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CAST FLARES FOR RED, GREEN AND BLUE COLOR

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ABSTRACT OF THE DISCLOSURE

Cast pyrotechnic flares for emitting red, green or blue light have a continuous solid phase of low melting mixtures of alkali and alkaline earth metal nitrates, a dispersed phase of magnesium powder and a dispersed phase of metal salt that emits colored light when burned.

This invention relates to colored illuminating flares and more particularly cast pyrotechnic flares that burn to provide red, green or blue light.

Pyrotechnic flares giving a high color intensity have heretofore conventionally been prepared by compressing mixtures of an oxidizer, a metal fuel, organic binders and a color generating material, or colorant, such as strontium nitrate, barium nitrate, realgar or Paris Green.

In United States Patent 3,370,537, Tepper has cast finely divided metal fuels dispersed in an oxidizer of low melting nitrate mixtures to form pyrotechnic compositions in which the metal fuel is dispersed in a matrix of the nitrate salts. Metal nitrate colorants can be added to the nitrate oxidizer, but they are very high melting, e.g. $Sr(NO_3)_2$ melts at 570° C. and $Ba(NO_3)_2$ melts at 592° C., so that only comparatively small amounts of colorant can be added without raising the melting point above that at which the nitrate oxidizer does not spontaneously react with the metal. The color intensity of such flares is weak. Cast pyrotechnics are desirable as they have high density and high uniformity that minimizes fluctuations of burning rate and light output. Also, casting is a less complex process than compressing particulate mixtures. Cast pyrotechnics also are desirable in that they self-bond to metal casings or the like.

It is accordingly an object of this invention to provide a cast flare that emits a high intensity colored light. Another object is to provide such a flare that is not impact sensitive.

In accordance with this invention, cast flares contain a continuous phase low-melting mixture of alkali metal or alkaline earth metal nitrates, a dispersed phase of magnesium and a second dispersed phase of color-producing material, or colorant, that is insoluble in the alkali or alkaline earth metal nitrates. The nitrates are melted, the magnesium and colorant are mixed into the molten nitrates, and the mixture is cooled to solidify the molten salt. In order to produce the compositions with satisfactory burning characteristics the materials used must be substantially anhydrous. In most cases it is sufficient to use commercial grade anhydrous salts, and to handle and process them in normal ambient air. Very hygroscopic salts, such as $LiNO_3$, are preferably protected from atmospheric moisture as by handling under inert atmosphere or in a dry room. Moisture contained in nitrate salt mixtures can conveniently be removed by holding them at an elevated temperature below their melting point for a short time.

The flare compositions contain between about 30 and 60% by weight colorant and between about 15 and 25% magnesium powder, the remainder being the low melting mixture of alkali metal and alkaline earth metal nitrates.

The magnesium is suitably between about 30 and 400 mesh, the particular particle size selected being dependent on the desired flare burning rate and the temperature being used to melt the nitrate oxidizer. The magnesium must not react spontaneously when mixed with the molten nitrates. At temperatures below about 250° C. any magnesium powder not pyroforic in air at the temperature can be used; at higher temperatures, up to about 350° C., coarser magnesium is used, suitably 30–70 mesh.

Suitable colorants include salts that are insoluble in the molten nitrate oxidizer and on burning emit a light in the desired portion of the visible spectrum. Red colorants may be strontium sulfide or strontium halides, alone or in combination with halides and sulfides of lithium, rubidium, potassium and cesium. Green colorants may be barium sulfide or barium halides. Blue colorant may be realgar (arsenic disulfide) or Paris Green (copper acetoarsenite), alone or in combination with copper powder.

Any mixtures of alkali metal and alkaline earth metal nitrates melting below 350° C. can be used, together with a compatible magnesium powder. Eutectic mixtures are preferred, and it is preferred to select mixtures that reinforce, or at least do not diminish, the coloration provided by the colorant. Thus it is preferred to use mixtures of lithium nitrate and potassium nitrate as the oxidizer for red flares, since the spectrum of both lithium and potassium show visible red lines. Rubidium and cesium also emit visible red light but they are quite costly compared to the other alkali metal salts. In the case of green flares, it is preferred to use mixtures of calcium nitrate and sodium nitrate. For blue flares, potassium nitrate-calcium nitrate mixtures are preferred; mixtures of potassium nitrate and lithium nitrate are also desirable.

Red flares.—Illustrative of a preferred flare for red illumination, 1 part of 70 mesh magnesium and 2 parts of strontium fluoride were stirred into 2 parts of molten lithium nitrate-potassium nitrate eutectic (32 weight percent $LiNO_3$-68% KNO_3 melting at 132° C.) and the mixture was poured into an aluminum container where it cooled and solidified. A 200 gram flare, 6 inches long, when ignited burned for 90 seconds giving a deep red illumination.

The fluorides are preferred colorants as fluorine provides illumination in the visible red spectrum. Strontium can be provided as its monosulfide, chloride or bromide with some decrease in color output compared to that of strontium fluoride. Up to about 50 weight percent of the strontium salt can be replaced with the fluorides of cesium, lithium or rubidium with no significant change in the color output. Variation can be made in the proportion between the colorant and oxidizer to vary the burning rate or melt fluidity. Increasing the colorant decreases the brightness of the flare, while increasing the nitrate decreases the color purity.

Green flares.—An illustrative preferred cast flare has 1 part of 70 mesh magnesium, 2 parts of barium chloride, and 2 parts of calcium nitrate-sodium nitrate eutectic (48% calcium nitrate-52% sodium nitrate melting at 232° C.) A six-inch long flare burned for about 90 seconds giving an intense green illumination. Barium chloride is a preferred colorant since chlorine has an emission in the green region. Other barium halides and barium sulfide may be used with some decrease in green color intensity. Other nitrate mixtures may be used, but they diminish the green output because of their own characteristic spectra.

Blue flares.—An illustrative preferred blue flare contains 1 part magnesium, 2 parts realgar and 2 parts calcium nitrate-potassium nitrate eutectic (69% calcium nitrate-31% potassium nitrate melting at 145° C.). A six-inch long flare burned for about 90 seconds giving

an intense blue illumination. Copper powder may be substituted for about 2–5% of the realgar. Paris Green may be used as a colorant instead of realgar to provide a slightly less intensive color. Potassium nitrate-lithium nitrate eutectic (68% potassium nitrate-32% lithium nitrate melting at 132° C.) can be used with no significant change or color output, but other nitrate mixtures substantially diminish the color intensity.

The flares of this invention are highly resistant to accidental ignition or explosion by ballistic impact. For example, they are non-igniting when struck by 30-caliber ammunition, either ball or armor piercing, fired at a distance of 30 feet or greater. Conventional compressed flares can be ignited by 30-caliber ball ammunition at a distance of about 200 feet.

According to the provisions of the patent statutes, I have explained the principle of my invention and have illustrated and described what I now consider to represent its best embodiment.

I claim:

1. A flare composition comprising (1) a matrix melting below about 350° C. and selected from the group consisting of at least two alkali metal nitrates, at least two alkaline earth metal nitrates and mixtures of at least one alkali metal nitrate with at least one alkaline earth metal nitrate, (2) a dispersed phase of magnesium powder, and (3) a dispersed phase of colorants comprising salts of a metal that when burned emit a colored light and that are insoluble in the said matrix when melted.

2. A composition according to claim **1** having between about 30–60% colorant, 15–25% magnesium and 15–45% matrix.

3. A flare composition according to claim **2** for red illumination in which the colorant comprises strontium fluoride, and the matrix is a mixture of lithium nitrate and potassium nitrate.

4. A flare according to claim **3** containing about 1 part magnesium, 2 parts colorant and 2 parts matrix.

5. A flare according to claim **4** in which the matrix is a eutectic.

6. A composition according to claim **2** for green illumination in which the colorant is barium chloride and the matrix is a mixture of calcium nitrate and sodium nitrate.

7. A composition according to claim **6** containing about 1 part magnesium, 2 parts colorant and 2 parts matrix.

8. A composition according to claim **7** in which the matrix is a eutectic.

9. A flare composition according to claim **2** for blue illumination in which the colorant is selected from the group consisting of arsenic disulfide, copper acetoarsenite and mixtures thereof and mixtures thereof with copper, and the matrix is a mixture selected from the group consisting of potassium nitrate-lithium nitrate and potassium nitrate-calcium nitrate.

10. A composition according to claim **9** containing about 1 part magnesium, 2 parts colorant and 2 parts matrix.

11. A composition according to claim **10** in which the matrix is the eutectic of potassium nitrate and calcium nitrate.

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