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DELAY POWDER

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

This invention relates to delay powders for use in fuzes of various types, the powders being an improvement on the type of powder disclosed in Patent No. 1,877,127, dated September 13, 1932.

In the patent cited, delay powders were described comprising a metallic chromate, a metal adapted to react with oxygen to form a solid, and a binder. Such powders have found extensive use for various purposes, particularly in closed systems where the development of gaseous products of combustion by a delay powder would be objectionable if not definitely prohibitive. Owing to the special property of such powders to produce little or no gas upon combustion, new demands have arisen in connection with their application, such demands making necessary powders having a much slower rate of burning than is obtainable with the type formerly developed. The reason that the chromate-metal powders cannot be adjusted by altering the proportion of the ingredients to obtain sufficiently slow burning delay trains, resides in the fact that slow burning powders of that type are very difficult to ignite and when used in delay trains of small diameter they often fail to burn completely through the delay train. The small quantity of powder in the delay train does not evolve sufficient heat to allow radiation to the metal of the fuze and still provide sufficient heat to maintain combustion. A further difficulty is that while the powders are essentially gasless, the use of linseed oil or other organic compound as a binding agent results in the development of a small but definite amount of gaseous products. In closed systems even small amounts of gaseous products decrease the uniformity of burning, this being accentuated with the slower burning powders.

The present invention has as its primary object the production of a gasless delay powder designed to overcome the deficiencies mentioned above. The objectives desired have been accomplished by combining reactions between solid oxidizing agents and metals with an entirely different type of reaction, viz., that between finely divided metals and solid non-metallic elements, such as sulphur, red phosphorus, selenium and tellurium. It has long been known that when many metals in finely divided state are mixed with sulphur such mixtures are readily ignitable and in many cases burn to yield only solid prod-

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ucts, i. e., sulphides of the metal. We found by experiment that by formulating delay powders so that a reaction between certain solid oxidizing agents and metals was involved and at the same time a reaction occurred between the particular metal used and a solid non-metallic element, the ignitability of such composition was much improved over that of a composition containing only these solid oxidizing agents and a metal. It was found further that the reaction products were entirely solid and practically no fumes from volatilization occurred even at the high temperatures produced by the burning composition, if metals having relatively high melting points were used, e. g., iron, titanium, manganese, chromium, aluminum, etc.

The solid oxidizing agents employed are such that when they react with the metals in the presence of solid non-metallic elements, the reaction products are entirely solid and practically no fumes or gaseous products occur even at the high temperatures produced by the burning composition. The compositions formulated according to the present invention are as a consequence substantially free of materials which form gaseous products of combustion when the mixture burns. Examples of oxidizing agents that may be used in practicing the invention are: oxides of heavy metals, e. g., ferric oxide, magnetic iron oxide, cuprous oxide, cupric oxide, silver oxide, lead oxide, lead peroxide, and red lead; and alkaline earth metal peroxides, e. g., barium, calcium and strontium peroxides.

Examples of compositions which have been especially successful in providing slow burning, readily ignitable, gasless delay powder trains are as follows:

No. 1:	Per cent
Silver oxide	50
Iron	25
Phosphorus	25
No. 2:	
Cuprous oxide	80
Manganese	10
Phosphorus	10
No. 3:	
Ferric oxide (Fe ₂ O ₃)	45
Manganese	45
Sulphur	10
No. 4:	
Barium peroxide	60
Chromium	25
Sulphur	15

The burning time of a powder column 2" long

and .22 in diameter for each of the examples given above is as follows:

	Seconds
No. 1 -----	6
No. 2 -----	12
No. 3 -----	9
No. 4 -----	5

The function of the solid non-metallic element in the above composition is to increase the ignitability beyond that attainable with the solid oxidizing agents and metals alone. This is attributed to the fact that the compositions have been formulated to involve the combination of a series of reactions. The separate reactions of oxidizing agents with metals, of oxidizing agents with solid non-metallic elements, and of metal with solid non-metallic elements are not entirely suitable for the production of acceptable slow burning delay powders. The reason is that compositions composed of a solid oxidizing agent and a metal, and compositions composed of a solid oxidizing agent and a solid non-metallic element, when adjusted to burn very slowly, are difficult to ignite and when ignited have a tendency to cease burning in delay trains of small diameter; on the other hand compositions involving the reactions between the finely divided metals and solid non-metallic elements are readily ignitable but burn entirely too fast for use as slow burning delay powders. By combining these reactions, the objections to each separate reaction are overcome, and delay powders of improved characteristics over those previously disclosed are obtained, i. e., slow burning compositions result which readily ignite and when the compositions are loaded in columns of small diameter burn completely through the columns. This is indicated by the data in the examples but additional test data show that with delay trains of smaller diameters, still slower burning of the powders is obtained, due to reduction in amount of heat liberated, until delays of the order of 20 seconds per inch of powder train is practicable without ignition failures or failures to burn through when once ignited.

Such slow burning is unusual and this characteristic of the new delay trains is of much significance since it permits longer delays in completely obturated fuzes than has been attained heretofore.

The new powders are relatively simple to prepare provided close control is exercised over the granulation of the ingredients. It is desirable that the solid oxidizing agents and the metal be sufficiently fine that they will pass a 250 mesh screen. The powders may be mixed in the dry state, or wet with water, carbon tetrachloride or other liquid to reduce the possibility of accidental ignition in manufacture. After thorough mixing the powders are granulated by passing through screens or treatment in mechanical granulators commercially obtainable for such purposes. No binding agent to assist in granulating has been found necessary although such might be used if necessary in some special case.

Powders of this type have been found to be non-hygroscopic and of excellent stability. They are entirely non-explosive since they evolve no gas upon combustion.

We claim:

1. A substantially gasless powder comprising a mixture of a finely divided solid non-metallic element selected from the group consisting of sulphur, phosphorus, selenium and tellurium, a finely divided heavy metal oxide, and a finely divided metal which reacts with said non-metallic element and said heavy metal oxide upon ignition, said non-metallic element, heavy metal oxide and metal being so proportioned that when the mixture thereof is ignited and burns no substantial quantity of gaseous products will be evolved and the said powder being substantially free of materials which form gaseous products of combustion when it burns.

2. A substantially gasless powder comprising a mixture of a finely divided solid non-metallic element selected from the group consisting of sulphur, phosphorus, selenium and tellurium, finely divided silver oxide, and a finely divided metal which reacts with said non-metallic element and said silver oxide upon ignition, said non-metallic element, silver oxide and metal being so proportioned that when the mixture thereof is ignited and burns no substantial quantity of gaseous products will be evolved and the said powder being substantially free of materials which form gaseous products of combustion when it burns.

3. A substantially gasless powder consisting essentially of a mixture of about 50 parts of finely divided silver oxide, about 25 parts of finely divided iron, and about 25 parts of finely divided phosphorus.

4. A substantially gasless powder comprising a mixture of a finely divided solid non-metallic element selected from the group consisting of sulphur, phosphorus, selenium and tellurium, finely divided ferric oxide, and a finely divided metal which reacts with said non-metallic element and said ferric oxide upon ignition, said non-metallic element, ferric oxide and metal being so proportioned that when the mixture thereof is ignited no substantial quantity of gaseous products will be evolved and the said powder being substantially free of materials which form gaseous products of combustion when it burns.

5. A substantially gasless powder consisting essentially of a mixture of about 45 parts of finely divided ferric oxide, about 45 parts of finely divided manganese, and about 10 parts of finely divided sulphur.

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REFERENCES CITED

The following references are of record in the file of this patent:

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Number	Name	Date
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