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IGNITING COMPOSITION AND METHOD OF PREPARING SAME

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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 a composition which is particularly useful as a first fire or igniting composition. That is, it is the material present in munitions which is ignited by a primer and which in turn ignites the munition filling and thus produces the required effects of the munitions.

Munitions with which this invention deals particularly are those used to obtain incendiary effects, as for example, magnesium bombs containing Thermit type fillings, Thermit incendiary bombs, Thermit grenades, smoke shells, floats, pots, and grenades.

An object of this invention is to provide a first fire igniting composition or starter which meets all the requirements for a satisfactory starting material. More specifically, the objects will appear as follows.

The first fire or igniting composition must be invariably ignited by the primer. This means that the mixture must have a sufficiently low ignition temperature. It has been found that the ignitability of gasless Thermit-type starters depends on several factors, such as the nature of the oxidizable metal powder and the oxidizing agent, the particle size of the first fire ingredients, and the composition of the mixture. To ensure ignition of the starter mixture it is preferred that the particle size of the starter mix be such that all the material passes a No. 200 U. S. Standard sieve and much of it passes a No. 325 U. S. Standard sieve. The nature of the surface of the starter ingredient is also important because powdered metals of the same particle size and apparently of the same composition may vary considerably in their ignitability, depending on their method of manufacture.

The first fire or igniting composition must dependably ignite the filling. In accordance with this invention, it was found that a starter that produces slag and evolves little or no gas would be more reliable in this case than a starter evolving gases and building up pressure in a confined space.

The first fire or igniting composition should remain unaffected by prolonged surveillance. It has been found that to obtain this object it is necessary to employ ingredients which are not affected by moisture. It is, therefore, advisable to eliminate all water-soluble ingredients and to utilize only materials that show little or no moisture absorption in a humid atmosphere.

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The materials comprising the first fire must be available in quantities sufficient to supply all the required munitions.

The first fire or igniting composition must be safe enough to manufacture and load into bombs. This means that it should be sufficiently insensitive to friction, impact, sparks and heat to be handled with the ordinary precautions for handling sensitive pyrotechnic mixtures.

The number of constituents should be a minimum required for proper functioning.

Heretofore, no starter or igniting material has been developed which has all of these properties. Nor has any such composition been proposed previously which is stable during storage. It is the object of this invention to provide a starting or igniting mixture which will satisfy all of the foregoing requirements.

While starters or igniters evolving little or no gas have been known in which combinations of manganese have been used in combination with various other metallic oxides, these compositions deteriorate in a humid atmosphere because the metallic powder slowly reacts with water in the air to form a coating of an oxide or hydrated oxide over the particles of metallic powder.

It has been found that a starter or igniting composition can be obtained which meets all the requirements set out above by employing a combination of iron oxide and a powdered metal selected from the group consisting of titanium and zirconium.

Such a starter has excellent stability in moist atmospheres and has the desired functioning properties of sensitivity to ignition and development of high temperature for ignition of Thermit-type compositions, which have ignition temperatures well above 1000° C.

The most satisfactory type of iron oxide should have a high degree of purity, and be free from gas-forming and hygroscopic impurities. It has been discovered that the percentage of moisture absorption by various fine ferric oxides is fairly high at 100% humidity, but at 80% humidity it is less than 0.2%. By heating ferric oxide to approximately 1000° C., the moisture absorption at 100% humidity is practically eliminated. However, the ferric oxide is converted to a powder which no longer forms a compact cake under pressure. The desired binding properties are destroyed. Since the moisture absorption was low at 80% humidity, it is practical to use the untreated iron oxide and determine by surveillance in tropical storage whether it is satisfactory.

In order to obtain good binding qualities it has been found that the iron oxide should be finely-

divided. While any iron oxide, for example Fe_2O_3, Fe_3O_4, and FeO, will make a good hot starter composition when mixed with the titanium or zirconium powder only an iron oxide of fine particle size will form a compact adherent cake upon consolidation under pressure.

It is believed that the method of preparation of the metallic powder influences the nature of the particle surface and is responsible for a difference in the reactivity of the powders. Titanium and zirconium made by the hydride process (in the case of titanium, the reaction of TiO_2 with calcium hydride (CaH_2) followed by the heating of titanium hydride (TiH_2) with liberation of hydrogen) are considerably more sensitive to ignition than powders made by grinding larger pieces of metallic titanium made by other processes. However, it is pointed out that the titanium and zirconium produced by these other methods are operable as a starter component.

Although a mixture of zirconium metal powder and iron oxide will also be stable in storage as well as the titanium-iron oxide mixture, the mixture with zirconium burns much more violently and is not as satisfactory from the standpoint of safety and availability of material. Therefore, the mixture of titanium and iron oxide is preferred; but the claims are not to be considered limited thereto.

The following compositions are examples of starters which are readily ignited by the primer, can be depended upon to ignite the munition filling, develop a high temperature, evolve no gas and burn without explosive violence in a combined space, form a compact adherent cake upon consolidation, and at the same time show no deterioration in storage due to reaction of moisture with metallic ingredients:

EXAMPLE 1

	Parts by weight
Ferric oxide (Fe_2O_3)	70
Titanium powder	30

EXAMPLE 2

	Parts by weight
Ferric oxide (Fe_2O_3)	55
Zirconium	45

The proportions may be varied depending on the particle size of the metal.

Another great advantage of titanium-iron oxide and the zirconium-iron oxide mixtures over previously employed compositions lies in their ease and safety of manufacture. Inasmuch as both titanium and zirconium show no appreciable reaction with water as do usual pyrotechnic mixtures containing Mg, Al, Mn, or water-soluble salts, it was found possible to blend the titanium or zirconium and iron oxide with water to form a paste. In this manner, a very intimate blending of fine powders could be obtained, and the necessity of handling the dry metal powder could be avoided. It was also found that the amount of water required to form a soft paste that could be readily handled, varied considerably with the type of iron oxide used.

The metal powder may be obtained in the wet condition and the blending with the iron oxide may be made while the mixture is wet with water. The mixture may then be dried and easily powdered. The following procedure has been found satisfactory in limited loading of instructional bombs M-1 with the Ti—Fe_2O_3 mixture.

EXAMPLE 3

The iron oxide employed here is a red iron oxide pigment in which the ferric oxide content usually runs from 98.5% to 99.0%. A paste was formed by adding 7½ parts of titanium (dry weight basis) to 12½ parts of water. When the paste was smooth, 17½ parts of the iron oxide was added, and the mixture was thoroughly blended by a sparkproof paddle. The mixture was forced through a No. 12 sieve, and the granules were dried in large flat-bottomed traps under a forced draft at 65° to 85° C. until the mixture contained not more than 0.10% moisture. The dried granules were allowed to cool and were transferred into dry, moisture-proof containers until required for use.

Various tests were conducted to determine the characteristics of the starter materials of this invention and to demonstrate their superiority over other known compositions for this purpose.

Table I demonstrates the effect of moisture on pyrotechnic ingredients. The ingredients were exposed to an atmosphere of 100% humidity. The second column in the Table I shows the percent increase in weight of the materials after they had been exposed in a desiccator containing water. The third column in Table I shows the percent increase over the original weight when the materials were placed in a desiccator containing sulfuric acid, sp. gr. 1.84, after having been exposed in a desiccator containing water.

Table I

Material	Weight Increase			
	In desiccator over water		In desiccator over H_2SO_4, sp. gr. 1.84 (after exposure in a desiccator containing water)	
	7 Days, Percent	42 Days, Percent	7 Days, Percent	24 Days, Percent
Magnesium powder	5.07	5.89	5.10	5.23
Manganese (passes No. 200 mesh sieve held by No. 325 mesh)	2.35	5.22	4.99	5.07
Manganese (passes No. 325 mesh sieve)	3.25	7.29	7.08	7.09
Manganese metal (50 mesh)	0.40	2.21	1.13	1.13
Mn-Ti alloy	1.55	1.05	0.24	0.07
Titanium	0.01	0.02	0.01	0.01
Zirconium	0.01	0.01	0.00	0.01

After having been exposed at 100% humidity, if the material dropped to their original weights when put into a desiccator containing sulfuric acid (sp. gravity, 1.84) it indicated that the moisture was merely absorbed. Metal powders such as manganese and magnesium did not lose their gained weight when put into a desiccator containing sulfuric acid. These materials react with water to form corresponding metallic oxide. In marked contrast to the other metal powders are titanium and zirconium powders. Reference to Table I indicates that the moisture absorption of titanium and zirconium powders at room temperature (approximately 22° C.) was practically nil within experimental error. The titanium-manganese alloy powder containing 40% manganese showed a gain in weight of approximately 1.1% after 42 days of a similar exposure. One might expect that if the moisture performance were merely a linear function of the composition, then by extrapolation, one would expect that approximately 0.5 to 0.3% gain in weight would be observed if pure titanium were used. However, the gain in weight with titanium powder was less than 0.01%. It is very important to have a starter

which is free from appreciable quantities of metals which can react with moisture to form metallic oxides, since the oxides are inert and only consume heat in a pyrotechnic mixture.

In Table II are listed, with results, some first fire starter or igniting mixtures that were tested in a primer testing machine. This machine, briefly described, has, on top, a depression where a primer holder may be placed. Screwed on top of this is a cylinder holding the firing pin. By dropping an iron cylinder on top of the firing pin, this pin is made to hit the primer which, in turn, flashes on to the first fire. Metal spaces are available to adjust the distance from the primer to the surface of the first fire (starter). The primer was approximately 2-in. away in these tests. The starters (10 g. samples in most instances) were tested in small steel cups, because the melting of the cup could be used as a rough visual indication of the temperature and heat evolved from each starter.

Table II

	Pyrotechnic Mixture	Wt. Percent	Fuze Ignition	Remarks
(1)	Fe_2O_3	70	Yes	Readily ignited.
	Ti	30		Cup melted.
(2)	Fe_2O_3	55	Yes	Too fast. The molten residue was ejected from the cup without melting the cup.
	Zr	45		
(3)	Fe^2O^3	60	No	
	Mn	40		
(4)	CuO	70	No	Slow burning, melted bottom of cup.
	Fe—Ti alloy	30		
(5)	Mn	60	No	
	S	40		
(6)	Mn—Ti	70	Yes	Very slow burning, did not melt cup.
	S	30		

It has also been observed that the iron oxide-metal powder of this invention when compacted under a dead load of 2,000 lb. in a hydraulic press made a hard pellet, and that the composition was still capable of being ignited by the primer.

As an example of a filling used in magnesium bombs with which the igniting materials of this invention have been found to be particularly effective is a composition known as Therm-64C. This mixture has the following ingredients:

Ingredient:	Parts by weight
Aluminum	16.0±0.3
Iron oxide, scale	44.0±0.5
Aluminum, grained	9.0±0.4
Barium nitrate	29.0±0.4
Sulfur	2.0±0.1

It is pointed out that other munition fillings can be utilized in conjunction with the starters described.

Additional components having oxidizing, reducing, or reaction-modifying properties, but which do not evolve much gas, or absorb or react with water may be present in the mixture.

Although the disclosed high-temperature, heat generating, gasless starting mixtures are particularly well adapted for warfare munitions, they may also be used industrially for obtaining quick, high-temperature heating effects, as for example, in welding and starting of Thermit mixtures.

Since certain changes and modifications may be made in the foregoing igniting compositions and methods of preparing the same, without departing from the scope of the invention, it is intended that all matter contained in the above description shall be considered as illustrative and that the claims be given a construction as broad as is consistent with the state of the prior art.

We claim:

1. An igniting composition consisting of about 70 parts by weight of ferric oxide and about 30 parts by weight of titanium.

2. A method of preparing an igniting composition paste which comprises mixing about 30 parts by weight of titanium with water, mixing the ingredients to form a smooth paste, adding about 70 parts by weight of ferric oxide, blending the mixture, and then drying said mixture.

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