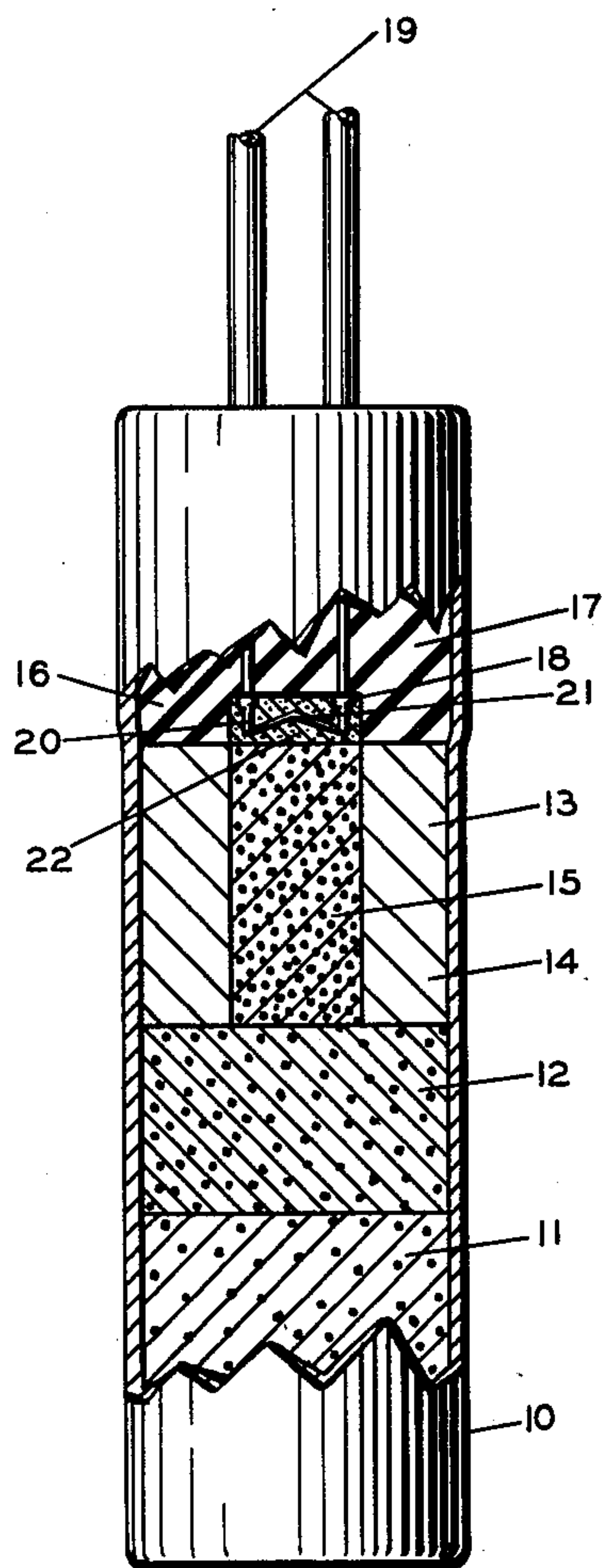


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ELECTRIC INITIATOR
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ELECTRIC INITIATOR

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This invention relates to electric blasting initiators and more particularly to delay electric initiators containing an improved ignition composition and to initiators having improved construction and performance. This application is a continuation-in-part of copending application Serial No. 574,349, filed January 24, 1945, now issued as U. S. Patent 2,473,405.

In delay electric initiators known to the art, it is most common to use a bronze shell with an upper inside diameter of about 0.30 inch stepped down to about 0.25 inch, a base charge of pentaerythritoltetranitrate or tetryl, or the like, a priming charge of diazodinitrophenol, mercury fulminate, or the like, plus an oxygen carrier, a fuse, an air space, and an ignition assembly with a cavity-type plug containing a flash mixture, usually diazodinitrophenol in conjunction with potassium chlorate, charcoal, and nitrostarch, or a matchhead-type ignition assembly consisting of a bead of copper acetylide on a bridge wire set in sulfur and enclosed in a paper cylinder or a bead comprising a lead salt of dinitro-orthocresol, smokeless powder, and potassium chlorate on the bridge wire. A layer of waterproofing and sulfur above the plug completes the assembly of the usual types. However, delay initiators known to the art have been subject to failure. To preclude the possibility of failure certain limitations have been imposed upon the design and use of the initiators. For example, if substantial gas pressure is developed within an initiator upon firing, the shell is apt to rupture or the ignition assembly is apt to be blown from the shell. Thus, the shell must be vented, or a suitable air space or absorbent material must be provided, or the shell and the ignition assembly must be of sufficient structural strength to withstand the pressure. Moreover, high gas pressure within an initiator is apt to alter its firing characteristics. For obvious reasons, the ventless-type initiator without an air space is preferred. This combination eliminates the possibility of moisture reaching the charges of the initiator and affords economy in manufacture, since the elimination of the air space permits shortening of the length of the initiator. In addition, the elimination of the air space improves an initiator for high voltage firing. In high voltage firing arcing accompanies many shots. This arcing occurs in the vicinity of the ignition assembly and punctures the shell of the initiator. When an air space is provided between the ignition assembly and the fuse, a rapid escape of the ignition heat through the puncture above

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the fuse takes place. Consequently, a considerable amount of the heat available to ignite the fuse does not contact the fuse and a complete misfire or abnormal ignition time may take place. When the air space is eliminated, the ignition assembly is substantially in contact with the fuse. In the event of a puncture due to arcing, a substantial proportion of the heat available to ignite the fuse contacts the fuse regardless of the puncture and positive firing and normal ignition time are obtained.

The objectives sought in the manufacture of initiators are ease of assembly, economy of material, and improved performance. The objectives are not attainable by increasing the structural strength of an initiator to withstand high internal gas pressure. Accordingly, a reduction of the internal gas pressure in an initiator and an improved initiator construction as a result thereof, is a definite contribution to the art.

Thus, it is the principal object of the present invention to provide an improved ignition composition which generates a minimum amount of gas in contrast to prior art ignition compositions.

It is another object of this invention to provide an initiator of improved construction and performance for normal or high voltage firing.

Other objects of the invention will appear hereinafter, the novel features and combinations being set forth in the appended claims.

Now in accordance with this invention, the improved ignition composition comprises primary explosive, oxidizing material, heat-producing material, and binding agent, wherein the particle size of the oxidizing material is not greater than about 74 microns and the oxidizing material is present in amount not greater than about 15% by weight of the ignition composition.

The improvement in delay electric initiators in accordance with this invention essentially comprises a fuse charge having superimposed thereon the ignition composition of this invention.

A preferred embodiment of the invention has been chosen for purposes of illustration and description and is shown in the accompanying drawing. In the drawing, there is illustrated a part sectional, part elevational view of a delay electric initiator in accordance with this invention.

With reference to the drawing, a ventless metal shell 10 has a base charge 11 pressed in the bottom thereof. A priming charge 12 is placed over the base charge 11 and a fuse charge 13 is inserted into the shell 10 and pressed upon the priming charge. The fuse charge 13 consists of a lead

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tube having a fuse powder 15 therein. An ignition assembly 16 was pressed upon the fuse charge 13. The ignition assembly 16 comprises a plug member 17 having a cavity 18, a pair of leg wires 19 connected at their terminal ends 20 by a bridge wire 21, and an ignition composition 22 placed in the cavity and subject to ignition by the bridge wire when electrical current is imparted to the leg wires.

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

Example 1

A bronze shell having an indented bottom and an inside diameter in the order of 0.25 inch was loaded with a base charge of 0.40 gram of pentaerythritoltetranitrate and pressed. A priming charge of 0.30 gram of a mixture of 75% diazodinitrophenol and 25% potassium chlorate was placed over the base charge. A fuse containing 84% barium peroxide and 16% powdered selenium was placed in a lead tube which was then swaged so that the mixture had a density of about 4.4 g./cc. This tube was cut into units $\frac{1}{64}$ inch long and each unit comprised a fuse charge. The fuse charge was placed upon the priming charge and pressed.

An ignition composition of 16% diazodinitrophenol, 62% barium peroxide-selenium mixture, 10% potassium chlorate having a particle size not greater than 74 microns, 10% charcoal, and 2% nitrostarch was used. The barium peroxide-selenium mixture used was 70% barium peroxide and 30% selenium. The ingredients of the ignition composition were thoroughly mixed and then made into a paste by wetting with butyl acetate. This paste was then buttered into a cavity-type plug provided with leg wires and a bridge wire. The cavity was $\frac{1}{8}$ inch long, $\frac{1}{16}$ inch wide, and $\frac{1}{16}$ inch deep. After the paste was dried, the ignition assembly was placed upon the fuse charge. A waterproofing compound and sulfur seal applied in the conventional manner completed the initiator.

Example 2

Delay electric initiators were prepared exactly as described in Example 1, with the exception that the ignition composition contained 16% diazodinitrophenol, 57% barium peroxide-selenium mixture, 15% potassium chlorate having a particle size not greater than 74 microns, 10% charcoal, and 2% nitrostarch.

Example 3

Delay electric initiators were prepared exactly as described in Example 1, with the exception that the ignition composition contained 16% diazodinitrophenol, 65% barium peroxide-selenium mixture, 7% potassium chlorate having a particle size not greater than 74 microns, 10% charcoal, and 2% nitrostarch.

Example 4

Delay electric initiators were prepared exactly as described in Example 1, with the exception that the ignition assembly comprised a plug of hard dielectric material which was forced into the shell and firmly pressed upon the fuse charge. In this example, the shell was shortened leaving a slight projecting rim after the ignition assembly was fully inserted. This rim was rolled over the top of the plug to complete the initiator. This construction eliminated the waterproofing compound and sulfur seal, thereby considerably

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shortening the shell, and constitutes the preferred embodiment of the invention as shown in the drawing.

With reference to the above examples, it was found that the ignition composition of this invention superimposed upon the fuse charge gave initiators that surpassed prior art initiators in general performance. This was particularly noted in high voltage firing where a series of 25 single shots were made at 440 volts A. C. without a failure. Prior art delay initiators are recognized as subject to failures when fired under these conditions. In a series of prior art delay initiators tested on a comparable basis, 45% of the initiators failed to fire. Since the ignition composition of this invention develops an extremely low internal pressure within the cap, conventionally assembled initiators employing this composition have an increased factor to insure positive firing and conventionally assembled initiators may be lightened in construction without sacrificing performance. Moreover, since the various charges may be pressed one upon the other, ease of assembly and permanence of position for the relative charges are obtained. In addition, it will be noted that the shells were of substantially uniform diameter throughout their length, thereby eliminating the stepped down construction employed with prior art devices.

In accordance with this invention, the base charge may be pentaerythritoltetranitrate, tetryl, nitrostarch, nitromannite, and the like. Pentaerythritoltetranitrate is preferred. The priming charge may be diazodinitrophenol, mercury fulminate, lead styphnate, silver azide, lead azide, and the like. Diazodinitrophenol is preferred. The fuse powder may be a mixture of a metallic oxide and a material such as selenium or tellurium. A mixture of about 84% barium peroxide and 16% selenium, by weight, compressed to a density in the order of 4 g./cc. in a metal tube is preferred. The fuse may be cut to various lengths to give fuse charges of predetermined intervals for delay firing.

The ignition composition in accordance with this invention essentially contains not more than about 15% by weight of an oxidizing material having a particle size not greater than about 74 microns. It is well known in the art that ignition compositions are capable of considerable modification. Regardless of the latitude afforded in formulation, it is still customary and necessary in the manufacture of prior art devices to add a relatively high percentage of an oxidizer to the ignition mixture to achieve satisfactory ignition. On account of using so much of this ingredient, an air chamber between the fuse and ignition assembly must be provided to accommodate the gases produced from the mixture upon ignition or other means such as heretofore described must be utilized. However, in accordance with this invention, it has been found that considerably less oxidizer is equally effective if this ingredient is very fine (maximum diameter about 74 microns) and intimately incorporated in the ignition composition. As a result of using less oxidizer, the ignition composition is appreciably less violent, and hence may be used in ventless delay initiators having no air chamber. The addition of barium peroxide-selenium mixture to the primary explosive and oxidizer appears to further reduce the violence of the ignition mixture. Barium peroxide-selenium also appears to increase the heat content of the ignited composition. It further appears that when a car-

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bonaceous material is added to the composition, the burning rate is retarded. Consequently, this makes it possible to obtain good series firing. The binding agent serves to hold the ignition composition in place when used in conjunction with a cavity-type plug.

Very satisfactory results may be obtained in accordance with this invention when using from about 10 to about 20% primary explosive, from about 50 to about 70% heat-producing material, from about 5 to about 15% oxidizing material, from about 5 to about 15% carbonaceous material, and from about 1 to about 5% binding agent.

The primary explosive may be finely divided explosives such as diazodinitrophenol, mercury fulminate, lead styphnate, and silver azide. Diazodinitrophenol of "flash" grade is preferred. This grade contains particles which range from about 50 to about 150 microns in diameter.

The heat-producing material should be a material for which the values for heat content and for free energy of formation of the oxides are high. Thus, mixtures of an oxidizing agent such as barium peroxide, potassium chlorate, potassium permanganate, or the like with an element such as selenium, tellurium, sulfur, or the like may be used. However, flash-producing metals such as aluminum, chromium, tin, copper, magnesium, or the like, such as disclosed in copending application Serial No. 574,349, may be used as a substitute for the mixtures, although the metals are less satisfactory. While these metals do increase the heat content, they do not assist in reducing the violence of the ignited composition as do the above mixtures. The ingredients for the heat-producing material should be finely divided to insure intimate mixture in the ignition composition. A mixture of commercial grade barium peroxide with selenium powder in a ratio of 70-30%, by weight, is preferred in which the particle size of the peroxide is not more than 0.10% on a U. S. Standards No. 200 sieve and 20% on a No. 325 sieve, and for the selenium not more than 1% on a No. 200 sieve and 10% on a No. 325 sieve.

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, perchlorates, such as sodium and potassium perchlorate, it is preferred to employ potassium chlorate, potassium nitrate, or potassium permanganate. The preferred compounds will be found to be superior to the other compounds particularly in consistent performance at high temperatures. Potassium chlorate having a particle size diameter from about 10 to about 74 microns has given excellent results and is preferred.

The carbonaceous material may be charcoal, lampblack, or the like in finely divided form. Willow charcoal dust has been found quite satisfactory and is preferred. The carbonaceous material may be omitted from the ignition composition, but as pointed out heretofore it appears to improve the characteristics of initiators fired in series.

As the binding agent, nitrostarch is preferred. However, other binders well known to the art, such as nitrocellulose, may be used.

In preparing the ignition composition heretofore described the ingredients are thoroughly mixed and then made into a paste by wetting

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with a volatile organic solvent such as butyl acetate to obtain the desired consistency. The composition is then buttered into the cavity of an ignition plug and then allowed to dry.

The shell material as 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 water-proofing composition, with a sulfur seal, if desired. However, this is not necessary with rubber or resin plugs as exemplified by the preferred embodiment of this invention. The lead wires employed are the customary wires used in the art and may be copper or iron, plain tin or enameled, or coated with cotton servings or plastic materials. The bridge wire used to connect the ends of the lead wires may be electrically-resistant wire such as platinum or iridium, or alloy such as nichrome, copper-nickel, platinum-iridium, and the like.

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, electric ignitors, or blasting caps, or in any such device where a minimum of internal gas pressure is desired upon ignition.

The advantages of the present invention are multifold. Better overall performance is obtained, particularly at high voltages. The elimination of the air space in conventional delay initiators using waterproofing and a sulfur seal has resulted in a reduction in length in the order of about $\frac{1}{8}$ of an inch for each delay length and makes the step down type shell unnecessary.

For initiators made in accordance with the preferred embodiment illustrated in the drawing, the reduction in length is much greater due to the additional elimination of the waterproofing and sulfur seal. The ignition of the fuse is more effective because of positive contact between the fuse and the ignition composition. Moreover, devices made in accordance with this invention are cheaper to manufacture and are improved both from the standpoint of performance and appearance.

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

1. An ignition composition for blasting caps comprising from about 10% to about 20% of finely-divided primary explosive; from about 50% to about 70% of a heat-producing material consisting of a finely-divided mixture of at least one nonmetallic member of the sulfur group with a substantially stoichiometric proportion of solid inorganic oxidizing salt; and an additional amount of not more than 15% by weight of a pulverulent inorganic oxidizing salt having a particle size not greater than about 74 microns.

2. An ignition composition according to claim 1 in which the heat-producing material is a substantially stoichiometric mixture of selenium and barium peroxide.

3. An ignition composition according to claim 1 in which is incorporated a binding agent.

4. An ignition composition according to claim 1 in which the additional oxidizing agent is potassium chlorate.

5. An ignition composition according to claim

1 in which the additional oxidizing agent is potassium permanganate.

6. An ignition composition according to claim 1 in which the additional oxidizing agent is potassium nitrate.

7. An ignition composition for blasting caps comprising from about 10% to about 20% of finely-divided diazodinitrophenol; from about 50% to about 70% of a mixture consisting of 70 parts barium peroxide and 30 parts selenium; from about 5% to about 15% of potassium chlorate having a particle size not greater than about 74 microns; from about 5% to about 15% charcoal; and from about 1% to about 5% nitrostarch.

8. In a delay electric initiator, the improvement which comprises an ignition composition superimposed upon a substantially gasless fuse charge, said ignition composition containing from about 10% to about 20% of finely-divided diazodinitrophenol; from about 50% to about 70% of a mixture consisting of 70 parts barium peroxide and 30 parts selenium; from about 5% to about 15% of potassium chlorate having a particle size not greater than about 74 microns; from about 5% to about 15% charcoal; and from about 1% to about 5% nitrostarch.

9. In a delay electric initiator the improvement which comprises an ignition composition superimposed upon a substantially gasless fuse charge, said ignition composition containing from about 10% to about 20% of finely-divided primary explosive; from about 50% to about 70% of a heat-producing material consisting of a finely-divided

mixture of at least one nonmetallic member of the sulfur group with a substantially stoichiometric proportion of solid inorganic oxidizing salt; and an additional amount of not more than 15% by weight of a pulverulent inorganic oxidizing salt having a particle size not greater than about 74 microns.

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