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O. A. GURTON ETAL
SELF-PRESSURIZING DETONATORS

3,162,122

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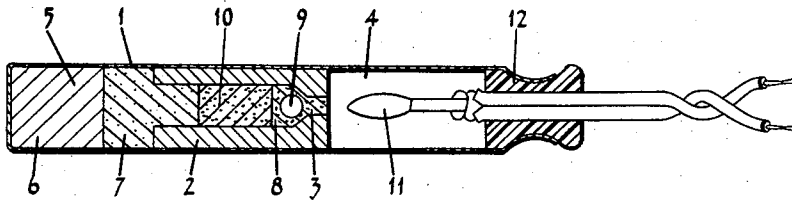


FIG. 1

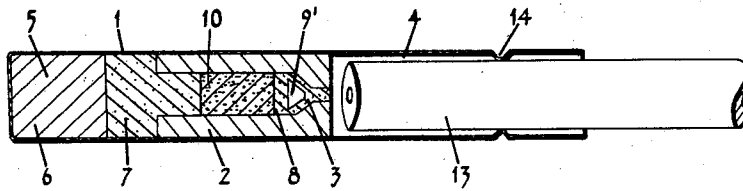


FIG. 2

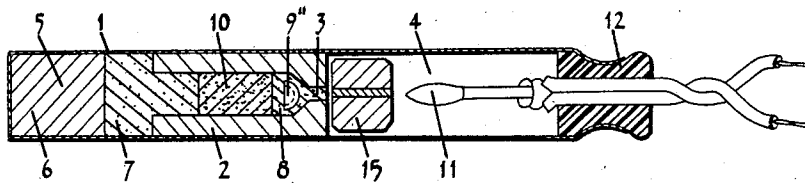


FIG. 3

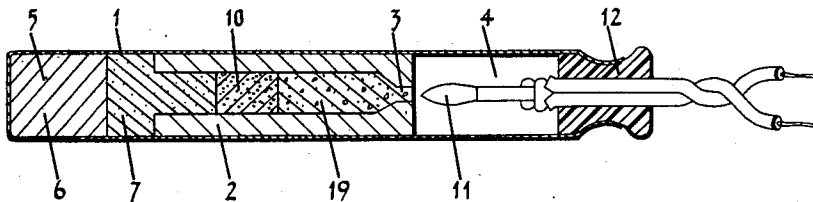


FIG. 4

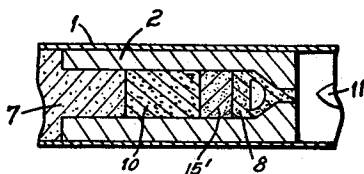


FIG. 3a

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3,162,122

SELF-PRESSURIZING DETONATORS

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38,053/61

11 Claims. (Cl. 102—28)

The present invention relates to detonators having reduced hazard of accidental detonation of their explosive charges during their manufacture and in normal handling.

The complete specification of the U.K. Patent No. 902,643 describes the disadvantages of detonators utilising primary initiating explosive and discloses a detonator employing a confined column of a highly compressed pentaerythritol tetranitrate composition which is spaced from a charge of less highly compressed pentaerythritol tetranitrate composition. The highly compressed column burns rapidly on ignition and this rapid burning changes to detonation at the density discontinuity between the column and the less dense charge. The advantages of detonators utilising this detonation principle having become increasingly apparent, the desirability of widening the scope of the application of this principle is equally apparent.

It is accordingly an object of the present invention to provide an improved detonator using the detonation principle disclosed in the specification of U.K. Patent No. 902,643 which may be ignited either by safety fuse or by an electric fuse.

It is also an object of the invention to provide a detonator which uses the detonation principle of the invention of U.K. Patent No. 902,643 but which is simpler and easier to manufacture. It is a further object of the invention to provide a detonator using this detonation principle into which a delay element can be incorporated.

According to the present invention a detonator of the kind employing a highly compressed column of a secondary initiating explosive confined in a stout tube and spaced from a less highly compressed charge of a secondary initiating explosive, the arrangement being such that on ignition the column burns rapidly and results in detonation of the less highly compressed charge, is provided with flame resistant sealing means adapted to permit ignition of the highly compressed column and which is closed after ignition by the effects of combustion to provide a seal against the escape from the detonator of gases generated by the combustion.

The gases generated by the combustion of the secondary initiating explosive may act to close the sealing means, or a charge of slugging composition may be located adjacent to the highly compressed column which on ignition burns to ignite the highly compressed column and produces a plug of slag which effectively seals the detonators. This slugging composition may act as a delay composition for the detonator.

In a preferred form of the present invention, a detonator comprises a thick walled tube formed with a constriction at one end, located fixedly within a thin walled blind casing extending beyond the end of the thick walled tube and having the constriction directed towards the mouth of the blind casing, a flame-resistant sealing pellet having an overall diameter larger than the diameter of the aperture through the constriction and located within the thick walled tube, said constriction being adapted to form a seat for the sealing pellet, a small charge of a fast burning composition located in said constriction and arranged to hold the sealing pellet away from its seat so that the fast burning composition is exposed through the

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aperture of the constriction, a column of a pentaerythritol tetranitrate composition compressed uniformly along its length at a pressure of at least 1,500 kg./cm.² and located within said thick walled tube adjacent to the fast burning charge, and a charge of a pentaerythritol tetranitrate composition spaced from said column and extending to fill the blind portion of the casing, said charge being compressed at a pressure not exceeding 350 kg./cm.², the arrangement being such as to permit ignition of the fast burning charge through the constriction whereupon the sealing pellet is urged into sealing engagement with its seat by the gases generated by the combustion of the fast burning charge and/or the pentaerythritol column ignited by the fast burning charge, whereby the gases are prevented from escaping from the detonator through the constriction.

The sealing pellet is preferably of geometric shape such as a sphere or cone, and in one preferred embodiment is a steel ball.

The detonator may be ignited either by means of an electric fuse or by means of safety fuse, and delay compositions may be inserted within the detonator casing to lie in the ignition train after the ignition means. In our preferred form of detonator the delay composition may be disposed to lie in the train between the ignition means and the ignition aperture provided through the constriction. The delay composition may alternatively be inserted within the thick-walled tube adjacent to the fast burning composition. The disposition of the delay composition within the thick-walled tube necessitates a longer tube but the delay composition may be of a slugging character such that the slag produced by its combustion forms the sealing pellet and prevents escape through the constriction of gases generated by the combustion of the pentaerythritol tetranitrate composition. In this latter case the delay composition can also perform the function of the fast burning charge located in the constriction.

The composition of the charges of pentaerythritol tetranitrate composition may conveniently consist entirely of pentaerythritol tetranitrate but it may sometimes be advantageous to include minor proportions of other ingredients, such, for example, as aluminum powder, to modify the burning characteristics of the composition. The loading of the detonator with the pentaerythritol tetranitrate composition is as described in the specification of U.K. Patent No. 902,643.

Four embodiments of the invention will now be described by way of example with reference to the accompanying drawings in which:

FIG. 1 is a longitudinal section of an electrically ignited detonator,

FIG. 2 is a longitudinal section of a detonator ignited by safety fuse,

FIG. 3 is a longitudinal section of a detonator incorporating a delay element,

FIG. 3a is a fragmentary view of a modified form of the detonator of FIG. 3, and

FIG. 4 is a longitudinal section of another detonator incorporating a delay element.

In the electric detonator illustrated in FIG. 1, the thin-walled blind tubular casing 1 of copper alloy encloses a thick-walled brass tube 2. The thick-walled tube 2 is 15 mm. long, has an inside diameter of 3 mm. and an outside diameter of 6 mm. One end of the thick-walled tube 2 is reduced at a slope of 100° for a length of 1 mm. to provide a constriction 3 having an aperture 2 mm. in diameter. The blind casing 1, which has a wall thickness of 0.325 mm. and an inside diameter of 6 mm. extends beyond both ends of the thick-walled tube 2 to provide an open-ended portion 4 beyond the constriction 3 and a closed portion 5

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beyond the other end of the thick-walled tube 2. A base charge 6 comprising about 0.2 g. pentaerythritol tetranitrate is compressed into the end of the closed portion 5 of the casing at a pressure not exceeding 350 kilograms per sq. cm. The remainder of the closed portion 5 of the casing 1 is filled with a loose charge 7 of about 0.1 g. of pentaerythritol tetranitrate which also extends within the thick-walled tube 2.

The constriction 3 and the adjacent 3 mm. of the bore of the thick-walled tube 2 contains a fast burning composition 8 comprising 50% lead dioxide and 50% silicon in which is embedded a fire resistant sealing pellet 9 in the form of a steel ball 2.4 mm. in diameter. The composition 8 holds the ball 9 free from contact with the aperture of the constriction 3.

The major portion of the thick-walled tube 2 contains an incrementally compressed charge 10 of pentaerythritol tetranitrate 8 mm. in length located between the loose charge 7 and the fast burning composition 8 and loaded in six increments at a pressure not less than 1750 kilograms per sq. cm. The loading of the detonator is carried out in the manner described in the specification of U.K. Patent No. 902,643.

An electric low tension fusehead 11 is located in open-ended portion 4 of the casing 1 by a neoprene plug 12 so that it is held adjacent to the aperture of the constriction 3. The fusehead comprises a composition including lead mononitroresorcinol and cerium and may be ignited by passing a current of 1 amp through its bridge wire for $\frac{1}{50}$ of a second.

In use, when the fusehead 11 is ignited, the flame gases produced in turn ignite the fast burning composition 8 which burns away to leave the ball 9 unsupported and also ignites in turn the highly compressed charge 10 of pentaerythritol tetranitrate. The gases generated by this combustion urge the ball 9 against the seat formed by the constriction 3 so as to seal the thick-walled tube 2 against egress of the flame gases. The lack of any substantial outlet for the flame gases to escape from the thick-walled tube 2 causes the flame gases to bear with great intensity on the highly compressed charge 10 of pentaerythritol tetranitrate which burns violently down the column. The abrupt reduction in charge density encountered by the propagating flame on reaching the end of column of the highly compressed pentaerythritol tetranitrate and the sudden release of the hot compressed reaction gases results in the detonation of the less highly compressed charges 6 and 7.

The detonator of the invention may alternatively be ignited by means of a high tension electric fusehead or by means of safety fuse. FIGS. 2, 3 and 4 illustrate three of the possible alternative combinations of ignition means, sealing pellet form and the introduction of delay compositions.

The detonator illustrated by FIG. 2 contains a sealing pellet 9' in the form of a brass truncated cone having a maximum diameter of 2.5 mm. and the detonator is adapted to be ignited by a length of safety fuse 13 held in the open-ended portion 4 of the casing by a crimp 14. In use, the fast burning charge 8 is ignited by the sputter from the end of the safety fuse 13 and the operation of the detonator thereafter continues as hereinbefore described.

The delay detonator illustrated in FIG. 3 comprises a sealing pellet 9'' in the form of a round-nosed hollow steel bullet having a maximum diameter of 2.5 mm. A charge of delay composition 15 is located adjacent to the aperture of the constriction 3 and the low tension fusehead 11. In operation the fusehead 11 ignites the charge of delay composition 15 which in turn ignites the fast burning charge 8 whereafter the detonator again operates in the manner above described.

In FIG. 3a there is shown a detonator which is the same as that of FIG. 3 except that a charge of delay composition 15' lies within the tube 2 adjacent the fast-burning charge 8.

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In FIG. 4 is illustrated a delay detonator of a different type, in which a sealing pellet 19 takes the form of a column of delay composition 10 mm. long located within the thick-walled tube 2 adjacent the aperture of the constriction 3. The construction of the detonator is otherwise as hereinbefore described except that the fast-burning charge 8 is omitted, since the pellet 19 is easily ignited, in use, through the constriction 3 by the fusehead 11. The slag formed by the combustion of the pellet 19 forms a plug within the thick-walled tube and seals the aperture of the constriction 3 against egress of combustion gases generated by the combustion of the pentaerythritol tetranitrate of the charge 10. The combustion of the pentaerythritol tetranitrate charges 6, 7 and 10 then continues to detonation at the density discontinuity as hereinbefore described.

What we claim is:

1. A detonator comprising a detonator casing having a closed end and a mouth end; a rigid metal walled tube within said casing; a charge of highly compressed secondary explosive confined in said metal walled tube; a charge of less highly compressed secondary explosive within said casing between its closed end and said highly compressed charge of secondary explosive and spaced from said highly compressed charge; sealing means for the end of said metal walled tube nearer to the mouth end of said casing which sealing means is normally sufficiently open to permit ignition of the contents of said tube by the passage of flame therethrough but is closeable by the effects of said ignition substantially to prevent the escape of gas from the space within said casing between said closed end and the sealed end of the metal walled tube.

2. A detonator as claimed in claim 1 in which the sealing means is closeable by the action thereon of the gases generated from combustion of the contents of said tube.

3. A detonator as claimed in claim 1 in which the sealing means comprises a combustible slugging composition located within said tube adjacent the highly compressed column which composition on ignition burns to ignite the highly compressed column and produces a plug of slag which effectively seals the detonator.

4. A detonator as claimed in claim 3 wherein the slugging composition is a delay composition for the detonator.

5. A detonator in accordance with claim 1 in which a delay composition is inserted within the detonator casing in igniting relationship with the highly compressed charge of secondary explosive.

6. A detonator as claimed in claim 1 wherein said rigid tube is a thick-walled tube located fixedly within said casing and formed with a constriction at one end having an aperture which is directed toward the mouth end of said casing and wherein said casing extends beyond the end of the said tube and further comprising: a flame-retardant sealing pellet having an overall diameter larger than the diameter of the aperture through the constriction and located within the thick-walled tube, said constriction being adapted to form a seat for the sealing pellet; a small charge of a fast burning composition located in said constriction and arranged to hold the sealing pellet away from its seat so that the fast burning composition is exposed through the aperture of the constriction, said charge of high compressed secondary explosive being a column of pentaerythritol tetranitrate compressed uniformly along its length at a pressure of at least 1500 kg./cm.² and located within said thick-walled tube adjacent the fast-burning charge, and said charge of less highly compressed secondary explosive being a charge of pentaerythritol tetranitrate composition spaced from said column and disposed in the closed end of the casing, said charge being compressed at a pressure not exceeding 350 kg./cm.², whereby ignition of the fast burning charge occurs through the constriction and whereby gases generated by the combustion of the

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contents of said tube are prevented from escaping from the detonator as a result of the sealing pellet's being urged into sealing engagement with its seat by said gases.

7. A detonator as claimed in claim 6 wherein the sealing pellet is a sphere.

8. A detonator in accordance with claim 6 in which a delay composition is disposed within said casing between said tube and said mouth end of said casing.

9. A detonator in accordance with claim 6 in which a charge of delay composition lies within the thick-walled tube adjacent the fast-burning composition.

10. detonator as claimed in claim 6 wherein one of the charges of pentaerythritol tetranitrate includes minor proportions of a modifying ingredient.

11. A detonator as claimed in claim 6 wherein the space between the highly compressed column of penta-

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erythritol tetranitrate composition and the less highly compressed charge of pentaerythritol tetranitrate composition contains a loose charge of pentaerythritol tetranitrate.

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