible by the sliding engagement of the lower rotor bearing 35. Underlying rotor bearing 35 and desposed between

it and the fuse base 11 is a spring washer 20 which normally maintains the rotor in elevated position with its overhang 38 raised off fuse casing flange 18 (as previously described). Under the stress of set-back of the rotor caused by firing, washer 20 is compressed, resulting in the seating of the rotor overhang 38 on the fuse casing flange 18, thus preventing the rotor from turning. As soon as the shell has left the gun, acceleration ceases; spring washer 20 resumes its normal shape lifting the rotor overhang from its seat on annular flange 18 and permitting the rotor to turn.

The rotor is provided with a centrifugal governor to maintain its rotation at a constant predetermined rate. The governor comprises a plurality of bell-crank levers 33 pivotly mounted at 33*a* to a collar 34 secured to the rotor and provided with weights 33*w* at the lower ends of the vertical legs of bell-cranks 33. The weights may be connected by springs, as shown in Fig. 6. The horizontal legs of the bell-cranks underlie the horizontal annular disc portion of an L-shaped flanged collar 37 which is slidably mounted on the rotor for a limited extent of vertical movement. A compression coil spring 37*s* is disposed between the upper end of slide collar 37 and a seat in the rotor overhang 38, urging the collar 37 downwardly against the upwardly directed force of the weighted bell-cranks 33. On the horizontal annular disc portion of slide collar 37 are a number of upstanding plungers 37*p* which clear through holes provided for that purpose in annular flange 18.

Centrifugal force caused by rotation of the rotor (at a higher speed than that of the entire shell) causes governor weights 33*w* to swing outwardly against the tension of the governor springs (Fig. 6) and pressing the horizontal legs of bell-cranks 33 against the horizontal flange portion of the slide collar 37 to raise the collar upwardly against the force of spring 37*s*. This upward movement of the collar forces its plungers 37*p* against the rotor overhang 38, thereby slowing it down until the governor weights move in—as a result of reduced speed of rotation—to relieve the pressure on the governor plungers.

The improved fuse of this invention operates as follows: Before firing, the nose of the shell, the fuse casing (10) end, is placed in a fuse-setter and, while the shell casing 1 is held stationary, is rotated the required amount relative to casing 1. Rotation of fuse casing 10 carries the worm gear train with it (as the latter is mounted thereon). Since a worm gear is irreversible, the gear train is turned orbitally in "frozen" condition with the fuse casing. (The rotor too is turned together with the fuse casing and the worm gear train.) Pinion 60, turning as part of the gear train, being in mesh with the ring gear 50, will rotate gear 50 relative to the fuse base 11, i. e., relative to shell casing 1. The rotation imparted to ring gear 50 will cause an elevation of the ring gear as its internal square thread 55 rides up on the external square thread 15 of the fuse base 11. Elevation of ring gear 50 carries with it the retainer ring 41, by reason of the connection between the two described above. But the retainer ring 41, in the setting of the fuse, is never raised sufficiently to permit passage of the stop balls 21, so that the striker 24 is maintained by the balls 21 against downward movement.

The round, after the setting of its fuse as described, is then loaded into the gun and fired.

As already described, the firing causes a loading or compressing of striker coil spring 23; and, also described above, set-back causes the rotor to be held against turning. As soon as acceleration sufficiently decreases, the rotor becomes free to be rotated by the air coming in at nose ports 16, as already described. The rotor acquires a speed of rotation which is higher than that of the shell itself and which, because of the functioning of the centrifugal governor, is constant. The gear train, including the worm reductions, is thus rotated at a constant speed to cause a slow but constant rotation of ring gear 50 and a slow elevation (or forward movement) of the gear and the retainer ring 41. The latter is not rigidly secured to the rotor but is permitted to be turned by the ring gear by reason of the reaction through the ball bearings between the ring gear 50 and flange 40 under the pressure imposed by the compressed striker spring 23. When the ring gear is sufficiently turned and the retainer ring 41 sufficiently raised, the retainer balls 21 are free to escape through the passages 31 of the rotor; whereat the striker 24 impelled by its spring 23 impinges downwardly to strike the detonator 4.

It will be noted that a predetermined amount of rotation of ring gear 50 is necessary before the striker 24 is released to its spring. This rotation is secured in two ways (*a*) by initial setting of the fuse setter and (*b*) by operation of gear-train. Hence, the greater amount of rotation in initial setting, the less will be required by gear-train. Accordingly, this fuse setting is opposite to conventional varieties, in that a shorter rotation of fuse setting causes a longer time of flight before fuse operates.

I claim:

1. In a time fuse for shells having a shell casing, a nose casing rotatively mounted thereon, and a detonator, the combination of a tubular rotor rotatively mounted in the said nose casing, a striker slidably mounted within the said tubular rotor and having a primer point contactable with the said detonator, spring means urging the striker towards the detonator, the said striker having a plurality of cupped cavities and the said tubular rotor having a plurality of holes aligned with the said cavities of the striker, a plurality of balls contained in the said cavities and the said holes, a retainer tube encircling the tubular rotor and covering its said holes whereby the balls are imprisoned in their said cavities to block the striker from moving towards the detonator under urgency of its said spring, a worm secured on the rotor, a double-reduction worm gear train mounted on the said nose casing with its high speed worm gear meshing with the said rotor worm and provided with a pinion on its low speed spindle, a ring gear mounted about the said rotor and provided with an internal screw thread, the said fuse casing being provided with an uprising annular hub having an external screw thread on which the said ring gear is screwed, the said ring gear having spur gear teeth meshing with the said pinion whereby rotation imparted thereby to the ring gear will cause longitudinal movement thereof, the ring gear being operatively connected to the said retainer tube whereby the said longitudinal movement of the ring gear will move the said retainer tube to uncover the said holes of the tubular rotor whereby the said balls may escape therethrough under urgency of the said striker spring and centrifugal force of the rotation of the said parts, thereby releasing the striker to its said spring.

2. In a time fuse for shells having a shell casing, a nose casing rotatively mounted thereon, and a detonator, the combination of a tubular rotor rotatively mounted in the said nose casing, a striker slidably mounted within the said tubular rotor and having a primer point contactable with the said detonator, spring means urging the striker towards the said detonator, the said striker having a plurality of cupped cavities and the said tubular rotor having a plurality of holes aligned with the said cavities of the striker, a plurality of balls contained in the said cavities and the said holes, a retainer tube encircling the tubular rotor and covering its said holes whereby the balls are imprisoned in their said cavities to block the striker from moving towards the detonator under urgency of its said spring, a gear mounted about the said rotor and provided with an internal screw thread, the said fuse casing being provided with an uprising annular hub having an external screw thread on which the said ring gear is screwed, speed reduction means between the rotor and the gear whereby rotation imparted to the gear will cause its longitudinal movement, the gear being operatively connected to the said retainer tube whereby the said longitudinal movement of the ring gear will move the said retainer tube to uncover the said holes of the tubular rotor whereby the said balls may escape therethrough under urgency of the said striker spring and the centrifugal force of the rotation of the said parts, thereby releasing the striker to its said spring.

3. In a time fuse for shells having a shell casing, a nose casing rotatively mounted thereon, and a detonator, the combination of a tubular rotor rotatively mounted in the said nose casing, a striker slidably mounted within the said tubular rotor and having a point contactable with the said detonator, spring means urging the striker towards the said detonator, the said striker having a plurality of cupped cavities and the said tubular rotor having a plurality of holes aligned with the said cavities of the striker, a plurality of balls contained in the said cavities and the said holes, a retainer tube encircling the tubular rotor covering its said holes whereby the balls are imprisoned in their said cavities to block the striker from moving towards the detonator under urgency of its said spring, a member mounted for combined rotary and longitudinal movement and operatively connected to the said retainer tube, and speed reduction means between the rotor and the said member whereby rotation imparted by the rotor to the said member will move the said retainer tube to uncover the said holes of the tubular rotor whereby the said balls may escape therethrough under urgency of the said striker spring and the centrifugal force of the rotation of the said parts, thereby releasing the striker to its said spring.

4. The combination according to claim 3 in which the rotor is provided at its tip end with vanes and the nose casing is provided at its tip with air entry ports and the shell casing is provided with air egress ports.

5. The combination according to claim 3 in which the rotor is mounted for a limited extent of longitudinal movement and is provided with an externally-disposed annular flange, the said nose casing being provided with an internally-directed annular flange, and spring means for urging the rotor in a forward direction to maintain its said flange removed from the said flange of the nose casing, the said rotor being moved

by set-back upon firing to contact its flange on the nose casing flange whereby the rotor is held against turning.

6. The combination according to claim 3 in which the nose casing is provided with an internal annular flange and the rotor is provided with a plurality of bell-crank levers the vertical legs of which are parallel to the axis of the rotor and weighted, the horizontal legs being contactable with the said annular flange as the weighted legs of the bell-crank swing outwardly due to centrifugal force when the rotor turning exceeds a predetermined amount.

7. The combination according to claim 3 further provided with a follower member slidably mounted in the said tubular rotor, the said follower member being implemented with a one-way ball clutch cooperative with the wall of the tubular rotor and a compression spring disposed between the said striker and the said follower member.

8. In a time fuse for shells having a shell casing, in combination, a shell having openings leading from its forward end through its walls to the atmosphere, a hollow nose on the shell and rotatable relative thereto, said nose having air passages adjacent its front end communicating with openings in the shell through the nose, a rotor rotatably mounted in said nose and provided with propeller means adjacent said passages against which air impinges during the flight of the shell to rotate the rotor, a spring-backed striker carried by the rotor, means for latching the striker to the rotor, a member axially movable relative to the rotor, and operable connections between said rotor and axially movable member to move said member when the rotor is rotated to render said latching means ineffective and release the striker, and a detonator positioned to be engaged by the striker.

9. In a time fuse for shells having a shell casing, in combination, a hollow nose carried by said shell and rotatable relative thereto, said casing having air passages adjacent to its front end, means rearward of said passage for the escape of air entering said passages, a tubular rotor rotatably mounted in the nose and positioned axially thereof and provided with propeller means adjacent the nose passages for impingement of air to rotate the rotor during the flight of the shell, a striker slidably mounted in the rotor, a spring backing the striker, means for normally latching the striker against movement, a gear surrounding the rotor and axially movable relative thereto and threadedly connected to the shell, a worm carried by the rotor, a worm gear train connecting the worm on the rotor with the rotor surrounding gear whereby when the rotor is rotated the surrounding gear will be axially moved relative to the rotor according to the setting of the nose on the shell, and means operable by the gear to unlatch the striker upon the axial movement of said gear, and a detonator positioned to be engaged by the striker.

10. The invention of claim 9 characterized in that the rotor is provided in its forward end with means operable upon set-back to compress the striker spring and hold the same compressed.

11. The invention of claim 9 characterized in that the means for compressing the spring in the rotor comprises a one-way ball clutch moved rearwardly by set-back.

12. The invention of claim 9 characterized in that there is spring means interposed between the rear end of the rotor and the shell body compressed by the rotor upon set-back to seat the rotor and prevent it from turning during firing, but adapted to restore the rotor to normal rotatable position upon cessation of acceleration of the shell.

13. The invention of claim 9 characterized in that the rotor is provided with a collar to which is attached a plurality of centrifugal governor arms, and means carried by the nose cooperating with said arms to assure the rotation of the rotor and shell at substantially the same speed.

14. In a time fuse for a shell having a casing, in combination, a shell having openings leading from its forward end through its walls to the atmosphere, a hollow nose on the casing and rotatable relative thereto, said nose having openings in its forward end communicating with openings in the shell through said nose, a hollow rotor axially mounted in the nose and having propeller means within the nose adjacent nose openings, whereby the rotor is rotated in the flight of the shell, a striker slidably mounted in the rotor, a spring in said rotor backing the striker, a follower in the rotor operable upon set-back to tension said spring and hold it tensioned, said rotor having oppositely disposed apertures in its wall, oppositely disposed pockets in the striker, locking devices partly in the apertures of rotor and partly in said pockets, a member rotatably carried by the shell and rotatably surrounding the rotor and movable axially thereof, means interposed between the rotor and said member for moving said member upon rotation of the rotor, and a retainer ring surrounding the rotor and normally holding said locking devices in said pockets and apertures, said retainer ring moved by the rotor surrounding member to release the locking devices and surrender the striker to its spring.

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