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3,474,730

LUMINESCENT COATED DETONATING FUSE

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8 Claims

ABSTRACT OF THE DISCLOSURE

A flexible, textile sheathed detonating fuse having a ductile, waterproof outer surface coating exhibiting luminescent light emission characteristics. The coating is formed through the addition of a luminescent substance to the liquid composition normally employed as the coating in an amount sufficient to provide the desired luminescent characteristics.

This invention relates to a textile-sheathed, detonating fuse having a luminescent outer surface and to a process for its preparation.

Detonating fuse (cord), formed with a core of high intensity explosive such as pentaerythritol tetranitrate (PETN), cyclotrimethylenetrinitramine (RDX), cyclotetramethylenetrinitramine (HMX) and the like, and including a surrounding cover of various waterproofed textiles, has long been used to initiate the detonation of an explosive charge. Such detonating fuse demonstrates many safety advantages over other types of ignition devices such as safety fuse and electrical wiring, while retaining high velocity ignition characteristics as well as the ruggedness and strength properties required for use under adverse field conditions.

In actual field use, the detonating fuse is connected at one end to the explosive charge and extended for the distance required to provide safety for those responsible for initiating the other end of the fuse to produce detonation of the charge. Thus the detonating fuse is often exposed for substantial distances across the surface of the terrain. Because of its inconspicuous appearance, conventional detonating fuse is not readily visible. As a result, it is occasionally subjected to accidental damage prior to its employment in the initiation of the explosive charge. When such damage occurs, blast sequences are interrupted and charges fail to detonate. In addition, preignition of the detonating fuse (without concurrent detonation of the explosive charge) may result and remain undetected. Of course, all of these conditions present a safety hazard during blasting operations.

It has now been found that by providing the detonating fuse with a highly visible, luminescent outer surface, the aforementioned hazardous circumstances are either completely eliminated or at least substantially minimized. The novel outer surface is formed by dispersing luminescent substances in a liquid composition and thereafter applying the composition as a covering or coating for the detonating fuse. It is necessary to employ the luminescent substance in concentrations sufficient to provide the resulting coated detonating fuse with the desired luminescence emission characteristics. In this manner, the detonating fuse will exhibit intense color and be easily visible. This invention is broadly applicable to safety fuse coatings as well as wax-containing and plastic (extruded) detonating fuse coatings.

More particularly, by employing commercially available luminescent pigments in concentrations of about 3–6% based on the total weight of the surface coating composition, the detonating fuse has been found to be readily apparent to the naked eye. Concentrations of luminescent pigments in excess of 8% by total weight of the surface coating composition have also been employed

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but do not appear to increase the intensity of luminescence emission that is produced. In addition, excessive concentrations are economically unattractive.

As used herein, the term "luminescent" is meant to particularly include those high-intensity, light-emitting materials that are classified as photoluminescent, i.e., fluorescent and phosphorescent. The term "fluorescent" is specific to the various organic dyes containing individual molecules capable of fluorescing. Although this invention contemplates the use of such organic dyes directly in the coating composition for the detonating fuse, further discussion will relate to the luminescent substances that are readily available commercially in the form of finely divided fluorescent pigments. These pigments are normally composed of an organic dye dispersed within a transparent organic resin carrier or matrix, such as triazineformaldehyde resin. The term "phosphorescent" is means to include the impurity phosphors as well as other materials of this type that are commercially available.

The term "paraffin wax" is used herein in a manner consistent with customary usage and has reference to any of the commercial paraffins obtained from solid, inflammable hydrocarbons of the methane series, boiling above about 300° C. and produced by distilling wood, shale, coal and the like, or occurring as a constituent of petroleum or as a solid deposit. Various natural waxes such as carnauba, beeswax and the like, as well as microcrystalline waxes, synthetic waxes, hydrogenated oils and stearates may also be employed as a low melting carrier material for the luminescent pigments.

Although coating compositions that contain luminescent pigments dispersed within waxes alone are meant to be included herein, special advantages have been found to be provided by including significant amounts of other well-known low-melting, coating components that beneficially modify the physical properties of the applied composition. Thus, various thermoplastic binders in amounts up to 10% and greater may be included to enhance the tensile strength and ductility of the luminescent wax coating. For example, ethylene-vinyl acetate copolymers, available in commercial forms such as EVA-505 from Union Carbide Co., may be employed. In addition, various materials in amounts such as up to 25% may be employed to increase the adhesive characteristics (tackiness) of the wax-containing coating composition. A typical example of such a material is Staybelite Resin, a hydrogenated wood rosin available from Hercules Powder Co.

Various thermoplastic resins, such as the chemically inert, polyterpene hydrocarbons, are also useful additions to the wax-containing coating composition for increasing the viscosity and assisting in suspension of the fluorescent pigment. Such materials also assist in stabilizing the coating composition near the softening point of the wax without adversely affecting coloring. Furthermore, it will be apparent to one skilled in this art that other well-known coating additives may also be employed where their specific properties are required in the ultimate coating compositions.

The light-emitting characteristics of commercially available fluorescent pigments are enhanced with a reduction in particle size. Optimum luminescence is provided when the particle size of the fluorescent pigments are reduced to less than 44 microns and especially between about 5 and 30 microns.

It is desirable to provide the detonating fuse with a fluorescent pigment-containing outer surface that is at least 1 mil in thickness. Of course it will be apparent to one skilled in this art that when the coating is applied in a liquid form directly to a textile covering, such as by conventional die application operations, the coating will flow into the voids between the textile strands. Therefore, the

actual coating application may be of widely varying thicknesses throughout a given length of denonating fuse. Where more intense luminescence is desired, coatings having an average thickness of up to 10 mils and greater can also be employed.

In order to insure that the luminescent pigments will be uniformly dispersed throughout the final coating composition, it has been found necessary to exercise accurate control of process conditions. Thus, the temperature employed during formulation of the luminescent pigment-containing composition is critical. Although the temperature must be at least sufficient to melt the paraffin wax and other low melting coating ingredients, temperatures in excess of 200° F. have been found to cause deterioration of the fluorescent pigment matrix. This in turn causes agglomeration of the fluorescent dye and/or chemical rearrangement of the luminescent molecular structure, either of which destroys the luminescent characteristics of the pigments. Through extensive experimentation, temperatures in the range of about 160°-180° F. have been found to be required to maintain conditions suitable for uniform dispersion without reducing luminescence.

In still another process aspect, it is necessary to maintain the melted coating components in a state of agitation, during the slow addition of the luminescent pigment thereto. In this manner, coagulation of the pigment particles within the wax-containing liquid composition is prevented.

To further illustrate the invention, the following examples are provided. It should be understood that the details thereof are not to be regarded as limitations as they may be varied as will be understood by one skilled in this art.

EXAMPLE I

A luminescent coating composition was prepared in the following proportions:

	Grams
Paraffin wax	98
P-1600-514 (Orange-Red) ¹	4

¹ A finely, ground fluorescent pigment available from Radiant Color Co., 2800 Radiant Ave., Richmond, Calif.

The wax was melted by raising the temperature to about 170° F. While subjecting the liquid wax to continuous agitation, the fluorescent pigment was slowly added thereto. Agitation was continued until the dispersion of pigment appeared to be uniform throughout the wax. The luminescent composition was then applied in a conventional manner to the outside of a length of orange-colored, textile sheathed detonating fuse. The resulting coating thickness was 2 mils. The color emitted by the coating was luminescent but of weak intensity. The pigments "wetted out" easily in the paraffin wax alone. It was found that the addition of other composition ingredients was most conveniently accomplished subsequent to the initial suspension of the pigment in the wax.

EXAMPLE II

Following the procedure set forth in Example I, a luminescent coating composition having the following proportions (in percent by weight) was prepared and applied to a length of detonating fuse:

	Percent
Paraffin wax	49
EVA-505 Plastic ²	5
Staybelite Resin ³	20
Nirez 1100 Resin ⁴	23
Day-Glo A-14 (Fire Orange) ⁵	3
	100

² An ethylene-vinyl acetate copolymer available from Union Carbide Co.

³ A hydrogenated wood resin available from Hercules Powder Co.

⁴ A polyterpene available from Newport Industries Div., Heyden Newport Chemical Corp.

⁵ A fluorescent pigment available from Switzer Bros., Inc.

The resulting coated detonating fuse displayed excellent luminescent light emission characteristics. The fuse was readily visible from a distance greatly in excess of that at which conveniently coated fuse can be observed.

Although the foregoing invention has been described in some detail by way of illustration and example for purposes of clarity of understanding, it will be apparent that certain changes and modifications may be practiced within the spirit of the invention as limited only by the scope of the appended claims.

What is claimed is:

1. A textile-sheathed detonating fuse including a core containing a high intensity explosive, a flexible sheath surrounding said core and an outer waterproof coating composition on said sheath, said coating composition including a luminescent substance, in an amount sufficient to provide the sheath outer surface of said fuse with luminescent emission characteristics.

2. A detonating fuse in accordance with claim 1 wherein said composition contains paraffin wax; said luminescent substance is a fluorescent pigment comprising from about 3 to 6% by weight of the total weight of said composition; and said outer coating surface comprises a thickness of at least 1 mil.

3. A detonating fuse in accordance with claim 2 wherein said coating composition also contains, in weight percentage, about 5% of an ethylene-vinyl acetate copolymer, about 20% of a hydrogenated wood rosin and about 23% of a polystyrene hydrocarbon resin, the remainder being paraffin wax.

4. A detonating fuse in accordance with claim 1 wherein said composition contains microcrystalline wax.

5. A textile-sheathed detonating fuse in accordance with claim 1 wherein said luminescent substance is a photo luminescent material selected from fluorescent and phosphorescent.

6. A process for preparing a flexible cored detonating fuse having a waterproof luminescent outer surface covering, comprising the steps of: adding a luminescent substance to a liquid coating composition, said substance being present in an amount sufficient to provide resulting composition with the desired light-emitting characteristics when applied to said fuse, continuously agitating said composition during the addition of said substance to produce uniform dispersion thereof, the temperature of said composition being sufficient to maintain said composition in a liquid state but insufficient to cause deterioration of said luminescent substance, and thereafter applying said luminescent composition as a surface coating to said detonating fuse.

7. A process in accordance with claim 6 wherein said liquid composition is maintained at about 160-180° F. during the addition of said luminescent substance.

8. A process in accordance with claim 6 wherein said luminescent substance is a fluorescent pigment, and said surface coating is applied to thickness of at least 1 mil.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,474,730 Dated October 28, 1969

Inventor(s) Harold W. Sheeran Assignee: Apache Powder Company

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 4, line 4, the word "conveniently" should be --conventionally--; line 29, the word "polystyrene" should be --polyterpene--.

SIGNED AND
SEALED
MAR 10 1970

(SEAL)

Attest:

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