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CALCIUM CONTAINING PYROTECHNIC COMPOSITIONS FOR HIGH ALTITUDES

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4 Claims. (Cl. 149—19)

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

This invention concerns new pyrotechnic compositions in flares, flashes, photoflash cartridges and bombs designed to operate effectively at very high altitudes of 100,000 feet and outside the earth's appreciable atmosphere to a distance of 1000 miles or more.

The primary object of this invention is to provide pyrotechnic compositions which will produce a higher light output at these altitudes on rockets and missiles than at sea level.

Present pyrotechnic compositions which are generally used in flares produce as little as one percent of their sea level light output at an altitude of 100,000 feet. Photoflash compositions also produce only 25–50% of their sea level output at 100,000 feet or more.

Specifically this invention employs powdered metallic calcium together with an oxidizing agent such as potassium perchlorate to form the pyrotechnic composition which on combustion will produce the desired result.

In the preparation of this pyrotechnic composition, control of the particle size of the ingredients is essential in order to obtain reproducible results. The average particle size of the metallic calcium powder is about 25 microns as measured by the air permeability method, while the average particle size of the oxidizing agent, such as potassium perchlorate, can vary over a large range of 25 to 150 microns, but should be controlled for each composition. Each of the ingredients are then exposed to the atmosphere for a period of less than fifteen minutes to establish a fairly high relative humidity of 75% as a safe upper limit for the succeeding operations of blending and loading. The required percentage weight of each ingredient was dry blended in atmosphere of low humidity at ambient temperatures and pressures and placed in a rubber container together with an equal weight of small rubber stoppers, the latter being added to improve the uniformity of the final blend. The rubber container is sealed by taping the cover, and the container and contents are rotated by remote control for a period of thirty minutes, after which the entire contents are transferred to a No. 16 mesh sieve for the purpose of separating the rubber stoppers from the powdered mixture. Thereafter the powdered mixture is packaged or loaded into suitable cartridges for ready use.

Binding agents may be used in conjunction with the composition for the purpose of improving the strength by utilizing the following binding agents such as nitrocellulose lacquer, vinyl acetate alcohol resin, laminac and epoxy resins. If the binding agent is utilized it is added to the powdered composition in liquid form and dispersed throughout the composition by means of remote controlled blenders, and after pelletizing the mixture, the binding agent hardens by solvent evaporation or chemical reaction.

Variations of the composition may be made in that calcium-magnesium and calcium-aluminum alloys are deemed satisfactory substitutes for calcium metal powder as highly efficient fuels for high altitude photoflash items and when tested had a much greater light output at 100,000 feet than at sea level. This same result may also be attained with compositions containing calcium salts that are oxidants such as calcium nitrate, calcium perchlorate, or additives calcium oxide or calcium fluoride. This indicates that calcium, as a metal powder, alloy or salt is necessary for the production of superior high-altitude flashes.

Some choice is also permitted in the selection of oxidants in this pyrotechnic composition in that for the potassium perchlorate there may be substituted the perchlorates of sodium, lithium, strontium or barium, or the nitrates of potassium, sodium or calcium.

Some of the results obtained with the various combinations are set forth in the following table:

Potassium Perchlorate, percent	Ca, percent	Al, percent	Barium Nitrate, percent	Mg, percent	Weight of Composition, grams	Total Light, candle-seconds	
						Sea Level	100,000 ft.
30	--------	40	30	--------	30	[1] 231,000	116,000
30	10	30	30	--------	25	190,000	177,000
30	20	20	30	--------	22	147,000	164,000
30	30	10	30	--------	20	80,000	132,000
60	40	--------	--------	--------	17	27,000	74,000
46.5	53.5	--------	--------	--------	14	50,000	123,000
42	58	--------	--------	--------	14	60,000	148,000
35	65	--------	--------	--------	15	111,000	183,000
20	80	--------	--------	--------	12	103,000	320,000
10	90	--------	--------	--------	------------	62,000	263,000
59	--------	--------	--------	41	25	90,000	9,000
----------	43	--------	57	--------	20	28,000	91,000
[2] 40	60	--------	--------	--------	------------	60,000	214,000
20	80	--------	--------	--------	------------	108,000	364,000
10	80	--------	[3] 10	--------	------------	107,000	343,000

[1] Standard. [2] $NaClO_4$. [3] $NaNO_3$.

The table in general indicates, within limits that the trend is toward increasing the light output of a fuel-oxidant mixture by increasing the fuel content and calcium in some form is an essential ingredient. Also the weight variation for each composition is due to the variations in their loading densities. The same test vehicle, which was a magnesium "Daisy" cartridge, was used to evaluate each composition which were loaded to the same volume, and therefore explains the variations in weight of the different compositions.

The present flashes obtained from standard photoflash powders owe their luminosity to grey body radiation, largely of a continuous nature. This continuous type radiation occurs at both sea level and at high altitudes. Since the total energy of a flash is radiated as heat and light and is proportional to the fourth power of the absolute temperature, the reduced temperature of the flashes due the lower pressures at high altitude causes less light to be emitted. Whereas the light output at sea level for the calcium containing compositions is also due essentially to grey body radiation and at high altitudes the combustion product of calcium (calcium oxide) has the ability to emit very intense band spectra and it is these intense bands that are responsible for the increased light output at higher levels.

In order to disclose the nature of the present invention, several specific embodiments are described. It should, however, be understood that this is done solely for the purpose of illustrating, by means of concrete examples, the basic principle involved and that such examples are not intended either to delineate the breadth of the invention or to restrict the scope of the appended claims.

What is claimed is:

1. A process for preparing a pyrotechnic composition comprising, grinding separately to a powder 40–90% of metal calcium and 60–10% of potassium perchlorate, exposing the powders to the atmosphere for a period of less than fifteen minutes to establish a humidity of 75% as a safety precaution for succeeding operations, blending the powdered ingredients in a rubber container with a low humidity, adding to the blend an equal weight of rubber stoppers, rotating the rubber container in a sealed condition to mix the powdered material into a uniform blend, removing the rubber stoppers with any suitable sieve and packaging the blended powdered mixture which on combustion will yield a light output at an altitude above 100,000 feet more than double that at sea level.

2. A process for preparing a pyrotechnic composition comprising, grinding separately to a powder metal calcium and potassium perchlorate, blending together in a sealed container the powdered constituents for a uniform mixture and packaging the powdered mixture into a vehicle which on combustion of the composition at an altitude above 100,000 feet will yield a higher light output than on combustion at sea level.

3. A process for preparing a pyrotechnic composition comprising, grinding separately to a powder 40–90% of metal calcium and 60–10% of potassium perchlorate, blending together the powdered constituents in a sealed container for a uniform mixture and packaging the powdered mixture into a vehicle which on combustion of the composition at an altitude above 100,000 feet will yield a light output more than double that emitted by combustion of composition at sea level.

4. A pyrotechnic composition yielding a higher light output on ignition at an altitude over 100,000 feet than on ignition at sea level in which the composition consists of a finely divided mixture of a powdered constituent containing calcium, a powdered oxidizing agent and a powdered binder selected from the group consisting of nitrocellulose lacquer, vinyl acetate alcohol resin, laminac and epoxy resins.

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