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JUNGHANS Microtech GmbH, Unterbergenweg 10, 78655
Dunningen-Seedorf

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Fuze for a projectile

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The invention relates to a fuze for a projectile having a firing chain and an interrupter for interruption of the firing chain.

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Projectiles such as artillery projectiles, mortar shells or direct projectiles normally have a fuze with a firing chain which, in its armed position, comprises two or more firing charges arranged one behind the other. The last of these firing charges, the booster, directs its firing energy at a main charge, which is arranged in the projectile body of the projectile, in order to transmit firing energy to fire the main charge.

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In order to interrupt the firing chain it is known from US 4,691,634 for an interrupter to be provided which moves one of the firing charges such that they are not arranged directly one behind the other when in the safe state, such that this charge cannot be struck and, in addition, cannot transmit firing energy any further. In order to arm the fuze, this firing charge is moved by the interrupter such that the charges are arranged directly one behind the other, thus allowing the firing charges to be fired successively.

One object of the invention is to specify a reliable fuze for a projectile, which can be designed to be particularly compact.

- 5 The invention is based on a fuze for a projectile having a firing chain, an interrupter for interruption of the firing chain, which is designed to snap from a safe position to an armed position when unlocked, and having a locking means for locking the interrupter in a
10 safe position and for unlocking the interrupter by an unlocking movement.

It is proposed that the unlocking movement of the locking means is, according to the invention, an axial
15 movement. An axial movement is a movement with a component in the axial direction, with the axial direction being the direction of flight of the projectile. The use of the axial direction for the unlocking movement allows the fuze to be designed to be
20 very compact in the radial direction, and is therefore suitable for small-caliber projectiles. In particular, the axial movement is directed only in the axial direction, with respect to the interrupter.

- 25 Advantageous refinements of the invention are described in the dependent claims, also in those which refer back to a further independent claim.

The interrupter advantageously supports a firing charge
30 which, when the firing chain is interrupted, that is to say in the safe position, is sufficiently far away from a subsequent firing charge that relaying is impossible. The snap-action of the interrupter to its armed position results in the interrupter moving digitally
35 from its safe position to its armed position, such that transitions are avoided by the very rapid movement of the interrupter. This digital behavior of the interrupter and its position resulting from this either in the safe position or in the armed position, but not

in an intermediate position, make it possible to achieve a high safety level. Furthermore, the fuze can be used both for fast and for slow projectiles, without special settings. The snap-action may be an
5 unrestrained movement, which is braked to a minor extent only by friction losses.

In the armed position, the locking means expediently engages in a closed cutout in the interrupter, for
10 example a hole through the interrupter, and in particular does not project beyond the interrupter in the radial direction. The locking means can therefore be considered to be mounted in the interrupter. A bolt which engages in a recess in the interrupter is
15 particularly suitable. The interrupter is advantageously a rotor. The movement of the rotor from the safe position to the armed position is a rotary movement about a rotation axis.

20 The fuze is advantageously designed such that, before carrying out the unlocking movement, the interrupter first of all must be unlocked, controlled by the projectile firing process, before the unlocking movement can be carried out. For this purpose, the fuze
25 advantageously has a means for unlocking the interrupter, controlled by the projectile firing process, in addition to the locking means for further unlocking. A double-bolt system is particularly suitable for unlocking controlled by the projectile
30 firing process. During the unlocking process controlled by the projectile firing process, the interrupter, and in particular also the locking means, advantageously remains in a position which is unchanged axially with respect to a fuze housing. This allows a separation
35 between firing charges to be kept short, thus making it easier to use insensitive firing explosive.

In order to reliably reach a safe arming distance, an escapement mechanism is advantageous in order to delay

the unlocking movement of the locking means after the unlocking process controlled by the projectile firing process. The escapement mechanism may be designed in the form of a clock mechanism with an armature, and may
5 have an element which can be moved from a locking position to a released position, in which the interrupter is released, or can be released by one or more further arming measures. This element is expediently a segment, in particular a tooth segment. A
10 radial physical space can be kept small if the segment is arranged at least partially on or under the interrupter in the axial direction. On and under should be understood in the sense of above and below, with above being the nose of the projectile.

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The axial physical space of the fuze can be kept compact if the locking means is mounted in the interrupter and, in particular, when in the safe position, engages in a recess in a component which is
20 fixed to the housing, and, in the armed position, is moved out of the recess. The component which is fixed to the housing may be a cover or cover panel, and is expediently mounted such that it cannot move with respect to a housing of the fuze. The locking means is
25 advantageously mounted in the interrupter both in the safe position and in the armed position, thus making it possible to keep the space required for the locking means small. The locking means expediently also carries out the snap-action movement.

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The snap-action movement can be spring-powered. The snap action movement can be carried out with a particularly high safety level if it is powered by centrifugal force. The required centrifugal force can
35 be produced by the projectile spinning during flight.

A particularly efficient unlocking procedure for the interrupter can be carried out if the locking means is held in its locking position by an escapement

mechanism, expediently by a segment. The escapement mechanism can thus release the locking means as it unwinds, thus unlocking the rotor. In the unlocked state, the locking means is advantageously inserted
5 into a recess in an escapement mechanism, in particular into a recess in a segment of the escapement mechanism. If the recess has a ramp, then the locking means can slide from its locking position to its released position. The locking means expediently slides into the
10 recess. The ramp allows the locking means to be moved out of the recess, thus making it possible to achieve a high freedom of movement for the locking means and the interrupter.

15 In a further advantageous embodiment of the invention, an element, in particular a segment, of an escapement mechanism is designed to also carry out at least a part of the snap-action movement to the armed position with the interrupter. This makes it possible to ensure that
20 the elements which carry out the snap-action movement have a high mass, which is useful for high reliability when carrying out the snap-action movement, particularly when this is a snap-action movement powered by centrifugal force. The joint snap-action
25 movement of the interrupter can be coupled to the segment by the locking means. The joint movement expediently comprises the start of the snap-action movement, such that the segment can pull the interrupter out of a slightly blocked position, if the
30 interrupter is jammed, as is possible after long storage. If the final part of the snap-action movement is carried out by the interrupter on its own and without the segment, the interrupter can carry out a long movement without having to move the segment as
35 well, thus making it possible to achieve a compact movement procedure.

In a further advantageous embodiment of the invention, the fuze comprises a double-bolt system for arming when

the projectile is fired. The projectile firing acceleration can be used as an arming force, without the interrupter carrying out an axial movement. Axial physical spaces can therefore be made particularly
5 small and the firing charges in the firing chain can be fitted very close to one another, thus making it considerably easier to use insensitive explosive.

Furthermore, the fuze expediently comprises an opposing
10 rotary spring in order to pull the interrupter in the direction of its safe position. This counteracts inadvertent movement of the interrupter from its safe position to its armed position, for example if the locking means is defective.

15 The interrupter is expediently locked in its armed position by the opposing rotary spring. This makes it possible to reduce the risk of an unexploded projectile. The double function of the opposing rotary
20 spring makes it possible to save a further component, and to reduce the physical space.

A spiral spring is particularly suitable for use as the opposing rotary spring for a rotor. This can be
25 integrated in a compact form in the fuze. The opposing rotary spring is expediently wound around a rotation axis of the interrupter, thus making it possible to design the fuze to be simple. For locking, the rotary spring advantageously engages in an element which is
30 fixed to the housing. It is also good for compactness for the opposing rotary spring to be mounted completely within the interrupter, except for an engagement element for locking engagement.

35 Further advantages will become evident from the following drawing description. The drawing illustrates one exemplary embodiment of the invention. The drawing and the description contain numerous features in combination, which a person skilled in the art will

expediently also consider individually and combine them to make further worthwhile combinations.

In the figures:

- 5
Figure 1 shows a detail of a fuze of a projectile in the safe position, in the form of a partially sectioned, perspective illustration,
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Figure 2 shows a further partially sectioned perspective view of the detail of the fuze, with a cover fitted,
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Figure 3 shows a plan view of the fuze in an intermediate position,
- Figure 4 shows a section through the fuze, along the section line IV - IV from Figure 3,
- 20
and
- Figure 5 shows a plan view of the fuze in its armed position.
- 25
Figure 1 shows a partially sectioned perspective illustration of a part of a fuze 2 with a housing 4 which is intended to be attached in its lower area 6 to a body of a projectile. A part of the fuze 2 which is at the front in the direction of flight 8 of the projectile, or is the upper part in the view shown in the figures, has been omitted, in order to illustrate the elements shown in Figure 1 better and comprises an upper part of the housing 4, an impact firing mechanism with a fuze needle for piercing a detonator 10, and
- 30
35 further elements.

The fuze 2 is provided with a double-bolt system 12 and with an escapement mechanism 14, which is designed like a clock mechanism, with a toothed segment 16 and an

interrupter 18, which is arranged on the segment 16 and in which the detonator 10 is mounted. The interrupter 18 and the segment 16 are illustrated in partially sectioned form in Figure 1. The detonator 10 is a part of a firing chain having at least two firing charges, specifically the detonator 10 and a booster, which is not illustrated but is arranged underneath the segment 16 on the center axis of the projectile or of the fuze 2.

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Figure 1 shows the fuze 2 in its safe position. In this position, the detonator 10 is arranged separately from the booster and sufficiently far away from it that relaying to the subsequent booster is reliably prevented in the event of inadvertent detonation of the detonator 10. An opening above the booster is covered by the segment 16, and blocks a direct connection between the detonator 10 and the booster. In addition, the segment 16 blocks any movement of the interrupter 18 directly to its armed position, since an element of the interrupter 18, specifically a depression 20 for holding the detonator 10, would strike against an edge 22 (see Figure 5) of the segment 16 if the interrupter 18 were to move to its armed position, thus blocking further movement of the interrupter 18 to the center.

Figure 2 shows a different, partially sectioned detail view of the fuze 2 with a cover panel 24 which is fixed to the housing fitted, likewise in the safe position. The interrupter 18 is shown in a sectioned form, thus providing a free view of an opposing rotary spring 26 and a locking means 28 within the interrupter 18. The opposing rotary spring 26 is a torsion spring in the form of a spring clip, one of whose limbs is held fixed to the housing in a gap in a shaft 30 about which the interrupter 18 is mounted such that it can rotate. The other limb is held in a slot 32, as illustrated in Figure 1, in the interrupter 18, which is in the form

of a rotor, and is prestressed torsionally, such that this limb loads the interrupter 18 with a counter-clockwise force, and in the opposite direction to the arming direction 34. The rotor or interrupter 18 is
5 thus pulled by the opposing rotary spring 26 in the direction of its safe position and is pushed against a stop 36, which predetermines the safe position.

In addition, the interrupter 18 is held in its safe
10 position by the double-bolt system 12 and the locking means 28, which is in the form of a bolt. The locking means 28 engages in a conical recess 38 in the cover panel 24 which is fixed to the housing, and is held all round by the interrupter 18, and is therefore mounted
15 in it, such that the locking means 28 is fixed firmly in the interrupter 18 in the radial direction and tangential direction. In the axial direction, that is to say parallel to the direction of flight 8 but downward, the locking means 28 is blocked by the
20 segment 16 of the escapement mechanism 14, thus blocking a downward unlocking movement. The locking means 28 locks the interrupter 18 in its safe position by means of this blocking and the engagement in the recess 38 which is fixed to the housing, as well as the
25 mounting in the interrupter 18.

Before the projectile is fired, the components of the fuze 2 are as illustrated in Figures 1 and 2. In addition to the locking means 28 and the opposing
30 rotary spring 26, the interrupter 18 is blocked in its safe position by stop 40 on a bolt 42 of the double-bolt system 12, on which one side 44 of the interrupter 18 rests. A further stop 46 on the bolt 42 blocks the segment 16 analogously in its locking position.

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When the projectile is fired, powerful acceleration forces act in the direction of flight 8 on all the components of the fuze 2. Because of their inertia, all the components are forced downward relative to the

housing 4, and in the opposite direction to the direction of flight 8. Therefore, also the two bolts 42, 48 of the double-bolt system 12, with the bolt 42 being mounted fixed to the housing by means of
5 a ball 50 which engages in a recess 52 in the bolt 42, and in the axial direction, that is to say parallel to the center axis 62, which is illustrated in Figure 3, of the fuze 2 and of the projectile. However, the bolt 48 can move freely axially and, driven by its inertia,
10 compresses a spiral spring 54 downward on its way, which spiral spring 54 holds it at the top in its safe position when there is no acceleration on the fuze 2.

During the downward movement of the bolt 48, the bolt
15 42 is also forced downward and an incline, which is not illustrated, at the end of the recess 52 in it presses against the ball 50 and into this in the tangential direction against the bolt 48, which blocks tangential movement of the ball 50. However, as soon as the bolt
20 48 has been forced sufficiently far downward that a chamfer 56 comes into the area of the ball 50, the ball 50 can escape in the tangential direction, and is forced out of the recess 52 by the chamfer on the bolt 42. As soon as the ball 50 has emerged completely out
25 of the recess 52, the bolt 42 is also forced downward and its side 46 blocks the ball 50 in the area of the chamfer 56, as a result of which the bolt 48 is blocked in its lower arming position and cannot be driven upward again by the spiral spring 54. As a result of
30 the release movement of the bolt 42, this first of all allows the interrupter 18 to carry out an arming movement which, however, is blocked again by the locking means and, as the process continues, also a release movement of the segment 16. As soon as the bolt
35 42 has been forced sufficiently far downward, a latching spring 58 springs into a recess 60, which forms the stop 40, in the bolt 42, and locks this in its lower unlocking position. The unlocking movement of the double-bolt system 12 therefore unlocks the segment

16, while the interrupter 18 is still locked by the locking means 28.

As the projectile is fired, a spinning movement is
5 impressed on the projectile, in the form of a rapid rotation about its centre axis 62. This results in a powerful centrifugal force being exerted radially outward on all the elements of the fuze 2. As can be
10 seen from Figure 2 and Figure 3, both the segment 16 and the interrupter 18 are mounted such that they can rotate about a rotation axis 64 within the shaft 30. These figures also show that the center of gravity of the segment 16 is not located on this rotation axis 64 but well away from it, as a result of which the
15 segment 16 is forced radially outward by the centrifugal force, and is thus forced to carry out a rotary movement in the clockwise direction about the rotation axis 64. The tooth system 66 on the segment 16 exerts a force on gearwheels 68, 70 of the escapement
20 mechanism 14, which in turn act on an armature wheel 72 and an armature 74 of the escapement mechanism 14. The armature 74 is moved in a reciprocating manner, analogously to a clock mechanism, and allows the armature wheel 72 to rotate in steps. This rotary
25 movement is transmitted, stepped down, to the segment 16, which rotates about the rotation axis 64 in the clockwise direction, or arming direction 34.

Figure 3 shows an intermediate position of the
30 segment 16 between its locking position, as illustrated in Figure 1, and its released position, as illustrated in Figure 5. This intermediate position is illustrated in a partially sectioned form in Figure 4. The rotary movement of the segment 16 moves a recess 76 toward the
35 locking means 28 as far as a position as illustrated in Figure 4. The locking means 28 is designed to be rounded at the bottom, that is to say toward the segment 16, advantageously in the form of a ball cup, with this rounded shape sliding into the recess 76 as a

result of further movement of the segment 16 on a ramp 78. The movement of the locking means 28 in the axial direction is produced by the centrifugal force of the interrupter 18 in conjunction with the inclined
5 surface of the conical recess 38, since the center of gravity of the interrupter 18 is also not located on the rotation axis 64, and the interrupter 18 is forced in the arming direction 34 by the centrifugal force. The locking means 28 is thus forced against the incline
10 on the conical recess 38, which forces it downward into the recess 76. This unlocking movement, which takes place downward in the axial direction 80 relative to the interrupter 18 and is subject to additional lateral components relative to the housing 4 because of the
15 lateral migration within the recess 38, results in the interrupter 18 being unlocked as soon as the locking means 28 has emerged completely out of the recess 38.

However, the interrupter 18 cannot snap immediately to
20 an armed position on its own even in its state in which it has been unlocked by the locking means, because the interrupter 18 and the segment 16 are coupled by the locking means 28 during their further movement. The interrupter 18 and the segment 16 have to move relative
25 to one another such that the locking means 28 remains within the recess 76, since the cover panel 24 prevents it from moving upward and out of the segment 16. As can be seen in Figure 3, the tooth system 66 ends up approximately coincidentally with the position in which
30 the locking means 28 has emerged completely out of the recess 38. This also ends the constriction of the release movement of the segment 16 by the escapement mechanism 14, and this can snap essentially freely to its released position, driven by centrifugal forces, as
35 is illustrated in Figure 5. This snap-action movement can also be carried out by the interrupter 18, as a result of which the segment 16 and the interrupter 18 synchronously move through the first part of the snap-action movement of the interrupter 18. In the situation

in which the interrupter 18 is not moved out of its safe position for any inadvertent reason, for example because a critical element has corroded such that it is fixed, then a stop surface 82 on the recess 76 strikes
5 against the locking means 28 and thus forces the interrupter 18 out of its safe position. The interrupter 18 is released from, for example, the seized position, and itself starts to carry out its arming movement in the direction of the armed position.
10 This results in a high degree of reliability against unexploded projectiles.

Once the segment 16 has reached its released position, and has partially accommodated the locking means 28,
15 the segment 26 and the interrupter 18 and, with it, the locking means 28, carry out the first part of the snap-action movement of the interrupter together, until the segment 16 strikes against a surface 84 of the housing 4. The segment 16 has reached its final
20 position while, in contrast, the interrupter 18 continues to carry out its snap-action movement. The locking means 28 is in this way guided onto the ramp 78 again, and is pulled out of the recess 76, with the locking means 28 entering a recess 86 (see Figure 2) in
25 the cover panel 24. The recess 86 makes it possible to decouple the movement of the interrupter 18 from the movement of the segment 16. The interrupter 18 carries out its snap-action movement essentially without impediment, as far as the armed position illustrated in
30 Figure 5.

On reaching this armed position, the interrupter 18 strikes against the stop 36, which therefore predetermines the armed position. The stop 36 is a
35 depression in the cover panel 24, and is therefore fixed to the housing. In this position, a tab 88 (see Figures 1 and 2) on the opposing rotary spring 26 latches into a recess 90 in the cover panel 24, and thus locks the interrupter 18 in its armed position.

The detonator 10 is now on the center axis 62 of the projectile and is arranged in line with the booster, which is located underneath it, thus allowing relaying to take place from the detonator 10 to the booster. The
5 interrupter 18 or rotor, and therefore the fuze 2, are in their armed position.

List of reference symbols

	2	Fuze
	4	Housing
5	6	Area
	8	Direction of flight
	10	Detonator
	12	Double-bolt system
	14	Escapement mechanism
10	16	Segment
	18	Interrupter
	20	Depression
	22	Edge
	24	Cover panel
15	26	Opposing rotary spring
	28	Locking means
	30	Shaft
	32	Slot
	34	Arming direction
20	36	Stop
	38	Recess
	40	Stop
	42	Bolt
	44	Side
25	46	Stop
	48	Bolt
	50	Ball
	52	Recess
	54	Spiral spring
30	56	Chamfer
	58	Latching spring
	60	Recess
	62	Center axis
	64	Rotation axis
35	66	Tooth system
	68	Gearwheel
	70	Gearwheel
	72	Armature wheel
	74	Armature

	76	Recess
	78	Ramp
	80	Axial direction
	82	Stop surface
5	84	Surface
	86	Recess
	88	Tab
	90	Recess

Patent Claims

1. A fuze (2) for a projectile having a firing chain, an interrupter (18) for interruption of the firing chain, which is designed to snap from a safe position to an armed position when unlocked, and having a locking means (28) for locking the interrupter (18) in the safe position and for unlocking the interrupter (18) by an unlocking movement, characterized
in that the unlocking movement of the locking means (28) is an axial movement, and
characterized
in that the locking means (28) is held in its locking position by an escapement mechanism (14).
2. The fuze (2) as claimed in claim 1, characterized
by an escapement mechanism (14) having a segment (16) with a locking position and a released position, which is arranged at least partially on or under the interrupter (18) in the axial direction (18).
3. The fuze (2) as claimed in claim 1 or 2, characterized
in that the locking means (28) is mounted in the interrupter (18) and, when in the safe position, engages in a recess (38) in a component which is fixed to the housing and, in the armed position, is moved out of the recess (38).
4. The fuze (2) as claimed in one of the preceding claims, characterized
in that the locking means (28) is mounted in the interrupter (18) both in the safe position and in the armed position.

5. The fuze (2) as claimed in one of the preceding claims,
characterized
in that, in the unlocked state, the locking means (28)
is inserted into a recess (76) in an escapement
mechanism (14).

6. The fuze (2) as claimed in one of the preceding
claims,
characterized
by a ramp (78) on which the locking means (28) slides
from its locking position to its released position.

7. The fuze (2) as claimed in claim 6,
characterized
in that the ramp (78) is introduced into an escapement
mechanism (14).

8. The fuze (2) as claimed in claim 6 or 7,
characterized
in that, in the armed position, the locking means (28)
is moved out of a recess (76) by means of the
ramp (78).

9. The fuze (2) as claimed in one of the preceding
claims,
characterized
in that a segment (16) of an escapement mechanism (14)
is designed to also carry out at least a part of the
snap-action movement to the armed position with the
interrupter (18).

10. The fuze (2) as claimed in claim 9,
characterized

in that the part comprises the start of the snap-action movement.

11. The fuze (2) as claimed in claim 9 or 10, characterized
in that the joint snap-action movement of the interrupter (18) is coupled to the segment (16) by the locking means (28).

12. The fuze (2) as claimed in one of claims 9 to 11, characterized
in that a final part of the snap-action movement is carried out by the interrupter (18) on its own, without the segment (16).

13. The fuze (2) as claimed in one of the preceding claims, characterized
in that the interrupter (18) is locked in its armed position by an opposing rotary spring (26), whose force pulls the interrupter (18) in the direction of its safe position.

14. The fuze (2) as claimed in one of the preceding claims, characterized
by a double-bolt system (12) for arming when the projectile is fired, which double-bolt system (12) locks both the interrupter (18) and an element (16) of an escapement mechanism (14) in the safe position.