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INCENDIARY MATERIAL

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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 improved incendiary compositions for incendiary bombs and munitions, such compositions being of a modified "thermit" type.

The recent widespread and large scale use of incendiary bombs and munitions in war has made the choice of the incendiary compositions to be used for such munitions and bombs a problem of great importance. Because of the great danger, distance, expense, and detailed planning, to which a tactical unit of the armed services must go to drop incendiary bombs on enemy installations and military objectives, and because of the momentous effect that a successful bombing mission may have, it is essential that the incendiary bombs used be as effective as possible. On the other hand, because of the enormous quantities and the extent in and to which such incendiary bombs are used, the amounts of strategic materials required for making such munitions must be kept to a minimum which is consistent with the most efficient functioning and operation thereof.

Accordingly, the object of this invention, generally stated, is the provision of incendiary compositions which operate with the highest degree of destructive effect and utilize to a maximum the strategic materials and metals employed therein.

More specifically, the object of this invention is the provision of incendiary compositions for incendiary bombs which compositions have the following improved characteristics in comparison with presently available compositions:

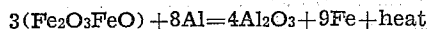
1. May be compressed to a relatively high density.
2. Have a minimum tendency for the components to segregate after compression.
3. Have a maximum penetration power on burning.
4. Have a positive ignition under substantially all conditions.
5. Insure propagation of the incendiary reaction to completion.
6. Evolve the maximum amount of heat per unit volume.
7. Are adapted to be compressed into incendiary pellets.

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Other objects of the invention will, in part, be obvious and will in part appear hereinafter.

For a more complete understanding of the nature and scope of the invention, reference may be had to the following detailed description thereof setting forth, by way of illustration, certain specific compositions and methods of compounding the same.

As indicated above, the invention concerns the provision of modified "thermit" compositions which are particularly adapted and suitable as fillings for incendiary bombs and munitions. As is well known, "thermit" consists essentially of a mixture of aluminum and iron oxide, which on ignition at high temperature, reacts according to the following, well known, strongly exothermic reaction:



It has been found that this basic "thermit" reaction can be intensified and adapted for incendiary purposes by adding certain ingredients to the standard mix. One of the essential ingredients which should be added is barium nitrate, this ingredient serving primarily to intensify and speed up the "thermit" reaction. The addition of this ingredient also insures the positive ignition of the incendiary composition and the propagation of the reaction to completion. However, the barium nitrate cannot be used to the most advantage as an ingredient by itself, because, among other factors, of its tendency to decompose with explosive violence.

According to this invention, it has been found that the maximum effect of barium nitrate can be obtained by incorporating therewith additional aluminium of a sufficient degree of fineness so that it reacts with and prevents the decomposition of the barium nitrate with explosive violence. This finely divided aluminum is in addition to that required for the "thermit" reaction. It has been further found that improved incendiary compositions are provided when an oil, or an oil and sulphur, are incorporated in relatively small quantities with the barium nitrate and fine aluminum.

The following specific examples of incendiary compositions, forming different embodiments of

the invention will more completely illustrate and make known to those skilled in the art the nature thereof:

Example 1

	From individual ingredients, percent by weight	From "thermit," percent by weight
"Thermit".....		75.2±0.5
Iron Oxide Scale.....	55.2±0.5	
Aluminum, granular.....	20.0±0.5	
Aluminum, grained.....	5.0±0.5	5.0±0.5
Barium Nitrate, free flowing.....	19.5±0.5	19.5±0.5
Castor Oil.....	0.3±0.05	0.3±0.05

The above composition has been compounded according to several different procedures. According to one method, which has been found suitable, the proper proportions of aluminum, both granular and grained, and castor oil are mixed in a suitable mixer until the aluminum is thoroughly coated with the oil. Then, there is added the proper proportions of iron oxide scale and barium nitrate and the mass is mixed until a homogeneous mixture, free from lumps, is formed.

According to a second method of preparation, utilizing commercial "thermit," one quarter of the total quantity of "thermit," and all of the castor oil are placed in a cone blender with a suitable number of brass balls and mixed for about five minutes. The brass balls are then screened out and the mix is replaced into the blender. Then, all of the other ingredients are added and the mass is mixed for about fifteen minutes.

Example 2

	Ingredients percent by weight
Iron oxide scale.....	61.2
Aluminum, granular.....	19.2
Aluminum, grained.....	2.8
Aluminum, flaked.....	1.0
Barium nitrate, free flowing.....	14.6
Sulphur.....	0.9
Castor oil.....	0.3

Example 3

	Ingredients percent by weight
Hammer scale.....	60.8
Aluminum, granular.....	19.2
Aluminum, grained.....	2.8
Aluminum, flaked.....	1.0
Barium nitrate, free flowing.....	15.0
Sulphur.....	0.9
Castor oil.....	0.3

Example 4

	Ingredients percent by weight
Iron oxide scale.....	59.2
Aluminum, granular.....	20.8
Aluminum, grained.....	3.8
Barium nitrate.....	15.0
Sulphur.....	0.9
Oil, S. A. E. 30.....	0.3

Examples 2, 3 and 4 may be compounded according to either of the procedures outlined above for preparing the compositions of Example 1. It will be understood that other methods of compounding the compositions of the invention may also be used as desired.

The purity, particle sizes, and sources, of the

various ingredients used in the above compositions are of importance. The iron oxide material used in the compositions may come from several different commercial sources, such as hammer scale or forge scale, magnetite of suitable purity, and other sources. One type of iron oxide scale which was found to be satisfactory for the compositions of this invention was one meeting the following specifications:

	Percent
Metallic iron.....	Maximum 1
Ferrous oxide (FeO).....	Maximum 22
Total iron.....	Maximum 69
Moisture.....	Maximum 0.2

This iron oxide scale had a particle size meeting the following U. S. Standard sieve requirements:

	Percent
Retained on No. 12 sieve.....	None
Passing No. 12, retained on No. 20 sieve.....	Maximum 5
Passing No. 20, retained on No. 50 sieve.....	Minimum 30
Passing No. 140 sieve.....	Maximum 10

The granular aluminum referred to in the above specific examples may be made by stirring molten aluminum slowly while it is cooling and solidifying. As the stirring continues, the aluminum breaks up into fine grains since it is "hot short" (brittle) at temperatures slightly below its melting point. The particles are rough, irregularly shaped and coarse. The granular aluminum should contain a minimum of 92.5% metallic aluminum and such impurities as copper, iron, silicon, zinc, manganese, lead, and moisture must be controlled within certain limits. The particle size of the granular aluminum used in Examples 1 through 4 was equivalent to the following U. S. Standard sieve requirements:

	Percent by weight
Retained on No. 12 sieve.....	None
Passing No. 12 sieve, retained on No. 30 sieve.....	13 to 26
Passing No. 30 sieve, retained on No. 50 sieve.....	35 to 45
Passing No. 50 sieve, retained on No. 140 sieve.....	30 to 46
Passing No. 140 sieve.....	0.0 to 3

The grained and flaked aluminum in the four examples given above were used to react with and prevent the decomposition of the barium nitrate with explosive violence. As will be noted, in Examples 1 and 4 only fine grained aluminum is used, while in Examples 2 and 3 both the flaked and the grained varieties are used.

Grained aluminum may be made by blowing a blast of air against a falling stream of molten aluminum so as to sub-divide the molten aluminum into minute droplets or globules, which, upon solidification, assume a generally nodular form. The grained aluminum should preferably be at least 96% pure and not contain more than 0.2% grease and fat. The grained aluminum used in Examples 1 through 4 had a particle size meeting the following U. S. Standard sieve requirements:

	Percent
Passing No. 100 sieve.....	Minimum 99
Passing No. 200 sieve.....	Minimum 75

The flaked variety of aluminum may be made by hammering or stamping annealed aluminum sheets or aluminum foil into flakes. A lubricant

is added to prevent the flakes from being welded together by the stamping operation. As the stamping or hammering proceeds, the cold working of the hot metal hardens the foil or sheets so that they readily break into small flakes consisting of irregular, flaked particles with flat, irregular contours. Ball mills may also be used for flaking aluminum. The flaked aluminum should have a purity of not less than 96% aluminum and should not contain more than 0.2% of grease and fats.

The flaked aluminum as used in Examples 2 and 3 had a particle size which met the following U. S. Standard sieve requirements:

	Percent
Passing No. 20 sieve.....	Minimum 98
Passing No. 100 sieve.....	Minimum 70
Passing No. 200 sieve.....	Minimum 35

The barium nitrate should be of a high grade, free flowing, variety and have a purity of about 99%. One grade of barium nitrate which served satisfactorily was one having substantially the following U. S. Standard sieve requirements as to particle size:

	Percent
Passing No. 50 sieve.....	Minimum 100
Passing No. 200 sieve.....	Maximum 75

The sulphur used should be of a high purity grade, a good grade of flowers of sulphur being suitable. The castor oil or other oil used should have a viscosity substantially equivalent to S. A. E. No. 30. As will be noted from Example 1, oil alone may in certain instances be used without the inclusion of sulphur.

It will be understood from the nature of the compositions concerned, the effects and action to be attributed to the different ingredients and grades thereof, cannot in all instances be determined and assigned with accuracy. However, it has been found that incendiary mixtures having the above general compositions function very satisfactorily and fulfill the objects and have the advantages pointed out above.

The incendiary compositions of this invention are adapted to be used as the main incendiary material in incendiary bombs having aluminum, iron, plastic, or other types of bodies. The compositions may also be used as the ignition mixture for magnesium bombs, and as a component of certain oil bombs.

Since certain changes and modifications may be made in the foregoing incendiary 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 incendiary composition composed essentially of a uniform mixture of from about 54.7 to about 61.2 parts by weight of iron oxide scale having a particle size substantially equivalent to the following U. S. Standard sieve requirements:

	Percent
Retained on No. 12 sieve.....	None
Passing No. 12, retained on No. 20 sieve...	Max. 5
Passing No. 20, retained on No. 50 sieve...	Min. 30
Passing No. 140 sieve.....	Max. 10

from about 14.6 to about 20.0 parts by weight of barium nitrate, having a particle size substantially equivalent to the following U. S. Standard sieve requirements:

	Per cent
Passing No. 50 sieve.....	Min. 100
Passing No. 200 sieve.....	Max. 75

and from about 23.0 to about 26.0 parts by weight of aluminum, from about 3.8 to about 5.5 parts by weight of said aluminum being sufficiently subdivided that it reacts with and prevents the decomposition of said barium nitrate with explosive violence, and the remainder of said aluminum having a particle size substantially equivalent to the following U. S. Standard sieve requirements:

	Per cent
Retained on No. 12 sieve.....	None
Passing No. 12 sieve, retained on No. 30 sieve	13 to 26
Passing No. 30 sieve, retained on No. 50 sieve	35 to 45
Passing No. 50 sieve, retained on No. 140 sieve	30 to 46
Passing No. 140 sieve	0.0 to 3

2. An incendiary composition composed essentially of a uniform mixture of about 55.2 parts by weight of iron oxide scale having a particle size substantially equivalent to the following U. S. Standard sieve requirements:

	Per cent
Retained on No. 12 sieve.....	None
Passing No. 12, retained on No. 20 sieve...	Max. 5
Passing No. 20, retained on No. 50 sieve...	Min. 30
Passing No. 140 sieve.....	Max. 10

about 19.5 parts by weight of barium nitrate having a particle size substantially equivalent to the following U. S. Standard sieve requirements:

	Per cent
Passing No. 50 sieve.....	Min. 100
Passing No. 200 sieve.....	Max. 75

about 5.0 parts by weight of grained aluminum having a particle size substantially equivalent to the following U. S. Standard sieve requirements:

	Per cent
Passing No. 100 sieve.....	Min. 99
Passing No. 200 sieve.....	Min. 75

about 20.0 parts by weight of granular aluminum having a particle size substantially equivalent to the following U. S. Standard sieve requirements:

	Per cent
Retained on No. 12 sieve.....	None
Passing No. 12 sieve, retained on No. 30 sieve	13 to 26
Passing No. 30 sieve, retained on No. 50 sieve	35 to 49
Passing No. 50 sieve, retained on No. 140 sieve	30 to 46
Passing No. 140 sieve.....	0.0 to 3

and about 0.3 of a part by weight of castor oil.

3. An incendiary composition composed essentially of a uniform mixture of about 59.2 parts by weight of iron oxide scale having a particle size substantially equivalent to the following U. S. Standard sieve requirements:

	Per cent
Retained on No. 12 sieve.....	None
Passing No. 12, retained on No. 20 sieve...	Max. 5
Passing No. 20, retained on No. 50 sieve...	Min. 30
Passing No. 140 sieve.....	Max. 10

about 15.0 parts by weight of barium nitrate having a particle size substantially equivalent to the following U. S. Standard sieve requirements:

	Per cent
Passing No. 50 sieve.....	Min. 100
Passing No. 200 sieve.....	Max. 75

about 3.8 parts by weight of grained aluminum having a particle size substantially equivalent to the following U. S. Standard sieve requirements:

	Per cent
Passing No. 100 sieve-----	Min. 99
Passing No. 200 sieve-----	Min. 75

about 20.8 parts by weight of granular aluminum having a particle size substantially equivalent to the following U. S. Standard sieve requirements:

	Per cent
Retained on No. 12 sieve-----	None
Passing No. 12 sieve, retained on No. 30 sieve-----	13 to 26
Passing No. 30 sieve, retained on No. 50 sieve-----	35 to 49
Passing No. 50 sieve, retained on No. 140 sieve-----	30 to 46
Passing No. 140 sieve-----	0.0 to 3

about 0.3 of a part by weight of oil having a viscosity of about S. A. E. 30, and about 0.9 of a part by weight of sulphur.

4. An incendiary composition composed essentially of a uniform mixture of about 61.2 parts by weight of iron oxide scale having a particle size substantially equivalent to the following U. S. Standard sieve requirements:

	Per cent
Retained on No. 12 sieve-----	None
Passing No. 12, retained on No. 20 sieve--	Max. 5
Passing No. 20, retained on No. 50 sieve--	Min. 30
Passing No. 140 sieve-----	Max. 10

about 14.6 parts by weight of barium nitrate having a particle size substantially equivalent to the following U. S. Standard sieve requirements:

	Per cent
Passing No. 50 sieve-----	Min. 100
Passing No. 200 sieve-----	Max. 75

about 1.0 part by weight of flaked aluminum having a particle size substantially equivalent to the following U. S. Standard sieve requirements:

	Per cent
Passing No. 20 sieve-----	Min. 98
Passing No. 100 sieve-----	Min. 70
Passing No. 200 sieve-----	Min. 35

about 2.8 parts by weight of grained aluminum having a particle size substantially equivalent to the following U. S. Standard sieve requirements:

	Per cent
Passing No. 100 sieve-----	Min. 99
Passing No. 200 sieve-----	Min. 75

about 19.2 parts by weight of granular aluminum having a particle size substantially equivalent to the following U. S. Standard sieve requirements:

	Per cent
Retained on No. 12 sieve-----	None
Passing No. 12 sieve, retained on No. 30 sieve-----	13 to 26
Passing No. 30 sieve, retained on No. 50 sieve-----	35 to 49
Passing No. 50 sieve, retained on No. 140 sieve-----	30 to 46
Passing No. 140 sieve-----	0.0 to 3

about 0.9 of a part by weight of sulphur, and about 0.3 of a part by weight of castor oil.

5. An incendiary composition composed essentially of a uniform mixture of about 60.8 parts by weight of hammer scale having a particle size substantially equivalent to the following U. S. Standard sieve requirements:

	Per cent
Retained on No. 12 sieve-----	None
Passing No. 12, retained on No. 20 sieve--	Max. 5
Passing No. 20, retained on No. 50 sieve--	Min. 30
Passing No. 140 sieve-----	Max. 10

about 15.0 parts by weight of barium nitrate having a particle size substantially equivalent to the following U. S. Standard sieve requirements:

	Per cent
Passing No. 50 sieve-----	Min. 100
Passing No. 200 sieve-----	Max. 75

about 1.0 part by weight of flaked aluminum having a particle size substantially equivalent to the following U. S. Standard sieve requirements:

	Per cent
Passing No. 20 sieve-----	Min. 98
Passing No. 100 sieve-----	Min. 70
Passing No. 200 sieve-----	Min. 35

about 2.8 parts by weight of grained aluminum having a particle size substantially equivalent to the following U. S. Standard sieve requirements:

	Per cent
Passing No. 100 sieve-----	Min. 99
Passing No. 200 sieve-----	Min. 75

about 19.2 parts by weight of granular aluminum having a particle size substantially equivalent to the following U. S. Standard sieve requirements:

	Per cent
Retained on No. 12 sieve-----	None
Passing No. 12 sieve, retained on No. 30 sieve-----	13 to 26
Passing No. 30 sieve, retained on No. 50 sieve-----	35 to 49
Passing No. 50 sieve, retained on No. 140 sieve-----	30 to 46
Passing No. 140 sieve-----	0.0 to 3

about 0.9 of a part by weight of sulphur, and 0.3 of a part by weight of castor oil.

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