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CONDUCTIVE PRIMING MIXTURE

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The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment of any royalty thereon.

This application is a continuation-in-part of my pending application entitled "Conductive Priming Mixture," filed May 15, 1956, Serial No. 585,126, now abandoned.

This invention relates to conductive priming mixtures, and has as an object to present a conductive priming mixture which is not critical to ageing, needs no carbon to conduct electrical energy, does not use lead styphnate for initiation, and therefore need not be blended under the critical conditions of the prior art mixtures.

In order to improve the rate of fire of automatic weapons, primer compositions were developed which functioned by transfer of electrical energy than mechanical energy, thus eliminating the need for bulky, sliding firing mechanisms, thereby reducing the firing delay between rounds.

A typical prior art conductive priming mixture comprises, by weight to total weight of mixture: about 40% lead styphnate, 40% barium nitrate, .5 to 1% of some form of the carbon element such as carbon black, acetylene black or graphite, and remainder a heat carrier such as calcium silicide or antimony tri-sulfide.

One of the greatest difficulties experienced with the prior art mixtures lay in the electrical instability of carbon, and the effect of ageing upon it. The phenomenon is not known, but it may be in the way which carbon combines with oxygen under various environmental conditions, and the difference in characteristics of a given compound when manufactured by different companies. The ageing effect is so serious that unless primers are charged within a short period after the mixture is blended, their functioning becomes unpredictable. This is believed to be due to the variation in resistance of the carbon constituent upon ageing. Since the functioning of the primer depended upon the molecular decomposition of the lead styphnate—brought about by the heat from the carbon—variation in resistance of the carbon constituent correspondingly varied the decomposition of the lead styphnate, and hence primer functioning.

The very presence of lead styphnate requires extreme care in handling during blending and charging, such that special loading and handling techniques need be employed.

I have invented a conductive priming mixture which eliminates the forging disadvantages. It is not sensitive to ageing after blending; does not involve the hazard associated with the handling of lead styphnate; has high uniformity of functioning; and has greater thermal output than prior art conductive priming mixtures.

More specifically, my invention employs a fuel-oxidant reactions rather than the use of a primary explosive.

In the typical prior art mixture, the prevailing theory is that the electrical current creates heat in the conduc-

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tor which causes a primary explosive such as lead styphnate, to decompose, react with the oxidizer and heat carrier, generate gas pressure which propels the burning particles into the propellant. Because the carbon constituent's variable resistance, the decomposition of the lead styphnate is unpredictable, and functioning is unreliable.

My composition employs a fuel-oxidant reaction, without the use of carbon. I believe that the mixture behaves as follows: upon passing an electric current through the mixture by means of conductor-oxidizer constituent—such as lead dioxide, causes the oxidizer (referred to as the primary oxidizer) to decompose and release oxygen. The oxygen thus released plus the heat from the electrical current causes a reaction with fine grains of metallic fuel, such as zirconium, which fuel acts as a flame initiator. The flame initiator then reacts with a secondary oxidizer, thereby raising the temperatures so as to ignite coarse fuel particles, while at the same time generating gas pressure which propels the burning particles into the propellant.

In some of my earlier mixtures, I attempted to use a large amount of finely particulated metallic fuel. However, the presence of a large amount of the fine particles imparted to the mixture a plastic state unadaptable to prevailing loading techniques; dissipated electrical energy-causing misfire, and failing to have the persistency of fire and particle mass sufficient to produce the action time required of a primer.

My present mixture has none of the aforementioned disadvantages. A partial key to the solution was found to reside in particle size. Coarse grained zirconium by itself was difficult to ignite and had a tendency to separate out of the mixture. However, by reacting fine grain zirconium with a primary oxidizer to create sufficient heat to bring about the reaction between the secondary oxidizer and the coarser grained fuel, the mixture produces a highly satisfactory output, as will be shown below.

The method of operation is believed to be as follows: an electric current is passed into the mixture by means of the moderate conductor PbO_2 , causing a heating effect and a release of oxygen which then causes a reaction with fine grained zirconium, as a flame initiator, which is highly exothermic, bringing about the decomposition of a secondary oxidizer, $Ba(NO_3)_2$ which reaction product ignites the coarse fuel particles. The gas generated during the reactions results in a pressure which propels the burning particles into the propellant. If it is desired to further improve the igniting characteristics of the mixture, a small amount of a high explosive fuel such as pentaerithritol tetranitrate (PETN) is added to increase the propulsive force of the burning particles into the propellant.

The general formulation comprises: lead dioxide, as a primary oxidizer and moderating conductor, about 25 parts by weight; zirconium powder having a particle size not larger than 5 microns, as a flame initiator; about $7\frac{1}{2}$ parts by weight; coarsely particulate zirconium in a range and distribution of particle sizes such that all particles pass through 100 mesh; about 50 weight percent pass through 200 mesh, not more than 35 weight percent pass through 325 mesh, and minimum particle size is at least 10 microns, as a fuel, about $32\frac{1}{2}$ parts by weight; and barium nitrate as a secondary oxidizer, 35 parts by weight.

The composition has further improved characteristics by the addition of pentaerithritol tetranitrate, to yield the following components and quantities: lead dioxide, 18 to 22 parts by weight; zirconium powder having a particle size not larger than 5 microns, 6 to 9 parts by weight; coarsely particulate zirconium in a range and

distribution of particle sizes such that all particles pass through 100 mesh, about 50 weight percent pass through 200 mesh, not more than 35 weight percent pass through 325 mesh, and minimum particle size is at least 10 microns, 30 to 35 parts by weight; barium nitrate, 15 to 25 parts by weight; and pentaerithritol tetranitrate, 15 to 23 parts by weight.

More particularly, the preferred embodiment comprises: lead dioxide, as a primary oxidizer and moderating conductor, about 20 parts by weight; zirconium powder having a particle size not larger than 5 microns, as a flame initiator, about 7½ parts by weight; coarsely particulate zirconium in a range and distribution of particle sizes such that all particles pass through 100 mesh, about 50 weight percent pass through 200 mesh, not more than 35 weight percent pass through 325 mesh, and minimum particle size is at least 10 microns, as a fuel, about 32½ parts by weight; barium nitrate as a secondary oxidizer, about 20 parts by weight; and pentaerithritol tetranitrate, as a propulsive agent, about 20 parts by weight.

The advantages including safety and increased output deriving from the improved formulation are demonstrated quantitatively in the following tabulations which compare with the prior preferred mixture the properties of conductivity before and after loading, responsiveness and reliability, sensitivity to stray electrical energy and performance at extreme temperatures:

Effect on resistance of batch ageing

	Improved Mixture—Resistance in Ohms			Prior Preferred Mixture—Resistance in Ohms
	Avg.	Max.	Min.	
Storage time (days) of Wet Mixture:				
1.....	1,200	4,000	500	From an initial average value of 100,000 ohms, the resistance increased within 24 hours to infinite value.
5.....	10,000	20,000	4,000	
18.....	60,000	500,000	140	
35.....	3,000	9,500	400	

Comparative resistance of loaded mixture (ohms)

Test No.:	Improved Mixture			Prior Preferred Mixture		
	Avg.	Max.	Min.	Avg.	Max.	Min.
1.....	1,724	3,000	700	31,562	1,200,000	1,600
2.....	1,668	2,900	300	58,717	900,000	2,200
3.....	1,875	3,400	400	96,654	5,000,000	2,300

Responsiveness and reliability in terms of voltage

	Improved Mixture			Prior Preferred Mixture		
	2 mfd.	4 mfd.	10 mfd.	2 mfd.	4 mfd.	10 mfd.
Mean Voltage V.....	26.5	23.2	18.4	37.0	35.2	30.0
Error of Mean.....	0.599	0.585	0.535	0.155	0.152	0.153
95% Confidence.....	25.3	22.0	17.3	35.5	33.7	29.2
Interval of Mean.....	27.7	24.4	19.5	38.6	36.7	31.5
Standard Deviation, S.....	6.3	6.0	5.1	10.6	10.1	10.0
Skewness.....	3.17	0.66	0.90	3.14	2.44	0.96
All-Fire Voltage, V 5S*.....	58.2	53.3	43.9	90.0	85.7	80.2
All-Fire Voltage, Corrected for Skewness.....	68.9	55.7	47.7	96.4	90.9	82.7

*Statistically determined voltage at which the probability of misfires does not exceed 3 in 10,000,000.

Comparative safety-sensitivity to electrostatic charge upon human body

	Improved Mixture		Prior Preferred Mixture	
	100 mmf.	400 mmf.	100 mmf.	400 mmf.
None-Fire Voltage.....	9,000 Beyond Scale.	1,300 5,000	1,000 3,300	100 700
All-Fire Voltage.....				

Comparative ballistic performance

Temperature	Improved Mixture			Prior Preferred Mixture		
	V.*	P.*	T.*	V.	P.	T.
165° F.....	3,523	60.0	3.25	3,496	59.8	3.60
70° F.....	3,480	55.3	3.27	3,480	55.5	3.74
-70° F.....	3,295	46.5	3.61	3,296	Below Scale.	Consistently Audible Hangfires.

*V=vel. of projectile in foot seconds; P=pressure, p.s.i. in thousands; T=action time in milliseconds, measured as time interval between application of energy to primer and emergence from muzzle of projectile.

It is believed that the combination as a whole, and the discovery of the approximate proportions of various materials named, especially the use of zirconium in the named particle sizes, are the factors which contribute to the improved performance of my mixture.

It is felt that any suitable fuel of comparably high exothermic qualities of about the same particle size as disclosed, could be substituted for zirconium such as titanium, anodized magnesium, aluminum alloy and silicone, and any suitable high explosive fuel could be substituted for pentaerithritol tetranitrate such as powdered TNT, as the propulsive agent without deviating from the scope of this invention.

I claim:

1. A conductive ammunition priming mixture consisting essentially of: About 25 parts by weight lead dioxide as a primary oxidizer and moderating conductor; about 7½ parts by weight zirconium powder having a particle size not larger than 5 microns, as a flame initiator; about 32½ parts by weight coarsely particulate zirconium in a range and distribution of particle sizes such that all particles pass through 100 mesh about 50 weight percent pass through 200 mesh, not more than 35 weight percent pass through 325 mesh, and minimum particle size is at least 10 microns, as a fuel; and about 35 parts by weight barium nitrate as a secondary oxidizer.

2. A conductive ammunition priming mixture consisting essentially of about 20 parts by weight lead dioxide, as a primary oxidizer and moderating conductor; about 7½ parts by weight zirconium powder having a particle size not larger than 5 microns, as a flame initiator; about 32½ parts by weight coarsely particulate zirconium in a range and distribution of particle sizes such that all particles pass through 100 mesh, about 50 weight percent pass through 200 mesh, not more than 35 weight percent pass through 325 mesh, and minimum particle size is at least 10 microns, as a fuel; about 20 parts by weight barium nitrate as a secondary oxidizer; and pentaerithritol tetranitrate, as a propulsive agent, about 20 parts by weight.

3. A conductive ammunition priming mixture consisting essentially of: 18 to 22 parts by weight lead dioxide; 6 to 9 parts by weight zirconium powder having a particle size not to exceed 5 microns; 30 to 35 parts by weight coarsely particulate zirconium in a range and distribution of particle sizes such that: all particles pass through 100 mesh, approximately 50 weight percent pass through 200 mesh, not more than 35 weight percent pass through 325 mesh, and minimum particle size is at least 10 microns;

15 to 25 parts by weight barium nitrate; and 15 to 23
parts by weight pentaerithritol tetranitrate.

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