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Rusbach

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[54] **PROJECTILE FUSE**

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[52] **U.S. Cl.** **102/56,** 102/78

[51] **Int. Cl.** **F42c 15/24**

[58] **Field of Search** 102/70, 78, 76, 79, 85.6, 102/56, 80, 73

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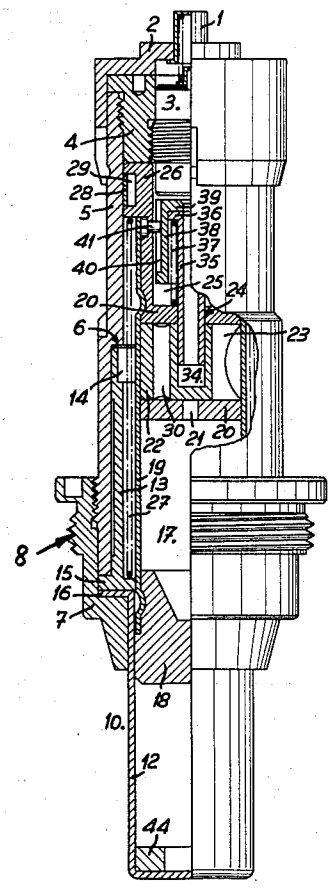
[57] **ABSTRACT**

A fuse for an explosive projectile comprises a forward primer and a rearward detonator that is exploded by the primer and that communicates with the primer through a firing passageway. The detonator and a valve that closes the passageway are mounted as an assembly for conjoint sliding movement from a forward position in which the detonator is outside the explosive charge of the projectile, to a rearward position in which the detonator is disposed within that explosive charge, under the influence of the inertia of the assembly when the projectile is launched and is accelerating. Thereafter, the deceleration of the projectile opens the valve, so that the projectile is armed only after it is well away from the launching site.

4 Claims, 8 Drawing Figures



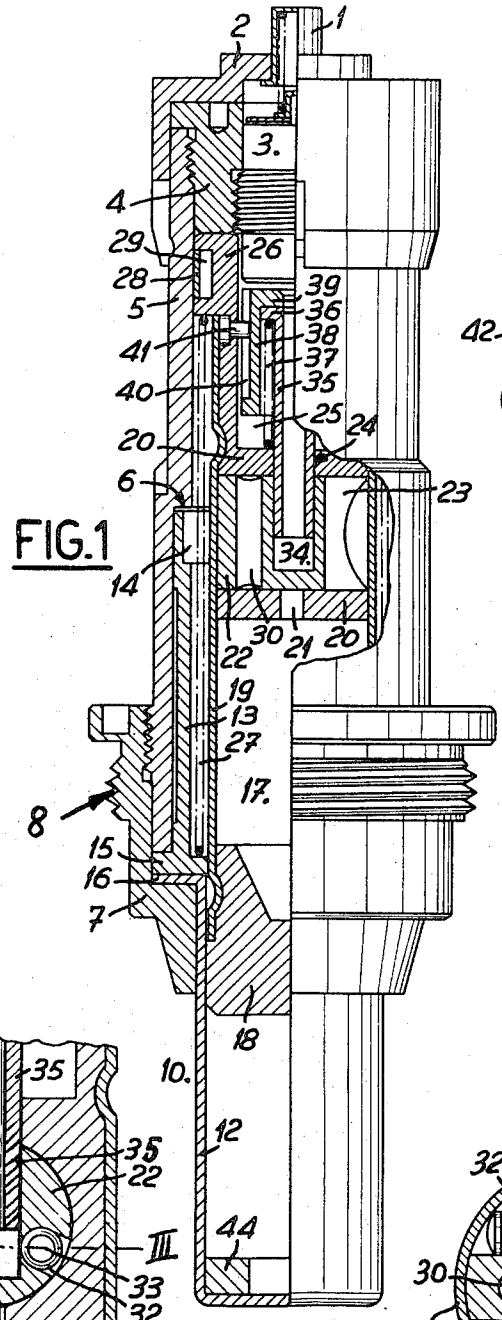


FIG.1

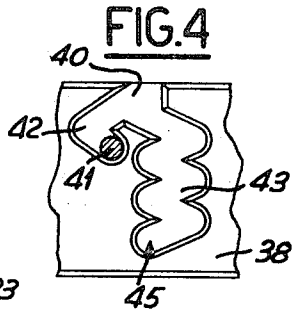


FIG.4

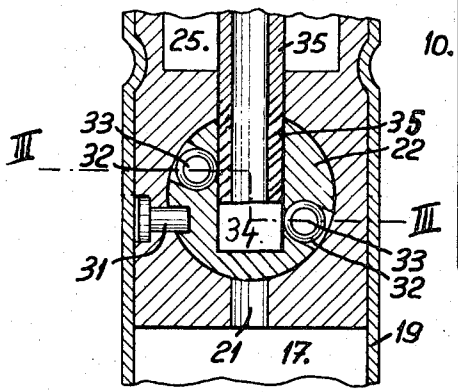


FIG.2

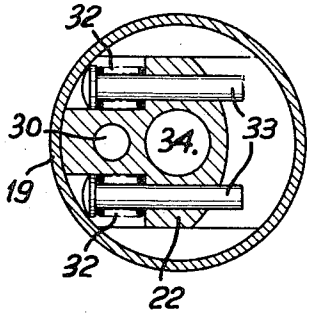


FIG.3

FIG.5

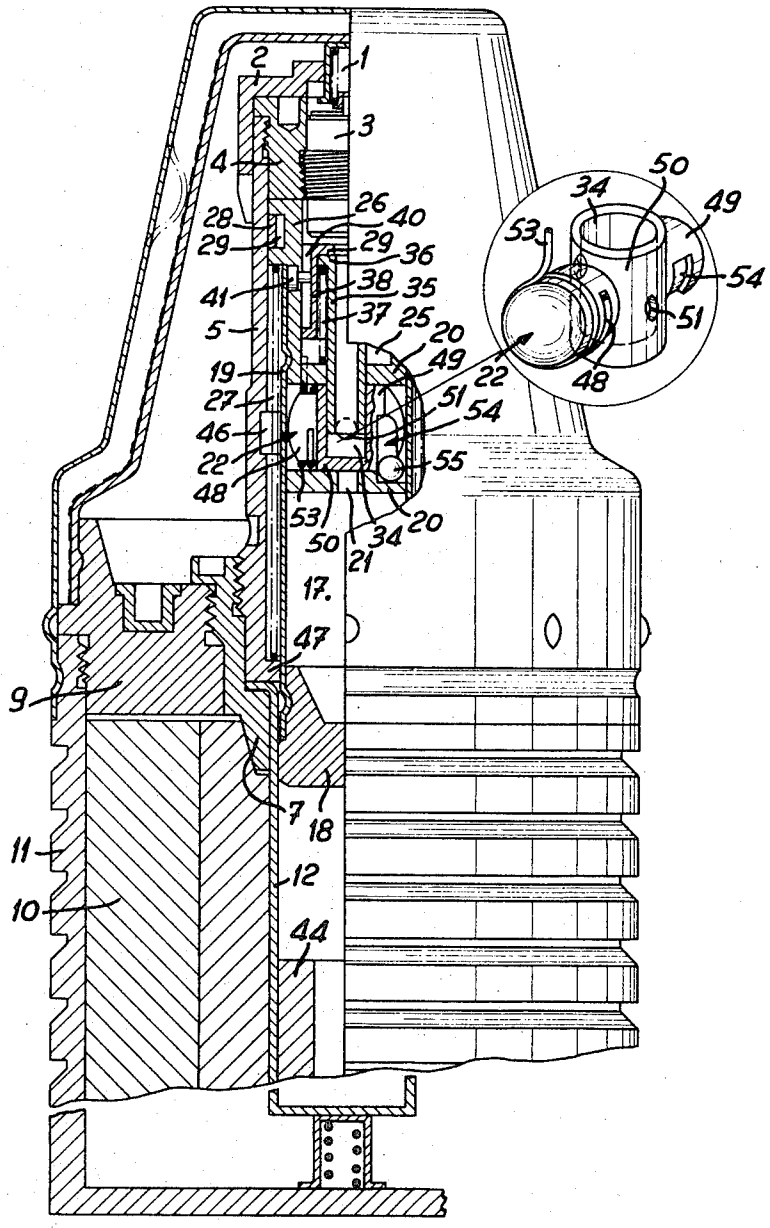

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FIG.6

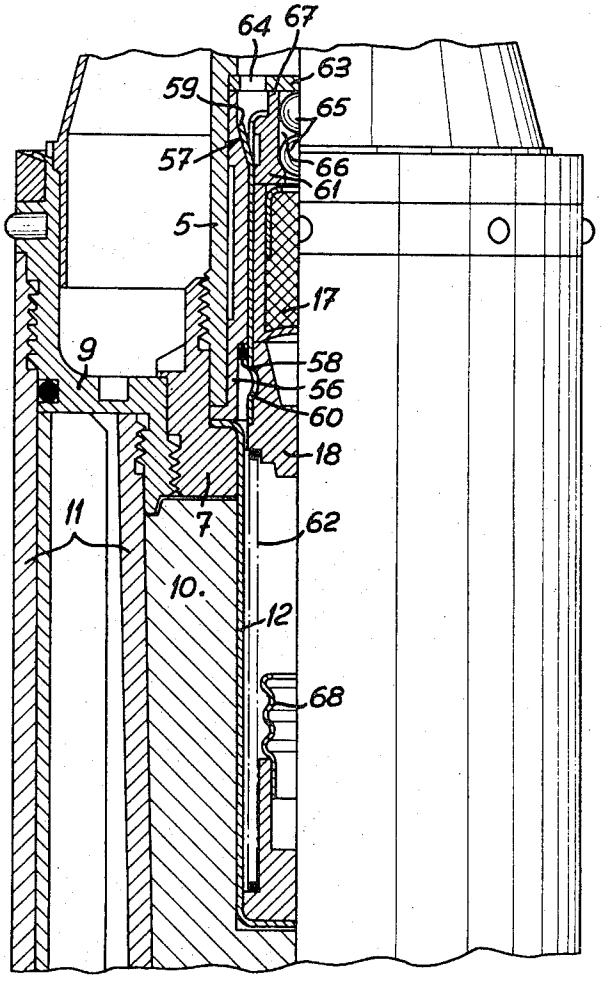


FIG. 7

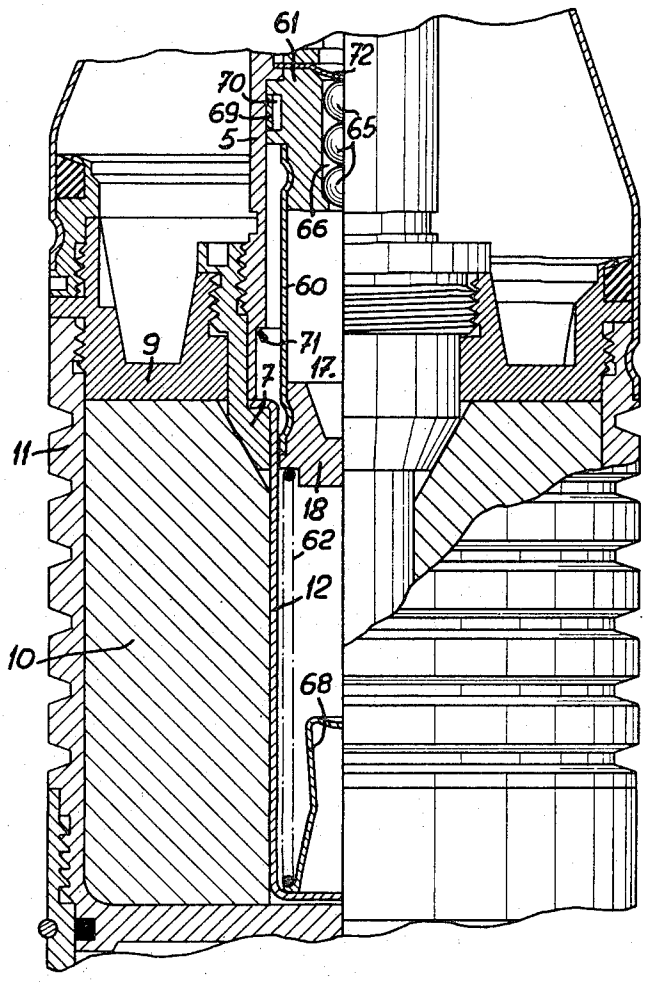
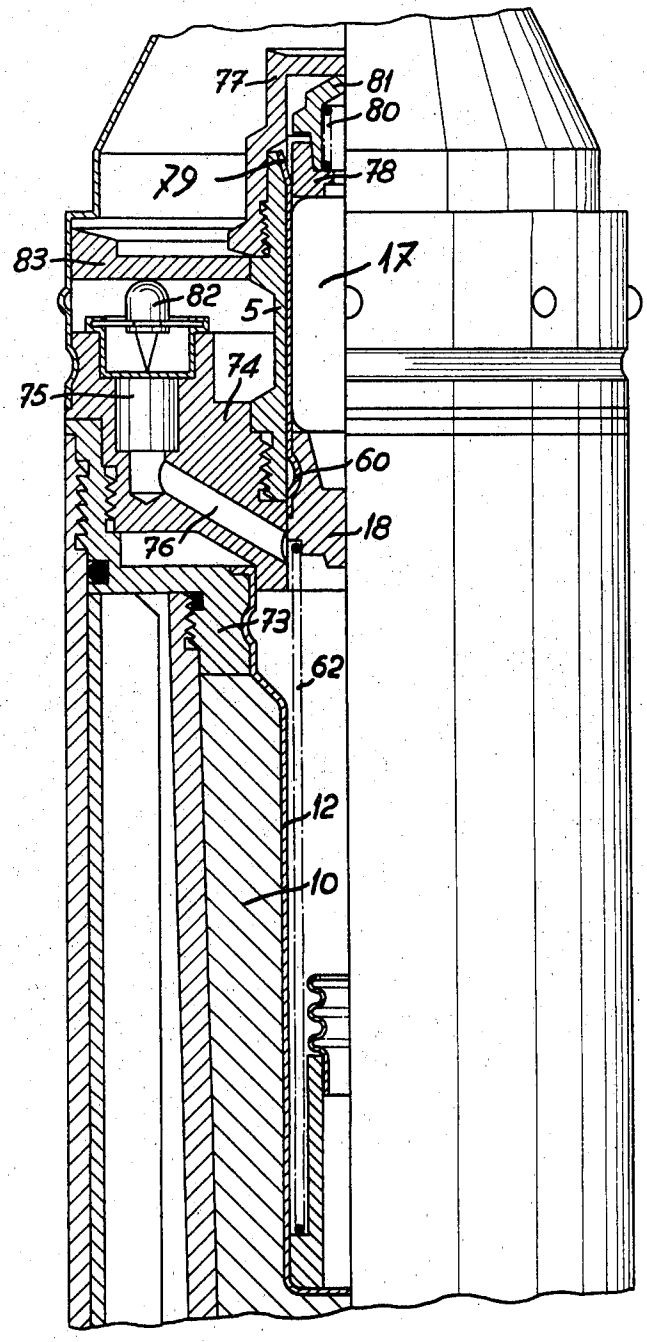


FIG. 8



PROJECTILE FUSE

The present invention relates to fuses for explosive projectiles. Numerous types of these fuses are known; however, they are ordinarily rather complex and troublesome and cumbersome, or else they do not have the necessary reliability.

An object of the present invention is the provision of a projectile fuse which overcomes the above disadvantages.

A further object of the present invention is the provision of a projectile fuse with which accidental explosion of the projectile is prevented.

A still further object of the invention is the provision of a projectile fuse which arms the projectile only when the projectile is well away from the launching site.

Another object of the present invention is the provision of a projectile fuse which will be relatively simple and inexpensive to manufacture, easy to assemble, light in weight, and reliable in use.

Briefly, the objects of the present invention are achieved by the provision of a projectile fuse comprising a firing primer at the forward end of the fuse and a detonator connected to the primer by a firing passageway which is ordinarily closed by a safety device. The detonator is displaceable between a forward inactive position in which it is disposed outside the explosive charge of the projectile and an active position in which it is located inside the explosive charge by the acceleration of the projectile upon launching, and is characterized by the fact that the displacement of the detonator takes place parallel to the longitudinal axis of the fuse and that the safety device comprises a valve that closes the firing passage and is mechanically connected to the detonator so as to move axially as an assembly with the detonator.

Other objects, features and advantages of the present invention will become apparent from a consideration of the following description, taken in connection with the accompanying drawings, in which:

FIG. 1 is an enlarged partially cross-sectional view of a first form of projectile fuse according to the present invention;

FIG. 2 is a fragmentary cross-sectional view taken at right angles to FIG. 1;

FIG. 3 is a cross-sectional view taken on the line 3—3 of FIG. 2;

FIG. 4 is a fragmentary view of the safety device of the fuse shown in FIG. 1;

FIG. 5 is a view similar to FIG. 1 but showing a second embodiment of the invention;

FIG. 6 is a view similar to FIGS. 1 and 5 but showing a third embodiment of the invention;

FIG. 7 is a view similar to FIGS. 1, 5 and 6, but showing a variant of the third form of FIG. 6; and

FIG. 8 is a view similar to FIGS. 1, 5, 6 and 7, but showing a fourth embodiment of the invention.

Referring now to the drawings in greater detail, and first to the embodiment shown in FIGS. 1–4, there is shown a fuse according to the present invention adapted to be fixed in operative position in the nose of an explosive projectile (not shown in FIG. 1) coaxially of the projectile. Thus the fuse forms in effect the forward end of the projectile and comprises a primer 3 as well as the primer's firing device, which latter may be either mechanical or electrical but in any event is operated by the impact of the projectile or by a timing device or an inertial device actuated by the launching or by the impact of the projectile.

In the first form shown in FIGS. 1–4, primer 3 is an electrical primer and is fired by the arrival of an electric current. This current is supplied by a current generator, which may for example be a battery or any other suitable generator, the current being delivered to the primer 3 when a switch, actuated by the impact of the projectile, is closed. The switch may have the conventional form of a double cap deformable by the impact of the projectile, each element of the cap being of an electrically conductive material and comprising one of the contacts of the switch.

Primer 3 is maintained in operative position in sleeve 4 by means of which it is maintained forwardly of the projectile. Primer 3 is threaded in sleeve 4 which itself is threaded in the upper end of a tubular casing 5 of the fuse. The other contact of the electric primer 3 is placed in electric contact by means of contact member 1 with the internal cap.

Contact member 1 is electrically insulated from the body of the projectile by the insulating member 2. The tubular casing 5 comprises a forward portion whose internal diameter is less than the internal diameter of its rear portion so that an annular shoulder 6 is provided about midway of the length of casing 5. A lower sleeve 7 is threaded on the lower end of casing 5 and also has an external screw thread 8 for securement of the fuse to the nose of the projectile. This securement may be effected, as indicated in FIG. 5, by means of a member 9 of insulating material, for example of plastic, having the form of a ring whose internal screw threading cooperates with that of the lower sleeve so that its external screw threading will mate with the forward end of the projectile which encloses the explosive charge 10, which in the embodiment illustrated in FIG. 5 is constituted by a frangible sleeve 11.

Lower sleeve 7 also serves for the mounting of a casing 12 which defines a cavity extending from the operative position of the fuse to the interior of the explosive charge 10 of the projectile and located along a prolongation of the axis of the fuse.

A guide socket 13 is disposed in the lower portion of larger diameter of casing 5 and comprises an internal wall located in the elongation of the internal wall of the upper part of casing 5. The upper end of guide socket 13 is of reduced thickness so as to be offset relative to the annular shoulder 6 and to form with shoulder 6 an annular recess 14. The lower end of guide socket 13 comprises a wall whose annular end 15 has an internal diameter corresponding to that of the recess formed by casing 12 and whose external diameter corresponds to that outside the casing. This guide sleeve is maintained in position by the lower sleeve 7 and is grasped by sleeve 7 between the lower confronting surface of the casing 5 and a flange 16 of casing 12.

Inside the sealed volume enclosed by the members 2, 3, 5 and 12 is disposed an assembly comprising a detonator 17 and the safetly device of the fuse. This assembly comprises a rear plug 18 to which is secured a tubular bushing 19. Detonator 17 is disposed in bushing 19 and rests on the forward surface of plug 18. An upper plug 20 is disposed atop detonator 17 and has a central opening 21 which comprises a portion of the firing passageway connecting the primer 3 to the detonator 17.

This assembly also comprises the safety device itself which, in its rest position shown in FIG. 1, closes the

firing passageway connecting the primer **3** to the detonator **17.** This safety device comprises a cylindrical valve **22** whose axis is perpendicular to that of the fuse. Valve **22** is displaceable linearly within a bore **23** provided in the upper plug **20.** The upper part of plug **20** comprises a guide and provides an opening **24** that communicates with bore **23** and which is coaxial with the fuse. The upper part of plug **20** also has a bore **25** of larger diameter whose upper part closes the lower end of the socket of primer **3.** The head **26** of the plug **20** slides in the casing **5** and has an external diameter corresponding to the internal diameter of casing **5** so as to guide the assembly in its axial displacements. Bushing **19** is also secured to the upper plug above latch **22** so that the axial positions of the upper and lower plugs as well as the axial position of the detonator are fixed relative to each other.

A coil compression spring **27** acts between the annular end wall **15** of guide socket **13** and the head **26** of the upper plug **20** to urge the assembly of the upper and lower plugs and the detonator to an advanced rest position in which the upper surface of head **26** of plug **20** bears against the lower face of the upper sleeve **4.** In this advanced rest position it will be noted that the detonator **17** is located outside of and above the explosive charge **10** of the projectile and is separated therefrom by the lower plug **18** which prevents any combustion from reaching the explosive charge **10** even if the detonator is accidentally fired.

The fuse also comprises means to maintain the axial operative position of the assembly **17, 18, 20,** comprising a resilient ring **28** which acts radially and which is disposed in a groove **29** provided in the peripheral wall of head **26.** In the operative position of the assembly **17, 18, 20,** the spring **27** is compressed, detonator **17** enters the casing **12,** and the resilient ring **28** bears on the shoulder **6** to maintain the assembly in this operative position.

The valve **22** of the safety device comprises an opening **30** which forms a portion of the firing passageway and which in the operative position comes opposite opening **21.** The angular position of valve **22** is maintained by pin **31** fixed in upper plug **20** and whose end extends within a groove provided in the periphery of cylindrical valve **22** and extends along a generatrix thereof.

Springs **32** tend to displace the valve to its operative position. These springs are disposed about guides **33** whose heads bear against the bushing **19** and extend in openings through the valve **22.** Valve **22** also has a blind bore **34** that is axially disposed in the rest position of valve **22,** in which position it is coaxial with openings **21** and **24** in the upper plug **20.** Blind bore **34** has the same diameter as opening **24.** A conduit **35** is, in the rest position, partially disposed in the blind bore **34** through the opening **24** and fixes thus the rest position of valve **22** against the action of springs **32.** The external diameter of this conduit **35** corresponds to the diameter of opening **24** and bore **34** and its internal bore is part of the firing passageway.

The conduit **35** has a flange **36** at its upper end which provides one of the seats against which the compression spring **37** presses, the other seat being provided by the bore **25** of the upper plug about the conduit **35.** This compression spring urges the conduit **35** forwardly of the fuse out of the blind bore **34** in valve **22.**

In the inactive position of the fuse, shown in FIG. **1,** all axial displacement of the conduit **35** under the action of compression spring **37** is prevented by a locking ring **38** whose upper flange **39** overlies the flange **36** of conduit **35.** The peripheral surface of locking ring **38** comprises a milled recess **40** as seen in FIG. **4,** of a shape so as to cooperate with a pin **41** fixed to upper plug **20.** In the inactive position, pin **41** is located as shown in FIG. **4,** in the recess **40** and prevents all displacement forwardly of the fuse of the ring **38** and thus of the conduit **35** which in turn locks the valve **22** in its inactive position.

As is also seen in FIG. **4,** the recess **40** comprises two branches, a shorter branch **42** and a longer branch **43.** The midline of each branch zigzags, so that relative movement of the pin **41** and the recess **40** is confined to a zigzag path and is thus retarded.

The fuse shown in FIGS. **1–4** operates as follows:

In the inactive position, which is the illustrated position, detonator **17** is located outside the explosive charge **10** of the projectile which is equipped with the fuse. Even if detonator **17** were to be fired, the charge would not explode. The firing passageway connecting the primer **3** to the detonator **17** is closed by valve **22** so that an accidental firing of primer **3** will not fire detonator **17.** In this inactive position, the projectile is thus disarmed and harmless.

To arm the projectile, that is, to change the fuse from its inactive position to its operative position, no manual operation is necessary. Instead, the arming operation proceeds automatically as the round is launched. At the moment of launching of the round, and even for several seconds thereafter if a rocket projectile is involved, the projectile is subjected to a very great acceleration such that the inertial forces acting on the assembly **17–20** cause this assembly to be displaced linearly against the action of the return spring **27,** toward the rear of the fuse. During this axial displacement of the assembly, the lower plug **18** will come to rest at the bottom of the casing **12.** The shock is absorbed by the shock absorber **44,** for example comprised by a ring of elastic deformable material, such that the casing **12** will not be damaged.

At the end of this axial movement, the assembly **17–20** will be positioned with respect to the casing **5** so that the resilient retaining ring **28** will confront the annular recess **14** under shoulder **6.** This retaining ring **28** deforms and expands so as to lock the fuse assembly in operative position. In this operative position, the detonator enters into the explosive charge surrounding casing **12.**

Simultaneously and/or partially sequentially with the displacement of the assembly **17–20** relative to casing **5,** the locking ring **38,** which is also subjected to inertial forces because of its mass, will be displaced with respect to the upper plug **20** toward the bottom of the bore **25** against the action of compression spring **27.** This axial displacement of the locking ring effects a zigzag displacement thereof as the pin **41** moves through the branch **42** of the recess **40.** When the ring arrives in abutment at the bottom of the bore **25,** the pin **41** is located in the upper opening of the reces **40.**

In this intermediate position of the fuse which is maintained while the projectile accelerates and for as long as the inertial forces due to acceleration are greater than the force of the return spring **37,** it will be noted that the firing passageway remains closed by the

valve 22. Thus during relative displacement of the locking ring 38 with respect to the upper plug 20, the conduit 35 is disposed forwardly in the blind bore 34 of the valve 22 maintaining the latter in its inoperative position against the action of the springs 32.

When the acceleration of the projectile ceases and its deceleration begins, the inertial forces due to acceleration, assisted by the action of the spring 35, effect axial displacement in a forward direction of the fuse, of the locking ring 38 and the conduit 35. This axial displacement is somewhat retarded by the fact that the pin 41 is obliged to follow the zigzag branch 43 of the recess 40, which imparts an angular displacement in a zigzag direction to ring 38 and so retards its axial displacement.

When the pin 41 arrives at the bottom of the branch 43 of recess 40, in the position 45 shown in FIG. 4, the amplitude of axial displacement of the locking ring 38 with respect to the upper plug 20 is sufficient that the rear end of conduit 35 will be completely free from and disposed outside of the blind bore 34 of the valve 22. This end of the conduit 35 will be disposed in the bore 24 of the upper plug which retains its centered position on the axis of the fuse.

At this moment, the valve 22 is freed and moves laterally under the action of springs 32 until it strikes against the bushing 19, in which position the passageway 30 is axially aligned with the fuse and connects the internal bore of conduit 35 with the bore 21 of the upper plug 20. At this time, the firing passageway is established and cleared and connects the primer 3 to the detonator 17. Thus when the primer 3 is fired by impact of the projectile, the shock wave thus produced will fire detonator 17 which in its turn, because it is disposed within the explosive charge, will explode the charge 10 through the casing 12 which ruptures under the force of explosion of the detonator 17.

This fuse accordingly provides a simple and easily constructed arrangement and simple and strong mounting, which also is characterized by total safety of the projectile, because the projectile is disarmed during storage and transport and in fact until it is fired. Moreover, as the projectile is not armed until its launching acceleration has diminished, the projectile is not dangerous until it is a substantial distance from its firing or launching site.

Turning now to FIG. 5, the alternative embodiment shown there is of the same general type as that described in FIGS. 1–4. However, in the embodiment of FIG. 5, the casing 5 is provided with an annular recess 46 whose function is identical to recess 14 and the shoulder 6 of the first embodiment. This arrangement permits the passage of the guide socket 13 while the rear end of the casing 5 comprises an annular flange 47 against which the spring 27 presses.

In addition, in the embodiment of FIG. 5, the valve 22 is differently constructed and is displaceable angularly about its own axis, perpendicular to the axis of the fuse.

Valve 22 in the FIG. 5 embodiment comprises two trunnions 48, 49 which pivot in the lower part of the upper plug 20 and are disposed on opposite sides of the body 50. Body 50 comprises, as in the first embodiment, a blind bore 34 in the interior of which is disposed in the inactive position the conduit 35. Perpendicular to the axis of the blind bore 34 and to the axis of the trunnions 48, 49 and extending through the intersection of these is a passage 51 traversing the body 50 from side to side.

A spring 53 acts on valve 22 to displace it angularly to a position in which the passage 51 is in alignment with the axis of the bore 21 and of the bore of conduit 35. Spring 53 is disposed about trunnion 48 and acts between this trunnion and the upper plug 20.

The other trunnion 49 is provided with an annular recess 54 that extends about 90° and provides a race for a portion of a ball 55 disposed in a housing provided in the upper plug 20. The ends of recess 54 cooperate with ball 55 to fix the angular operative position of the latch and to limit its angular displacement under the action of the spring 53.

The operation of the second embodiment shown in FIG. 5 is similar to that of the first embodiment of FIGS. 1–4. When the conduit 35 escapes the blind bore 34 in the valve 22, the valve 22 is displaced angularly to its operative position, which is determined by the entry into contact of the ball 55 and one end of the recess 54, in which position the passageway 51 places the bore of conduit 35 in communication with the bore 21 so that the firing passageway between primer 3 and detonator 17 is open.

In the third form of the invention shown in FIG. 6, the positioning means of the axially movable assembly is formed by a guide bushing 56 which is secured in the lower portion of casing 5 as in the first form of FIGS. 1–4. This bushing comprises an internal wall which has a truncated upper portion 57 and a lower shoulder 58. Resilient ears 59 are confined by the body of bushing 56 maintaining the detonator 17 between the lower plug 18 and the upper plug 61. In their inoperative position, the ears 59 rest against the conical portion 57 while in their operative position they move under the shoulder 58 of the guide bushing 56 to fix the position of the movable assembly against the action of spring 62 bearing on the bottom of casing 12 and against the rear face of the lower plug 18. This spring tends to maintain the movable assembly in its advanced inoperative position.

The forward edge of the guide bushing 56 presses a shielding plate 63 against a shoulder of casing 5 and holds it there. This shielding plate extends perpendicular to the axis of casing 5 and has one or more holes 64 therethrough which are located in the immediate proximity of the wall of casing 5.

In the FIG. 6 form, the safety device which closes the firing passageway when the fuse is in its inoperative position comprises fixed closure means in the form of the shielding plate 63 as well as insert removable closure means in the form of the balls 65 disposed in the central bore 66 of the upper plug 61. In the illustrated inoperative position, the mobile assembly is maintained in a position such that the annular forward edge 67 of the upper plug 61 will bear against the shielding plate 63. This edge 67 is located on a circumference disposed inside the holes 64; and as moreover the central bore of the plug 61 is closed by the balls 65, the firing passageway between a primer, located above the plate 63 and not shown, and the detonator 17 is closed. Moreover, the detonator 17 is in the inoperative position outside the explosive charge 10 from which it is separated by the plug 18.

Upon firing the round, the mobile assembly comprising the detonator and its safety device is displaced rearwardly under the effect of acceleration of the projec-

tile, against the action of spring **62.** The shock of plug **18** against the bottom of the casing **12** is absorbed by a shock absorber **68** comprising a resilient member disposed adjacent the bottom of casing **12.** The resilient ears **59** expand and engage under the shoulder **58,** which maintains the mobile assembly in its operative position in which the detonator **17** in introduced into the explosive charge **10.**

While the projectile accelerates, the balls **65** are maintained inside the bore **66** so that the firing passageway is closed, while the forward edge **67** of the upper plug will not be applied against the plate **63.** On the other hand, when the projectile decelerates, the balls **65** are moved forwardly outside the bore **66.** At this moment, the projectile is armed because the firing passageway connecting the primer to the detonator is opened. This firing passageway comprises the holes **64,** the internal space of a portion of the casing **5,** and the bore **66** of plug **61.**

The disarmed condition of the projectile until it has left the firing vicinity is due, in the FIG. **6** embodiment, to the balls **65** which do not leave the bore **66** until the projectile has lost its initial acceleration.

The modified form of FIG. **6,** shown in FIG. **7,** is similar in a number of respects to that of FIG. **6.** The arrangement for positioning the movable assembly comprises a resilient ring **69** provided in a groove **70** in the peripheral wall of the upper plug. This resilient ring cooperates with a shoulder **71** of the casing **5.** In this fashion the guide bushing can be eliminated.

In addition, the safety device of FIG. **7** comprises three balls **65** instead of two, and the shielding plate **63** is replaced with a membrane **72** which is ruptured by the explosion of the primer.

When the round is fired, the movable assembly **17, 18, 60, 61** is displaced axially while the membrane **72** remains in place, which permits the balls **65** to leave passage **66** upon deceleration.

The operation of the embodiment of FIG. **7** is thus identical to that of FIG. **6** by virtue of the fact that the firing passageway is not opened until the moment when the primer ignites, upon impact of the projectile, which ruptures the membrane **72.** The operation of the primer may be effectuated as well by compression as by inertia.

The last embodiment of the fuse, illustrated in FIG. **8,** is more particularly designed for projectiles that are mechanically detonated upon high impact. Such a projectile comprises an explosive charge **10** in which is disposed the casing **12** in the interior of which the movable assembly of the fuse slides. This casing is carried by an annular support **73** connected to the casing **5** of the fuse by a circular primer seat **74.** This primer seat **74** has spaced about its periphery four, six, eight or any other number of mechanical percussion primers **75.** These primers **75** are disposed in recesses of the primer seat **74** and are connected to the inside of the casing **12,** near the upper end of this casing, by channels **76** provided in the primer seat **74.** The casing **5** of the fuse is fixed to the primer seat **74** and is closed at its forward portion by an end piece **77.**

The movable assembly of the fuse comprises a lower plug **18,** the detonator **17** and an upper ring **78** maintained in assembly by a bushing **60.** This bushing **60** comprises resilient ears **79** cooperating in a forward rest position with a conical portion of the upper end of the casing **5.** In the operative position, the ears **79** expand under the lower face of the primer seat **74** and thus maintain the movable assembly against the action of spring **62.** Here again, the detonator is outside the charge in the inoperative position but enters into the explosive charge in the operative or armed position.

Also in the advanced inactive position, the movable assembly occupies a position such that the lower plug **18** will be situated above the channels **76** and will thus prevent any communication between the primers **75** and the detonator **17.** It should be noted that the firing of one or more primers will in this position not rupture the casing **12** and therefore will not fire the explosive charge **10.**

The movable assembly also comprises a plug **81** centered on the ring **78** and subjected to the action of a spring **80** which tends to separate ring **78** and plug **81.** In the inactive position, therefore, the plug **81** is compressed between ring **78** and the end piece **77** by the spring **62.** The projectile also comprises mechanical firing pins **82** for each primer **75** actuated by a percussion plate **83.**

Upon firing, the mobile assembly is displaced under the effect of the acceleration of the projectile, to its operative position in which the detonator **17** is introduced into the charge. This assembly is maintained in this position by its maintenance means.

It should be noted that the plug **81** follows the movable assembly during its movement, the force of the spring **80** being less than the inertial forces acting on the stop during the acceleration of the projectile. Thus while the projectile is accelerated, and even though the detonator is disposed in the charge, the firing passageway is closed and the projectile is thus disarmed. Thus while the channels **76** give access to the detonator, it is not until the projectile decelerates that the plug **81** will separate from the ring **78** under the action of the spring **80** and the inertial forces acting thereon during deceleration of the projectile. This arrangement keeps the projectile disarmed until it is a substantial distance from the firing site.

It will accordingly be seen that the projectile fuse of the present invention comprises a combination of a detonator located outside the explosive charge and introduced into the explosive charge upon firing, and a safety device closing the firing passageway which connects the primer to the detonator until a given moment after firing when some suitable mechanism which acts to open the firing passageway after the detonator has entered the explosive charge.

In view of the foregoing disclosure, therefore, it will be evident that all of the initially recited objects of the present invention have been achieved.

Although the present invention has been described and illustrated in connection with preferred embodiments, it is to be understood that modifications and variations may be resorted to without departing from the spirit of the invention, as those skilled in this art will readily understand. Such modifications and variations are considered to be within the purview and scope of the present invention as defined by the appended claims.

Having described my invention, I claim:

1. A projectile containing an explosive charge, and at the forward end of the projectile a fuse comprising a primer fixedly mounted in a forward portion of the fuse, a detonator containing an explosive charge, means defining a firing passageway between the primer

and the detonator such that when the passage-way is open and the primer is fired, the primer will fire the detonator, means mounting the detonator for movement between a forward inactive position forward of and outside the explosive charge of the projectile and a rear active position to which the detonator moves by inertia when the projectile is fired and in which rear position the detonator is within the charge of the projectile, the fuse having fixed closure means which close said passageway in the forward position of the detonator and open said passageway in the rear position of the detonator, said detonator having movable closure means which move rearwardly with said detonator and close said passageway when said detonator moves toward said rear active position and which move forwardly relative to the detonator and open said passageway upon deceleration of the projectile, spring means resisting said rearward movement of the detonator and yieldably maintaining the detonator in said forward inactive position forward of and outside the explosive charge, and means to lock said detonator in said rear position.

2. A projectile fuse as claimed in claim **1**, and a plug at the rear of the detonator charge to separate the detonator charge from the projectile charge in said forward position of the detonator.

3. A projectile fuse as claimed in claim **1**, said movable closure means comprising at least one ball disposed in a portion of said passageway that extends through a forward portion of said detonator.

4. A projectile fuse as claimed in claim **3**, said fixed closure means comprising a shielding plate that extends across the interior of said fuse and that has a central imperforate portion that closes and retains said at least one ball in said portion of said passageway carried by the detonator, said shielding plate being perforate outwardly of said central portion to complete said passageway through said plate.

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