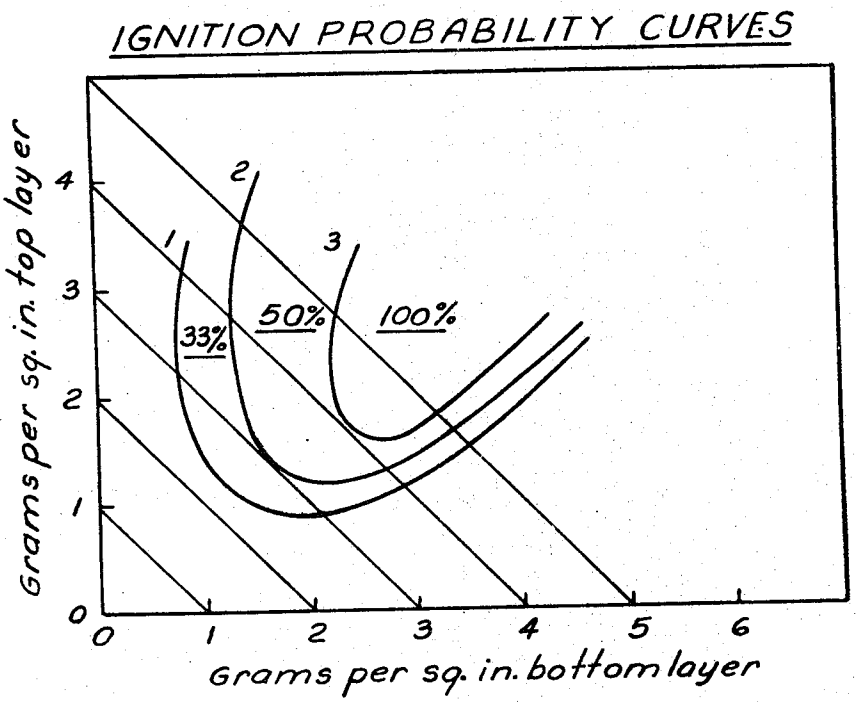
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LAYERED MAGNESIUM CONTAINING STRUCTURE

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LAYERED MAGNESIUM CONTAINING STRUCTURE

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ABSTRACT OF THE DISCLOSURE

A system for ensuring the complete ignition of massive magnesium which comprises a fast-burning layer adjacent to the magnesium surface covered by a slow-burning surface layer.

BACKGROUND OF THE INVENTION

The use of finely divided particulate magnesium, e.g. powdered magnesium capable of passing through #400 mesh U.S. standard sieve, as an incendiary and flare component is well known. However, because of high thermal conductivity, massive forms of magnesium such as coarse scrap and sheet cuttings are extremely hard to ignite. Only by heating such massive forms of magnesium above their melting point will the metal burn. With larger structures such as sheets, plates, castings, and the like, the difficulty of ignition is increased. By way of contrasts, small particles of magnesium, i.e. file dust and magnesium ribbon, can be ignited with a match, since owing to the smallness of the individual particles, the heat cannot readily be conducted away.

It is a principal object of the present invention to provide a massive magnesium structure having a coating which assures ready ignition of the magnesium.

It is also an object of the present invention to provide such a coating which is easily applied to magnesium and is not soluble in most organic solvents.

Another object of the present invention is to provide such a coating that will not detonate or ignite at normal temperatures.

These and other objects and advantages of the present invention will readily become apparent from the detailed description presented hereafter.

SUMMARY OF THE INVENTION

The present invention comprises a massive magnesium structure having a layer of a rapid-burning composition adjacent to the surface of the magnesium and a surface layer of a relatively slower burning composition.

The use of such multiple layered coating enhances the ease with which the magnesium can be ignited. The bottom layer burns with an evolution of intense heat, which causes the magnesium to reach its kindling temperature, and the top layer serves as an insulator, i.e. maintains the heat energy from the burning bottom layer in close proximity to the magnesium and combustion products. By using two layers of characteristics, as set forth herein, the total amount of kindling material needed to ignite the massive magnesium is appreciably reduced.

By the term magnesium is meant elemental magnesium or an alloy containing greater than 70 percent magnesium. The term massive magnesium includes forms of magnesium which are substantially impossible to impossible to ignite without melting.

In the first embodiment of the invention, the coating layer adjacent to the magnesium, i.e. bottom layer, comprises a combustilble composition consisting of at least one finely pulverized metal, a metallic oxide and an oxidizer, the combination of which is capable of entering

into a thermit reaction. Exemplary of such a composition is a blend of ferric oxide, a metal capable of reducing the ferric oxide to elemental iron such as magnesium, aluminum or zinc and a nitrate or perchlorate containing salt.

Usually in the preparation of this composition, the combustibles are dispersed in a liquid fuel capable of dissolving appreciable quantities of the oxidizer. Also a thickener ordinarily is employed, e.g. a polymer capable of swelling in the liquid fuel and which will hold the solid particles in suspension. It has been found that a polyacrylamide having a molecular weight of approximately 1,000,000 works well as thickener in conjunction with the favored liquid fuels. An epoxy resin may also be used as the thickener. By selecting an epoxy resin and hardener which are miscible with the liquid fuel, a solid resin may be used. A liquid resin, capable of dissolving the oxidizer could also be used. This combination would have the advantage of acting both as thickener and liquid fuel in the system. The composition of the thickener may be varied in order to attain certain desirable characteristics. Carboxymethylhydroxyethyl cellulose, hereinafter referred to as CMHEC gum, may be added to shorten the gelling time, and potato starch may be added to give the cured coating a dry rather than sticky surface.

Another embodiment of the bottom layer consists of a mixture of asphalt and a perchlorate containing salt. This embodiment has the disadvantage of being soluble in organic liquids; however, by coating this layer with the gelled bottom layer of the first embodiment which also serves to ignite and insulate the asphalt perchlorate layer, this disadvantage is obviated. Due to the fact that the asphalt perchlorate mixture is somewhat shock sensitive, the first embodiment is preferred.

The top layer at the first embodiment comprises a thickener, oxidizer and liquid fuel which may be the same as used in the bottom layer, but excluding the finely pulverized metals and thermit forming metal oxide.

The coating composition of the first embodiment of the bottom layer is prepared by dry blending all of the dry components, screening the mixture to remove any large particles and adding the liquid fuel until the desired consistency is reached. The coating composition of the top layer is prepared in a similar fashion. The coating material will not detonate or ignite at normal temperatures. It is pourable or castable when first mixed, sticks readily to most surfaces, and remains flexible even at low temperatures; however, the final properties will vary with the thickener content.

The bottom layer usually is applied to the surface of magnesium like paint and cured with the magnesium surface needing no special preparation. The top layer is applied in the same manner as the first and cured.

Due to its gelled nature when cured the coating composition of both layers is not soluble in most organic solvents and is somewhat water resistant. The coating composition can be applied to the magnesium surface like paint, e.g. by spraying, brushing, dipping or roll coating; however, the practicality of various methods will vary with the viscosity of the final mixture. After applying the bottom layer, it is cured by heating at temperatures sufficient to congeal the coating composition and the top layer is applied in a similar manner. The top layer is similarly cured after application.

The accompanying drawing represents in graphic form the results of empirical tests which were conducted to determine the thickness of coatings required for ignition of 1/16 inch thick, flat magnesium sheet. The ordinate indicates the grams/square inch needed in the bottom layer, and the abscissa indicates the required grams/square inch in the top layer. The drawing indicates that in the thick-

ness ranges represented by areas between lines **1** and **2**, there is a 33⅓% probability of ignition. A 50% probability of ignition occurs when the thickness is as indicated by the area between lines **2** and **3**. There is a 100% probability of ignition in the area inside the concavity of line **3**.

The drawing represents the operable thicknesses for flat magnesium sheet. Cylindrical pieces of magnesium require less of the coating than do flat surfaces. The thickness of the coating composition may be cut almost in half when cylindrical magnesium is used.

DESCRIPTION OF PREFERRED EMBODIMENTS

The layered ignition coatings of the present invention are useful as a lining for magnesium casings for liquid hydrocarbons to insure their complete ignition. It can also be used for coating massive magnesium particles such as, for example, magnesium chips, cylinders or other configurations which are too large to light with a match. Such coated particles may be dispersed in liquid hydrocarbons wherein they will provide many areas of concentrated heat upon ignition. The size of the particles is not critical. Preferred sizes for complete dispersion vary from maximum dimensions of ¾" to 1¼".

A preferred composition for the bottom layer of the present invention contains, on a weight basis, 0 to 1.5 parts CMHEC gum, 5 to 8 parts of a polyacrylamide having a molecular weight of approximately 1,000,000 and 1 to 2 parts potato starch as thickeners. Preferred metal combustibles are 0 to 30 parts finely divided (—20 to —325 mesh) 60/40 magnesium/aluminum alloy, 0 to 30 parts finely divided (—20 to —325 mesh) magnesium metal with the mixture of metals comprising from 5 to 50 parts of the system, and 3 to 10 parts finely divided (—200 mesh to pigment size particles) ferric oxide. Either black or red ferric oxide may be used; however, red ferric oxide is preferred. Since either the primary magnesium or the mg./Al alloy must be readily ignitable, it is preferred that as the particle size of one is increased, the other is decreased, thus insuring the ignition of one from which the other will be ignited. Optionally, 0 to 3 parts powdered sugar may be added as a combustible. From 20 to 30 parts finely divided (—20 to —325 mesh) sodium nitrate is preferred for use as an oxidizer; however, sodium perchlorate may also be used. An amount of 30 to 50 parts ethylene glycol is preferred for use as the liquid fuel; however, formamide may be substituted with nearly equal effectiveness.

One particularly effective bottom layer composition contains, on a weight basis, 1.5 parts CMHEC gum, 7.5 parts said polyacrylamide and 1 part potato starch as thickeners.

The combustible in this composition consists of 12.6 parts finely divided (—80 mesh) 60/40 magnesium/aluminum alloy, 8.4 parts magnesium metal (—40 mesh) and 4.2 parts red ferric oxide (pigment size particles). 1.57 parts powdered sugar has been found to be an effective quantity of this combustible. A particularly effective oxidizer is 26.3 parts finely divided (—40 mesh) sodium nitrate. The preferred liquid fuel consists of 36.8 parts ethylene glycol.

A preferred embodiment of the top layer of the present invention consists of the thickener, oxidizer and liquid fuel used in the bottom layer. When used in conjunction with the preferred bottom layer, the preferred top layer consists of 0 to 5 parts CMHEC gum, 0 to 5 parts potato starch, 2 to 12 parts of the said polyacrylamide, 64 to 89 parts of finely divided (—20 to —325 mesh) sodium nitrate and 9 to 34 parts ethylene glycol.

One particularly effective composition for the top layer consists, on a weight basis, of 0.4 part CMHEC gum, 0.5 part potato starch, 5.6 parts of polyacrylamide, 68 parts (—40 mesh) sodium nitrate and 30 parts ethylene glycol. The particle size specifications all refer to the U.S. standard sieve series.

The bottom layer should be spread on the magnesium to a thickness of no less than the minimum grams per square inch as indicated by the concavity within line **3** of the accompanying drawing. This amount can be reduced by approximately one-half when the magnesium is in a cylindrical configuration. Many conventional methods can be used to apply the coating such as brushing or spraying; however, roll dipping is preferred when cylinders are being coated. After the material is applied, it is cured at about 75° F. for approximately 24 hours.

After applying and curing the bottom layer, the top layer should be applied in a similar manner to a thickness no less than the minimum grams per square inch as indicated by the concavity within line **3** of FIGURE 1, when flat magnesium is being used. As in the case with the bottom layer, a smaller amount of the top layer can be used when the magnesium is in a cylindrical configuration. After application, the top layer is cured at about 75° F. for approximately 24 hours.

After the layered coating is cured, it has a rather flexible rubber-like texture. Although the material is somewhat water resistant, it is also slightly hydroscopic. Therefore, magnesium coated with the material should be stored in a substantially anhydrous atmosphere. The material is effectively insoluble in hydrocarbon solvents.

The following examples will serve to further illustrate the invention:

Example 1

A substantial quantity of a bottom layer of the coating material was prepared by dry blending, on a weight basis, 1.5 parts CMHEC gum, 7.5 parts of a polyacrylamide having a molecular weight of approximately 1,000,000, 1 part potato starch, 12.6 parts finely divided (—80 mesh) 60/40 magnesium/aluminum alloy, 8.4 parts finely divided (—40 mesh) magnesium, 4.2 parts finely divided (pigment size particles) red ferric oxide, 1.5 parts powdered sugar, and 26.3 parts finely divided (—40 mesh) sodium nitrate. The material was finely sifted to remove any lumps and mixed with 36.8 parts of ethylene glycol.

The mixture, having a consistency of light glue, was applied to a 1/16" thick magnesium cylinder to a thickness of 2.5 grams of coating per square inch of magnesium. After application, the material was allowed to cure at 75° F. for approximately 24 hours.

The material for the top layer was prepared by dry blending, on a weight basis, 0.4 part CMHEC gum, 0.5 part potato starch, 5.6 parts of the said polyacrylamide and 68 parts finely divided (—40 mesh) sodium nitrate. After finely sifting the material, 30 parts of ethylene glycol was added. This layer was applied on top of the bottom layer by roll coating to a thickness of 1.6 grams of material per square inch of magnesium and cured at 75° F. for about 24 hours.

Jellied gasoline was spread on the surface of the matrix and ignited by conventional means. The test resulted in complete ignition of the magnesium.

Example 2

The first layer was prepared and applied to a 1/16" thick magnesium cylinder in the manner used in Example 1, but to a thickness of 1.3 grams of material per square inch of magnesium.

The top layer was prepared and applied as described in Example 1 to a thickness of 1.1 grams of material per square inch of magnesium. The system was ignited as in Example 1 with the result being complete ignition of the magnesium cylinder.

Example 3

Finely divided asphalt roofing cement was dry blended with pulverized sodium perchlorate in proportions of 20 to 80 weight percent respectively. Sufficient acetone was added to make a slurry and the material applied to a thickness of 2 grams/square inch on 1/16" thick magnesium sheet. After curing, during which the acetone evapo-

rated, a 2 grams/square inch thick coating of the bottom layer of the first embodiment was applied and cured. Ignition of the system resulted in complete ignition of the magnesium.

Example 4

The composition used as the bottom layer in Example 1 was applied to a 1/16" thick piece of magnesium sheet to a thickness of 5.8 grams/square inch. The top layer was omitted. The coating was cured as was that in Example 1 and ignited in a similar fashion. The test failed to ignite the magnesium sheet.

Various modifications can be made in the present invention without departing from the spirit or scope thereof, for it is understood that we limit ourselves only as defined in the appending claims.

I claim:

1. A massive ignitable layered magnesium structure which comprises a layer of a rapid burning composition adjacent to a layer of magnesium, said rapid burning layer comprising a fuel and an oxidizer which upon ignition produces sufficient heat to bring the magnesium to its kindling temperature, and a top layer of a relatively slower burning composition, adjacent to said layer of rapid burning composition, said slower burning composition comprising a fuel and having a burning rate such that the heat energy produced by said rapid burning second layer will be maintained in close proximity to the magnesium.

2. The structure of claim **1** wherein the rapid burning layer adjacent the magnesium comprises a combustible composition, which upon ignition produces sufficient heat to bring the magnesium to its kindling temperature, a liquid fuel and an organic thickener for the fuel and the slow burning layer comprises a liquid fuel, oxidizer and organic thickener for the liquid fuel.

3. The structure of claim **1** wherein the rapid burning layer comprises a combustible composition consisting of at least one finely divided metal, a metallic oxide and an oxidizer the combination of which is capable of entering into a thermit reaction, a liquid fuel capable of dissolving appreciable quantities of the oxidizer, and a thickener which consists of a polymer capable of swelling in the liquid fuel; and the slow burning layer comprises an oxygen containing compound, a liquid fuel capable of dissolving appreciable quantities of the oxygen containing compound and a thickener which consists of a polymer capable of swelling in the liquid fuel.

4. The combustible composition of claim **3** in which the finely divided metal is at least one selected from the group consisting of magnesium, aluminum, zinc and alloys thereof which range in size from −20 to −325 mesh, the metallic oxide consists of finely divided (−200 mesh to pigment size) ferric oxide and the oxidizer consists of a finely divided (−20 to −325 mesh) nitrate or perchlorate containing salt.

5. The combustible composition of claim **3** containing additionally powdered sugar.

6. The liquid fuels of claim **3** which consists of one of the group of ethylene glycol and formamide.

7. The thickeners of claim **3** which consists of a mixture of carboxymethyl hydroxyethyl cellulose, a polyacrylamide having a molecular weight of approximately 1,000,000 and potato starch.

8. The structure in accordance with claim **1** wherein the rapid burning layer adjacent to the magnesium containing layer consists, on a weight basis, of:

(a) a thickener containing 0 to 1.5 parts carboxymethyl hydroxyethyl cellulose, 0 to 2.0 parts potato starch and 5 to 8 parts of a polyacrylamide characterized by having a molecular weight of approximately 1,000,000;

(b) a combustible composition containing 5 to 50 parts of a finely divided (−20 to −325 mesh) metal, said metal consisting of a mixture of from 0 to 30 parts magnesium and from 0 to 30 parts 60/40 magnesium/aluminum alloy, 3 to 10 parts finely divided (−200 mesh to pigment size) ferric oxide, 20 to 30 parts finely divided (−20 to −325 mesh) sodium nitrate and 0 to 3 parts powdered sugar;

(c) a liquid fuel consisting of 30 to 50 parts ethylene glycol; and

the slow burning layer which consists on a weight basis of 0 to 5 parts potato starch, 0 to 5 parts carboxymethyl hydroxyethyl cellulose gum, 2 to 12 parts of the said polyacrylamide, 64 to 89 parts finely divided (−20 to −325 mesh) sodium nitrate and 9 to 34 parts ethylene glycol.

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