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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 me 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 my prior 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 the 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 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 chromate and metals with an entirely different type of reaction, viz., that between finely divided metals and solid non-metallic elements such as sulphur. 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 products, i. e., sulphides of the metal. I found by experiment that by

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formulating delay powders so that a reaction between metallic chromates and metals was involved and at the same time a reaction occurred between the particular metal used and sulphur, the ignitability of such composition was much improved over that of a composition containing only the chromates 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, manganese, aluminum, etc.

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

	Per cent
No. 1:	
Barium chromate	90
Zirconium	5
Sulfur	5
No. 2:	
Strontium chromate	80
Manganese	16
Sulfur	4
No. 3:	
Barium chromate	80
Manganese	13
Sulfur	7
No. 4:	
Barium chromate	74
Manganese	24
Phosphorus	2

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	11
No. 2	13
No. 3	16
No. 4	17

The function of the sulphur or non-metal in the above composition is to increase the ignitability beyond that attainable with chromates and metals alone. This is attributed to the fact that the compositions have been formulated to involve the combination of a series of reactions. It has been found for example that each of the above chromates as well as silver chromate, calcium chromate and lead chromate not only react with finely divided metals such as those listed in the examples as well as magnesium, aluminum and

many other metals, but also the chromates react with sulphur, phosphorus, or other of the non-metals. In addition the metals alone are very reactive with sulphur, phosphorus or other non-metals. However, these separate reactions of chromates with metals, of chromates with non-metals, and of metals with non-metals are not suitable for the production of acceptable slow burning delay powders. The reason is that the chromate-metal compositions and the chromate-non-metal compositions 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 non-metals are readily ignitible 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 by me 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 compositions 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 chromates and the metals be sufficiently fine that they will pass a 250 mesh screen. The powders may be incorporated in the dry state, or wet with water, carbon tetrachloride or other liquid to reduce the possibility of accidental ignition in manufacture. After thorough incorporation, 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.

Having thus described the invention, what is claimed as new is:

1. A delay powder which is substantially non-gaseous and non-explosive including a metallic chromate, a metal, and a solid non-metallic element selected from the group consisting of sulphur and phosphorus, said chromate and said metal being present in a finely divided state.

2. A delay powder which is substantially non-gaseous and non-explosive including a metallic chromate, a metal, and sulphur, said chromate and said metal being present in a finely divided state.

3. A delay powder which is substantially non-gaseous and non-explosive including 80 per cent barium chromate, 13 per cent manganese, and 7 per cent sulphur, said chromate and said manganese being present in a finely divided state.

4. A non-explosive delay powder formed of a mixture comprising a finely divided metallic chromate, a finely divided metal, and a solid non-metallic element selected from the group consisting of sulphur and phosphorus, said mixture being substantially free of material which forms gaseous products upon combustion.

5. A non-explosive delay powder formed of a mixture comprising a finely divided alkaline earth chromate, a finely divided metal, and a solid non-metallic element selected from the group consisting of sulphur and phosphorus, said mixture being substantially free of material which forms gaseous products upon combustion.

6. A non-explosive delay powder formed of a mixture comprising finely divided barium chromate, a finely divided metal, and a solid non-metallic element selected from the group consisting of sulphur and phosphorus, said mixture being substantially free of material which forms gaseous products upon combustion.

7. A non-explosive delay powder formed of a mixture comprising finely divided barium chromate, a finely divided metal, and sulphur, said mixture being substantially free of material which forms gaseous products of combustion when the mixture burns.

8. A non-explosive delay powder comprising a mixture of a metallic chromate, a metal which reacts with oxygen and a material selected from the group consisting of sulphur and phosphorus, the said ingredients being so proportioned that when burned no substantial quantity of gaseous products will be evolved.

9. A non-explosive delay powder comprising a mixture of barium chromate, manganese, and sulphur, the said ingredients being so proportioned that when burned no substantial quantity of gaseous products will be evolved.

10. A delay powder consisting of 74 to 90 per cent of a metallic chromate, 5 to 24 per cent of a metal which reacts with oxygen, and 2 to 7 per cent of a material selected from the group consisting of sulphur and phosphorus.

11. A delay powder consisting of 80 per cent of barium chromate, 13 per cent manganese and 7 per cent of sulphur.

12. In the art of improving the ignitability of delay powders including a metallic chromate and a metal, the improvement which comprises incorporating in such a delay powder a material selected from the group consisting of sulphur and phosphorus.

13. The method of improving the ignitability of a delay powder comprising an alkaline earth chromate and a metal, the said method comprising incorporating in said powder a material selected from the group consisting of sulphur and phosphorus.

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

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