

Electric detonator and method for producing an electric detonator

TECHNICAL FIELD

The present invention relates to a lead-free electric
5 detonator.

BACKGROUND AND PRIOR ART

Conventional electric detonators, also referred to as
electric detonating caps, normally comprise primers,
10 also referred to as primary explosives, which contain
lead, for example lead azide ($\text{Pb}(\text{N}_3)_2$) or silver azide
(AgN_3) and lead trinitroresorcinol (2,4,6-
trinitrobenzene-1,3-diol). Lead trinitroresorcinol is
used to increase sensitivity, especially at low
15 temperatures.

New and intensified environmental requirements mean
that lead-containing primers must be replaced with
environmentally friendly alternatives. However, trials
20 conducted with just silver azide as the primary
explosive show impaired functioning at low
temperatures.

There is therefore a need for lead-free electric
25 detonators having improved low temperature
characteristics. There is also a need for lead-free
electric detonators which are smaller and lighter than
present-day lead-free electric detonators.

30 OBJECT OF THE INVENTION AND ITS DISTINGUISHING FEATURES

A main object of the present invention has thus been to
provide a reliable and environmentally friendly
electric detonator in which lead-containing primers are
replaced with environmentally friendly alternatives,
35 chosen and configured such that the low temperature
characteristics of the electric detonator have been
improved.

A further object of the invention has been to provide a reliable and environmentally friendly electric detonator more compact and lighter than present-day conventional electric detonators.

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The said objects, as well as other objects which are not enumerated here, are satisfactorily met by that which is defined in the present independent patent claim.

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Embodiments of the invention are defined in the dependent parent claims.

Thus, according to the present invention, a
15 functionally reliable and environmentally friendly electric detonator comprising a cap, comprising a priming charge and an electrode, comprising a positive pole, a negative pole and a resistor element, the said priming charge comprising at least two primary
20 explosives, a first primary explosive and a second primary explosive, and at least one secondary explosive, has been provided.

Electric detonators are characterized in that the two
25 primary explosives and the secondary explosive are arranged in layers, in an increasing degree of sensitivity, bearing one against the other, wherein the first primary explosive, constituting the most sensitive of the two primary explosives, is arranged
30 closest to the resistor element and the second primary explosive is arranged thereafter between the first primary explosive and the secondary explosive.

According to further aspects of the electric detonator:

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the positive pole of the electrode is configured as a rod or pin axially arranged in the cap and the negative

pole is configured as a socket arranged coaxially to the pin,

5 the first primary explosive comprises potassium 4,6-dinitrobenzofuroxane and the second primary explosive comprises silver azide, and the secondary explosive comprises cyclotrimethylenetrinitramine,

10 the resistor element is configured as a thin film bridge, comprising a layer of zirconium,

the pin and the socket are electrically insulated from each other via an electrical insulator, comprising steatite.

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According to the present invention, a method for producing an electric detonator comprising a cap, comprising a priming charge and an electrode, comprising a positive pole and a negative pole and a resistor element, the said priming charge comprising at least two primary explosives, a first primary explosive and a second primary explosive, and at least one secondary explosive, has also been provided.

25 The method is characterized in that the two primary explosives and the secondary explosive are arranged in layers, in an increasing degree of sensitivity, bearing one against the other, wherein the first primary explosive, constituting the most sensitive of the two primary explosives, is arranged closest to the resistor element and the second primary explosive is arranged between the first primary explosive and the secondary explosive.

35 According to further aspects of the method:

the resistor element is configured as a thin film bridge, comprising a layer of zirconium, wherein the

thin film bridge is produced by zirconium being evaporated through a mask in order, with a given geometry, to provide a given electrical resistance.

5 ADVANTAGES AND EFFECTS OF THE INVENTION

The invention signifies a number of advantages and effects, the most important being: the electric detonator is environmentally friendly, withstands a wide range of temperatures and allows a compact design.
10 Layered application of the primary explosives and the secondary explosive in the cap allows a flexible and simple production process.

The invention has been defined in the following patent
15 claims and will now be described in somewhat greater detail in connection with the appended figure.

Further advantages and effects will emerge from a study and consideration of the following, detailed
20 description of the invention with simultaneous reference to the appended drawing figure, in which:

Fig. 1 shows in schematic representation an electric
 detonator having two primary explosives and a
25 secondary explosive, arranged one upon the other in layers, adjoining a thin film bridge.

DETAILED DESCRIPTION OF EMBODIMENTS

30 The electric detonator 1 in Figure 1 comprises a cap 2, which comprises a priming charge 3 and an electrode 4 for initiation of the said priming charge 3, wherein the said electrode 4 comprises a positive pole, configured as a rod or pin 5 axially arranged in the
35 cap 2, and a negative pole, configured as a socket 6 coaxially arranged with the pin 5, the said cap 2 also comprising a resistor element 8 arranged between the pin 5 of the positive pole and the socket 6 of the

negative pole. In an alternative embodiment (not shown), the negative pole is instead constituted by the pin 5 and the positive pole by the socket 6. The positive pole and the negative pole are electrically
5 insulated from each other via an electrical insulator 7, comprising glass, a plastic or a ceramic material, such as, for example, porcelain or steatite, also referred to as soapstone.

10 The electric detonator 1 further comprises a resistor element 8 disposed, in bridging arrangement, between the centrally arranged pin 5 and the coaxially arranged socket 6.

15 The resistor element 8 is realized in the form of a thin film bridge, comprising a thin layer of zirconium.

The said thin layer bridge is, preferably, produced according to MEMS (Micro-Electro-Mechanical Systems)
20 technology by zirconium being evaporated through a mask, wherein the thin film bridge, with a given geometry, provides a given electrical resistance.

The priming charge 2 comprises at least two primers,
25 also referred to as primary explosives, a first primary explosive 9 and a second primary explosive 10, as well as at least one secondary explosive 11. The primary explosives 9, 10 and the secondary explosive 11 are arranged in layers, and bearing one against the other,
30 in an increasing degree of sensitivity, wherein the first primary explosive 9 is arranged closest to the resistor element 8 and the second primary explosive 10 is arranged on the first primary explosive 9 and finally the secondary explosive 11, which is arranged
35 on the second primary explosive 10.

The first primary explosive 9, which constitutes the more sensitive of the two primary explosives,

preferably comprises potassium 4,6-dinitrobenzofuroxane (KDNBF), the second primary explosive 10 preferably comprises silver azide (AgN_3), and the secondary explosive 11 preferably comprises hexogen, chemical name cyclotrimethylenetrinitramine, also referred to as RDX. Alternatively, the secondary explosive 11 can comprise other types of nitramine explosives, such as, for example, octogen, chemical name cyclotetramethylene-tetranitramine (octogen), also referred to as HMX, or CL-20, chemical name 2,4,6,8,10,12-hexanitro-hexaazaisowurtzitane.

In an alternative embodiment, a third primary explosive (not shown), more heat-sensitive than the first primary explosive 9, also forms part of the priming chain.

Upon initiation, the current is conducted to the resistor element 8 via the positive pole 5 of the electrode 4, and back via the negative pole socket 6 of the electrode 4. The electric pulse, which causes the priming charge 9 to ignite and the detonator 2 to detonate by burning-off of the resistor element 8, can be generated by any kind of voltage source.

Most commonly, however, the voltage source is constituted by a capacitor, wherein the capacitor discharge is generated by piezocrystals. Alternatively, the discharge can be generated by charging with battery.

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The invention is not limited to the embodiments shown, but can be varied in different ways within the scope of the patent claims.

PATENT CLAIMS

1. An electric detonator comprising a cap, comprising: a priming charge; and an electrode, comprising a positive pole, a negative pole and a resistor element, configured as a thin film bridge comprised of a layer of zirconium, and wherein:

i) said positive pole is configured as a rod or pin axially arranged in the cap, and

10 ii) said negative pole is configured as a socket arranged coaxially to the pin; or

iii) said negative pole is configured as a rod or pin axially arranged in the cap, and

15 iv) said positive pole is configured as a socket arranged coaxially to the pin; and

wherein said priming charge comprising at least two lead-free primary explosives, a first primary explosive and a second primary explosive, and at least one secondary explosive, wherein the two primary explosives and the secondary explosive are arranged in layers, in an increasing degree of heat sensitivity, bearing one against the other, wherein the first primary explosive, constituting a more heat sensitive of the two primary explosives, is arranged closest to the resistor element, and wherein the second primary explosive is arranged thereafter between the first primary explosive and the secondary explosive.

2. The electric detonator according to Claim 1, wherein the positive pole of the electrode is configured as a rod or pin axially arranged in the cap, and in that the negative pole is configured as a socket arranged coaxially to the pin.

3. The electric detonator according to Claim 1, wherein the first primary explosive comprises potassium 4,6-dinitrobenzofuroxane, wherein the second primary explosive
5 comprises silver azide, and wherein the secondary explosive comprises cyclotrimethylenetrinitramine.

4. The electric detonator according to claim 1, further comprising a third primary explosive more heat-sensitive
10 than the first primary explosive.

5. The electric detonator according to claim 1, wherein the first primary explosive comprises potassium 4,6-dinitrobenzofuroxane and the second primary explosive
15 comprising silver azide.

6. The electric detonator according to claim 1, wherein the priming charge is ignited and the detonator is detonated by burning-off of the resistor element connected
20 to a voltage source via the positive pole and the negative pole.

7. The electric detonator according to claim 1, wherein the resistor element is directly connected between the
25 centrally arranged pin and the coaxially arranged socket.

8. A method for producing an electric detonator providing a cap, providing a priming charge and an electrode, providing a positive pole and a negative pole and a
30 resistor element, said priming charge comprising at least two lead-free primary explosives, a first primary explosive and a second primary explosive, and at least one secondary explosive, arranging the two primary explosives and the

secondary explosive in layers, in an increasing degree of heat sensitivity, bearing one against the other, arranging the first primary explosive, constituting a more heat sensitive of the two primary explosives, closest to the resistor element, and arranging the second primary explosive between the first primary explosive and the secondary explosive, and providing the resistor element as a thin film bridge, comprised of a layer of zirconium, producing the thin film bridge by zirconium being evaporated through a mask in order, with a given geometry, to provide a given electrical resistance.

9. The method for producing an electric detonator according to claim 8, further comprising burning-off of the resistor element connected to a voltage source via the positive pole and the negative pole to ignite the priming charge and detonate the detonator.

10. An electric detonator comprising: a cap; a priming charge; and an electrode, comprising a positive pole, a negative pole and a resistor element, said priming charge comprising at least two lead-free primary explosives, a first primary explosive and a second primary explosive, and at least one secondary explosive, wherein the two primary explosives and the secondary explosive are arranged in layers, in an increasing degree of heat sensitivity, bearing one against the other, wherein the first primary explosive, constituting a more heat sensitive of the two primary explosives, is arranged closest to the resistor element, and wherein the second primary explosive is arranged thereafter between the first primary explosive and the secondary explosive, wherein the resistor element is configured as a thin film bridge, comprised of a layer of

zirconium, and wherein the thin film bridge is produced by zirconium being evaporated through a mask.

11. The electric detonator according to claim 10, further
5 comprising burning-off of the resistor element connected to a voltage source via the positive pole and the negative pole to ignite the priming charge and detonate the detonator.