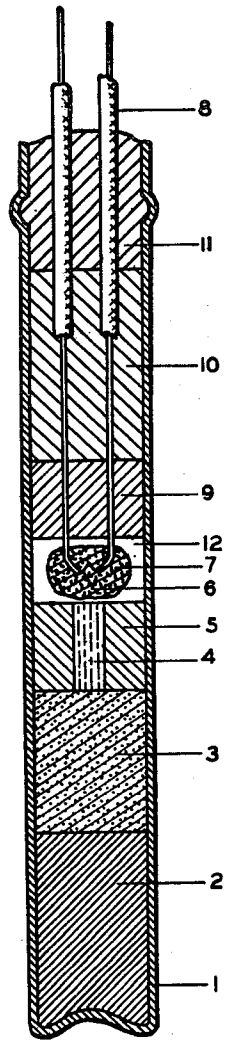
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DELAY ELECTRIC INITIATOR

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DELAY ELECTRIC INITIATOR

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This invention relates to electric blasting initiators and more particularly to delay electric blasting initiators provided with matchhead-type ignition assemblies.

In delay electric blasting initiators, it has been customary to employ cavity-type ignition assemblies using flash mixtures such as mercury fulminate or diazodinitrophenol, potassium chlorate, charcoal, and nitrostarch. Matchhead-type assemblies have also been used, in which case ignition compositions such as copper acetylide set in sulfur or a mixture of lead dinitroorthocresol, smokeless powder, and potassium chlorate have been used. However, delay initiators known to the art have given numerous failures, when fired at high voltages.

Now in accordance with this invention, delay electric blasting initiators have been prepared which have shown satisfactory performance not only under normal operational voltages, but also at high voltages. This has been accomplished by employing an ignition assembly of the matchhead type having the bridge wire embedded in a bead formed of a primary explosive, an oxidizing material, a flash-producing metal, and a binder.

The delay electric initiator in accordance with this invention comprises a metal shell of the type employed in the art having in general a base charge, a priming explosive superimposed upon the base charge, and a delay fuse element. The matchhead-type ignition assembly comprises a plug with two lead wires inserted therethrough, the terminal ends of which are electrically connected by a bridge wire. The bridge wire is embedded in the flash mixture of this invention. The ignition assembly is inserted in the shell such that the flash bead is about $\frac{1}{8}$ inch or less above the fuse. A waterproofing composition and a sulfur seal may complete the initiator, as required.

The invention has been generally described, and now reference is made to the drawing, which is a specific embodiment thereof. The drawing represents a ventless delay electric blasting initiator comprising a bronze shell 1, pressed in the bottom of which is a base charge 2 of pentaerythritol tetranitrate. Above the base charge is the priming explosive 3, in this instance a mixture containing 75% diazodinitrophenol and 25% potassium chlorate. This mixture is slightly pressed by a length of delay fuse, which comprises a mixture of 84% barium peroxide and 16% powdered selenium as the fuse powder 4 compressed to the proper density in a tube 5. Almost in contact with the fuse is the ignition composition, surrounding the bridge wire 6 which is formed of an electrically-resistant metal, in this case platinum alloy, as a bead 7 comprising 40% diazodinitrophenol, 35% potassium chlorate, 20% powdered magnesium, and 5% nitrocellulose, held together by a 4% solution of nitrocellulose in butyl acetate. The bridge wire is affixed to the terminal ends of a pair of lead wires 8 which are embedded in the plug 9. Above the plug is placed a layer of waterproofing material 10 and a sulfur seal 11. It will be noted that the bead 7 is disposed in a relatively small air space. In fact, the air space in the initiator of this invention is only between one-fourth and one-third as great as that in ventless delay electric blasting initiators of the prior art.

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The practical application of this invention is illustrated in the following examples:

Example 1

In shells of the type illustrated in the drawing were placed 0.40 gram of pentaerythritol tetranitrate as a base charge, and 0.30 gram of a mixture of 75% diazodinitrophenol and 25% potassium chlorate as the primary explosive. A mixture of 84% barium peroxide and 16% powdered selenium was placed in a tube which was then swaged such that the mixture had a density of 4.4 g./cc. Strips of this tube $\frac{16}{64}$ inch long were cut and placed in each shell above the priming explosive mixture, to act as the fuse element.

Forty grams of diazodinitrophenol having a particle size between 50 and 150 microns, 35 grams of potassium chlorate (through a 60-mesh screen), 20 grams of magnesium powder, and 5 grams of nitrocellulose were thoroughly mixed. The mixture was then moistened with a 4% solution of nitrocellulose in butyl acetate to form a thick sirup. Standard electric blasting-type plugs having a platinum alloy bridge wire affixed to the projecting terminal ends of the lead wires were dipped in this sirup. In each case, upon removal, a portion of the sirup adhered to the bridge wire and the ends of the lead wires in the form of a bead. After the bead had hardened the assemblies were inserted in the shells such that the bead rested directly on or less than $\frac{1}{8}$ inch above the fuse. An air space about $\frac{5}{32}$ inch in height was thus formed between the upper face of the fuse and the lower face of the plug. A waterproofing wax material was then poured on top of the plug and allowed to harden. Molten sulfur was poured on top of the waterproofing seal and also allowed to harden, thereby completing the initiators.

One hundred of the initiators prepared as described above were fired at a current of 440 volts (A. C.) in single shots. None failed to fire. Five groups of 20 each arranged in parallel were fired at 440 volts. There were no failures. The maximum resistance which could be placed in series with 75 caps hooked in parallel at 220 volts A. C. was 6.4 ohms. The critical firing current of 30 caps in series was 0.9 amp. The initiators prepared as described above were stored for 5 months at 120° F. without affecting their ability to function.

Example 2

Twenty-five grams of diazodinitrophenol having a particle size between 50 and 150 microns, 49.9 grams of potassium chlorate (through a 60-mesh screen), 22.1 grams of aluminum powder, and 3 grams of nitrocellulose were thoroughly mixed. The mixture was then moistened with a 4% solution of nitrocellulose in butyl acetate in an amount sufficient to form a thick sirup. Electric blasting-type plugs whose lead wires projected from the lower face of the plug and were bridged by a section of platinum alloy wire were dipped in the sirup. In this manner, the bridge wire was embedded in a bead of the sirupy ignition composition. After the bead had hardened, the plugs were inserted in shells of the type illustrated in the drawing, in which were placed 0.40 gram of pentaerythritol tetranitrate as a base charge, 0.30 gram of a mixture of 75% diazodinitrophenol and 25% potassium chlorate as the primary explosive, and a $\frac{19}{64}$ inch long section of a swaged delay fuse, the powder of which was a mixture of 84% barium peroxide and 16% powdered selenium. The plugs were inserted so that the matchhead rested less than $\frac{1}{16}$ inch above the upper face of the delay fuse. An air space about $\frac{3}{32}$ inch in height was thus formed between the upper face of the fuse and the lower face of the plug. The shells were completed by addition of a waterproofing wax material and a layer of molten sulfur.

Two lots of initiators were tested, one of which had been stored for 5 months at 120° F. The critical firing current of 30 caps in series was 0.9 amp. for both stored and unstored initiators. This indicated that the ignition mixture was stable.

Example 3

Delay electric initiators were prepared exactly as described in Example 2. The ignition composition employed contained 25% diazodinitrophenol of a particle size between 50 and 150 microns, 26.6% potassium chlorate, 45.4% chromium powder, and 3% nitrocellulose. The ignition composition ingredients were thoroughly mixed while dry and then moistened with a 4% solution of nitrocellulose in butyl acetate, employing a sufficient amount to form a thick sirup. Plastic plugs, the terminal ends of whose lead wires projected from the face of the plug and were bridged with platinum alloy wire, were dipped in this sirup to obtain a bead of the ignition composition surrounding the bridge wire and the terminal ends of the lead wires. This bead was allowed to harden and the ignition plug then inserted in the shells such that the matchhead was less than $\frac{1}{16}$ inch above the delay fuse.

A number of these initiators were stored at 120° F. for 5 months. Both initiators which had been stored and initiators which had not been stored gave equally good performance when fired in groups of 30 caps each in series at 0.9 amp. There were no failures.

Example 4

Delay electric blasting initiators containing ignition assemblies of the matchhead type were prepared as described in Example 2. The ignition composition employed contained 25% diazodinitrophenol having a particle size between 50 and 150 microns, 43% potassium chlorate, 29% manganese powder, and 3% nitrocellulose. The ingredients were mixed dry in the customary manner and moistened with a 4% solution of nitrocellulose in butyl acetate to form a thick sirup. Ignition plugs whose bridged terminal ends of the lead wires projected from the face of the plug were dipped in the mixture, obtaining a bead surrounding the bridge wire and the ends of the lead wires. The bead was allowed to dry and the ignition assemblies inserted in the shells such that the matchhead was less than $\frac{1}{16}$ inch above or rested upon the delay fuse. An air space about $\frac{3}{32}$ inch in height was thus formed between the upper face of the fuse and the lower face of the plug.

These initiators were tested as before. The critical firing current of 30 caps in series was 0.9 amp. before and after storage at 120° F. for 5 months.

The ignition flash mixture employed in accordance with this invention is prepared by forming a dry mix of between about 18% and about 50% by weight finely divided priming explosive, between about 16% and about 55% of an oxidizing compound, between about 10% and about 64% of a powdered metal, and between about 2% and about 12% of a binding agent. The mix is then moistened with a solution of a binding agent so as to form the sirup from which the ignition beads are prepared.

Certain compositions are preferred. For example, mixtures of 25% diazodinitrophenol, between about 30% and about 50% potassium chlorate, between about 17% and about 42% magnesium or aluminum powder, and about 3% nitrocellulose have been found to give excellent service at normal and extremely high voltages. Similarly, mixtures of 25% diazodinitrophenol, between about 25% and about 50% potassium chlorate, between about 20% and about 50% chromium powder, and about 3% nitrocellulose have been found quite satisfactory, even after hot storage at 120° F. for 5 months.

Although a number of oxidizing compounds known to the art may be employed as the oxidizing material, such as dichromates (potassium and sodium dichromates), nitrates (sodium, potassium, and barium nitrates), oxides, such as copper oxide, and perchlorates, such as sodium and potassium perchlorate, it is preferred to employ potassium chlorate, potassium nitrate, or potassium permanganate. These have in general been superior to the other compounds in consistent performance at high voltages, especially after storage at high temperatures.

As the primary explosive, finely divided diazodinitrophenol of a particle size between 25 and 200 microns is preferred. However, explosives such as mercury fulminate, lead styphnate, and silver azide may be employed, under most conditions.

It is important to use a flash-producing metal for which the values for heat content and for free energy of formation of the oxides are high. Such metals greatly increase the ability of the

composition to ignite fuses. Thus, aluminum, chromium, zirconium, iron, titanium, cobalt, antimony, and magnesium have been found to be quite satisfactory. Other metals which may be employed include manganese, zinc, and cadmium. Tin and copper have given fair results.

As the binding agent, nitrocellulose is preferred. However, other binders well known to the art, such as nitrostarch, have been utilized effectively. The binder is combined in the dry mix in the proportions given above. A solution containing between 2% and 12% binding agent dissolved in a volatile organic solvent is also employed, to moisten the dry mix to form a sirup of the desired consistency.

It is desirable that the bead be of such a shape that a small air cavity is formed between the lower face of the plug and the upper face of the fuse. Thus, beads which are between about 0.12 and about 0.18 inch long, between about 0.04 and about 0.08 inch wide, and about 0.08 inch deep or larger have been satisfactory. Such beads permit an air space between about $\frac{8}{64}$ and about $\frac{12}{64}$ of an inch high. This represents an air space one-fourth to one-third smaller than has been previously possible in ventless delay initiators of the matchhead type. It has been effected by the combination of ingredients employed in applicant's ignition compositions. The flash-producing metal in the composition combines with oxygen and nitrogen evolved during combustion. Hence, the gas pressure exerted within the shell during combustion of the ignition composition is reduced to a minimum.

The shell materials employed in preparing the initiators of this invention may be the standard materials employed in the art, such as bronze, copper, or aluminum. The plug materials may be either softer or harder than the shell casing and include sulfur, plastic compositions such as rubber, and synthetic resins such as phenol-formaldehyde resins, polystyrene resins, and ethyl cellulose. The plugs may be sealed in the shell using a waterproofing composition, with a sulfur seal, if desired. However, this is not necessary with rubber or resin plugs. The lead wires employed are the customary wires used in the art and may be copper or iron, plain, tinned, or enameled, or coated with cotton servings or plastic materials. The bridge wire used to connect the ends of the lead wire may be electrically-resistant wire such as platinum, or iridium, or alloys such as nichrome, copper-nickel, platinum-iridium, etc.

In the above description, ventless initiators of the delay type have been described. However, the ignition composition employed is also adapted for use in vented delay electric blasting initiators, and it may, for example, be used in electric squibs, electric igniters, or electric blasting caps, of either the vented or ventless type.

The reduction in the height of the expansion cavity in initiators of this invention has made possible a reduction in the shell length of about $\frac{5}{16}$ inch. Thus, a shorter initiator is produced. Also, the ignition of the fuse by the matchhead igniter is made more effective, since this element rests in close proximity to the fuse. Since the flash functions in a relatively small area, most of the heat evolved is concentrated directly over the fuse. This permits the use of delay fuse of higher density, which ordinarily is more difficult to ignite and is therefore usually not employed in delay initiators of the matchhead type. Higher density delay fuse is desirable because of its better uniformity in burning time.

In high voltage firing, arcing accompanies many shots. When this occurs, heat escapes through the shell wall through a hole made during this action. By placing the assembly nearer the fuse in the initiators of this invention, any escape of heat as a result of arcing will have the opportunity to pass over the fuse and ignite it. It is thus seen that the initiators of the present invention possess advantages not found in those of the prior art.

All parts and percentages in the specification and claims are by weight.

What I claim and desire to protect by Letters Patent is:

1. An ignition composition for delay electric blasting initiators comprising, by weight, between about 18% and about 50% primary explosive, between about 16% and about 55% oxidizing material, between about 10% and about 64% flash-producing metal, and between about 2% and about 12% binding agent.

2. An ignition composition for delay electric blasting initiators comprising, by weight, between about 18% and about 50% diazodinitrophenol, between about 16% and about 55% oxidizing material, between about 10% and about 64% flash-producing metal, and between about 2% and about 12% binding agent.

3. An ignition composition for delay electric blasting initiators comprising, by weight, between about 18% and about 50% primary explosive, between about 16% and about 55% oxidizing material, between about 10% and about 64% magnesium, and between about 2% and about 12% binding agent.

4. An ignition composition for delay electric blasting initiators comprising, by weight, between about 18% and about 50% primary explosive, between about 16% and about 55% oxidizing material, between about 10% and about 64% aluminum, and between about 2% and about 12% binding agent.

5. An ignition composition for delay electric blasting initiators comprising, by weight, between about 18% and about 50% primary explosive, between about 16% and about 55% oxidizing material, between about 10% and about 64% chromium, and between about 2% and about 12% binding agent.

6. An ignition composition of the matchhead type for delay electric blasting initiators comprising, by weight, about 25% diazodinitrophenol, between about 30% and about 50% potassium chlorate, between about 17% and about 42% magnesium, and about 3% nitrocellulose.

7. An ignition composition of the matchhead type for delay electric blasting initiators comprising, by weight, about 25% diazodinitrophenol, between about 30% and about 50% potassium chlorate, between about 17% and about 42% aluminum, and about 3% nitrocellulose.

8. An ignition composition of the matchhead type for delay electric blasting initiators comprising, by weight, about 25% diazodinitrophenol, between about 25% and about 50% potassium chlorate, between about 20% and about 50% chromium, and about 3% nitrocellulose.

9. A delay electric blasting initiator comprising a shell, a delay fuse element, a plug, lead wires inserted therethrough, the terminal ends of said lead wires projecting from the lower face of the plug, and a bridge wire affixed to the terminal ends of the lead wires and embedded in an igni-

tion composition bead comprising, by weight, between about 18% and about 50% primary explosive, between about 16% and about 55% oxidizing material, between about 10% and about 64% flash-producing metal, and between about 2% and about 12% binding agent, said bead disposed less than about 1/8 inch above the upper face of the fuse element, said initiator having a relatively small air space between the plug, and the bead being in close proximity to said plug and said delay fuse element.

10. A delay electric blasting initiator comprising a shell, a delay fuse element, a plug, lead wires inserted therethrough, the terminal ends of said lead wires projecting from the lower face of the plug, and a bridge wire affixed to the terminal ends of the lead wires and embedded in an ignition composition bead comprising, by weight, between about 18% and about 50% primary explosive, between about 16% and about 55% oxidizing material, between about 10% and about 64% flash-producing metal, and between about 2% and about 12% binding agent, said bead disposed substantially adjacent the delay fuse element, said initiator having a relatively small air space between the plug, and the bead being in close proximity to said plug and said delay fuse element.

11. A delay electric blasting initiator comprising a shell, a delay fuse element, a plug, lead wires inserted therethrough, the terminal ends of said lead wires projecting from the lower face of the plug, and a bridge wire affixed to the terminal ends of the lead wires and embedded in an ignition composition bead comprising, by weight, between about 18% and about 50% primary explosive, between about 16% and about 55% oxidizing material, between about 10% and about 64% flash-producing metal, and between about 2% and about 12% binding agent, said bead disposed in contact with the delay fuse element, said initiator having a relatively small air space between the plug, and the bead being in close proximity to said plug and said delay fuse element.

DAVID T. ZEBREE.

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Certificate of Correction

Patent No. 2,473,405. June 14, 1949.

DAVID T. ZEBREE

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows:

Column 7, line 9, claim 9, line 26, claim 10, and column 8, line 8, claim 11, after the word "plug" and before the comma, insert *and the delay fuse element*; column 8, line 9, claim 11, after "plug" strike out "and said delay fuse element";

and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 15th day of November, A. D. 1949.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.