

- [54] **PYROTECHNICAL MIXTURE FOR PRODUCING A SMOKE SCREEN**
[75] **Inventor:** **Uwe Krone**, Hamfelde, Fed. Rep. of Germany
[73] **Assignee:** **Rheinmetall GmbH**, Düsseldorf, Fed. Rep. of Germany

- [21] **Appl. No.:** **350,737**
[22] **PCT Filed:** **May 5, 1988**
[86] **PCT No.:** **PCT/EP88/00378**
§ 371 **Date:** **Apr. 26, 1989**
§ 102(e) **Date:** **Apr. 26, 1989**

- [87] **PCT Pub. No.:** **WO89/01926**
PCT Pub. Date: **Mar. 9, 1989**

- [30] **Foreign Application Priority Data**
Aug. 26, 1987 [DE] Fed. Rep. of Germany 3728380

- [51] **Int. Cl.⁵** **C06B 33/14**
[52] **U.S. Cl.** **149/41; 149/42; 149/43; 149/44; 149/61; 149/70; 149/77; 149/83; 102/334**
[58] **Field of Search** **149/70, 61, 41, 77, 149/42, 83, 43, 44; 102/334**

[56] **References Cited**
U.S. PATENT DOCUMENTS

H232	3/1987	Selzer	149/30
H233	3/1987	Tracy	149/83
H705	11/1989	Selzer et al.	149/61
1,461,646	7/1923	French et al.	149/61
2,995,526	8/1961	DeMent	252/305
3,274,035	9/1966	Burkardt et al.	149/40
3,862,866	1/1975	Timmerman et al.	149/21

4,100,102	7/1978	Shaffer	149/87
4,435,233	3/1984	Rayer et al.	149/87
4,438,700	3/1984	Knapp	102/334
4,474,715	10/1984	Weber et al.	149/76
4,697,521	10/1987	Espagnacq et al.	149/87
4,698,108	10/1987	Vega et al.	149/87
4,724,018	2/1988	Espagnacq et al.	149/87
4,841,865	6/1989	Lieberman	149/87

FOREIGN PATENT DOCUMENTS

803645	2/1951	Fed. Rep. of Germany
918196	8/1954	Fed. Rep. of Germany
2743363	9/1977	Fed. Rep. of Germany
2819850	5/1978	Fed. Rep. of Germany
339233	1/1905	France
2032588	5/1980	United Kingdom

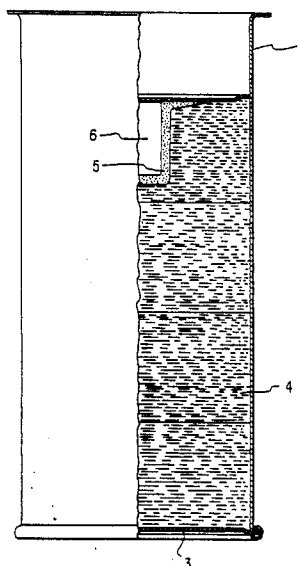
OTHER PUBLICATIONS

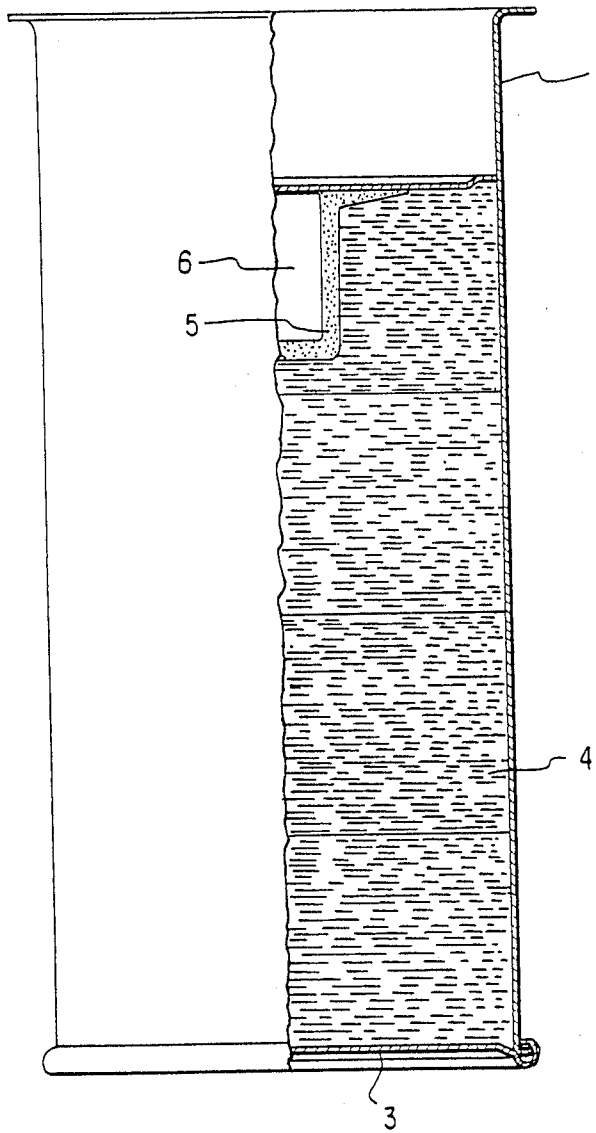
- T. L. Davis, *The Chemistry of Powder and Explosives*, 1943, pp. 324-325.
H. Ellern, *Military and Civilian Pyrotechnics*, 1968, pp. 174-175.
J. A. Conkling, *Chemistry of Pyrotechnics—Basic Principles and Theory*, 1985, pp. 147-151.
Primary Examiner—Stephen J. Lechert, Jr.
Attorney, Agent, or Firm—Spencer & Frank

[57] **ABSTRACT**

A pyrotechnic mixture for producing a smoke screen includes a reduction agent comprising a light metal, at least one oxidation agent comprising potassium nitrate, combustion moderators including at least one carbonate and a nitrogen producing compound and at least one sublimable or evaporatable, smoke generating, nontoxic additive.

16 Claims, 1 Drawing Sheet





PYROTECHNICAL MIXTURE FOR PRODUCING A SMOKE SCREEN

BACKGROUND OF THE INVENTION

The invention relates to a pyrotechnic mixture for producing a smoke screen.

Such mixtures are known per se. Hygroscopic compounds, such as metal chlorides ($ZnCl_2$, $FeCl_3$, $AlCl_3$, $TiCl_4$, $SiCl_4$) or phosphorus oxides (P_2O_3 , P_2O_5) are produced, evaporated and then hydrolyze with air to form smoke clouds suitable for camouflage. Regarding the mechanism of this method of smoke generation see H. Ellern, *Military and Civilian Pyrotechnics*, Chem. Publ. Comp., Inc., N.Y., 1968, pages 147-151; John A. Conkling, *Chemistry of Pyrotechnics*, Marcel Dekker Inc., N.Y., 1985, pages 174, 175.

Due to hydrolysis with humid air, the resulting smoke, particularly a smoke composed of hexachloroethane containing, so-called HC smoke, compositions, but also phosphorus smoke compositions, is highly acidic since it is primarily hydrochloric acid (HC smoke) or phosphorus acids (phosphorus smoke) that are formed. The smoke is therefore toxic and incompatible with plant life.

Moreover, in the smoke mixture most frequently employed which is based on hexachloroethane (HC) and zinc or zinc oxide, the heavy metal zinc is discharged into the environment.

There has been no lack of attempts to overcome these drawbacks. For example, the pyrotechnic smoke compositions disclosed in German Patents Nos. DE-PS 2,743,363 and DE-AS No. 2,819,850 are constructed in such a manner that the acid effect of the resulting smoke is partially or completely cancelled out by corresponding chemical complex formation or neutralization of the resulting $ZnCl_2$ or of the phosphorus acids. However, toxic substances that are not compatible with the environment are still generated.

SUMMARY OF THE INVENTION

It is therefore an object of the invention to provide a smoke screen which is particularly suitable for training purposes and which is composed of a nontoxic aerosol which therefore is unable to produce a toxic effect on humans and animals and, is compatible with the environment. When NaCl is not employed as an additive, the smoke is primarily composed of macronutrients suitable for plants.

A pyrotechnic mixture for producing a smoke screen, the mixture comprising:

- a reduction agent comprising magnesium powder,
- at least one oxidation agent comprising potassium nitrate,
- combustion moderators including at least one carbonate and a nitrogen producing compound and
- at least one sublimable or evaporatable, smoke generating, nontoxic additive.

The invention as described above generates a nontoxic smoke of sufficient optical density for military training purposes.

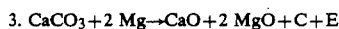
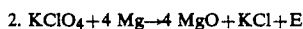
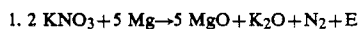
BRIEF DESCRIPTION OF THE DRAWING

The drawing FIGURE shows the mixture of the invention as used in a smoke generating device.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Smoke generation occurs in the following way: the components magnesium powder, potassium nitrate and potassium perchlorate, when converted in a range of $2500^\circ C$. will already produce smoke-like clouds. The density of the smoke is improved particularly by adding potassium chloride and/or sodium chloride whose sublimation boiling points are $1500^\circ C$. and $1450^\circ C$., respectively, far below the reaction temperature for the conversion of magnesium and potassium nitrate. The reaction products of the chemical reaction of magnesium with potassium nitrate, potassium perchlorate, calcium carbonate, etc. thus form with the sublimating potassium chloride or the evaporating sodium chloride a useful training smoke without toxic or environmentally damaging components.

The chemical reactions in the smoke composition can be represented in a simplified manner in the three equations below:



The energy (E) released in the three listed basic reactions serves to sublime/evaporate the potassium chloride and sodium chloride.

To improve combustion control, substances such as azodicarbonamide, oxamide or dicyandiamide which produce nitrogen are preferably added to the mixture. This produces a continuous gas stream for better transport of the aerosol particles and an increased aerosol yield since the permanently formed gases prevent the slag from flowing together and enhance sublimation and evaporation by an enlarged surface area.

When the mixture burns, a pure, white aerosol results which is composed primarily of the components potassium chloride, magnesium oxide, calcium hydroxide, calcium carbonate, sodium chloride and potassium carbonate. These components are compatible with the environment and nontoxic and, except for NaCl, are macronutrients for plants.

The pH of the resulting smoke is highest at the point where it is generated where it has a pH of 9. Chemical reactions of the oxides K_2O and CaO , which are the primary oxides produced, (Equations 1, 3) with components of the air, primarily H_2O and CO_2 , form $KHCO_3$, K_2CO_3 , $Ca(OH)_2$ and $CaCO_3$ and by dilution, cause the pH to decrease rapidly. For example, at a distance of 5 to 10 m from the source of the smoke, the pH of the ambient air reaches about 6 (≈ 6).

A pyrotechnic composition including the same components as the mixture for producing the smoke screen can be employed as an ignition mixture, with, however, the content of magnesium and oxidation agents being increased so as to raise ignition sensitivity and the reliability of ignition transfer. The ignition composition may be composed, for example, of the following percentages of the components: 25% Mg, 35% KNO_3 , 10% $KClO_4$, 20% $CaCO_3$, 10% KCl.

The smoke composition and ignition composition are pressed into casings in a known manner and are caused to react by means of conventional ignition means.

The drawing figure shows one embodiment of a smoke generating body including the novel mixture. In a casing 1 having a bottom 3 there is disposed the compacted mixture 4 which is capped by a pressed-on ignition mixture 5. The embodiment of the drawing includes a recess 6 for the insertion of a known initiation means.

Preferred embodiments of the mixture are listed in the table below:

(a)	Mg	15%
	KNO ₃	30%
	KClO ₄	0%
	CaCO ₃	15%
	KHCO ₃	0%
	KCl	32%
	NaCl	0%
	azodicarbonamide	8%
(b)	Mg	12%
	KNO ₃	25%
	KClO ₄	5%
	CaCO ₃	18%
	KHCO ₃	2%
	KCl	30%
	NaCl	0%
	oxamide	8%
(c)	Mg	20%
	KNO ₃	20%
	KClO ₄	8%
	CaCO ₃	0%
	KHCO ₃	12%
	KCl	15%
	NaCl	15%
	dicyandiamide	10%

I claim:

1. A pyrotechnic mixture for producing a smoke screen, the mixture including:

a reduction agent comprising light metal powder, at least one oxidation agent comprising potassium nitrate, combustion moderators including at least one carbonate and a nitrogen producing compound, and at least one sublimable or evaporatable, smoke generating, nontoxic additive.

2. The mixture according to claim 1, wherein said at least one sublimable, smoke generating, non-toxic additive comprises potassium chloride.

3. The mixture according to claim 1, wherein the nitrogen producing compound comprises one of the compounds selected from the group consisting of azodicarbonamide (NH₂-CO-N=N-CO-NH₂), oxamide (CONH₂)₂ and dicyandiamide (NH=C(NH₂)NH-CN).

4. The mixture according to claim 1 wherein:

said reduction agent comprises Mg present at 10-25% by weight;

said oxidation agent comprises KNO₃ present at 20-36% by weight and;

said at least one carbonate comprises CaCO₃ present at 9-20% by weight;

said at least one sublimable or evaporatable, smoke generating, nontoxic additive comprises at least one compound selected from the group consisting of KCl and NaCl present at 20-50% by weight; and said nitrogen producing compound comprising at least one compound selected from the group consisting of azodicarbonamide, oxamide and dicyandiamide present at 5-20% by weight.

5. A smoke producing device comprising: a smoke generating composition including:

a reduction agent comprising Mg present at 10-25% by weight,

an oxidizing agent comprising KNO₃ present at 20-36% by weight,

a carbonate comprising CaCO₃ present at 9-20% by weight,

at least one sublimable or evaporatable, smoke generating, nontoxic additive comprising at least one compound selected from the group consisting of KCl and NaCl present at 20-50% by weight, and a nitrogen producing compound comprising at least one compound selected from the group consisting of azodicarbonamide, oxamide and dicyandiamide present at 5-20% by weight;

a casing for receiving said smoke generating composition; and

an ignition mixture located at one end of said casing.

6. The smoke producing device according to claim 5, wherein said ignition mixture includes the same components as the smoke generating composition but in different quantitative amounts.

7. The mixture according to claim 1, wherein said light metal powder comprises magnesium.

8. The mixture according to claim 1, wherein said at least one evaporatable, smoke generating, non-toxic additive comprises sodium chloride.

9. The mixture according to claim 1, wherein:

said reduction agent comprises Mg present at about 15% by weight;

said oxidation agent comprises a mixture of KNO₃ present at about 25% by weight and KClO₄ present at about 5% by weight;

said at least one carbonate includes a first carbonate comprising CaCO₃ present at about 12% by weight and a second carbonate comprising at least one of the compounds selected from the group consisting of KHCO₃, NaHCO₃, K₂CO₃ and Na₂CO₃ present at about 3% by weight;

said at least one sublimable or evaporatable combustion moderator comprises at least one compound selected from the group consisting of KCl and NaCl present at about 30% by weight; and

said nitrogen producing compound comprises at least one compound selected from the group consisting of azodicarbonamide, oxamide and dicyandiamide present at about 10% by weight.

10. The mixture according to claim 1, wherein said oxidation agent comprises a mixture of potassium nitrate and potassium perchlorate.

11. The mixture according to claim 1, wherein said at least one carbonate comprises a compound selected from the group consisting of calcium carbonate, potassium hydrogen carbonate, sodium hydrogen carbonate, potassium carbonate, sodium carbonate.

12. The smoke producing device according to claim 5, wherein said ignition mixture includes about 25% by weight Mg, about 35% by weight KNO₃, about 10% by weight KClO₄, about 20% by weight CaCO₃ and about 10% by weight KCl.

13. The mixture according to claim 4, wherein said oxidation agent further comprises KClO₄ present at about 5% by weight in the total mixture.

14. The mixture according to claim 4, wherein at least one said carbonate further includes a second carbonate selected from the group consisting of KHCO₃, NaHCO₃, K₂CO₃ and Na₂CO₃ present at about 3% by weight in the total mixture.

5

6

15. The smoke producing device according to claim 5, wherein said oxidation agent further comprises KClO_4 present at up to 5% by weight in the total mixture.

5, wherein said at least one carbonate further includes a second carbonate selected from the group consisting of KHCO_3 , NaHCO_3 , K_2CO_3 and Na_2CO_3 present at about 3% by weight in the total mixture.

16. The smoke producing device according to claim 5

* * * * *

10

15

20

25

30

35

40

45

50

55

60

65