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IGNITION COMPOSITION

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This invention relates generally to electric detonators or blasting caps, and particularly to the ignition component of the explosive train therein.

One of the most satisfactorily functioning instantaneous electric detonators heretofore offered is one wherein a metallic case having an external diameter of about .310 inch contains an explosive train consisting of: a base charge composed of 4.0 to 4.5 grains of cyclonite pressed into the closed end of the case and overlaid by an initiating charge composed of 2.9 to 3.1 grains of lead azide, the latter being compressed beneath a protective member which limits the exposure of said initiating charge to the superposed ignition charge composed of 4 to 4.5 grains of 85% mercury fulminate—15% litharge, surrounding a bridge wire of rhodium-ruthenium-platinum alloy of the character disclosed in Patent No. 2,080,110. While such an electric detonator is somewhat larger than is desirable for many purposes, it has an advantageously short ignition time and total explosion time, and it is relatively insensitive to mechanical shock. When efforts were made to reduce the physical dimensions of the electric detonator above-described, it was found that the detonator became prohibitively sensitive to impact and of erratic performance when connected in series with other caps of conventional type.

The initial objective of the present invention was to reduce the physical dimensions of the above-described electric detonator without sacrificing any of the advantageous characteristics thereof. In the pursuit of such objective, it became a further object to provide an ignition composition which, when coordinated with other components, would permit such reduction of size without sacrificing any advantage. The ignition composition hereinafter disclosed not only accomplishes these objectives, but, in addition, and quite unexpectedly, provides further advantageous results, among which are an increase in the number of caps which can be fired in series without misfires, and an improvement in the constancy of ignition time and in resistance to mechanical impact, adverse storage, and rough handling. The ignition composition contemplated by the present invention is composed of mercury fulminate and comminuted dense smokeless powder in the proportions of from 1 to 2.3 parts by weight of the smokeless powder to each part of mercury fulminate. By "dense" smokeless powder is meant a smokeless powder base which has been colloided by means of a solvent or plasticizer, shaped and hardened. An example of dense smokeless powder eminently suitable for use in accordance with the present invention is cannon powder having a chemical composition substantially as follows:

	Percent
Diphenylamine	.3 to 1.2
Graphite	Max. 5.0
Ash	Max 3.0
Moisture and volatiles	Max 2.0
Ether extractables	Max 2.75
Nitrocellulose (12.0 to 12.7% N)	Balance

The cannon powder is ground to pass a screen having 60 mesh per lineal inch and mixed dry with mercury fulminate substantially fine enough to pass a screen having 100 mesh per lineal inch and 40–90% passing a screen having 200 mesh per lineal inch. A typical screen analysis for the ground cannon powder is as follows:

	Percent
On 60 mesh	None
On 80 mesh	10
On 100 mesh	50
Through 200 mesh	25–55

A typical screen analysis of the mercury fulminate is as follows:

	Percent
On 100 mesh	0.5
Through 200 mesh	70

The ground cannon powder and mercury fulminate are mixed dry in proportions such as to provide a mixture containing, by weight, between 50% and 70% ground cannon powder with from 50% to 30% mercury fulminate. As the mercury fulminate approaches the lower limit, the ignition time and total explosion time are increased so that, with a mercury fulminate content of less than 30%, the firing time of the mixture is undesirably long. As the content of mercury fulminate approaches 50%, the firing times are shortened, but the difference between the firing times at 40% mercury fulminate and 50% mercury fulminate is too slight to justify the economic disadvantage of the greater mercury fulminate content. From the standpoint of both performance and economics, mixtures containing about 60% ground cannon powder, with about 40% mercury fulminate, are preferable.

So long as the ground cannon powder has a fineness such as to pass an 80-mesh screen, it is of no great significance whether the fines be screened out. This is particularly true of the 60/40 mixture of ground cannon powder and mercury fulminate, and of mixtures within +5% or −5% thereof.

As specific examples of ignition mixtures compounded in accordance with the present invention, the ground cannon powder may have the composition indicated under A and B, respectively, in the following table:

	A	B
Diphenylamine, percent	0.36	0.38
Graphite, do	2.94	4.92
Ash, do	3.17	2.36
Moisture and volatiles, do	2.23	1.62
Ether extractables, do	0.8	1.07
Nitrogen content of nitrocellulose, do	12.18	12.50
Gravimetric density	400	420

Mercury fulminate was mixed with powders A and B, respectively, in the proportions of 50/50, 40/60, and 30/70, and the respective mixtures charged as a loose ignition mixture in electric detonators having a metallic case whose internal diameter was 0.256 inch, with a base charge consisting of 4½ grains of cyclonite pressed into the end of the case, and an initiating charge consisting of 3 grains of lead azide pressed on the base charge. The ignition mixture was charged in a volume sufficient to substantially fill the space between the initiating charge and the conventional bridge-wire-supporting plug, so that the ignition charge thoroughly surrounded the bridge wire. The weight of the ignition charge varied between 1.7 and 2.1 grains.

The series of caps containing the several ignition mixtures were tested for impact sensitivity by being subjected to the blow of a 10-pound weight dropped six feet onto the loaded caps in the axial position, and dropped four

feet onto the loaded caps in the radial position. In such tests, none of the loaded caps exploded. When the axial drop was increased to seven feet, one out of ten of the caps charged with the 30/70 mixture fired, but none of the caps charged with either the 50/50 or 40/60 mixtures fired.

The firing times (in milliseconds) for caps charged with the various mixes are indicated in the following table:

	50/50 Mix		40/60 Mix		30/70 Mix	
	Ignition	Total	Ignition	Total	Ignition	Total
Avg	3.6	10.9	3.9	13.2	5.3	18.0
Max	4.5	12.4	4.5	17.4	9.0	20.1
Min	2.5	9.9	3.0	11.8	3.5	16.4

Neither storage at 130° F. for one week, nor storage at —40° F. for one week, nor storage at 85% relative humidity and 122° F. for thirty days, nor shaking for eight hours on a standard shell shaker, had any substantial adverse effect upon either the impact sensitivity or the firing times of such shells.

An important advantage of blasting caps provided with ignition mixtures in accordance with the present invention, over the instantaneous larger size cap first above-mentioned, lies in the increase in the number of caps which may be dependably fired in series. The standard series firing test involves connecting a given number of caps in series and firing them to ascertain the maximum number which can be so connected and energized in three consecutive tries without a misfire. On tests made with a conventional 10-cap blaster, the best results obtainable were 52 before shaking and 50 after shaking, with the prior art cap above-described. With caps of the present invention, containing the 40/60 ignition mixture, 69 caps were successfully fired in series, both before and after shaking, when compounded with powder A; and 69 and 65, respectively, before and after shaking, when compounded with powder B.

From the foregoing description, those skilled in the art should readily understand the advantages which inhere in the use of an ignition mixture composed of comminuted dense smokeless powder and mercury fulminate. The specific scientific explanation of the improved performance in the several respects above-indicated is not yet ascertained with certainty.

While several specific examples of the ignition composition have been delineated hereinbefore and alternatives indicated, it is to be distinctly understood that the invention is not limited to the precise proportions or to the specific compositions of dense smokeless powders hereinbefore specified save as indicated in the appended claims.

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

1. In an electric detonator having a base charge and an ignition charge, said ignition charge comprising mercury fulminate mixed with ground dense smokeless powder in the proportions of from 1.0 to 2.3 parts by weight of the powder to each part of mercury fulminate.

2. The improvement of claim 1 wherein the powder has a fineness such as to pass a 60-mesh screen, and the fulminate has a fineness such that 40–90% passes a 200-mesh screen.

3. The improvement of claim 1 wherein the powder is composed substantially as follows:

	Percent
Diphenylamine	.3 to 1.2
Graphite	Max. 5.0
Ash	Max 3.0
Moisture and volatiles	Max. 2.0
Ether extractables	Max 2.75
Nitrocellulose (12.0 to 12.7% N)	Balance

4. An ignition composition for detonators and blasting caps comprising mercury fulminate mixed with ground dense smokeless powder wherein the mercury fulminate constitutes about 40% by weight of the mixture.

5. In an explosive train for detonators and blasting caps having a cyclonite base charge, a lead azide initiating the charge, and an ignition charge, the improvement which comprises, said ignition charge being composed of 50–30% loose dry mercury fulminate mixed with 50%–70% ground dense smokeless powder, said initiating charge being interposed between the ignition charge and the base charge.

6. A composition of matter suitable for use as the ignition charge in electric detonators consisting of a mixture of mercury fulminate and ground dense smokeless powder in the proportions of from 1.0 to 2.3 parts by weight of the powder to each part of mercury fulminate.

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