United States Patent

Selleck et al.

[15] **3,653,995**

[45] **Apr. 4, 1972**

[54] INCENDIARY COMPOSITION

[72] Inventors: **Edward G. Selleck**, San Diego; **Alfred F. Weinberg**, El Cajon; **Geoffrey R. Tully, Jr.**, Poway, all of Calif.

[73] Assignee: **Gulf Oil Corporation**, San Diego, Calif.

[22] Filed: **Mar. 26, 1969**

[21] Appl. No.: **810,804**

[52] **U.S. Cl.** **149/19**, 75/.5, 149/20, 149/21, 149/87, 149/114

[51] **Int. Cl.** **C06d 1/02**

[58] **Field of Search** 149/19, 114, 87, 20, 21

[56] **References Cited**

UNITED STATES PATENTS

3,565,706	2/1971	Waite	149/19
2,560,452	7/1951	Kerr et al.	149/114 X
3,235,422	2/1966	Stang	149/19
3,275,484	9/1966	Foote et al.	149/38
3,441,549	4/1969	Gardiner et al.	260/88.3

Primary Examiner—Carl D. Quarforth
Assistant Examiner—E. A. Miller
Attorney—Fitch, Even, Tabin and Luedeka

[57] **ABSTRACT**

A pyrophoric powder made of an alloy of misch metal having a particle size distribution making it particularly suitable for employment in an airborne incendiary device in combination with an organic binder that serves to initiate oxidation and as an oxidizer. Incendiary devices using the powder dispersion exhibit prompt and sure ignition followed by the formation of a clinker with uniform and slow secondary burning properties.

7 Claims, No Drawings

INCENDIARY COMPOSITION

The present invention relates generally to pyrophoric powders and more particularly to a pyrophoric power having excellent characteristics for ordnance purposes.

Solid pyrophoric materials are well known and have the property of emitting sparks when scratched or struck with a hard object such as steel. Pyrophoric material are commonly used in cigarette lighter flints and in lighters for gas welding apparatus.

It has been proposed to provide pyrophoric materials in a finely divided, particulate form referred to herein as a pyrophoric powder. Such pyrophoric powders are useful as incendiary materials in the manufacture of incendiary weapons and the like. A particularly useful pyrophoric material is disclosed in U.S. Pat. application Ser. No. 752,172, filed Aug. 13, 1968, entitled "Pyrophoric Powders and Method for Producing Same". This application discloses making a pyrophoric powder from misch metal, which is a well known metal alloy that consists of a crude mixture of cerium, lanthanum, neodymium, praseodymium and other rare earch metals in the approximate ratio in which they occur in monazite sand or bastnasite ore. A friable substance is created by combining misch metal with a suitable alloying material, such as zinc, carbon, or silicon.

An incendiary device should have particular characteristics to perform its function adequately, and these characteristics are in great part imparted to it by the pyrophoric powder. The pyrophoric metal powder when combined with a binder material should be readily ignitable, and after ignition, the combined system should undergo uniform, long, secondary burning, The powder should also be preliminarily compatible with the organic binder system in which it is usually employed in an incendiary device.

It is an object of the present invention to provide an improved pyrophoric powder. It is another object of the present invention to provide a pyrophoric powder with improved dispersion, ignition and burning characteristics. It is a further object to provide an improved incendiary dispersion for use in an incendiary device. These and other objects of the present invention should be apparent from the following detailed description.

Generally, a pyrophoric metal alloy is provided having a particular particle size distribution which results in both good ignition and in slow and uniform secondary burning when combined with a suitable binder material. It has been determined that the proportion of relatively fine and relatively coarse particles in the pyrophoric powder is important in providing the desired ignition and burning characteristics for an incendiary device.

It has been found that the presence of a relatively fine powder fraction facilitates ignitability. However, uniform long burning is a characteristic of the formation of a fairly solid clinker from the pyrophoric metal powder, and it is has been found that the formation of a clinker is aided by the provision of some relatively coarse particles in the particle size spectrum of the pyrophoric powder. To provide an incendiary device having the desired characteristics, the size distribution of the powder is regulated so that between about 1 and 4 weight percent of the particles are larger in size than 160 microns and between 35 and 50 weight percent of the particles are less than 45 microns in size.

As explained in detail hereinafter, it is contemplated that the powder will be dispersed in an oxidizing organic binder when employed as an incendiary. Usually, the powder will be mixed with a monomer in generally liquid or plastic form which can be cast to the desired shape and then polymerized. It is important that the powder spectrum be compatible with the monomer system employed and that if form a stable uniform dispersion with the monomer during casting and polymerization. It has been found that the inclusion of between about 35 and 50 weight percent of the particles in size range between 45 microns and 20 microns facilitates the initial formation of a stable dispersion of the powder in the monomer and that such a powder spectrum has a character that is fully compatible with the polymerization of the system, as explained in more detail hereinafter.

As indicated above, the preferred pyrophoric powder is an alloy of misch metal plus an alloying material which imparts friability. In the preferred composition, misch metal is combined either with 15 to 20 percent by weight of silicon, or with about 8 to 10 percent by weight of carbon, or with about 25 to 40 percent by weight of zinc, (all percentages being based on the final pyrophoric metal alloy). Various combinations of the alloying materials may also be used at intermediate levels to provide a suitable alloy.

The final pyrophoric powder desirably has a density of between about 6.5 to 7.5 g/cm.$^{3.}$ An additive can be combined with the alloy, if necessary, to adjust its density to within this desired range. Examples of suitable additives are metals having a density between about 5.0 g./cm.^{3} and about 19.5 g./cm.$^{3.}$ such as cadmium, tungsten and lead, or compounds thereof. Mixtures of such metals may also be used.

Grinding of pyrophoric alloy should be carried out in an inert atmosphere. Attempts are made to grind the alloy in a manner to produce powder having approximately the particle size distribution desired; however, it is realized that subsequent separation of the particle fractions is usually required to obtain the desired size distribution. The ground pyrophoric powder fractions may be separated by any suitable technique, such as screening, into a relatively coarse fraction above about 160 microns and a relatively fine fraction below about 45 microns. Desired relative proportions of the fractions are thereafter recombined with a suitable amount of particles in the intermediate size range to provide a pyrophoric powder having the desired particle size distribution. Although no absolute limits are set for the maximum and minimum particle sizes, no substantial proportion of the particles in the final product are usually less than about 20 microns or more than about 200 microns.

Usually, the ground powder is separated by conventional sizing techniques, such as sieve screening, and appropriate portions of the fractions are then recombined to provide a pyrophoric powder having the desired particle size distribution. In addition to maintain the fraction of particles greater than about 160 microns at a level of 1 to 4 weight percent and the fraction of particles less than 45 microns at a level between 35 and 50 weight percent, there is a preferred size distribution for the particles within the intermediate fraction, which constitutes between about 46 to 64 weight percent of the total product. Of this intermediate fraction, it is preferred if about one-half (by weight) is made up of particles about 75 microns in size and the other half is below 75 microns in size. It has been found that the employment of about one-half of the intermediate fraction in the particle size range between 45 microns and 75 microns further aids in the dispersibility of the powder when mixed with the monomer and amplifies the stability of the dispersion of the powder in the monomer, i.e., resisting settling prior to and during polymerization.

As previously indicated, it is contemplated that the pyrophoric powder will be employed as a dispersion in a solid polymeric organic material that serves as a binder and an oxidizing agent and the also burns itself to initiate oxidation of the powder. The use of such organic materials is generally known in the art of incendiary devices, and various suitable organic materials may be employed with the pyrophoric powder described hereinbefore.

Of course, one of the chief functions of the organic material is to serve as a binder to hold the particles together as a single entity. In this respect the binder should have sufficient strength, at the percentage levels at which it would be employed with the pyrophoric powder, to permit normal handling in the fabrication and delivery of the incendiary device. Desirably, the incendiary dispersion contains about 40 volume percent of the pyrophoric powder and about 60 volume percent of the organic binder, and it is considered that the organic material should not constitute more than 65 volume per-

cent of the dispersion. In addition to providing structural strength during fabrication, and subsequent handling and delivery, the organic material should also retain its strength during the early state of oxidation to physically hold the particulate dispersion together as an entity until the clinker is formed.

The other main function of the organic binder is to initially burn by combination with oxygen from the atmosphere to thereby initiate oxidation of the misch metal alloy. In an incendiary device of this type, a suitable igniter will be used to start the initial burning of the organic material. In addition, the organic binder also serves as an oxidizer to facilitate the oxidation of the misch metal alloy.

Suitable organic binders may utilize epoxy monomers and/or derivatives of methacrylic acid, for example. As one example, one might employ equal parts by weight of glycidyl methacrylate and one or more methacrylic acid derivative which are chosen for their capability to serve as oxidizer, such as esters of methacrylic acid and nitroalcohols and/or fluoroalcohols. Suitable inhibitors, such as hydroquinone, and polymerization catalysts, which are well known in the art, are also included. It is important for fabrication purposes that the presence of the powder should not adversely affect the organic system, as it is possible that the presence of finely divided metals might perturb the catalyst and prevent the polymerization from occurring in its intended manner. Either too rapid or incomplete polymerization could hamper fabrication and might result in an end product of lower than adequate strength of one of poor uniformity. However, it has been found that if the powder contains not more than 50 weight percent of particles below about 45 microns and no substantial portion below 20 microns, the polymerization of epoxy and methacrylate monomers should proceed without adverse affect.

A pyrophoric powder of the alloy specified above having a particle size distribution as above-indicated is considered to perform excellently for incendiary purposes. The powder is considered particularly suitable for employment in an airborne incendiary device wherein it will be combined with an organic binder that serves to initiate oxidation and as an oxidizer. The powder is compatible with binders of this sort, and incendiary devices using such a powder dispersion exhibit prompt and sure ignition followed by the formation of a clinker with uniform and slow secondary burning properties.

Various of the features of the invention are set forth in the appended claims.

What is claimed is:

1. An incendiary dispersion of pyrophoric powder in a polymerized organic binder for employment in an incendiary device, said powder comprising an alloy of misch metal and an alloying material selected from the group consisting of zinc, silicon, carbon and combinations thereof, said alloy being present in the form of particles having a particle size distribution such that about 1 to 4 weight percent of the particles are above 160 microns, about 46 to 64 weight percent of the particles are between 45 and 160 microns, and about 35 to 50 weight percent of the particles are less than 45 microns, said organic binder serving as an oxidizer to facilitate oxidation of said misch metal alloy.

2. An incendiary dispersion in accordance with claim 1 wherein about one-half by weight of said particles between 45 and 160 microns are below 75 microns in size.

3. An incendiary dispersion in accordance with claim 1 wherein said organic binder is present in an amount not greater than about 65 volume percent of the total of powder plus binder.

4. An incendiary dispersion in accordance with claim 3 wherein said organic binder is a mixture of epoxy and methacrylate monomers which have been polymerized and cast to a desired solid shape.

5. An incendiary dispersion in accordance with claim 4 wherein no substantial portion of the said particles are below about 20 microns or above about 200 microns.

6. An incendiary dispersion in accordance with claim 3 wherein said organic binder is present in an amount of about 60 volume percent of said dispersion.

7. An incendiary dispersion in accordance with claim 1 wherein said organic binder includes glycidyl methacrylate.

* * * * *