Feb. 17, 1959 J. A. TAYLOR ET AL 2,873,677

CONCRETE PIERCING FUSE

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Fig. 1.

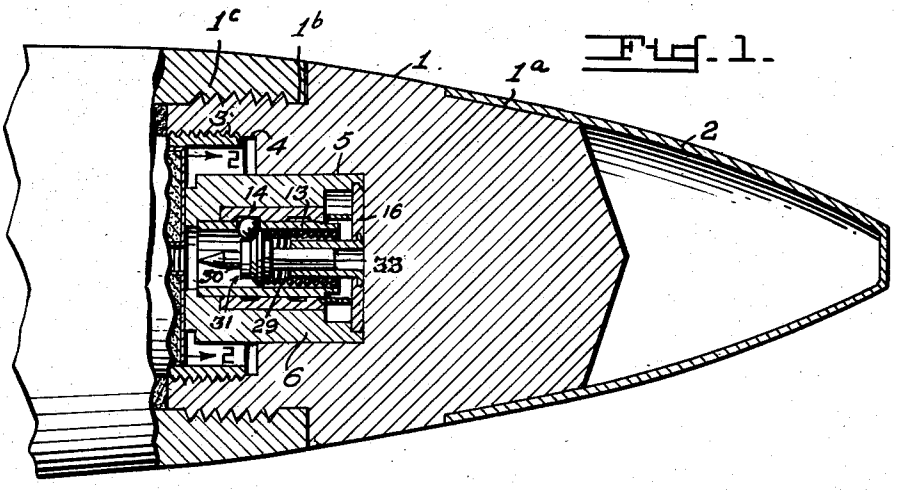


Fig. 2.

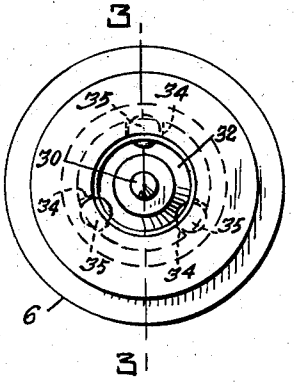


Fig. 3.

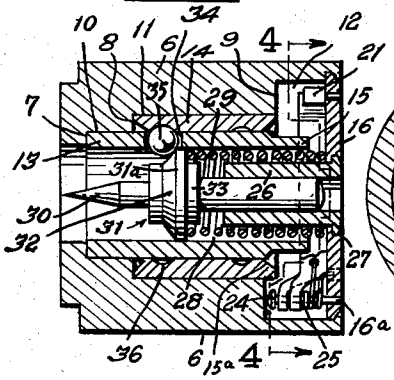


Fig. 4.

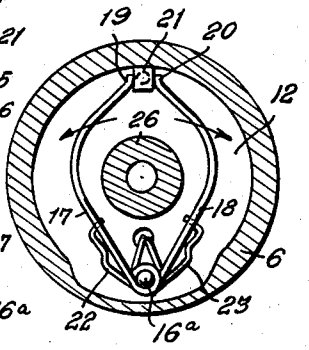


Fig. 5.

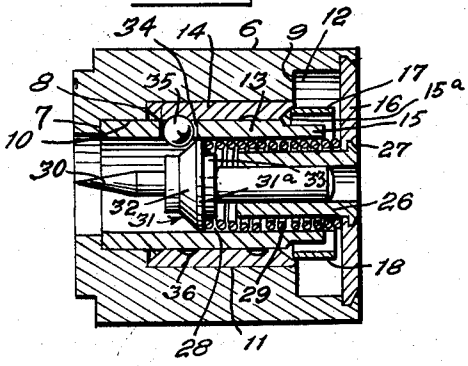
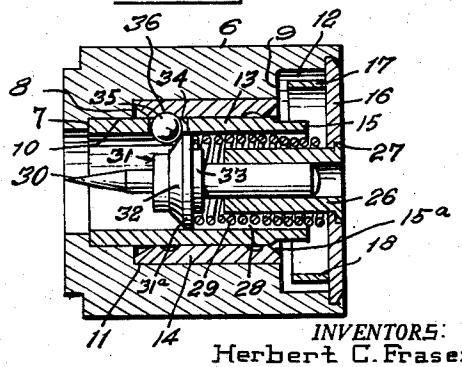


Fig. 6.



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Fig. 7.

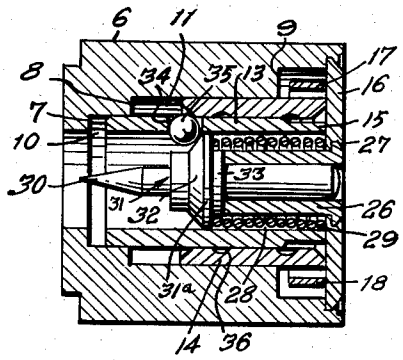


Fig. 8.

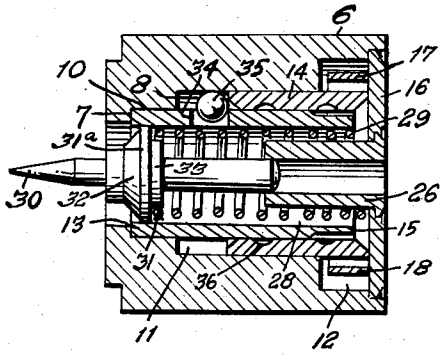


Fig. 9.

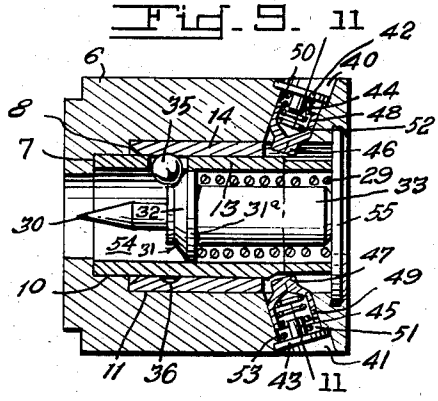


Fig. 10.

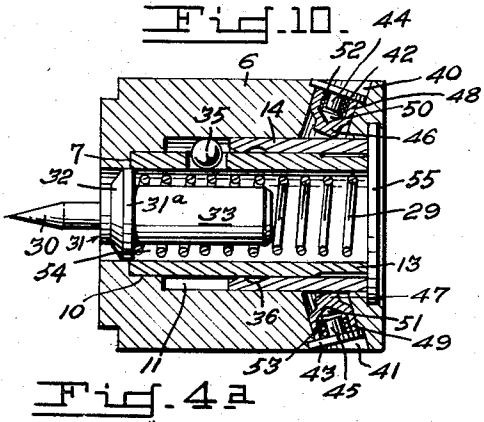


Fig. 11.

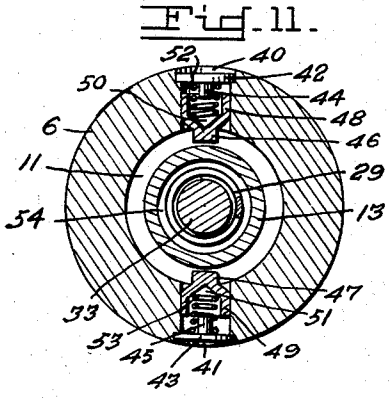
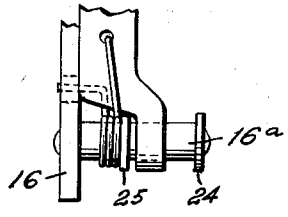


Fig. 4a



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2,873,677

CONCRETE PIERCING FUSE

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Application December 21, 1951, Serial No. 262,776

13 Claims. (Cl. 102—75)

The present invention relates to a fuse for a spin stabilized projectile.

More particularly, the present invention relates to a fuse for a spin stabilized projectile, especially adaptable for concrete piercing, which is safe under ordinary conditions of handling, which will remain safe if dropped, and which utilizes arming means responsive to centrifugal force to lock the fuse elements in safe position upon setback, until the projectile is free of the bore, when setback forces cease.

In ordinary missiles, which commonly carry high explosive charges, it is desirable that each missile remain "unarmed" or safe under ordinary conditions of handling or if dropped. Also desirable is the expedient of providing a precautionary safety device to lock the arming mechanism in safe position until the missile has left the gun bore, in order to insure maximum safety of the operating personnel. If the missile is to be used for specialized purposes, as for example in destroying concrete pill boxes, or other impenetrable objects such as tanks, a momentary delay in explosion after impact is a desired objective, in order that the full blast effect of the explosion may be brought to bear upon the target to be destroyed.

It is therefore an object of this invention to provide a fuse for a spin stabilized projectile which is armed by centrifugal force, but which is locked in safe position by the forces of setback until the projectile leaves the gun bore, when setback ceases.

It is also an object of this invention to provide a fuse in which the centrifugal force responsive means acts as a safety device to preclude arming of the fuse due to impact caused by accidentally dropping a projectile.

It is also a further object of this invention to provide a fuse having a plurality of sleeves axially slidable relative to one another to fully arm the fuse at impact and incorporating an "anti-creep" device comprising detent means associated with two of the sleeves to lock the sleeves together while the projectile is in flight.

It is also a further object of this invention to provide a fuse having an arrangement of parts to insure a momentary delay in explosion after impact in order to reap the maximum advantage of blast propagation.

With these and other objects in view, which will become apparent as the following specification develops, reference is made to the accompanying drawing in which:

Figure 1 is a longitudnial section taken through the forward end of a projectile provided with the novel fuse which is the subject of this invention and showing the fuse with elements in normal position before firing.

Figure 2 is a section looking in the direction of arrows 2—2 on Figure 1.

Figure 3 is a longitudinal section taken on line 3—3 of Figure 2.

Figure 4 is a transverse section taken on line 4—4 of Figure 3.

Figure 4*a* is a fragmentary detail of the pin for mounting the centrifugally responsive spring arms.

Figure 5 is a view similar to Figure 1 but with the elements in position at setback.

Figure 6 shows the same parts in position at cessation of setback and when the projectile is in flight.

Figure 7 shows the position of the fuse elements at impact, and

Figure 8 shows the position of the fuse elements at maximum penetration or complete perforation.

Figures 9–11 illustrate a modification of the fuse shown in Figures 1–8.

Referring to the drawing wherein like parts in the different figures are represented by the same numeral, the projectile is provided with a solid steel forwardly, tapering main body portion 1 circumferentially recessed at 1*a* to accommodate a wind shield or nose 2 secured in any convenient manner to the main body portion to complete the forward ogive of the projectile. The main body portion 1 includes a second rearward and deeper circumferential recess 1*b* externally threaded to screw-threadably receive the projectile casing 1*c* which contains (not shown) the main explosive charge, primer and detonator as is well known.

The main body of the fuse is provided at its rearward portion with an axial bore 3 circumferentially stepped as at 4 to form a second axial bore 5 of reduced diameter, in which is pressed or secured in any conventional manner a cylindrical sleeve 6 to make a tight fit with the main body portion of the fuse. Cylindrical sleeve 6 is circumferentially stepped at 7, 8 and 9 to provide a plurality of recesses 10, 11 and 12, forwardly axially increasing in diameter to accommodate the moving parts of the fuse as subsequent to be described.

A pair of concentric cylindrical sleeves 13 and 14 are received respectively within recesses 10 and 11 and are axially slidable relative to one another. When the fuse is in normal or "safe" condition, outer sleeve 14 extends between stepped portions or shoulders 8 and 9, and inner sleeve 13 which is the longer of the two sleeves, abuts shoulder 7 on its rearward end and forwardly extends beyond the forward end of sleeve 14 partially into recess 12 as at 15. The forward end of sleeve 14 is also provided with a rearwardly inwardly beveled face 15*a*. A flat plate or disc 16 is secured in any convenient manner to the forward end of sleeve 6 with its forward face abutting the forward wall of bore 5 to act as a closure member for recess 12, and an eccentrically located pin 16*a* having one end press fitted into plate 16 extends rearwardly into recess 12 to act as a pivot for two outwardly bowed spring arms 17 and 18 swingable in opposite directions under the influence of centrifugal force. In contracted or normal position spring arm free ends 19 and 20 abut a stud 21 also secured to plate 16 in any convenient manner to extend rearwardly into recess 12 and at a location diametrically opposite pivot pin 16*a*. Spring arms 17 and 18 are normally biased into contracted position by counterbiasing springs 22 and 23 coiled around pivot pin 16*a* and having one end anchored to the spring arms and the other end secured to closure plate 15. Sufficient clearance is provided between the contracted spring arms and the inner peripheral wall of recess 12 to allow for counter-pivoting and expansion of the spring arms when centrifugal force acts on the projectile. Spring arms 17 and 18 are supported on pivot pin 16*a* so as to be axially slidable between stops 24 and 25 secured to the pin and for a purpose to be later described, however, in normal position springs 22 and 23 bias the spring arms forwardly on the pivot pin and against forward stop 25, as seen in Figures 3 and 4*a*.

A third cylindrical sleeve or firing pin guide hub **26**, secured as at **27** to the wall of a bore formed in flat plate **16** extends rearwardly a substantial distance into the bore in the inner movable sleeve **13** and is concentric therewith and radially spaced therefrom to form an annular chamber **28** to receive a coil spring **29**. Axially slidable within the bore of sleeve or hub **26** is a rearwardly directing firing pin **30** about which is fixed an enlargement or collar **31** having a central cylindrical portion **31***a* abutting the inner peripheral wall of sleeve **13** to guide the firing pin, a rearwardly directed beveled face **32** and a forwardly projecting reduced cylindrical portion **33**, but of a diameter greater than firing pin **30**. Sleeve **13** is provided with a plurality of equiangularly spaced holes **34** to receive the major portions of detent balls **35**. The preferred embodiment shows 3 balls as clearly seen in Figure 2, however, the number may be varied as desired. An inward portion of each detent ball abuts against the beveled face **32** of enlargement **31** to releasably lock the firing pin in safe position until the projectile strikes the target. In this position spring **29** is compressed between the forward face of enlargement **31** and the rear face of plate **16** to bias firing pin rearwardly so as to leave a clearance between the forward end of the firing pin and the forward wall of bore **5** in the fuse body and to retain sleeve **13** against shoulder **7**. Outer sleeve **14** is provided with a circumferential groove **36** in its inner wall for receiving a small portion of detent balls **35**, thus preventing sleeve **14** from creeping forwardly in flight and also to retain it in rearward position against shoulder **8**. Groove **36** is made sufficiently deep so as to permit the forces developed at impact to overcome the resistance of the detent balls to completely arm the fuse. Impact caused by blows in handling or by inadvertent dropping of the projectile is not sufficiently strong to overcome this resistance.

The operation of the fuse is as follows: Figures 1 and 3 show the relative location of the moving parts of the fuse in normal position and before the projectile is fired. If in handling, the projectile were to be dropped on its nose or struck a sharp blow, spring arms **17** and **18** would prevent sleeve **14** from sliding forwardly to arm the fuse even if the impact were sufficient to overcome the resistance provided by detent balls **35** resting in groove **36**. When the projectile is fired the initial setback forces will cause the spring arms to slide rearwardly on pivot pin **16***a* until rearward stop **24** is encountered. Centrifugal action has not yet become effective to swing the spring arms outwardly, and they will abut the beveled surface **15***a* of outer cylinder **14**. In this position centrifugal force will have no effect on spring arms **17** and **18** since they are locked against pivoting by beveled surface **15***a*. This condition is clearly shown in Figure 5. When the projectile is free of the gun bore and when setback forces have ceased, centrifugal force and linear acceleration acting on spring arms and against beveled surface **15***a*, will cause the arms to creep forward on pivot pin **16***a* until they are no longer restrained whereupon they will swing outwardly to assume the position shown in Figure 6. This position may be designated as "semi-armed," and the anti-creep device consisting of groove **36** in sleeve **14**, holes **34** in sleeve **13**, detent balls **35** and beveled face **32** on the firing pin enlargement, will serve to retain the moving parts in this position until impact. At impact the resistance provided by detent balls in groove **36** is overcome and sleeve **14** is forceably moved forwardly until its forward edge abuts plate **16**. Sleeve **13** and firing pin **30** are also driven forward by the impact until the forward face of reduced portion **33** of the firing pin abuts the rear annular wall of fixed sleeve **26**, thus compressing spring **29**. This is the "fully armed" position as clearly seen in Figure 7, and as soon as the forces of inertia resulting from impact are overcome, spring **29** will expand and the beveled face **32** will exert pressure on the detent balls to force them sufficiently into the rearward portion of recess **8** vacated by the forwardly sliding sleeve **14**, to free the firing pin so that it can move rearwardly under influence of spring **29** to strike the detonator (not shown) usually provided in projectiles as is well known.

A projectile incorporating the above described novel fuse has been found to be extremely effective in destroying concrete pill boxes. The momentary delay in explosion of the projectile after impact provides time sufficient to enable the projectile nose to either pierce the wall of the target or to become imbedded in it so that the full effect of the blast is propagated throughout the structure to be destroyed.

The modification illustrated in Figures 9, 10 and 11 though differing in some of the structural details is similar in action to the fuse illustrated in Figures 1–8. Figure 9 illustrates the fuse as assembled and on setback, Figure 10 illustrates the relative position of parts following cessation of impact forces and Figure 11 is a section taken on line **11—11** of Figure 9. Referring to the drawings where similar numbers have been utilized to designate parts similar to the species of Figures 1–8, the fuse is represented by a cylindrical member **6** which is forwardly and outwardly stepped to provide shoulders **7** and **8** forming annular recesses **10** and **11** for receiving respectively, relatively axially slidable sleeves **13** and **14** concentrically arranged. Outer sleeve **14** is the shorter of the two sleeves, is relatively slidable with respect to sleeve **13** and in unarmed position is located rearwardly in recess **11** so as to leave the forward portion of recess **11** unoccupied. Inner sleeve **13** on the other hand occupies the entire recess **10** and is not movable. In communication with this forward portion of recess **11** are two opposed substantially radial bores **40** and **41** which are slightly rearwardly sloped and in which are received the centrifugal force responsive locking mechanism, as now described. Spanning the outer ends of bores **40** and **41** and normal to the side wall of the bores are plates **42** and **43** to which are secured in any convenient manner inwardly directed studs **44** and **45**. Received in the bores and slidable therein are pins **46** and **47** having integral therewith outwardly depending sleeves **48** and **49** which in outermost position lie with the outward ends of sleeves **48** and **49** abutting plates **42** and **43**. The outer wall of the sleeves contact the wall of bores **40** and **41** whereas the inner walls of sleeves **48** and **49** are spaced from the surfaces of studs **44** and **45** to form chambers **50** and **51** for receiving springs **52** and **53** which are coiled about studs **44** and **45** and in unarmed position bias the pins **46** and **47** and integral sleeves inwardly into recess **11** to abut the ends of cylinder **14**. As plainly seen in Figures 10 and 11, the modification is also provided with the anti-creep device comprising equiangularly spaced holes **34** in inner sleeve **13** to receive a major portion of the detent balls **35**, and annular groove **36** in outer sleeve **14** to receive a small portion of the detent balls. Inner sleeve **13** forms an axial bore **54** in which firing pin **30** is slidably guided for movement to explode the fuse. Pin **30** is also provided with enlargement **31**, central cylindrical guiding portion **31***a* to abut the wall of bore **54** so as to guide the firing pin, beveled face **32** and forward reduced portion **33**. A heavy backing or closure plate **55** is secured to cylinder **6** and abuts the main body portion of the fuse to close off the forward end of bore **54**. The firing pin guide hub has been eliminated in this species and the firing pin is of larger diameter than in the before described species so that spring **29** is compressed in the annular chamber formed by the firing pin and the inner wall of sleeve **13**.

Referring to Figures 9 and 10 the operation of the device is as follows. In unarmed position, firing pin **30** directly abuts plate **55**, to compress spring **29** between plate **54** and the forward face of enlargement **31**, and the

centrifugal force responsive mechanisms is in inwardly locked position so that the ends of pins **44** and **45** abut the forward end of sleeve **14** to lock this sleeve rearwardly in recess **11**. Detent balls **35** are also pressed rearwardly by spring and beveled face **32** and are retained in holes **34** and grooves **36**. The springs **52** and **53** in the centrifugal force responsive mechanism are calibrated so that the force required to compress them and the friction between the sloped walls of bores **40** and **41** and sleeves **48** and **49** are sufficient to retain the parts in locked position until setback ceases, hence on setback the parts are in position as seen in Figure 9, with the firing pin and sleeve **13** abutting plate **55**. Due to the inclination of bores **40** and **41**, setback also tends to increase the frictional force between the locking pins and corresponding bore walls.

Upon cessation of setback, centrifugal force compresses the springs in the centrifugal force responsive mechanism and the pins are withdrawn so that they no longer abut the forward end of sleeve **14**. The fuse is now in "semi-armed" position and sleeve **14** is prevented from creeping forwardly by the anti-creep device, as previously explained. Upon impact, the resistance of the detent balls in groove **36** is overcome and sleeve **14** is forced forwardly to abut plate **55**. The fuse is now completely armed so that when inertia due to impact force is overcome spring **29** expands and the pressure exerted by beveled face **32** of the firing pins forces the detent balls into the unoccupied rear end of recess **11** to release the firing pin to forceably drive the firing pin rearwardly and into contact with the detonator (not shown) in the projectile casing. The relative position of parts following cessation of impact forces is clearly seen in Figure 10.

The species illustrated by Figures 9, 10, and 11, eliminates the firing pin guide hub, however, it is within the contemplation of this disclosure to include this expedient similarly as in the first described species. Other modifications and alterations of the structure which has been disclosed herein for purposes of illustration will be apparent to one skilled in the art, and it is obvious that the same may be made without departing from the spirit and scope of the invention as defined in the following claims.

We claim:

1. In a projectile fuse, a firing pin moveable from safe position to armed position at impact and to firing position after impact, resilient means biasing said pin into firing position, a detent means jointly coacting with said detent to lock said firing pin in safe position, said locking means, said pin and said detent being unitarily moveable at impact against the bias of said resilient means to move said pin to armed position, means normally immobilized by said detent and moveable at impact to free said detent for movement to position to release said firing pin, and means after impact including said resilient means actuable to move said detent to position to release said firing pin, whereby said resilient means propels said pin to firing position.

2. The combination in claim 1 wherein said projectile is spin stabilized, means responsive to set-back forces normally engaging said detent immobilized means and additionally securing said pin in safe position, said set-back responsive means being also responsive to centrifugal force at cessation of set-back to disengage said detent immobilized means.

3. In a projectile fuse, a firing pin moveable from safe position to armed position at impact and to firing position after impact, resilient means biasing said pin to firing position, a detent, first and second elements jointly co-acting with said detent to lock said pin in safe position, said first element, said second element, said firing pin and said detent being unitarily moveable at impact against the bias of said resilient means to move said firing pin to armed position, said second element being also responsive at impact to free said detent for movement to position to release said firing pin, and means after impact including

said resilient means actuable to release said firing pin from said detent and said first element, whereby said resilient means propels said firing pin to firing position.

4. The combination in claim 3 wherein said projectile is spin-stabilized, means responsive to set-back forces engaging said second element and additionally securing said pin in safe position, said set-back responsive means being also responsive to centrifugal force at cessation of set-back to disengage said first element.

5. In a fuse, a firing pin moveable from safe position to armed position at impact and to firing position after impact, resilient means biasing said pin to firing position, a detent, first and second sleeves concentric with said firing pin jointly co-acting with said detent and said resilient means to lock said firing pin in safe position, said first and second concentric sleeves, said detent and said firing pin being unitarily moveable at impact against the bias of said resilient means to move said firing pin to armed position, means responsive to impact to release said second sleeve from said detent, and means after impact including said resilient means actuable to release said pin from said detent and said first sleeve for movement to firing position.

6. The combination in claim 5 wherein said projectile is spin-stabilized, means responsive to set-back forces for engaging said second sleeve and additionally securing said firing pin in safe position, said set-back responsive means being also responsive to centrifugal force at cessation of set-back to disengage said second sleeve.

7. A fuse according to claim 5 wherein said detent comprises an enlargement on said firing pin engaging the inner wall of said first sleeve and having a beveled surface, and a plurality of equiangularly spaced detent balls abutting said bevelled surface and extending through radially alined holes in said inner sleeve to rest in a circumferential groove in said outer sleeve.

8. In a fuse for a projectile, a firing pin moveable from safe position to armed position at impact, and to firing position after impact, a detent, inner and outer sleeves concentric about said firing pin jointly co-acting with said detent to lock said pin in safe position, resilient means within said inner sleeve biasing said pin to firing position, said inner and outer sleeves, said detent and said firing pin being unitarily movable at impact to armed position against the bias of said resilient means, means responsive to impact to release said outer sleeve from said detent and said inner sleeve, and means after impact including said resilient means to release said pin from said detent and said inner sleeve for movement to firing position.

9. The combination in claim 8 wherein said projectile is spin-stabilized, means responsive to set-back for engaging said outer sleeve and additionally securing said pin in safe position, said set-back responsive means being also responsive to centrifugal force at cessation of set-back to disengage said outer sleeve.

10. A fuse according to claim 8 wherein said detent comprises an enlargement on said firing pin engaging the inner wall of said inner sleeve and having a beveled surface, and a plurality of equiangularly spaced detent balls abutting said beveled surface and extending through holes in said inner sleeve to rest in a circumferential groove in said outer sleeve.

11. In a deceleration activated spin stabilized fuse for a projectile, a body portion, an axial bore in said body portion, inner and outer concentric sleeves forwardly axially slidable in said bore, a firing pin reciprocable within said inner sleeve from safe position forwardly to armed position at impact, then rearwardly after impact to firing position, resilient means biasing said pin into firing position, a detent, said inner and outer sleeves jointly co-acting with said detent to lock said firing pin in safe position, said inner and outer sleeves, said detent and said firing pin being unitarily slidable at impact to armed position, means responsive to impact including additional forward movement of said outer sleeve for releasing said outer sleeve from said detent and said inner sleeve, and means after

impact including said resilient means responsive to said additional forward movement for releasing said pin from said detent and said inner sleeve for movement to firing position.

12. The combination in claim 11 including means responsive to set-back forces to engage said outer sleeve for additionally securing said pin in firing position, said set-back responsive means being also responsive to centrifugal force to disengage said outer sleeve.

13. A fuse according to claim 11 wherein said detent comprises an enlargement on said firing pin engaging the inner wall of said inner sleeve and having a beveled surface, and a plurality of equiangularly spaced detent balls abutting said beveled surface and extending through holes

in said inner sleeve to rest in a circumferential groove in said outer sleeve.

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