

Aug. 21, 1951

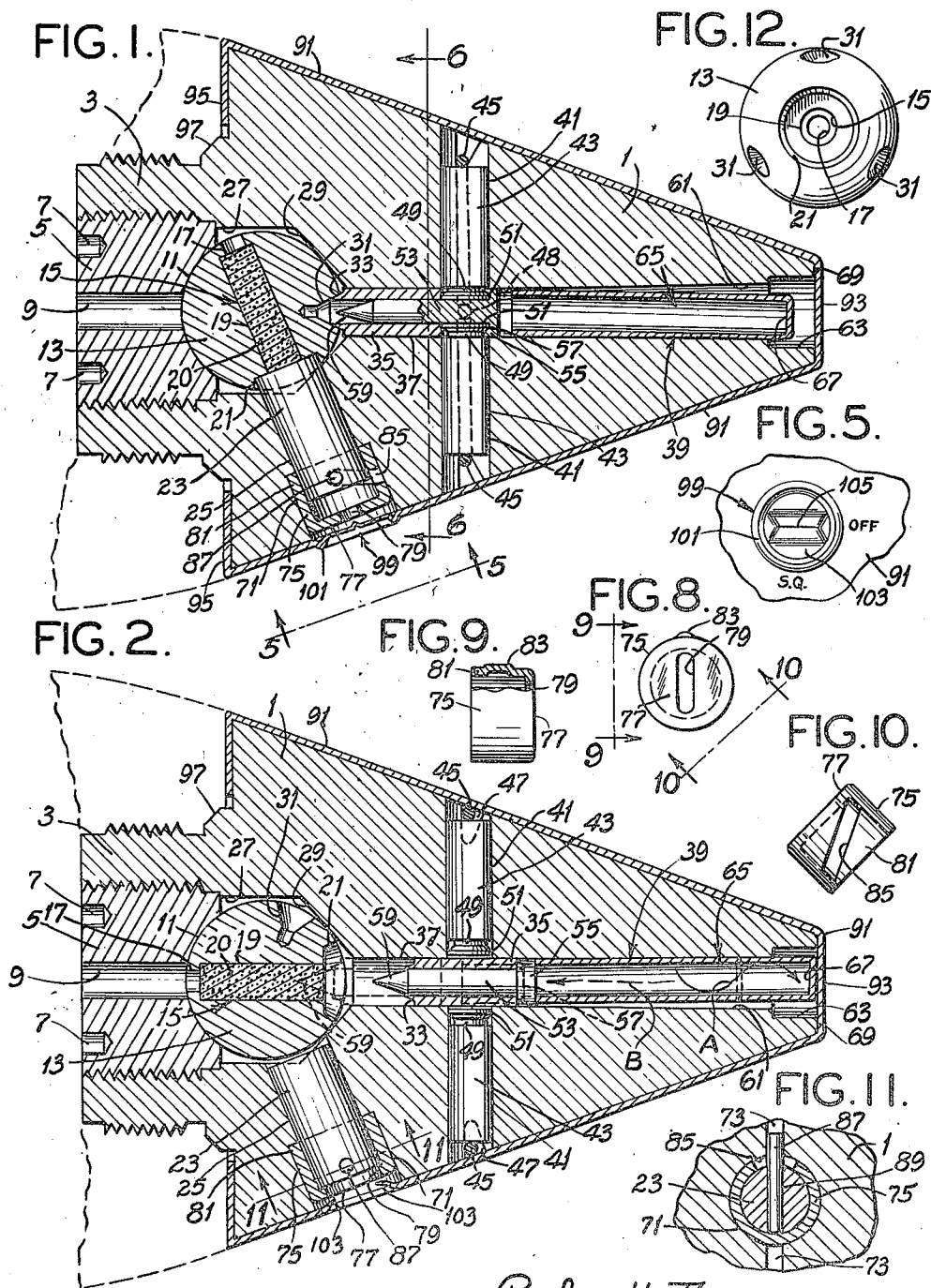
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2,564,797

FUSE

Filed May 5, 1945

2 Sheets-Sheet 1



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FIG. 3.

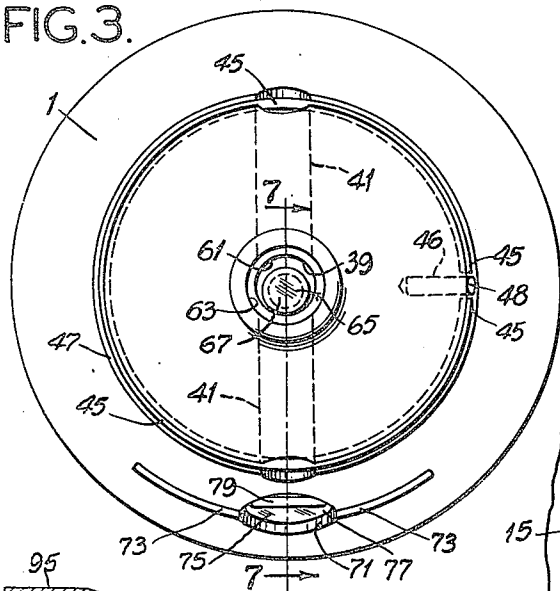


FIG. 6.

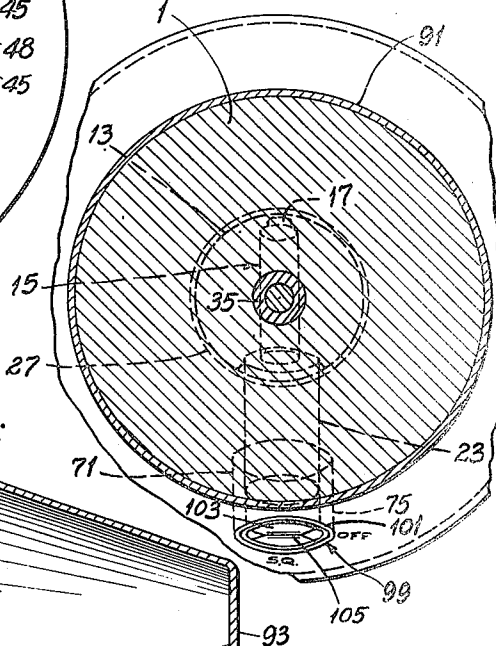


FIG. 4.

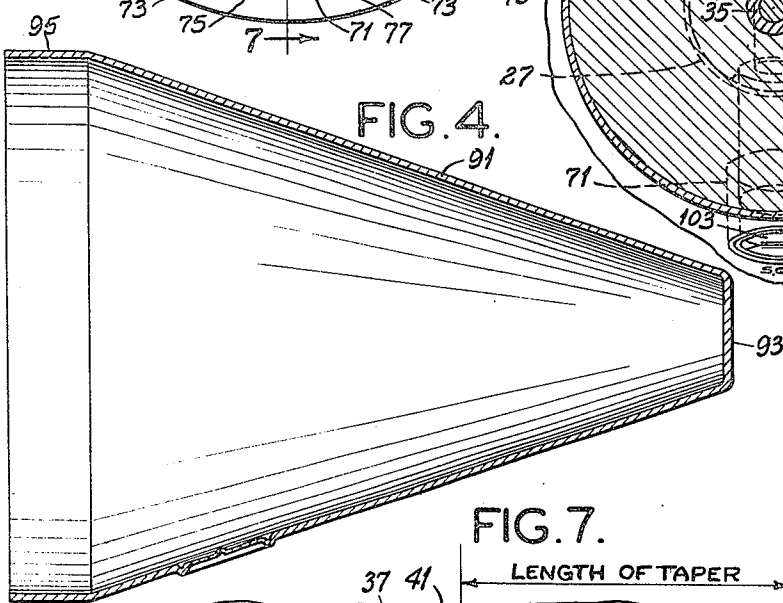
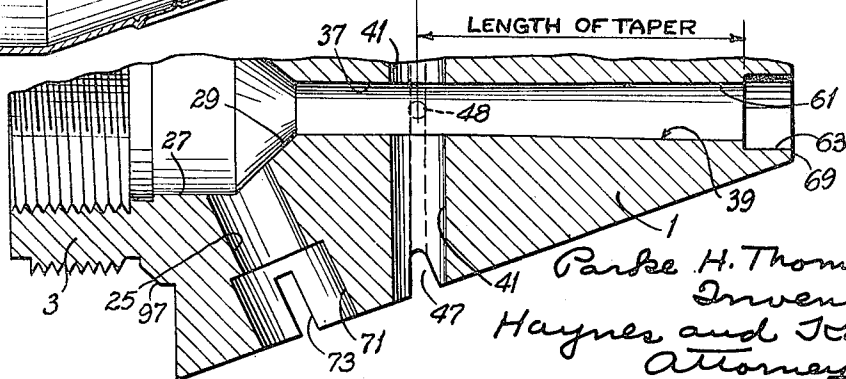


FIG. 7.



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UNITED STATES PATENT OFFICE

2,564,797

FUSE

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mesne assignments, to Marion L. J. Lambert,
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Application May 5, 1945, Serial No. 592,131

6 Claims. (Cl. 102-79)

This invention relates to fuzes for projectiles and the like, and with regard to certain more specific features, to improvements upon the fuze shown in my United States patent application for Fuze, Serial No. 537,563, filed May 27, 1944, eventuated as Patent 2,495,431, dated January 24, 1950.

Among the several objects of the invention may be noted the provision of a point-detonating fuze which is extremely reliable in detonating instantly upon initial impact even with extremely fragile target material; the provision of a fuze of the class described in which the point of its firing pin is thoroughly protected until it has performed its firing function; the provision of a fuze of this class which may be interiorly selectively set for point detonation, or base detonation; the provision of a fuze of the class described having a hermetically sealed cover but which may have its interior selector conveniently reached from the exterior for setting purposes; and the provision of a fuze of this class which is simple to construct. 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 claims.

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

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

Fig. 2 is a view similar to Fig. 1 showing in solid lines the parts in armed condition during flight after having been set for point detonation, and showing in dotted lines a firing condition;

Fig. 3 is a right-end view of Fig. 1 with the fuze cover removed;

Fig. 4 is a cross section of the cover before application to the fuze;

Fig. 5 is an oblique elevation viewed from line 5-5 adjacent to Fig. 1, but viewed with the point of the fuze up;

Fig. 6 is a fragmentary cross section taken on line 6-6 of Fig. 1;

Fig. 7 is a fragmentary view taken on line 7-7 of Fig. 3 with internal parts removed;

Fig. 8 is a detail plan view of a selector cup;

Fig. 9 is a side elevation of said cup viewed from line 9-9 of Fig. 8, parts being shown in section;

Fig. 10 is a side elevation of the selector cup, being viewed from line 10-10 of Fig. 8;

Fig. 11 is a cross section taken on line 11-11 of Fig. 2; and,

Fig. 12 is a detail plan view of a rotor viewed from the right in Fig. 2.

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

The invention is applicable to all rotary ammunition, including that for 20 mm. to 16 inch diameter guns, rifled mortars, rotating rockets, etc. The fuze is point detonating, and is to be used in connection with ammunition that is also base detonating and is provided with means for selectively determining point or base detonation.

Referring now more particularly to Fig. 1, at numeral 1 is shown a tapered fuze body or head having a threaded shank 3 for application to the threaded end of a shell, rocket or the like suggested by the dotted lines. The shell or the equivalent, as is usual, carries the main explosive charge to be detonated by the fuze, and it also carries a booster charge directly behind the shank 3. It is this booster charge that the detonator charge of the present fuze sets off. The shank 3 is hollow and is interiorly threaded to receive a threaded retainer 5. This retainer has spanner sockets 7 with which a spanner wrench may cooperate for threading the retainer to its seat. Through the retainer is located a central passage 9 for transmitting to the booster charge the effect of the detonator charge when fired in the fuze. At the forward end of this passage 9 the retainer 5 is formed as a spherical seat 11 for seating a spherical safety rotor 13.

The rotor 13 has a bore 15 along an axis which passes through its spherical center. This bore consists in the short, small-diameter bore portion 17, and a larger main bore portion 19 filled with a sensitive detonating charge 20. At the end of the bore 19 is a short circular recess 21 which forms a shoulder within which seats one end of a selector pin 23. The pin 23 has a sliding fit in an angular bore 25, which extends outward from a counterbore 27 of the body 1, the counterbore 27 being located ahead of the retainer 5. The bottom of this counterbore 27 is conical as indicated at 29, the dimensions being such that when the rotor 13 is unlocked, it may freely rotate in the space thus provided for it but without undue looseness.

As indicated in Fig. 12, the rotor 13 carries recesses 31 at 120° intervals on a circular belt

which is spaced from the central recess 21. Any one of the recesses 31 may be positioned on the longitudinal axis of the fuze when the selector pin 23 interlocks with the recess 21. A number of the recesses 31 are used at equal intervals in order to effect required rotary balance around the axis of the bore 19. Each recess 31 has a beveled edge for cooperation with the beveled end 33 of a safety sleeve 35. This safety sleeve slides in the rear cylindric part 37 of an axial bore 39. The front end of the safety sleeve is flush with the rear elements of two coaxial crossbores 41 which intersect the axial bore 39 at 90°. Each crossbore 41 carries a cylindric detent slide 43. The slides 43 are encircled and normally held inward by a circular arming spring 45. This spring seats in a peripheral groove 47 cut into the body 1 in a position to intersect the outer ends of the crossbores 41. A pin 48 is staked into a hole 46 drilled into the groove 47 at 90° to the axes of the detent slides 43 (Fig. 3). The ends of the spring 45 are held adjacent to the pin 48 so that the spring exerts equal thrust on both detent slides 43.

The inner-ends of the detent slides 43, by means of peripheral grooves 49, are formed with beveled undercut heads 51. These heads 51 between them accommodate the shank of a firing pin 53. This firing pin at the front end has a flat circular head 55 undercut as indicated at 57 for cooperation with the undercut heads 51 of the detent slides 43. The rear end of the firing pin 53 is pointed as indicated at 59, the length of the pin being such that its point under safety conditions lies within the safety sleeve 35 (Fig. 1). Thus the point 59 is normally completely protected from damage, and, as will appear, it per se does not release the rotor, this function being reserved for the safety sleeve 35.

The forward portion 61 of the axial bore 39 is tapered outwardly toward the pointed nose of the body 1, the taper preferably starting at the center line of the crossbores 41. For example, on one size of fuze, the portion of the bore 61 adjacent said center line may be made .25 inch in diameter and tapered .006 inch per inch of length larger on the diameter passing forward. The largest diameter is forward, at which is a counterbored recess 63, open at the front.

Within the tapered bore 61 is a hollow striker 65, which is open at its rear end adjacent to the head 55 and closed at the front end, as indicated at 67. With the rear end against the head 55, the front end 67 lies in said enlarged recess 63 but at some distance away from the outer edge 69 of said recess. The striker is relatively light, being hollow and made with thin walls. Since there is more metal at the closed end 67 than at the rear open end, the center of gravity of the striker 65 lies forward with respect to a central point along its length. This fact, and particularly the fact of the tapered portion 61 of the bore 39, are of importance, as will appear in the description of operation.

Referring again to the passage 25 for the selector pin 23, it will be seen that towards its outer end it has an enlarged counterbore 71, traversed by a slot 73 (Figs. 3 and 7). The counterbore receives a selector cup 75, the latter being detailed in Figs. 3, 9 and 10. This cup comprises a flat top 77 in which is a slot 79 for accommodating a selector or setting tool such as a screw driver or the like. Extending from the top 77 is a skirt 81, one side of which is bulged as shown at 83. The purpose of this bulge is to provide

means for a light, force-fit between the selector cup 75 and the counterbore 71. This fit is tight enough to hold the selector cup in any position into which it may be turned but free enough to permit it to be rotated by a tool (like a screw driver) in the slot 79.

On another side of the skirt 81 is a helical slot 85. This slot accommodates a selector guide pin 87. Pin 87 is fixed in an opening 89 in the selector pin 23, and extends through said slot 85 in cup 75 and into the slot 73 in the body 1. Thus, although the selector cup is rotary, the pin 23 is not rotary but is movable axially in the bore 25. The result is that by turning the cup 75 against the force of its tight fit, it is possible to move the selector pin 23 from the locking or unarmed position shown in Fig. 1 to the unlocking or armed position shown in Fig. 2. In the former position of Fig. 1 it positively locks the rotor 13 so that it will not be point detonated, even when the ammunition is fired. Under such conditions the projectile can only be base detonated, with some delay upon impact. When in the unlocking position of Fig. 2 the rotor is free, so far as is concerned the pin 23, and when the ammunition is fired will become automatically armed according to the operation to be described.

In order hermetically to seal the fuze, a cover 91 is employed, made for example of thin aluminum. This has a front impact diaphragm 93 which covers the opening 63 and a rear skirt 95 which is clinched over the base of the body 1 as shown in Figs. 1 and 2. This clinched portion 95 is then held hermetically by the adjacent parts of the shell when the shank 3 is screwed into position. An auxiliary seat 97 is used further to assure a seal at the end of the shell. This is similar to the showing in said Patent 2,495,431. A suitable additional gasket may be employed if desired.

It will be seen that since the cover is also over the opening 71, means needs to be provided for reaching the selector cup 75 with the setting tool. This is accomplished by embossing or pressing thin a suitable region of the cover 91 which will be located over the cup 75, at target 99. The embossing operation is such as to provide a circular bead 101 which serves as a locator for applying, say, a screw driver. Within the bead 101 the material of the cover 91 is pressed to a breakable thinness, approaching that of foil, as indicated at 103. However, it is made only thin enough that it may easily be broken by means of the setting tool but not thin enough that it will be easily broken in shipment. Across the central portion of this diaphragm 103 is formed a guide depression 105 which is parallel to the position of the slot 79 when the selector cup 75 is set into its locking position, as illustrated in Figs. 1 and 5. This position is crosswise of the axis of the projectile as a whole. For convenience, index characters of "Off" and "S. Q." are set at 90° intervals around the target 99, indicating two alternative settings. The index "Off" is opposite one end of the depression 105 and means that point detonation will not occur, but instead base detonation if the projectile is equipped for it. The index "S. Q." means super-quick, or point detonation.

The dynamic operation of the rotor 13 per se is similar to that described in said Patent 2,495,431. The normal position of the safety sleeve 35 and of the selector pin 23 are such that the rotor 13 is doubly locked by the selector pin 23 and the safety sleeve 35, as shown in Fig. 1.

Upon manual retraction of the safety pin 23 the rotor 13 is still locked.

If and when the ammunition is rotated at substantial angular velocity and the sleeve 35 moves forward, the rotor will automatically move from the angle position shown in Fig. 1 to the armed position shown in Fig. 2. This is because the density of the detonating charge 20 is less than the density of the rotor, which is made for example of commercial brass. This produces centroids in any section of the rotor on opposite sides of the axis through bore 15. Hence when the rotor spins, as upon firing the ammunition, the centroids will tend to seek a common plane of rotation perpendicular to the axis of spin. This will place the bore 15 of the rotor 13 coaxial with the bore 39 of the body 1, which is the desired arming position.

Operation is as follows:

The fuze is assembled as shown in Fig. 1, wherein it is statically safe. This is because the rotor 13 is positively locked by the selector pin 23 and by the safety pin 35. There is no conceivable practical condition of handling the projectile on which the fuze is located which would cause the rotor to turn into its armed position. Furthermore, since the entire fuze is hermetically sealed, it will remain in operating condition indefinitely since no moisture can enter to initiate corrosion of the parts or to accelerate deterioration of the detonator.

If the ammunition is to be fired for base detonation, that is slightly delayed action at the target, nothing at all is done to the selector cup adjustment, the portion 103 being left untouched at the "Off" setting.

If it is desired to render the fuze point detonating prior to firing, a screw driver or the like is applied to the groove 105 and punched in through the embossing 103, whereupon it will enter the aligned slot 79 in cup 75. A quarter turn clockwise to the "S. Q." position of the selector cup will then cause the groove 35 to pull up the selector guide pin 87. This pin being in the slot 73 prevents the selector pin 23 from rotating but withdraws it from the counter-bore 21. Rotation of the screw driver proceeds easily because the material 103 will tear upon rotation. Since the cup 75 has a tight frictional fit in the opening 71, it will retain the super-quick (S. Q.) adjustment in which the rotor is released for subsequent arming. Nevertheless the projectile is still safe because of the locking action on the rotor 13 of the still locked safety sleeve 35.

Next, the projectile is loaded into the gun and fired by the propellant charge (not shown). Both linear and angular accelerations then set in as the shell passes through the rifled barrel. If the projectile is of the rocket or similar type, rotation may be obtained by tail vanes operated upon by the air. In any event, firing at first involves initial linear set-back forces on all movable parts as angular rotation also sets in. Thus a set-back force is operative upon the rotor 13 which tends to seat it firmly upon the spherical seat 11. The safety sleeve 35, being set back, positively holds the rotor in a bore-safe condition. It will be noted that it is not the delicate point 59 of the firing pin 53 that holds the rotor, and thus this pin is preserved in prime condition until needed. The set-back action of the strong safety sleeve 35 in holding the rotor 13 makes the fuze positively bore safe.

In addition, set-back forces tend to send the

striker 65 back against the head 55 of the firing pin, thus tending to lock said head under the heads 51 of the detent slides 43. This in addition to the spring 45 tends for a certain period to hold the slides. After the projectile has angularly accelerated for a period, the angular velocity reaches a point at which the spring 45 expands, and the detent slides 43 move out. Then after linear acceleration ceases, linear deceleration sets in (Fig. 2), due to unbalanced axial frictional forces exerted upon the projectile in passing through the air. Since there is no frictional force on the striker 65, the firing pin 53 and safety sleeve 35 tend to drift forward. This drift by itself may be indifferent. But, since the projectile is by this time spinning on its longitudinal axis at a substantial speed, and since the striker 65 has a conical spin in the conical bore 61, the striker independently of drift is positively moved forward against the impact diaphragm 93 and positively remains there. The solid-line position of the striker in Fig. 2 is illustrative of this point (see also the solid skew arrow A). This movement forward of the striker due to the conical spin in the conical passage 61 is of great importance. Heretofore reliance has been placed entirely upon linear decelerating forces (or drift as it is called) to hold similar strikers forward. It is believed that toward the end of the trajectory the decelerating forces may be so small that in older fuzes the striker by the time the target is reached and under yawing movements of the projectile, may have again crept rearwardly, with the consequence that detonation may not be as reliable as with the present structure. By means of this new spinning feed action on the striker in the tapered bore 61 there is positive assurance that the striker will be resting against the impact diaphragm 93 when the target is reached, because the angular velocity is maintained fairly well to the end of a trajectory.

It will be clear that before the target is reached, the initial high deceleration of the projectile after leaving the gun barrel will have moved the firing pin 53 forward, thus releasing the slides 43. Centrifugal forces on the detent slides causes them to move outward against the constricting action of the spring 45. Outward movement of the slides 43 also releases the safety sleeve 35 which may move forward under said initial high linear deceleration. The forward movement of the safety pin thereafter locks out the detent slides 43.

When the safety sleeve 35 leaves the rotor 13, the latter spins into position with its detonating charge coaxial with the bore 39. This action of this type of rotor is described in detail in said patent.

The target is reached with the assurance that the striker 65 is against the impact diaphragm discharge 93. The blow on the diaphragm 93 which is then in direct contact with the striker drives the latter back with considerable force against the head 55 of the firing pin (Fig. 2, dotted lines and see the dotted arrow B). Since the clearance between the head 55 and the end of the safety sleeve 35 has been eliminated by removal of the heads 51 of the detent slides 43, the point 59 of the firing pin then projects from the rear end of the safety sleeve as the two are driven back under impact from the striker. Hence the exposed point 59 enters the detonator charge 20, thus firing it through the opening 9

to the booster charge (not shown) behind the retainer 5.

The invention has all of the advantages of the device described in said Patent 2,495,431, but these are not reiterated herein. It also has the following advantages:

If the fuze be placed on its nose end while unarmed, the firing pin 53 may move down with the striker 65, but the slides 43 cannot move from an intersecting position behind the safety sleeve 35. The firing pin may move forward but never backward enough to expose the point 59 from the safety pin 35. The point of the firing pin is not used as an interlock which might become damaged upon release of the rotor 13. Ordinarily such a point is too delicate an instrument to be used for interlock purposes. The present invention avoids this through the use of the hollow safety sleeve 35. Hence there is no possibility of damaging the point 59 of the firing pin 53, as would be the case if it were used for directly locking the rotor 13. Also, the sleeve 35 acts as an alignment bearing for the headed firing pin to prevent it from wobbling. Also, the broad contact between the end of the relatively large safety sleeve 35 and one of the recesses 31 of the rotor provides a much more satisfactory interlock, so far as holding operations are concerned.

The invention provides a hermetically-sealed cover for a construction adapted selectively to be set one way or another on the inside, which may be reached by a hermetically sealing but frangible portion on said cover. The fuze is absolutely foolproof until set, and then it is very bore safe.

On the other hand, the fuze is extremely sensitive and positive in its detonating action upon reaching the target. This is because of the positive movement of the striker 65 forward against the diaphragm 93 while the ammunition is in flight, this being due to the forward movement caused by the conical spin of the striker in the conical bore 61. Also, a continuing force due to this conical spin holds the striker in the desired position.

The device is quite easy to make and assemble, consisting of simple forms which with minimum cost may be manufactured to close tolerances. For example, the screw feed for the selector pin 23 is carried out very simply and is rugged and reliable and also easy to assemble. Also, the skew feed for the striker is accomplished very simply. It is quite easy to assemble the arming spring which is merely slipped over the conical body 1 until it reaches the groove 47, whereupon it springs into position behind the previously inserted detent slides 43, the gap between its ends being at the pin 48.

Cross-reference is made to my copending divisional application Serial No. 122,818, filed October 21, 1949, for Sheathed Body, Particularly a Sheathed Fuze, and Sheath Therefor.

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 comprising a head having an axial passage from front to rear, a centrifugally-arming rotor toward the rear of said passage, said

head having cross passages intersecting said axial passage between the ends of the axial passage, centrifugally-operated detents in said intersecting passages normally biased toward the longitudinal passage, a hollow safety sleeve interlocking rearwardly with the rotor in a non-armed position of the latter, said safety sleeve being normally held in interlocking position by said detents, a firing pin inserted with its point within said safety sleeve and ahead of the rotor and having a portion between said detents and a head forwardly of them and normally interlocking therewith, an elongate striker ahead of said firing pin, said axial passage being tapered with its large diameter forward in the region where it contains said striker, and impact means located forwardly on said head with which said striker is adapted to engage upon its forward movement under rotation of the head, whereby said striker is always held in position against the impact means to be driven back by said impact means when the head strikes an object.

2. A fuze comprising a head having a forward nose, an axial passage through said head from said nose, centrifugally-operated arming rotor means associated with said passage, a safety interlocking sleeve for said rotor means, a headed firing pin extending into said sleeve and being pointed at one end and headed at the other end, said sleeve and said firing pin being in said passage, centrifugally-operated detent means adapted normally to hold the sleeve interlocked with the rotor means, and also adapted normally to hold the head of the firing pin so that its point is withdrawn into the sleeve, a striker in the forward part of said passage, said passage being tapered with its large diameter forward whereby centrifugal motion of the head will through conical motion of the striker bias said striker forward, said centrifugal action also moving the detent means to allow the point of the firing pin to emerge from the sleeve for movement into the rotor means, and means at said nose for limiting the bias movement of said striker, said striker being driven back against the firing pin when the nose strikes an object, whereby the point of the firing pin is driven to emerge from the safety sleeve and into the rotor means.

3. A fuze comprising a head having an axial passage from front to rear, centrifugally-operated arming means associated with said passage and under centrifugal force being movable from an unarmed to an arming position, said arming means having a locking recess adapted to register with said passage when the arming means is in unarmed position, a safety sleeve in said passage ahead of the arming means and upon set-back cooperating with said recess to form a lock, a firing pin sliding in said safety sleeve, said firing pin having a head normally spaced from the forward end of said safety sleeve, said head having a cross passage communicating with said axial passage, a detent slide in said cross passage and having a head normally interlocking between the front end of said safety sleeve and the head of said firing pin but under centrifugal force moving from interlocking position, means biasing said detent toward said interlocked position, a striker located in said axial bore ahead of said firing pin, said axial bore on the region of said striker being tapered with its large diameter forward, whereby centrifugal action under rotation of the head will cause conical movements of the striker to move it forwardly in the

axial bore, and impact means engageable by the striker upon its forward movement, said impact means upon impact driving back the striker, firing pin and sleeve past the then centrifugally-moved detent slide.

4. A fuze comprising a fuze body having a nose and an axial passage opening at the nose, an impact member closing the forward end of the passage at the nose, a detonating charge in the fuze body at the rearward end of the passage, a firing pin in the passage ahead of the charge, said passage ahead of the firing pin having a portion of generally conical form diverging toward the nose of the fuze body, a generally cylindrical elongate striker loose in the conical portion of the passage, the diameter of the striker being less than the diameter of the rearward and smaller end of the conical passage, the distribution of the mass of the striker being such that its center of gravity is forward of its center of length, the sum of the lengths of the firing pin and striker being less than the distance from the forward end of the detonating charge to the impact member, whereby the striker is adapted to spin conically and move forward in the conical portion of the passage against the impact member upon spinning of the fuze body.

5. A fuze comprising a fuze body having a nose and an axial passage opening at the nose, an impact member closing the forward end of the passage at the nose, a detonating charge in the fuze body at the rearward end of the passage, a firing pin in the passage ahead of the charge, said passage ahead of the firing pin having a portion of generally conical form diverging toward the nose of the fuze body, an elongate striker loose in the conical portion of the passage, said striker comprising a thin-walled hollow cylinder, the diameter of which is less than the diameter of the rearward and smaller end of the conical passage, the striker being open at its rearward end and closed at its forward end so that its center of gravity is forward of its center of length, the sum of the lengths of the firing pin and striker being less than the distance from the forward end of the

detonating charge to the impact member, whereby the striker is adapted to spin conically and move forward in the conical portion of the passage against the impact member upon spinning of the fuze body.

6. A fuze comprising a fuze body having a nose and an axial passage opening at the nose, an impact member closing the forward end of the passage at the nose, a detonating charge in the fuze body at the rearward end of the passage, a firing pin in the passage ahead of the charge, the portion of said passage ahead of the firing pin having a portion of generally conical form diverging toward the impact member at the nose of the fuze body, an elongate striker contained loosely enough in the conical portion of the passage so as to assume a conical spin in response to any spin attained by the fuze body due to firing from a gun, whereby the striker independently of drift is positively moved forward in the conical portion of the passage and against the impact member in response to said body spin, the sum of the lengths of the firing pin and the striker being less than the distance of the forward end of the detonating charge to the impact member.

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