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IGNITION MIXTURE

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This invention relates generally to ignition compositions for blasting caps and detonators, and has particular reference to improving the uniformity of performance of ignition compositions of the lead-selenium type.

Ignition compositions of the lead-selenium type are well-known, and because of their gaslessness are desirable for use under certain circumstances, but because of their non-uniform performance, have not heretofore been adapted for other uses where uniformity of firing time is essential.

It has heretofore been proposed to control the rate of burning of such ignition composition by incorporating lead oxide (PbO) with it, and while the presence of lead oxide does lengthen the firing time of such mixes, the erratic performance is not thereby overcome. For example, with a series of identically loaded detonators in which the ignition composition consisted of 60% pure lead powder, 25% selenium, and 15% lead oxide (in which the lead oxide was incorporated as uniformly as possible by treatment of the mixture for several hours in a conical shaped tumbling apparatus), the firing time at one ampere varied from a minimum of 137 milliseconds to a maximum of 195 milliseconds, with an average of 173 milliseconds. This represents a variation above the minimum of 42.3%, which is considerably outside the range of variation which can be tolerated where firing time is an important factor.

The object of the present invention generally stated is to provide an ignition composition of the lead-selenium type in which the firing times are less erratic than has been previously experienced.

I have discovered that if in lieu of incorporating lead oxide as a separate ingredient with a lead-selenium mix, the particles of lead be deliberately and substantially oxidized so as to produce in situ thereon and retain thereon the desired quantity of lead oxide, the performance of the resultant mix time-wise is substantially improved. By "substantially oxidized" as expression is used herein and in the appended claims, it is intended to contradistinguish from the quick oxidation which lead particles undergo immediately upon exposure to air. To produce the desired quantity of oxide on the lead powder and to control the extent of the oxidation, it is preferred to heat the lead powder in an internally baffled rotating drum in an oxidizing atmosphere. The degree of oxidation varies with the temperature, time, particle size, and rate at which the drum is rotating. In general, the higher the temperature, the longer the time of treatment, the smaller the particle size; or the faster the rotation of the drum; the greater the oxidation. At a temperature of 250° C. three to four hours is required to produce an oxide content of about 20% on a charge of lead powder. The degree of oxidation desired depends upon the time characteristics which it is desired to achieve with the resultant mix. In general, the greater the oxidation of the lead particles, the longer the pulse-time and the firing time of the resultant mix.

As one example of an ignition mix prepared in accordance with the present invention, the lead powder was heated at a temperature of 250° C. and repeatedy sampled until it was 20% oxidized, that is, so that the charge in the rotating drum consisted of four parts pure lead to each one part of lead oxide calculated as PbO. This required four hours in a drum rotating at 22 R. P. M., with lead powder having a fineness such that about 96% passed through a screen having 325 mesh per lineal inch. The oxidized lead powder was then incorporated with selenium in the proportions of three parts of oxidized lead to each part of selenium, so as to secure a mix for the purpose of comparison with a mix consisting of 60% pure lead powder, 25% selenium, and 15% lead oxide (separately introduced). The oxidation of the lead particles may, however, be varied to provide 10–40% of lead oxide in the mix.

A series of deonators identically charged, except that part were loaded with the ignition mix (hereinafter designated "mix A") above-described, wherein the lead oxide was separately introduced, and part were loaded with the ignition mix (hereinafter designated "mix B") wherein the lead oxide was formed in situ on the lead particles, were fired to compare their firing times. In both mix A and mix B, the ignition mixture contained 60% lead powder, 25% selenium, and 15% lead oxide (formed in situ on the lead particles in the case of mix B). The results of the test are indicated in the following table:

Total firing time

[In milliseconds—at one ampere]

	Ave.	Min.	Max.	Extreme Variation
Mix A	173	137	195	58
Mix B	134	128	145	17

From the tabulated results, it is apparent that whereas with mixes in which the lead oxide is separately introduced, the maximum firing time was over 142% of the minimum firing time, with mixes wherein the oxide was formed in situ on the lead particles, the maximum firing time was only 113% of the minimum firing time. Thus the spread between maximum and minimum firing times is substantially reduced by producing the desired amount of oxide in situ on the lead particles.

The firing time of mixes containing oxidized lead is longer than the firing time for mixes which contain no oxide, but at comparable oxide contents, the mix in which the lead is oxidized has a consistently shorter firing time than comparable mixes in which the lead oxide is separately introduced. In order to reduce the firing time of a given mix, therefore, it is possible either to utilize lead with less oxidation, or to blend with lead of a given oxidation, lead of lesser or no oxidation.

To illustrate the effect of varying the degree of oxidation of the lead particles upon the pulse time for ignition mixes of the lead-selenium type, a series of tests comparing ignition mixes containing 27.6% selenium, balance oxidized lead particles, were run, with the following typical results:

Pulse time

[In milliseconds—at one ampere]

Percent PbO	Ave.	Max.	Min.
12.11	3.5	4.4	3.2
12.99	4.0	5.2	3.8
14.18	4.4	6.0	4.0
17.52	4.6	6.0	4.4

When the extent of the oxidation of the lead particles was increased to 41.20%, the mixes did not fire after being energized at one ampere for 35 milliseconds. While longer pulse time periods are permissible, when one is assured that no attempt will be made to fire the caps in series with other caps which are so fast that their total firing time is less than the pulse time of any cap in the series, it is desirable for practical purposes to maintain the pulse times at a sufficiently low value that it is impossible to have an electrically connected series in which the total firing time of one cap is less than the pulse time of any other. This practical consideration dictates that the lead particles in the mix should not be oxidized to an extent greater than about 40%. Indeed, it is preferred that ignition mixes prepared in accordance with the present invention have the lead particles therein oxidized to an extent not more than 20%, thus allowing a substantial factor of safety in the performance of the detonators.

While scientific explanation for the improvement in the uniformity of firing times accomplished by oxidizing the lead particles instead of incorporating lead oxide in the mix is not yet ascertained with certainty, it may be postulated that the results are attributable to the uniformity in which the lead oxide is distributed with reference to the lead particles throughout the mix. Since each particle of pure lead may be considered as being coated with lead oxide, and since the depth of the coating will be uniform on all particles which have been subjected to the same oxidation treatment, it is apparent that all increments of lead carry equivalent increments of lead oxide. Thus in the mixing operation, it is unnecessary to distribute three ingredients uniformly each with respect to two others, but only one ingredient, the selenium, need be distributed uniformly with respect to one other, the oxidized lead particles.

From the foregoing description, those skilled in the art should readily understand the principles of the present invention, and realize that it accomplishes its object, and substantially eliminates the erratic performance firing-

time-wise of lead-selenium ignition mixes. While the invention has been described with particular reference to a typical lead-selenium priming mix in which the selenium content amounted to 25%, it is to be understood that the invention is not limited to that particular proportion of selenium, but that the invention is applicable to such ignition mixtures containing as much as 60% or as little as 15% selenium.

Having thus described the invention, what is claimed and desired to be secured by Letters Patent is:

1. In the manufacture of lead-selenium ignition mixtures, the improvement which comprises, providing particles of lead, and substantially but incompletely oxidizing the lead particles before incorporation with the selenium, to an extent sufficient to provide 10–40% of lead oxide in the mix.

2. In a lead-selenium ignition mix, the improvement which comprises, the lead particles being substantially but incompletely oxidized to an extent sufficient to provide 10–40% lead oxide in the mix.

3. In a lead-selenium ignition mix, the improvement which comprises, the particles of lead being substantially uniformly coated with lead oxide, to provide 10–40% of lead oxide in the mix, said particles having cores of unoxidized lead.

4. An ignition mix comprising particles of lead, said particles being substantially but incompletely oxidized to an extent sufficient to provide 10–40% of lead oxide in the mix and the oxide remaining in situ thereon.

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