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BLACK SMOKE MARKER

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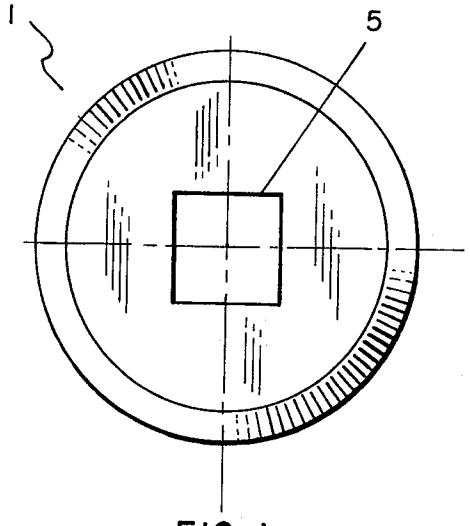


FIG. 1

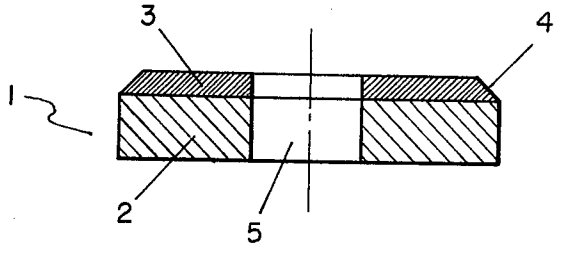


FIG. 2

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BLACK SMOKE MARKER

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ABSTRACT OF THE DISCLOSURE

A black smoke marker pellet for projectiles comprises an igniter composition composed of boron powder, potassium nitrate and a binder superimposed directly on a novel black smoke composition consisting essentially of hexachlorocyclopentadiene dimer and/or hexachlorobenzene, a polycyclic aromatic hydrocarbon such as anthracene, a powdered metallic fuel such as magnesium and an inorganic oxidizer such as strontium nitrate.

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

BACKGROUND OF THE INVENTION

This invention relates to novel black smoke marker compositions particularly suitable for use in ammunition.

It is known to use incendiary and smoke generating compositions in projectiles as tracing means to render the trajectory of the projectile visible to the human eye. Incendiary tracers are generally satisfactory as smoke tracers for daytime use, since they do not produce a visible trail which persists for a sufficient period. Smoke tracer compositions are advantageous in that they leave a persistent trail of smoke. However, to be effective and satisfactory for practical use, smoke markers or tracers must possess a combination of properties which are unusual and difficult to attain in high degree. Thus, they must be capable, inter alia, of being ignited within a few milliseconds and of generating a large volume of smoke in a short period, e.g. 0.5 to 1 second, so as to discharge from a projectile traveling at high velocity a persistent trail of smoke, which is readily visible day or night without binoculars from a distance of one or two miles. In the past smoke tracer compositions have not been wholly satisfactory in that they have not provided sufficient volume and/or intensity of smoke to enable the observer to follow the path of the projectiles, or they have been deficient in other properties, e.g. slow ignition, hazardous and/or costly manufacturing processes, etc.

DESCRIPTION OF THE INVENTION

An object of the invention is to provide a novel black smoke composition particularly suited for use as a marker or tracer for ammunition.

A particular object of the invention is to provide a novel smoke marker pellet for artillery ammunition, which is capable of being ignited after fuze function near the target to generate a large volume of black smoke so as to leave a persistent smoke trail readily visible during day time or at night to an observer to radio range and deflection errors to gun position.

Another object is to provide a novel smoke marker comprising a novel black smoke generation composition and an igniter composition therefor, which possesses excellent storage stability and can be manufactured safely and economically.

Other objects of this invention are obvious or will be apparent to those skilled in the art from the following disclosure.

These objects are attained by the black smoke marker pellet of our invention which comprises

(1) a novel black smoke-generating composition consisting essentially of

(a) a perchlorinated hydrocarbon of the group consist- of hexachlorobenzene and hexachlorocyclopentadiene dimer (also known as Dechlorane®),
(b) an aromatic hydrocarbon containing a plurality of fused benzene rings capable of producing black smoke on combustion, such as anthracene and naphthalene,
(c) a powdered metallic fuel, e.g. magnesium and aluminum, together with an inorganic oxidizer therefor, e.g. strontium nitrate, sodium nitrate, potassium perchlorate, and ammonium perchlorate,

(2) an igniter composition consisting of essentially of

(a) powdered boron
(b) potassium nitrate

The black smoke marker pellet of this invention can be obtained by suitable molding methods. For example, the powdered igniter mixture can first be poured into a mold of preferably cylindrical shape sufficient to coat the entire bottom surface of the mold; then the powdered smoke mixture is poured in, slowly at first to avoid moving the igniter mix, after which the mold contents are compressed under a suitable pressure, e.g. 4000 p.s.i., to produce the complete marker pellet. Alternatively, the marker pellet can be obtained by placing the powdered black smoke mixture in a cylindrical mold, tamping it into a cylindrical pellet, adding the powdered igniter mixture sufficient at least to completely cover the face of the smoke pellet, and then pressing the igniter mixture onto the smoke tablet to form the final marker pellet. Also, the black smoke mixture and the igniter mixture each in powdered form, may be separately tamped into pellets, after which the igniter pellet can be pressed onto the smoke pellet to produce the complete smoke marker pellet.

FIG. 1 illustrates a top elevation of a cylindrical smoke marker pellet of the invention. FIG. 2 shows a side elevation of the pellet of FIG. 1.

The black smoke generating composition preferably includes the following proportions of ingredients in percentages by weight:

	Percent
(a) Dimer of hexachlorocyclopentadiene or hexachlorobenzene	45–65
Anthracene (or other aromatic hydrocarbon containing a plurality of fused benzene rings capable of producing a black smoke on combustion)	15–25
(c) Strontium nitrate (or other inorganic oxidizer e.g. potassium perchlorate)	5–10
(d) Powdered magnesium (or other powdered metallic fuel, e.g. aluminum)	10–20

A small amount (e.g. 1%) of a binder e.g. a Laminac resin (polyesterstyrene resin) or a polyvinyl alcohol-polyvinyl acetate copolymer resin, dissolved in a suitable solvent, may be added to improve the strength of the pellet obtained when the composition is molded under pressure.

The igniter composition consists essentially of a mixture of powdered boron and finely divided potassium nitrate together with a small amount of a binder therefor e.g. Laminac resin and, in particular, a polyvinyl alcohol-polyvinyl acetate copolymer resin, sufficient to bond the mixture into a coherent layer which is firmly bonded to

the black smoke composition layer when the pellet is compression molded. Preferably, the igniter composition contains the following proportions of ingredients by weight:

	Percent
Boron	20–30
Potassium nitrate	65–80
Binder	.1–5

The following example illustrates the production of a novel smoke marker pellet of this invention. The percentages are by weight.

EXAMPLE 1

Part (A)

A black smoke-generating composition was prepared by mechanically mixing the following powdered ingredients until a homogeneous power was obtained. All ingredients were in the form of powders of 200 to 325 mesh size.

Ingredients:	Percentage
Dechlorane [1]	57.76±2.0
Anthracene	20.30±2.0
Magnesium powder	14.78±1.0
Strontium nitrate	6.93±0.5
Polyethylene	0.23±0.1

[1] Dimer of hexachlorocyclopentadiene, trademark of Hooker Chemical Corp.; also known as dodecachlorooctahydro-1,3,4-methano-1H-cyclobuta[c,d]pentalene.

Part (B)

An igniter composition was prepared by slurrying the following ingredients in ethanol:

Ingredients:	Percentage
Boron, amorphous powder 1 micron	25±2
Potassium nitrate powder 15 microns	74±2
Polyvinyl alcohol-polyvinylacetate copolymer resin	1±.5

The slurry was allowed to evaporate almost to dryness and the slightly moist product thus obtained was screened through a 24 mesh screen to produce a finely divided product.

Part (C)

0.5 gram of the igniter composition obtained in Part B was poured into a cylindrical mold of 1.75 inches diameter, provided with a 0.5 inch square coaxial key and a ram piston, so as to uniformly cover the bottom surface of the mold. 20 grams of the black smoke composition obtained in Part A was poured on top of the igniter composition. The mold charge was then compressed under a pressure of 4000 p.s.i. for 2 seconds into a pellet approximately 0.53 inch in height. The pellet was removed from the mold and given a 45° bevel by machining. The resulting pellets, as illustrated in FIGS. 1 and 2, was a cylinder **1** about 1.75 inch diameter consisting of a layer **2** of the black smoke composition 0.41 in. thick and a layer **3** of igniter composition about 0.12 in. thick provided with a 45° bevel **4** and square coaxial key **5** so as to fit into a fuze adapter of a projectile.

The marker pellet thus obtained was placed in the fuze adapter of a projectile wherein it was positioned to become ignited by a spit of flame from a detonator activated by a mechanical time fuze. The fuze was set to function 2.7 seconds after firing with the projectile traveling 1800 feet per second. The marker gave a dense black smoke trail about 1000 feet long which peristed for about 22 seconds under nearly calm conditions. The marker was observed from a helicopter up to about 13,000 feet maximum slant range with the sky as a backdrop and also with the ground as a backdrop. Under these conditions the marker consistently provided a trail of good visibility of about 1000 feet long with a delay of less than 100 feet from the first function of the projectile to start of trail. The trail was easily visible both in daylight and at night.

Pellets obtained as described in the example possessed excellent storage stability. They exhibited no separation of igniter composition layer from the black smoke composition on storage and showed no harmful corrosion of the aluminum housing conventionally used to contain the pellet in the projectile.

When the dechlorane was replaced by an equal weight of hexachlorobenzene in the foregoing example, a black smoke marker pellet of essentially the same properties was obtained.

By way of comparison various known igniter compositions, e.g. boron-barium chromate, boron-zirconium-barium chromate, and black powder were tested in plate of the boron-potassium nitrate igniter in the production of marker pellets as described in the example. All were found unsuitable, since they failed to ignite the black smoke composition. Another test was carried out using a known "hot, photoflash" igniter of the prior art consisting of a mixture of nitrocellulose (3 parts), 50/50 mixture of magnesium and aluminum 200 mesh (4 parts) and barium nitrate (6 parts). This composition ignited the smoke composition under the aforesaid test conditions; however, it was unsatisfactory for military use, since it split away from the pellet. The latter igniter composition was too brittle to adhere to the smoke pellet under pressure; hence it was brushed on as a slurry in acetone and allowed to dry.

From the foregoing description it is evident that the invention provides a number of valuable and unobvious advantages over the prior art. Thus, it provides a novel black smoke composition combined with a particular igniter composition, which is capable of igniting said smoke marker for use in artillery projectiles, which ignites essentially instantaneously after fuze function near the target and provides a persistent trail of intense black smoke, which is readily visible day or night without binoculars. Also, it employs dechlorane nad hexachlorobenzene which unlike hexachloroethane previously employed in smoke markers, are not readily lost from the composition by volatilization under ordinary temperatures, and are relatively non-corrosive to metals. Further, the novel smoke marker pellets of this inventtion exhibit relatively little deterioration on storage and are relatively non-corrosive to aluminum fuze adapters conventionally used, which could interfere with functioning of the marker. Also, the smoke marker pellet can be manufactured safely and economically from readily available low cost materials, simply by compressing the novel powdered black smoke composition and the igniter composition for example in a cylindrical mold. The pellet thus produced is composed of a cylinder of the black smoke composition whose end surface is covered with a layer of the igniter composition, which does not split away and separate from the smoke composition on storage.

We wish it to be understood that we do not desire to be limited to the exact method and detail of construction described for obvious modification will occur to persons skilled in the art.

What is claimed is:

1. A black smoke marker pellet comprising a black smoke generating composition consisting essentially of

(a) a perchlorinated hydrocarbon of the group consisting of hexachlorocyclopentadiene dimer and hexachlorobenzene,

(b) an aromatic hydrocarbon containing a plurality of fused benzene rings capable of producing a black smoke on combustion,

(c) a powdered metallic fuel,

(d) an inorganic oxidizer,

and an igniter composition therefor consisting essentially of powdered boron, potassium nitrate and a binder, the igniter composition being present as a separate layer in contact with the smoke composition.

2. A pellet according to claim 1, wherein the black smoke generating composition consists essentially of

	Percent
(a) a perchlorinated hydrocarbon of the group consisting of hexachlorocyclopentadiene dimer and hexachlorobenzene	45–65
(b) an aromatic hydrocarbon containing a plurality of fused benzene rings capable of producing a black smoke on combustion	15–25
(c) a powdered metallic fuel	10–20
(d) an inorganic oxidizer	5–10

and the igniter composition consists essentially of

	Percent
(e) boron powder	20–30
(f) potassium nitrate	65–80
(g) binder	.1–5

3. A pellet according to claim 2, wherein the aromatic hydrocarbon is anthracene, the metallic fuel is magnesium and the inorganic oxidizer is selected from the group consisting of strontium nitrate and potassium perchlorate.

4. A pellet according to claim 3, wherein the binder is a polyvinyl alcohol-polyvinyl acetate copolymer resin.

5. A pellet according to claim 4, wherein the black smoke geenrating composition consists essentially of

	Percent
(a) hexachlorocyclopentadiene dimer	56–60
(b) anthracene	18–22
(c) magnesium powder	14–16
(d) strontium nitrate	6.5–7.5

and the igniter composition consists essentially of

	Percent
(e) boron powder	23–27
(f) potassium nitrate	72–76
(g) polyvinyl alcohol-polyvinyl acetate coplymer resin	0.5–1.5

6. A black smoke generating composition consisting essentially of

(a) a perchlorinated hydrocarbon of the group consisting of hexachlorocyclopentadiene dimer and hexachlorobenzene,

(b) an aromatic hydrocarbon containing a plurality of fused benzene rings capable of producing a black smoke on combustion,

(c) a powdered metallic fuel,

(d) an inorganic oxidizer.

7. A black smoke generating composition according to claim 6, wherein the ingredients are present in the following percentages by weight:

	Percent
(a) a perchlorinated hydrocarbon of the group consisting of hexachlorocyclopentadiene dimer and hexachlorobenzene	45–65
(b) an aromatic hydrocarbon containing a plurality of fused benzene rings capable of producing a black smoke on combustion	15–25
(c) a powdered metallic fuel	10–20
(d) an inorganic oxidizer	5–10

8. A black smoke generating composition according to claim 7, wherein the aromatic hydrocarbon is anthracene, the metallic fuel is magnesium and the inorganic oxidizer is selected from the group consisting of strontium nitrate and potassium perchlorate.

9. A black smoke generating composition according to claim 8, wherein the ingredients are present as follows:

	Percent
(a) hexachlorocyclopentadiene dimer	56–60
(b) anthracene	18–25
(c) magnesium powder	14–16
(d) strontium nitrate	6.5–7.5

References Cited

UNITED STATES PATENTS

1,042,176	10/1912	Völler	102—60 X
2,960,934	11/1960	Jackson et al.	102—65 X
3,430,569	3/1969	Crane et al.	149—84 X
3,475,237	10/1969	Lane et al.	149—22
3,617,403	11/1971	Johnson	149—19
3,633,512	1/1972	Schlack et al.	102—87

OTHER REFERENCES

Ray: "Industrial and Engineering Chemistry," 18, No. 1, pp. 10–17, (January 1926).

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