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Fuze for a projectile

10 The invention relates to a fuze for a projectile having
a firing arrangement for firing a main charge of the
projectile and having a delay detonator for firing the
firing arrangement after a delay time which is defined
by a burning distance of a delay charge, with the delay
detonator having a housing with a fuze half in which it
15 is fired and having a detonator half which contains a
detonator charge for firing the firing arrangement.

Fuzes for artillery projectiles, mortar shells or
direct-fire projectiles are normally provided with a
20 firing arrangement having a firing chain by means of
which a main charge in the projectile is fired. The
firing arrangement or firing chain comprises a firing
charge which is fired electronically or mechanically at
a specific time or in a specific fuze situation, and
25 which passes its firing energy directly to the main
charge or, for example, to a booster charge in the
firing chain, which itself fires the main charge.

When such mechanical or electronic initiation of the
30 firing charge fails, the projectile becomes an
unexploded munition after it has landed, which
represents a considerable source of danger for a very
long time period. An unexploded munition such as this
can arise, for example, when a projectile with an
35 impact fuze lands in deep snow or in a snow drift and
the impact fuze does not fire, or the projectile
strikes the ground at such a flat angle that it slides
over the ground and comes to rest only slowly.

In order to ensure firing even in an irregular situation such as this, it is known for the fuze to be provided with a delay detonator which is fired for example on firing of the projectile and fires the firing arrangement after a preset delay time of a number of seconds, when this firing arrangement has not already been fired in the normal manner by a time fuze or impact fuze or the like. A delay detonator such as this normally comprises a delay charge which, for example, is fired when the projectile is fired and which - in a similar manner to a detonation cord - burns for a defined time period in order to transfer firing energy to a detonator, in order to fire the firing arrangement, once this delay time has elapsed.

One object of the present invention is to specify a fuze for a projectile which provides reliable protection against becoming an unexploded munition.

This object is achieved by a fuze of the type mentioned initially, in which, according to the invention, the housing in the fuze half has a relief opening with an opening cross section which can be passed through freely when the delay detonator is in the firing state.

The invention is based on the idea that the delay time can be set very precisely by means of a delay charge. Furthermore, the burning of a delay charge is very robust when subjected to mechanical loads, as a result of which the firing of the firing arrangement by the delay detonator can also take place when the fuze has in the meantime been subjected to high loads, such as those which can occur when the projectile is being fired and on impact. However, the high mechanical load which occurs when the projectile is fired can result in the homogeneous structure of the combustion material in the delay charge being somewhat interfered with. If high pressure peaks occur as a result of non-uniform combustion when the delay detonator is fired, hot

- combustion gases can pass through the delay charge as a result of inhomogeneities in the fuel structure, for example microcracks, thus bridging the delay charge and prematurely firing the detonator charge. If it is fired
- 5 prematurely, a firing charge of the firing arrangement may possibly not yet have been armed, and initiation of the firing arrangement by the detonator of the delay detonator will be prevented.
- 10 Pressure peaks which can occur as a result of firing of the delay detonator can be dissipated through a relief opening in the fuze half of the housing of the delay detonator, as a result of which the pressure that builds up is not sufficient to force hot combustion
- 15 gases through the delay charge. Bridging of the delay charge can be reliably prevented, and firing of the firing arrangement after the defined delay time can be ensured.
- 20 When the delay detonator is being fired, the relief opening allows gas to pass freely from a charge of the delay detonator into its surrounding area. When the delay detonator is being fired, the relief opening is provided with an opening cross section which can be
- 25 passed through freely and has a size of at least 1 mm^2 . This allows sufficient gas to escape through the relief opening in order to dissipate pressure peaks. Pressure relief in the fuze half becomes even more necessary the greater the pressure peaks which occur on firing. In
- 30 order to allow even large pressure peaks to be dissipated, which can occur in the event of high mechanical loads or as a result of inhomogeneities in charges, the relief opening expediently has an opening cross section, which can be passed through freely when
- 35 the delay detonator is being fired, of at least 5 mm^2 .

The housing of the delay detonator expediently surrounds all the charges of the delay detonator, for example a piercing charge, a relay charge between the

piercing charge and a delay charge, and possibly a further relay charge and a detonator charge. Since the pressure peaks are formed predominantly on firing of the delay detonator, the relief opening is arranged in the fuze half of the housing, that is to say in the half in which the delay detonator is fired, for example by means of a piercing needle which is pushed into a firing charge.

When using a firing needle, this is passed through the housing in order to fire the delay detonator, and the housing may have a piercing opening for this purpose. When the delay detonator is being fired, that is to say in the state in which the firing needle enters a firing charge and fires it, this piercing opening is blocked by the firing needle to such an extent that it cannot be used as a relief opening. A small slot between the firing needle and the housing is sufficient for use as a relief opening only if it has an aperture with a size of at least 1 mm², which must also not be covered by an element of the firing needle, for example a cover or stop.

In one advantageous embodiment of the invention, the relief opening opens directly to a piercing charge of the delay detonator. Pressure peaks which occur when the piercing charge is being fired can be dissipated particularly well through this opening. It is likewise possible to arrange the relief opening on a relay charge between a piercing charge and a delay charge, in order to dissipate pressure peaks which can occur when energy is being transferred from one charge to another. It is also advantageous for the relief opening to be arranged both on the piercing charge and on the relay charge.

In order to provide longer delay times, the delay detonator is expediently made elongated, such that its length in a burning direction is longer, in particular

more than twice as long, than its extent in the two other spatial directions.

5 In order to provide a compact fuze, it is advantageous to arrange the elongated delay detonator transversely with respect to a direction of flight of the projectile. To this end, the burning direction of the delay detonator, that is to say the direction advantageously transversely with respect to a direction
10 of flight of the projectile, is expediently located at an angle of between 70 and 110 degrees with respect to the direction of flight of the projectile, in particular at right angles to the direction of flight of the projectile. The burning direction is the
15 direction in which a delay charge of the delay detonator burns, for example from a piercing charge to the detonator charge.

20 In one advantageous refinement of the invention, the piercing opening and the relief opening are two separate openings in the housing. This makes it possible to separate the processes of piercing and pressure relief, and the openings can be optimized for reliable firing of the delay detonator and for good
25 pressure relief. Alternatively or additionally, it is possible for the relief opening to form the piercing opening at the same time, through which a piercing needle can be passed in order to fire the delay detonator.

30 The delay detonator is advantageously pierced when the projectile is fired and using the firing acceleration. In this case, a particularly simple fuze design can be achieved if a piercing direction of the piercing needle
35 through the piercing opening is in the opposite direction to the direction of flight of the projectile. The arrangement of the piercing direction parallel to but in the opposite direction to the direction of flight of the projectile makes it possible to make use

of the inertia of the piercing needle for acceleration and piercing into the delay detonator, without any need for other propulsion means.

5 Hot combustion gases can be forced through the delay detonator when a pressure peak occurs only when there is a corresponding opposing pressure in the opposite direction to the burning direction in the delay detonator. The production of an opposing pressure such
10 as this can be counteracted particularly effectively by arranging the relief opening with respect to a piercing opening in the housing in the opposite direction to a burning direction of a delay charge. Accelerated, hot gases can leave the delay detonator without changing
15 direction, thus making it possible to dissipate pressure particularly effectively.

The relief opening is advantageously arranged opposite a detonator opening in the housing. Pressure relief in
20 the opposite direction to the burning direction can in this way be achieved in a particularly simple form. In this case, the relief opening can be incorporated on a rear face of the housing which, in particular, is arranged parallel to the front face. Rear and front can
25 in this case be defined by the fuze half which is the rear half and the detonator half, which is the front half.

In a further advantageous refinement of the invention,
30 the delay detonator is provided in order to accelerate an armed firing charge of the firing arrangement against a piercing needle. The firing arrangement can be fired and the main charge can in this way be caused to detonate.

35 The invention can be used particularly advantageously in the case of a fuze which is an impact fuze. If there is no impact or the impact is too weak, the firing energy which is required to fire the firing arrangement

can be made available by the delay detonator, for example by accelerating the firing charge of the firing arrangement against the piercing needle.

5 Further advantages result from the following description of the drawing, in which one exemplary embodiment of the invention is illustrated. The drawing and the description contain numerous features in combination, which a person skilled in the art will
10 expediently also consider individually and combine to form worthwhile further combinations.

In the figures:

15 Figure 1 shows a schematic perspective illustration of a fuze with a delay detonator, and

Figure 2 shows the delay detonator in the form of a sectioned side view.

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Figure 1 shows a fuze 2 of a projectile, which is not illustrated in any more detail, for example of a mortar shell, an artillery projectile or a direct-fire projectile in the form of a partially sectioned and
25 highly simplified illustration. The fuze 2 is an impact fuze and can be screwed into a projectile body via a thread 4, by which means the projectile is produced. The fuze 2 comprises a fuze housing 6 with a base 8 on which elements of the fuze 2 are fixed, for example a
30 delay detonator 10 and, alongside this, a double-bolt system 12, only part of which is illustrated, schematically, for clarity. The figure likewise only indicates a rotor 14, which can rotate about a bolt 16, and two piercing needles 18, 20 for firing a firing
35 charge 22 in the rotor 14 and a piercing charge 24 (see Figure 2) in the delay detonator 10, whose mounting in the fuze housing 6 is likewise not illustrated, for clarity.

Figure 2 shows the delay detonator 10 in the form of a sectioned illustration. The piercing charge 24, a relay charge 28, a delay charge 30, a further relay charge 32 and a detonator charge 34 are arranged from front to rear in a housing 26. The housing 26 is provided in the area of the piercing charge 24 with a piercing opening 36 through which the piercing needle 20 can be inserted into the piercing charge 24. The housing 26 is provided with a relief opening 40, on the rear face 38 of the housing 26 and likewise in the area of the piercing charge 24. On the opposite front face 42, the housing 26 is open, thus forming a large detonation opening 44. The delay detonator 10 is a good 20 mm long, and the diameter of the relief opening is about 3.5 mm.

When the projectile is fired, the fuze 2 is accelerated very greatly in the direction of flight 46. This results in a bolt 48 which is indicated in the double-bolt system 12 being forced downward, that is to say in the direction of the projectile body, and, with it, a second bolt, which is not illustrated, of the double-bolt system 12. This unlocks the rotor 14, which is rotated about the bolt 16 by an appropriate mechanism, such that the firing charge 22 is moved under the piercing needle 12, corresponding to the arrow 50. When the projectile strikes a target, the fuze 2 is accelerated very greatly in the opposite direction to the direction of flight 46, as a result of which the rotor 14 is moved upward, that is to say in the direction of flight 46, relative to the fuze housing 6, as is indicated by an arrow 52. The piercing needle 18 remains fixed in the fuze housing 6, as a result of which the firing charge 22 is forced against the piercing needle 18 and is fired. The firing charge 22 results in firing energy being forced through the base 8 onto a main charge, which is not illustrated, of the projectile, and thus firing this main charge. The firing charge 22, the rotor 14 and the piercing needle 18 are components of a firing arrangement 54 which, if

required, may also comprise one or two further charges in a firing chain.

If the projectile makes a soft landing or the
5 projectile decelerates slowly when making a flat
landing on flat ground, the deceleration of the fuze 2
may be too low to force the rotor 14 upwards in the
direction of flight 46 and to force the firing charge
22 against the firing needle 18. The projectile comes
10 to rest without the main charge being detonated, and
thus becomes an unexploded munition. In order to
prevent this, the fuze 2 is provided with the delay
detonator 10, which is fired when the projectile is
fired. When the projectile is fired, the piercing
15 needle 20, which is mounted in the fuze housing 6 so
that it can move, is accelerated by its inertia
relative to the fuze housing 6 in the piercing
direction 56, that is to say in the opposite direction
to the direction of flight 46, towards the delay
20 detonator 10, as a result of which its point is moved
through the opening 36 in the housing 26 into the
piercing charge 24. Its movement into the piercing
charge 24 is stopped by a stop 58, in the form of a
flange on the piercing needle 20, with the stop 58
25 resting like a cover all round the piercing opening 36
when the piercing charge 24 is fired, thus closing the
piercing opening 36.

The piercing charge 24 fires the relay charge 28 which
30 itself fires the delay charge 30. The delay charge 30
is set such that it burns for a period of 15 seconds
from its rear end on the relay charge 28, until the
burning process arrives at its front end, and thus at
the relay charge 32. The relay charge 32 is fired after
35 this 15-second period and itself fires the detonator
charge 34, which emits a powerful gas pressure shock
outwards. This gas pressure shock accelerates the rotor
14 in the direction of flight 46, as a result of which
the firing charge 22 is forced against the piercing

needle 18 and is fired. This results in the main charge of the projectile being fired at the latest after 15 seconds, if it has not already been fired in the normal manner prior to this by impact of the fuze 2.

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When the piercing charge 24 and the relay charge 28 are fired, it is possible for a high gas pressure to be formed within the housing 26, in the area of the piercing charge 24 and/or of the relay charge 28. This
10 can result in hot gases being suddenly forced through the delay charge 30, particularly if the delay charge 30 has microcracks or the like which, for example, can be created when the projectile is fired. The relay charge 32 is fired immediately and, with it, the
15 detonator charge 34, thus producing the gas pressure shock in order to lift the rotor 14 during or shortly after the firing of the projectile. At this time, the rotor 14 has not yet been rotated to its unlocked position, as a result of which the firing charge 22 can
20 not yet be forced against the piercing needle 18. The main charge is not detonated and will also not be detonated if the impact is too small. The projectile becomes an unexploded munition. Furthermore, the rotor 14 may be damaged by the gas pressure shock of the
25 detonator charge 34, as a result of which it may become jammed and cannot rotate to its armed position. The firing charge 22 can in this way not be fired even when a normal impact occurs, and the projectile in any case becomes an unexploded munition.

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In order to prevent this, the relief opening 40 is introduced in the fuze half 60 of the delay detonator 10. The fuze half is the rear half, on the basis of its dimensions, of the delay detonator 10. The firing
35 charge 22 is located in it. The front half of the delay detonator 10 is its detonator half 62, in which the detonator charge 34 is located. Undesirable pressure peaks are dissipated through the relief opening 40 by the capability for combustion gases to escape from the

housing 26 through the relief opening 40. The delay charge 30 can burn in the normal manner, thus reliably preventing the projectile from becoming an unexploded munition.

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In order to allow a long burning distance 64 in the burning direction 66, the delay charge 30 is elongated and, with it, the delay detonator 10. In order to achieve a compact fuze 2, the longitudinal direction of the elongated delay detonator 10 and, with it, a burning direction 66 of the delay charge 30 are arranged at right angles to the direction of flight 46. In order to make use of the inertia of the piercing needle 20 to fire the delay detonator 10, the piercing needle 20 is arranged such that it is introduced into the housing 26 from the side, with respect to the longitudinal direction of the delay detonator 10 and the burning direction 66, in order to fire the delay detonator 10.

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List of reference symbols

	2	Fuze
	4	Thread
5	6	Housing
	8	Base
	10	Delay detonator
	12	Double-bolt system
	14	Rotor
10	16	Bolt
	18	Piercing needle
	20	Piercing needle
	22	Firing charge
	24	Piercing charge
15	26	Housing
	28	Relay charge
	30	Delay charge
	32	Relay charge
	34	Detonator charge
20	36	Piercing opening
	38	Rear face
	40	Relief opening
	42	Front face
	44	Detonator opening
25	46	Direction of flight
	48	Bolt
	50	Arrow
	52	Arrow
	54	Firing arrangement
30	56	Piercing direction
	58	Stop
	60	Fuze half
	62	Detonator half
	64	Burning distance
35	66	Burning direction

CLAIMS:

1. Fuze for a projectile having a firing arrangement for firing a main charge of the projectile and having a delay detonator for firing the firing arrangement after a delay time which is defined by a burning distance of a delay charge, with the delay
5 detonator having a housing with a fuze half in which it is fired and having a detonator half which contains a detonator charge for firing the firing arrangement, wherein the housing in the fuze half has a relief opening with an opening cross section that allows gas to escape freely from the housing when the delay detonator is in the firing state.
2. Fuze according to Claim 1, characterized in that the relief opening has
10 an opening cross section, which can be passed through freely in the firing state of the delay detonator, of at least 5 mm².
3. Fuze according to Claim 1 or 2, wherein the relief opening opens directly to a piercing charge of the delay detonator.
4. Fuze according to any one of claims 1 to 3, wherein a burning direction
15 of the delay detonator is located transversely with respect to a direction of flight of the projectile.
5. Fuze according to any one of claims 1 to 4, wherein in addition to the relief opening, the housing has a piercing opening for insertion of a piercing needle in order to fire the delay detonator.
- 20 6. Fuze according to Claim 5, wherein a piercing direction of the piercing needle through the piercing opening is in the opposite direction to the direction of flight of the projectile.
7. Fuze according to any one of claims 1 to 4, wherein with respect to a
25 piercing opening in the housing, the relief opening is arranged in the opposite direction to a burning direction of the delay charge.

8. Fuze according to any one of claims 1 to 7, wherein the relief opening is arranged opposite a detonator opening in the housing.
9. Fuze according to claim 1 or 2, wherein the delay detonator is provided in order to accelerate an armed firing charge of the firing arrangement against a
5 piercing needle.
10. Fuze according to any one of claims 1 to 9, wherein the fuze is in the form of an impact fuze.