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P. H. THOMPSON

2,495,431

FUSE

Filed May 27, 1944

FIG. 1.

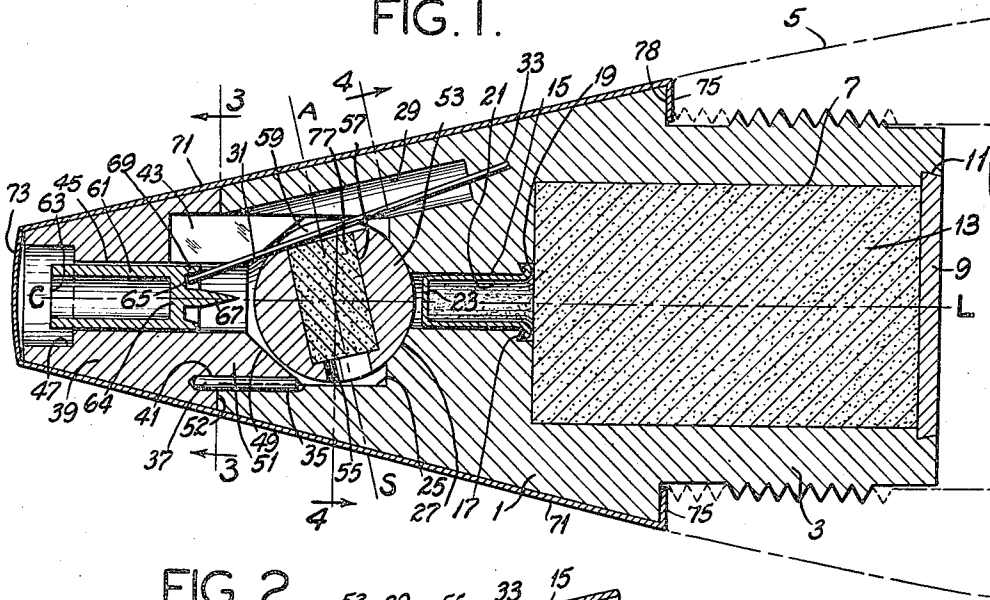


FIG. 2.

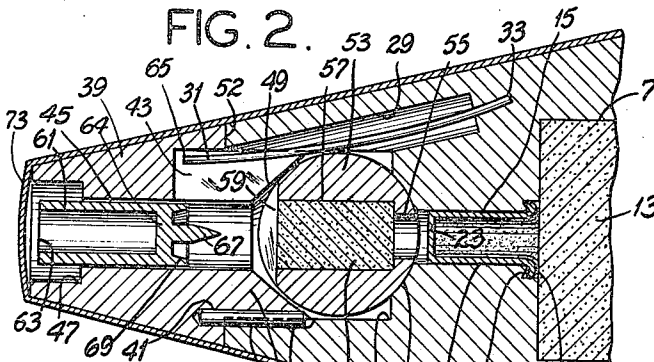


FIG. 3.

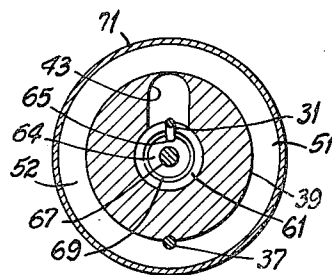


FIG. 4.

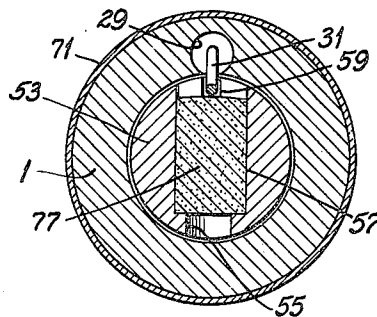
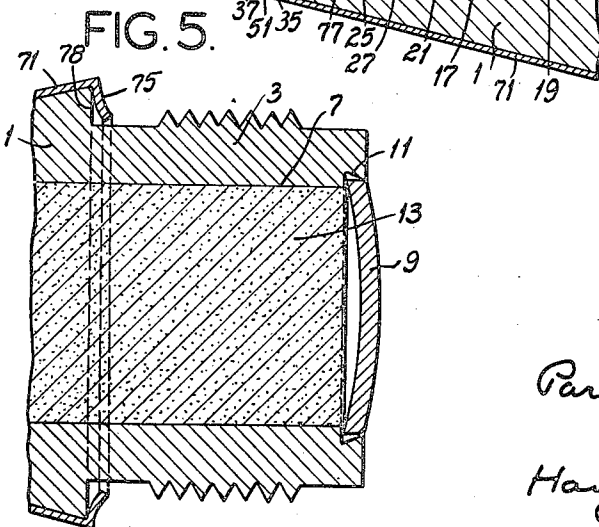


FIG. 5.



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UNITED STATES PATENT OFFICE

2,495,431

FUSE

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1 Claim. (Cl. 102—70)

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This invention relates to fuzes, and with regard to certain more specific features, to point-detonating fuzes for projectiles and the like.

Among the several objects of the invention may be noted the provision of a completely safe, simple, compact and permanently reliable point-detonating fuze for projectiles and the like; the provision of a fuze of this class which, when attached to a shell, provides an air-tight seal to prevent breathing of atmosphere into and out of the projectile so as to avoid deterioration of its contents; and the provision of a fuze of this class which is easy to manufacture. Other objects will be in part obvious and in part pointed out hereinafter.

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 claim.

In the accompanying drawings, in which is illustrated one of various possible embodiments of the invention,

Fig. 1 is a longitudinal section of the new fuze, showing it in the unarmed or safe condition of its parts;

Fig. 2 is a fragmentary view similar to Fig. 1 showing the parts in armed condition;

Fig. 3 is a vertical section taken on line 3—3 of Fig. 1;

Fig. 4 is a vertical section taken on line 4—4 of Fig. 1; and,

Fig. 5 is a fragmentary detail of certain parts of Fig. 1 prior to complete assembly.

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

The invention is an improvement upon the construction shown in Scelzo United States Patent 2,155,100, dated April 18, 1939. It is applicable to various classes of ammunition, for both small and large calibers. However, it has particular advantages in connection with the smaller and medium sizes because of the small space within which the elements of the invention may be housed.

Referring now more particularly to Fig. 1, there is shown at numeral 1 a tapered fuze body having a hollow threaded shank 3 for application to the threaded end of a shell 5 shown in dot-dash lines. The shell has an internally threaded front end surrounded by a front end seat and as usual carries the main explosive charge to be detonated by the fuze per se. The shank 3 is formed interiorly as a hollow cylinder 7 for receiving a

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cylindric pre-consolidated pellet of booster charge material 13. This material is held in place by means of a so-called Welsh plug 9 pressed into an undercut peripheral recess 11.

Since the manner of applying the plug 9 is of some importance, the details of this will be explained, referring to Fig. 5. This plug is initially bulged as shown in Fig. 5, with a cylindric margin which will allow it to be snugly inserted into the narrowest portion of an undercut groove 11. This is done after the pre-consolidated booster charge pellet 13 has been slipped into the cylinder 7. This pellet is about equal to or if necessary slightly longer than the cylinder 7 measured out to the base of the groove 11. Thereafter, the plug 9 is pressed from the bulged condition shown in Fig. 5 to the flat condition shown in Fig. 1. This expands its margin to interlock in the undercut groove 11. At the same time its central portion exerts a final re-consolidating effect upon the booster charge 13, thus assuring that the latter will entirely compactly fill up the space in the cylinder 7. This assures reliable travel through the pellet 13 of the detonating wave which is to set it off. Unreliable booster charge action is often due to its improper consolidation in its containing chamber, and this method of re-consolidating it by means of the holding plug 9 increases its reliability.

Extending forward from the cylinder 7 on the center line of the body 1 is a cylindric connecting passage 15. At the rear end of this passage is a crimping groove 17 for receiving a flange 19 of a primer cup 21, closed at its opposite end as shown at 23. This is sometimes known as a leading cup, being filled with an explosive such as tetryl.

Beyond the passage 15, the body 1 is provided with a counterbore 25. This counterbore 25 connects with the passage 15 by means of a spherical seat 27. The largest diameter of the seat 27 is preferably smaller than the diameter of the counterbore 25 for reasons which will appear.

Extending at an angle from one side of the counterbore 25 is a passage 29 for accommodating an angularly located cantilever wire spring 31 which is staked into the bottom of the passage as indicated at 33. Obviously, other methods for fastening the spring may be employed. The cross section of the passage 29 is optional but a round bore is shown. The counterbore 25 also includes at its outer end a keyway 35 for a key 37. Key 37 also seats in a keyway 41 in a nose 39. Other equivalent key means may be used.

Adjacent to, and connecting with the hole 29 in body 1, the nose 39 is provided with a radial

recess 43 accommodating movement of the end of spring 31, as may be seen by comparing Figs. 1 and 2. The nose 39 has a central passage or bore 45 communicating with the recess 43. The end 65 of spring 31 normally extends into this passage 45.

At the forward end of the opening 45 is a counterbore 47. At its rearward end the opening is flared out by means of a beveled portion 49. This beveled portion 49 is carried in an extending portion 51 of the nose, determined by a seat 52. Portion 51 telescopes into the counterbore 25 of the body 1. No threads are used at this point. A press fit may be used. The diameter of the counterbore 25 and the position of the chamfer 49 are such as just to accommodate a spherical rotor 53 which engages the spherical seat 27. This rotor is rotary in the space provided for it.

The rotor is bored out along an axis of symmetry A—S which passes through its geometric center. This bore consists in a small-diameter portion 55 and a larger counterbore 57. At the large end of the counterbore 57 is a cross slot 59 which is symmetrical with respect to said axis A—S. This slot is designed to accommodate the spring 31 and allow it free movement. The counterbore 57 from the end of the bore 55 to the slot 59 is filled with a sensitive detonating charge 77.

The normal position of spring 31 is such as suggested in Fig. 1, that is, the rotor 53 is maintained with the axis of symmetry A—S at an angle, with respect to the center line of the fuze, which is greater than 45°, preferably of the order of 70° or so. The exact value of this angle is not critical but it is important that it be over 45° or so, in order that in its safe condition the outlet 55 of the counterbore 57 may be presented to the counterbore 25 on the outside of the spherical seat 27. The purpose of this will appear. The bias of the spring is inward toward the center line of the fuze so that it tends to seat the rotor on its seat 27, or at least prevents it from moving about in the space provided for it.

In the bore 45 of the nose 39 is a hollow firing pin 61 which may be open at the front as indicated at 63 and closed at the rear as indicated at 64. The point 67 of this pin extends from the enclosure 64. On the periphery of the enclosure 64 and around the point 67 is an inwardly tapered skirt 69, which when the firing pin is back (Fig. 1), takes up a position outside of the spring end 65. This, under certain conditions to be described forms an interlock for resisting radial movement of the spring. When the firing pin is forward, this interlocking action does not occur (Fig. 2).

The outer surfaces of the body 1 and the nose 39 are machined on a taper which may be constant as shown, or otherwise. Closely fitting over the taper is a tapered cover or shield cup 71 having a truncated, closed top 73 forming a drum over the open end of the counterbore 47. The area of the inside of the drum 73 is several times larger than the projected area of the firing pin 61 considered as a piston in bore 45.

At its base, the cover 71 is spun over as indicated at 75 in Fig. 5. This is done after its application to the assembled nose 39 and body 1. It is not spun completely flat against the undercut bottom or shoulder seat 78 of the body 1 but is left slightly angular as shown in Fig. 5. Hence when the fuze assembly is screwed to the shell 5,

the flange 75 is springingly deformed so as to assure a perfect hermetic seal against entry into the mechanism of foreign elements. This seal prevents breathing of the atmosphere into and out of the mechanism with temperature changes. Thus fuzes made according to the invention may be stored for much longer periods of time without deterioration of their contents.

An additional function of the cover 71 is to provide means for properly drawing the cover against the nose 39 to the body 1 without employment of threads of any kind. The initial position of the spun flange 75 is angular as indicated in Fig. 5. Thus when the threaded attachment is made between the body 1 and the shell 5, the resulting deformation of the flange 75 has a fulcrum effect which draws back the conical cover as a whole, thus firmly drawing it down on the nose 39 and the body 1. Since the nose and the body 1 form a continuous rearwardly flaring conical or tapered surface engaged throughout by the corresponding inner surface of the cover 71, the nose is wedgingly held by the cover even though the telescoping fit between the nose and body be other than the press-fit variety. Thus a permanently proper relationship between the nose and cover is assured despite any variations in the said telescopic fit. Also, since the entire conical surface of the cover is supported by the solid body and nose damage from accidental blows is avoided. It is to be understood that the term tapered as used herein includes conical and ogive forms. It will be noted that the only threads employed in the whole construction are those for attaching the fuze as a whole to the shell 5, those which would ordinarily be used between the nose and the body having been eliminated.

Operation is as follows:

Regardless of the position of the firing pin 61, the normal bias of the spring 31 is to the inward position shown in Fig. 1. It therefore cooperates with the groove or notch 59 and holds the rotor 53 in the stated approximate 70° position of the axis A—S. Forces due to normal handling of the ammunition are normally not capable of deflecting the spring 31 enough to permit the rotor 53 to move more than a small amount from this position. Furthermore, any temporary displacement of the spring 31 under almost inconceivable conditions of handling would be followed by prompt return to the holding position shown in Fig. 1, without imposition on the rotor of any forces which might send it to the armed position.

The normal bias of the spring 31 tends to maintain the rotor 53 on the spherical seat 27, thus sealing off the passage 15 from the detonating charge 77. Furthermore, the angle of the axis A—S is such that the opening 55 from the detonating charge is directed into the counterbore 25 and not against the seat 27. Hence if an over-sensitive detonating charge should accidentally explode of its own accord, its expansive force would not be directed against the leading cup 21 in passage 15. This preserves the booster charge 13 against detonation. The expansive force is then safely expended in the passages 25 and 45. This important safety feature is due to the high angle of the axis A—S which keeps the passage 55 forward with respect to the seat 27. This high angle has another advantage which will be explained at the proper point herein.

In view of the above, it is clear that the fuze is statically safe.

Next, assume that the shell is loaded into a gun barrel and fired by the propellant charge (not

shown). Both linear and angular acceleration then set in as the shell passes through the barrel. This at first involves initial linear set-back forces on all movable members.

Thus a set-back force is operative upon the rotor 53 which tends to seat it firmly upon the spherical seat 27. The charge 77 is positioned symmetrically with respect to the center line C—L; also the bore 55 and groove 59 represent losses of metal from the rotor having about equal moments with respect to this center line C—L so that, in view of the friction on said seat 27, the rotor maintains its safe position under linear acceleration along line C—L (Fig. 1).

It will also be noted that a set-back force is operative upon the spring 31 and since it is anchored at 33 farther from the center line C—L than its free end 65, a counterclockwise moment is applied to the spring. This adds to the normal bias of the spring in helping to maintain the rotor 53 seated on the spherical seat 27. The set-back force on firing pin 61 adds to this counterclockwise moment on spring 31 by pressing backward on the spring end 65. Thus the fuze is bore safe, for, should the detonator 77 for some unknown reason at this time explode, the pressure at seat 27 would positively block transmission of the detonation to the booster charge 13.

The linear acceleration which causes a set-back force on the firing pin 61 also holds it back so that the flange 69 locks around the end of the spring 31. Therefore as angular acceleration occurs, due to the rifling of the gun, the flange 65 acts as an interlock preventing the centrifugal action of spring 31 from substantially moving it outward. Therefore, as long as linear acceleration continues, which is as long as the shell is in the gun barrel, the rotor positively remains in its safe position, as indicated in Fig. 1.

The relationship between parts continues in the Fig. 1 position until the shell leaves the gun barrel. At this time linear acceleration ceases and linear deceleration sets in, due to frictional forces exerted upon the projectile in passing through the air. Since these forces are not applied to the floating firing pin 61, it drifts forward toward drum 73. It should be noticed, however, that the frictional forces on the shell exert a much smaller component toward effecting angular deceleration than they do toward effecting linear deceleration. Therefore, although there is enough linear deceleration to cause the pin 61 to drift forward, as indicated in Fig. 2, the angular velocity continues high enough so that the centrifugal force bends the spring 31 out radially from the slot 59. Since the density of the detonating charge 77 in the passage 57 is less than the density of the rotor 53, which is made, for example of commercial brass, and since A—S is an axis of symmetry between two centroids not in the same plane normal to C—L, this axis A—S will tend to swing into coincidence with the center line C—L of the fuze assembly. In this position the centroids are co-planar. This places the passage 55 in communication with passage 15 as indicated in Fig. 2, the rotor remaining stable under rotation in the Fig. 2 position. The projectile is then armed in flight. It appears from tests that the arming in flight is desirably delayed until an initial short part of the trajectory has been traversed. There are several possible explanations for this, one being that as the spring 31 releases the rotor, the latter becomes in effect a gyroscopic element free to precess the axis A—S toward axis C—L. The time

required by gyroscopic precession involves the desired delay, particularly in view of the high initial angle between A—S and C—L. Toward the end of the precession, there occurs possibly also a conical nutation of A—S with respect to C—L which makes the opening 55 nutate in a circle around the opening 15 without having these openings connect until the very last stages of the movement of the axis A—S. This nutation is possible because the spring 31 at this time is disconnected. It is of course also possible that the last part of the motion may involve a period of damped oscillations of the opening 55 across the opening 15. In any event, the initial large angle of A—S with respect to C—L seems to introduce a very desirable safe period during the initial traverse of the trajectory.

After the device is once armed in flight, as shown in Fig. 2, should the angular velocity drop to a point allowing the spring 31 to press against the armed rotor 53, the device would remain armed since the spring would simply hold the rotor in the armed position. Thus once armed, the fuze is permanently armed while in flight.

Rain drops encountered by the drum 73 will not deform it and without deformation the drum 73 is incapable of driving the firing pin 61 backward. Therefore premature detonation will not occur during flight in bad weather.

When the shell reaches its objective, collision with the fuze deforms the drum 73 which causes a pressure wave from drum 73 to impinge against the firing pin 61. The projected area of the piston-like firing pin 61, being substantially less than the area of the inside of the drum 73 (for example in the ratio of 1:4), any pneumatic compression drives the firing pin at a velocity higher than the deflection rate of the drum. Thus the action of the firing pin in moving backward upon impact is very fast, driving its point 67 into the detonating charge 77 which fires against the cup 21. This sets off the booster charge 13 against the member 9. It is to be understood that the cup 21 may be dispensed with and the detonating charge permitted to fire directly down the channel 15 into the booster charge.

Certain advantages of the angle greater than 45° specified for the axis of symmetry A—S have already been stated. An additional one is that the effective centrifugal moment, at a given angular velocity of the shell, tending to turn the rotor from the Fig. 1 to the Fig. 2 position is maximum at 45° of A—S. Hence it is less at angles greater than 45° while the spring is latched in the rotor notch. This reduces the static cam action of the bottom of the notch 59 on spring 31 under accelerating conditions in the gun barrel, since the position of rotor axis A—S during acceleration is greater than 45°. This increases bore safety.

Another important feature of the invention is that the forms of the parts 1, 39 and 61 lend themselves to easy manufacture by die casting. No threads are involved, except those at 3 necessary to attach the entire fuze to the shell. The integral protective cover 71 may easily be pressed or spun. Assembly is simple and fool-proof.

Unlike the Scelzo construction above mentioned, the present fuze does not depend merely upon friction between the rotor 53 and its seat 27 for delaying or preventing arming in the gun barrel. It has a positive interlock in the spring 31 and notch 59 held by the pin 61 which positively prevents arming in the barrel. In this respect spring 31 and notch 59 may be designated as a latch. In addition, this latch interlock acts

as a positive driving connection between the body 1 and the rotor 53 so that the latter is positively angularly accelerated at the same rate as the angular acceleration of the body. A mere frictional drive in this respect is avoided. Thus by the time that the projectile decelerates axially, the rotor is positively rotating at a maximum speed equal to that of the body 1. This assures its proper arming action when the latch (31, 59) is released by drift of the pin or striker 61.

The delayed arming means is claimed in my copending application, Serial No. 646,530, filed February 9, 1946, for Fuze, a division of this application, and to which this reference is made under rule 43.

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:

A fuze for a shell, the latter having an internally threaded front end surrounded by a front end seat, said fuze comprising a body including threads for attachment to the threaded shell, said body having a rearwardly directed seat facing said front end seat upon threading, a nose, said body having a forward recess for telescopic reception of a rearward extension from said nose, the outsides of the body and nose being formed as a continuous forwardly tapered surface, a one-

piece forwardly tapered sheet metal hollow shield cup, the inside of which is adapted to contact substantially throughout said tapered surfaces of the body and nose, and an inwardly directed flange on said shield cup fulcrumed to bias the shield cup back upon the body and nose when the shell and body are threaded together so as permanently to hold these together regardless of the character of the telescopic fit and whereby the contents of the fuze are hermetically sealed.

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