

## Pyrotechnic Fuze With Mechanical Alignment Mechanism

### Field of Invention

**[001]** The present invention relates to a pyrotechnic fuze with mechanical alignment mechanism, particularly for a hand grenade.

### Background

**[002]** Most modern hand fragmentation grenades have not detracted from the Mills Bomb design of 1915; each grenade has a body with a pineapple look, a hand lever secured by a safety pin and a delay detonator. Some grenades have improved safety by requiring the safety pin to be twisted and pulled to release the hand lever; others have improved delay columns by incorporating air gaps between ignition charges, penetration charges or booster charges. Besides the need for increased safety against accidental activation, there is also a push to meet the insensitive munitions requirements.

**[003]** In one approach, US Patent No. 8,408,134, assigned to Diehl BGT Defence GmbH, discloses a hand grenade that separates a detonator from a booster charge in an unarmed state. After a delay charge is initiated, heat from burning of the delay charge releases a solder fuze connection so that the detonator is being moved to an armed position. In another configuration, the grenade uses a spherical detonator holder to keep the detonator misaligned with the delay and booster charges. After release of the solder fuze connection, the delay charge holder is biased to turn the spherical detonator holder so that the detonator is aligned with the delay and booster charges.

**[004]** In another approach, US Patent No. 7,712,419, assigned to the US Army, discloses a detonator case, a slider transversely reciprocal between an unarmed position and armed position, and a shape memory metal to move the slider from the unarmed position to the armed position under the influence of heat from burning of a delay charge. In the armed position, the delay charge becomes aligned with a booster charge disposed below the slider.

**[005]** In yet another approach, US Patent No. 6,578,489, assigned to the French Armament Bureau and Jason Engineering S.A., discloses the use of a striker piston and a misaligned detonator disposed in a rotor. The rotor is externally controlled to align the detonator with the striker piston.

**[006]** It can thus be seen that there exists a need for another mechanism to prevent accidental or unintentional alignment of a delay charge with a detonator or booster charge in a pyrotechnic fuze.

### Summary

**[007]** The following presents a simplified summary to provide a basic understanding of the present invention. This summary is not an extensive overview of the invention, and is not intended to identify key features of the invention. Rather, it is to present some of the inventive concepts of this invention in a generalised form as a prelude to the detailed description that is to follow.

**[008]** The present invention seeks to provide a pyrotechnic fuze with increased safety for a hand grenade and a hand grenade that is insensitive to accidental or unintentional activation. Grenades made according to the present invention may be reclassified under a less stringent hazard class or storage compatibility class, thereby possibly impacting on future costs of storing and transporting these redesigned grenades.

**[009]** In one embodiment, the present invention provides a fuze mechanism for a hand grenade comprising: a fuze case connected at an upper end to a fuze holder whilst a lower, opposite end projects near to a centre of a shell of a hand grenade, wherein the fuze case contains a percussion primer and a pyrotechnic delay charge is disposed inline between the percussion primer and a detonator charge; and a sliding sleeve and an annularly shaped booster charge connected to a lower end of the sliding sleeve are disposed to slide co-axially along the fuze case, so that in an unarmed position, the booster charge is laterally or radially misaligned with the detonator charge and in an armed position, the booster charge is laterally or radially aligned with the detonator charge.

**[0010]** Preferably, the sliding sleeve has a hole formed near an upper end of the sliding sleeve and a tension spring is disposed inside the sliding sleeve to bias the sliding sleeve against the fuze body. The sliding sleeve is releasable under the influence of the tension spring by a releasable projection, ball or pin.

**[0011]** Preferably, a lower end of the sliding sleeve comprises an annular ring which has an inside diameter that is threaded and cooperates with a stepped cylindrical lock nut. A booster charge is secured between the annular ring and the stepped cylindrical lock nut.

**[0012]** Preferably, an open tubular housing is disposed with the open mouth located at a mouth of the grenade shell and the tubular housing surrounds and protects the lower end of the fuze case, including the booster and detonator charges.

**[0013]** In another embodiment, the present invention also provides a method for mechanically interrupting an explosive chain in a fuze for a hand grenade. The method comprises: connecting an upper end of a fuze case to a fuze holder, with the fuze case containing a percussion primer, a pyrotechnic delay charge and a detonator charge; and mounting an annularly shaped booster charge to a lower end of a sliding sleeve and arranging the booster charge and sliding sleeve to slide coaxially along the fuze case, so that in an unarmed state, the booster charge is laterally or radially misaligned with the detonator charge and in an armed state, the booster charge is laterally or radially aligned with the detonator charge.

**[0014]** Preferably, putting the grenade in the unarmed state comprises compacting a tension spring and restraining the sliding sleeve to the fuze body by a releasable projection, ball or pin. Putting the grenade in the armed state comprises releasing the sliding sleeve under the influence of the tension spring by releasing a projection, ball or pin that restrains the sliding sleeve to the fuze body.

### Brief Description of the Drawings

**[0015]** This invention will be described by way of non-limiting embodiments of the present invention, with reference to the accompanying drawings, in which:

**[0016]** FIG. 1A illustrates a known grenade, whilst FIG. 1B illustrates a position of a handle at which a striker lever is released during arming;

**[0017]** FIG. 2A illustrates a sectional view of a grenade in an unarmed state, with a pyrotechnic initiation fuze in a mis-aligned state according to an embodiment of the present invention; FIG. 2B illustrates the grenade in an armed state, with the striker lever in position to activate a percussion primer and the detonator and booster are aligned with each other;

**[0018]** FIG. 3A illustrates a grenade according to another embodiment, whilst FIG. 3B illustrates the grenade in an armed state; and

**[0019]** FIG. 4A illustrates yet a grenade according to yet another embodiment, and FIG. 4B illustrates the grenade in an armed state.

### Detailed Description

**[0020]** One or more specific and alternative embodiments of the present invention will now be described with reference to the attached drawings. It shall be apparent to one skilled in the art, however, that this invention may be practised without such specific details. Some of the details may not be described at length so as not to obscure the invention. For ease of reference, common reference numerals or series of numerals will be used throughout the figures when referring to the same or similar features common to the figures.

**[0021]** Most known grenades rely solely on one safety feature provided by a manually releasable handle to activate a percussion primer, which is used to set off an in-line pyrotechnic delay fuze. These known grenades are identified by a hazard class and a storage compatibility group number. Hazard class 1 covers explosives, with sub-class 1.2 for identifying explosives with projection hazard, and a storage compatibility group F covers explosives containing in-line initiators. If the pyrotechnic delay fuzes are re-designed and the grenades have increased safety; as a result of the grenades becoming insensitive to unintentional activation, the hazard and/or storage compatibility

classification could be moved to a lower stringent class or group, such as hazard class D or E; this reclassification would result in lower costs of storing and transporting grenades made according to the present invention.

**[0022]** Now, in FIGs. 1A and 1B, a known grenade **10** is shown. The grenade **10** has a grenade shell **20**, a fuze holder **40** which includes a fuze case **42** that is being threaded connected into the grenade shell **20** and a manually releasable arming handle **30** being pivoted to the fuze holder **40**. The arming handle **30** is restrained in a normal home or safe position by a twist-and-pull safety pin **25**. The safety pin **25** goes through a hole **26** at the arming handle and another hole **26a** in register at the fuze holder **40**. When the safety pin **25** is removed and the arming handle **30** is released from a user's hand, the arming handle **30** is rotated about a pivot **31** through an angle of about substantially 50 degrees before a spring activated striker lever **36** is released to hit a percussion primer **43** disposed at a top end of the fuze case **42** as seen in FIG. 1B. The striker lever **36** is rotated about a pivot **37** located at the fuze holder by a torsion spring **38** and the position of the striker lever **36** at which it is released is controlled by a distal end of the striker lever in contact with a shoulder **32** formed on an inside surface of the arming handle **30**. A strike point **39** for initiating the percussion primer **43** is formed on the striker lever **36** on the same side where the fuze case **42** is located. The percussion primer **43**, a delay fuze **44** and a detonator **45** form an explosion chain to the main explosive charge **22** contained in the shell **20**.

**[0023]** FIG. 2A shows a simplified sectional view of a grenade **100** according to an embodiment of the present invention. With a similar series of referencing the technical features used in FIGs. 1A and 1B, FIG. 2A shows an arming handle **130** is restrained in the home or safe position by both safety pin **125** and pivot **131** to a fuze holder **140**. In FIG. 2B, the arming handle **130** has been released and a striker lever **136** is shown in an activated position for striking the percussion primer **143**. As seen in FIG. 2A, the fuze case **142** is configured to contain a column of a pyrotechnic delay compound **144** disposed below the percussion primer **143** and a detonator charge **145** disposed at the bottom of the fuze case. The column of pyrotechnic compound **144** is compacted to a predetermined length so that it burns for a predetermined period of time, such as, about 3.5 seconds; the time taken to burn the pyrotechnic delay compound **144** thus provides a time delay before an explosive charge **122** in the grenade shell **120** is allowed to go off. The fuze case **142** is substantially prismatic in cross-section, which may be circular or polygonal in shape. Near

the mid-length of the fuze case **142** there is a step-down shoulder **146**. The portion of the fuze case above the shoulder **146** is disposed inside a lock sleeve **150**. The lock sleeve **150** is threadedly connected to an upper part of the fuze holder **140** such that there is a tubular space **147** between an exterior surface of the lock sleeve **150** and an interior surface in the fuze holder **140**. Exterior to the tubular space **147**, the fuze holder has a neck **148**. The neck **148** of the fuze holder has an external thread for connection to a mouth of the grenade shell **120**. Disposed coaxially with the fuze case **142** inside the grenade shell **120** is an open tubular housing **162**. The open end of the tubular housing **162** is located at the mouth of the grenade shell **120** and the tubular housing **162** is also held in position by packing of the explosive charge **122** in the grenade shell; in this way, the tubular housing **162** surrounds and protects a lower part of the fuze case **142**, in particular, to a booster charge **190** and the detonator charge **145**. At the same time, the shoulder **146** on the fuze case is also used to define the position of the booster charge **190** with respect to the detonator charge **145**.

[0024] Referring again to FIG. 2A, a sliding sleeve **180** is disposed to slide in the tubular space **147**. An upper end of the sliding sleeve **180** is open and is received in the tubular space **147** between the lock sleeve **150** and the interior surface of the fuze holder **140**, whilst a lower end of the sliding sleeve **180** is fitted with an annular ring **181**. An inside hole **182** of the annular ring **181** is threaded to receive a hollow lock nut **183**. The hollow centre **184** of the lock nut **183** is shaped and dimensioned to loosely fit with the lower or free end of the fuze case **142**. The lock nut **183** has a stepped cylindrical shape. In one embodiment of the lock nut **183**, the stepped-down portion has a plurality of transverse openings **185**; in another embodiment, the stepped-down portion does not have any transverse opening. Preferably, an end face of the large portion has two or four blind holes **186** for engaging with a locking spanner, which is used during assembling. In use, a booster charge **190** is located at the stepped-down portion of the lock nut **183** and is secured in position against the annular ring **181**. When the grenade **100** is assembled and un-armed, the sliding sleeve **180** is fully received in the tubular space **147**. In addition, the sliding sleeve **180** is restrained in this unarmed position by a projection **135** that engages with a hole **189** formed near an upper end of the sliding sleeve **180**. The projection **135** extends from an adjacent face of the striker lever **136** and also goes through a hole **141** formed in the fuze holder **140**, with the hole **141** in register with the hole **189** in the sliding sleeve **180**. As seen in FIGs. 2A and 2B, a tension spring **188** is disposed inside the sliding

sleeve **180** and biases the sliding sleeve **180** against the fuze holder **140**. In this un-armed position, the booster charge **190** is laterally or radially mis-aligned with the detonator charge **145**. In the event of an accident with the booster charge **190** still mis-aligned with the detonator charge **145**, for example, during a high temperature “cook off”, the air gap between the booster and detonator charges would maintain a break in the chain of explosion to the explosive charge **122**. By laterally or radially mis-aligning the detonator and booster charges in the unarmed state, the grenade **100** according to the present invention thus provides an additional safety feature. When the grenade **100** is in the armed state, the sliding sleeve **180** is released from the projection **135** and the booster charge **190** becomes substantially aligned laterally or radially with the detonator charge **145**; when the grenade **100** is then activated, the explosive chain from the detonator charge **145** is transmitted to the booster charge **190**, which in turn sets off the (main) explosive charge **122** contained in the grenade shell **120**. When the stepped down portion of the lock nut **183** is provided with the transverse holes **185**, transmission of the explosive chain from the detonator charge **145** to the booster charge **190** is made more certain, but not essential.

[0025] FIG. 2B shows the arming handle **130** has been released and the striker lever **136** is at the position for striking the percussion primer **143**. The striker lever is driven by a torsion spring **138**; as soon as the striker lever is released, the projection **135** is being dislodged from the hole **189** on the sliding sleeve **180** and the hole **141** in the fuze holder **140**; as a result, the tension spring **188** is also released and the booster charge **190** becomes laterally or radially aligned with the detonator charge **145**; the grenade thus becomes armed, and a grenade event is initiated once the percussion primer **143** and pyrotechnic delay compound **144** have been activated.

[0026] FIG. 3A shows a simplified sectional view of a grenade **100a** according to another embodiment of the present invention. The grenade **100a** is similar in construction to the above grenade **100** except that the sliding sleeve **180** is restrained in the annular space **147** by a ball **135a** fitted in the holes **141** and **189**. When the arming handle **130** is in the home or unarmed position, the striker lever **136** presses the ball **135a** and keeps the ball **135a** seated in the holes **141** and **189**. When the arming handle **130** and striker lever **136** are released, the ball **135a** is allowed to drop out of the seat in the holes **141** and **189** so that the booster charge **190** becomes radially aligned with the detonator charge **145**, and the grenade **100a** then becomes armed.

[0027] FIGs. 4A and 4B show a simplified sectional view of a grenade **100b** according to another embodiment of the present invention. The grenade **100b** is also similar in construction to the above grenades except that the sliding sleeve **180** is restrained in the unarmed position by a pin **135b** being tight fitted in the holes **141** and **189**. The pin **135b** is releasable by a flexible link **195** connected to the striker lever **136** or arming handle **130**. The pin **135b** may be tight fitted in the hole **141**, **189**, for example, by press-fit or by a detent so that during release of the striker lever **136** or arming handle **130**, the inertia of the pivoting lever or arming handle overcomes the tight fit of the pin **135b** in the holes **141** and **189**. In this way, releasing of the arming handle or striker lever allows the pin **135b** to be released to put the grenade **100b** into an armed state.

[0028] In the above description, putting the grenade in an unarmed or armed state is synonymous with putting the sliding sleeve **180** in a respective unarmed or armed position.

[0029] While specific embodiments have been described and illustrated, it is understood that many changes, modifications, variations and combinations thereof could still be made to the present invention without departing from the scope of the invention. For example, the projection **135** on the striker lever **136** may be elongate and the cooperating hole **189** through the side of the sliding sleeve is a slot and the hole **141** in register is also a slot. It is also possible for the sliding sleeve **180** to be formed integrally with the annular ring **181**.

**CLAIMS:**

1. A fuze mechanism for a hand grenade comprising:

a fuze case connected at an upper end to a fuze holder whilst a lower, opposite end projects near to a centre of a shell of a hand grenade, wherein the fuze case contains a percussion primer and a pyrotechnic delay charge is disposed inline between the percussion primer and a detonator charge; and

a sliding sleeve and an annularly shaped booster charge connected to a lower end of the sliding sleeve are disposed to slide co-axially along the fuze case, wherein the annularly shaped booster charge is not in line with the pyrotechnic delay charge and detonator charge;

whereby in an unarmed position, the booster charge is laterally or radially misaligned with the detonator charge and in an armed position, the booster charge is laterally or radially aligned with the detonator charge; wherein setting the sliding sleeve in the unarmed and armed positions is synonymous with putting the grenade in corresponding unarmed and armed states.
2. The fuze mechanism according to claim 1, further comprising a tension spring disposed coaxially inside the sliding sleeve, with the tension spring biasing the sliding sleeve in a direction from the unarmed position to the armed position.
3. The fuze mechanism according to claim 2, wherein the sliding sleeve has a hole formed near an upper end of the sliding sleeve for the hole to cooperate with a projection formed on a striker lever, so that engagement of the projection in the hole restrains the sliding sleeve in the unarmed position.
4. The fuze mechanism according to claim 3, wherein the striker lever comprises a strike point for activating the percussion primer and the striker lever is released by contact with an arming handle.
5. The fuze mechanism according to claim 1, further comprising a lock sleeve disposed co-axially around the fuze case to threadedly connect the fuze case to the fuze holder.

6. The fuze mechanism according to claim 5, wherein the fuze case further comprises a shoulder, which cooperates with the sliding sleeve to locate booster charge with respect to the fuze holder.
7. The fuze mechanism according to claim 6, wherein the lower end of the sliding sleeve comprises an annular ring, which has an inside diameter that is threaded to cooperate with a stepped cylindrical lock nut, and the booster charge is secured between the annular ring and the stepped cylindrical lock nut.
8. The fuze mechanism according to claim 7, wherein the stepped-down portion of the cylindrical lock nut does not have any transverse hole formed therein.
9. The fuze mechanism according to claim 7, wherein the stepped-down portion of the cylindrical lock nut has one or more transverse holes formed therein.
10. The fuze mechanism according to claim 1, wherein the fuze holder has a threaded neck for connection to a mouth of the grenade shell.
11. The fuze mechanism according to claim 10, further comprising an open tubular housing which open end is located at the mouth of the grenade shell and is held in position by packing of an explosive charge in the grenade shell, such that the tubular housing surrounds and protects the lower end of the fuze case, including the booster and detonator charges.
12. The fuze mechanism according to claim 2, wherein the sliding sleeve has a hole formed near an upper end of the sliding sleeve for the hole to receive a ball, such that the ball is kept in the hole by a striker lever in an unarmed state and the ball is released when the striker lever is being pivoted out in an armed state.
13. The fuze mechanism according to claim 2, wherein the sliding sleeve has a hole formed near an upper end of the sliding sleeve for the hole to be tight fitted with a pin, and the pin is operated to be released by a flexible link connecting the pin to an arming handle.

14. The fuze mechanism according to claim 2, wherein the sliding sleeve has a hole formed near an upper end of the sliding sleeve for the hole to be tight fitted with a pin, and the pin is operated to be released by a flexible link connecting the pin to a striker lever.

15. A method for mechanically interrupting an explosive chain in a fuze for a hand grenade, the method comprising:

connecting an upper end of a fuze case to a fuze holder, with the fuze case containing a percussion primer, a pyrotechnic delay charge and a detonator charge; and

mounting an annularly shaped booster charge to a lower end of a sliding sleeve and arranging the booster charge and sliding sleeve to slide coaxially along the fuze case, wherein the annularly shaped booster charge is not in line with the pyrotechnic delay charge and detonator charge; whereby in an unarmed state, the booster charge is laterally or radially misaligned with the detonator charge and in an armed state, the booster charge is laterally or radially aligned with the detonator charge.

16. The method according to claim 15, further comprises biasing the sliding sleeve to slide along the fuze case with a tension spring.

17. The method according to claim 16, wherein putting the grenade in the unarmed state comprises compacting the tension spring and restraining the sliding sleeve to the fuze body by a releasable projection, ball or pin.

18. The method according to claim 16, wherein putting the grenade in the armed state comprises releasing the sliding sleeve under the influence of the tension spring by releasing a projection, ball or pin that restrains the sliding sleeve to the fuze body.