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METHOD OF COATING MAGNESIUM METAL TO PREVENT CORROSION

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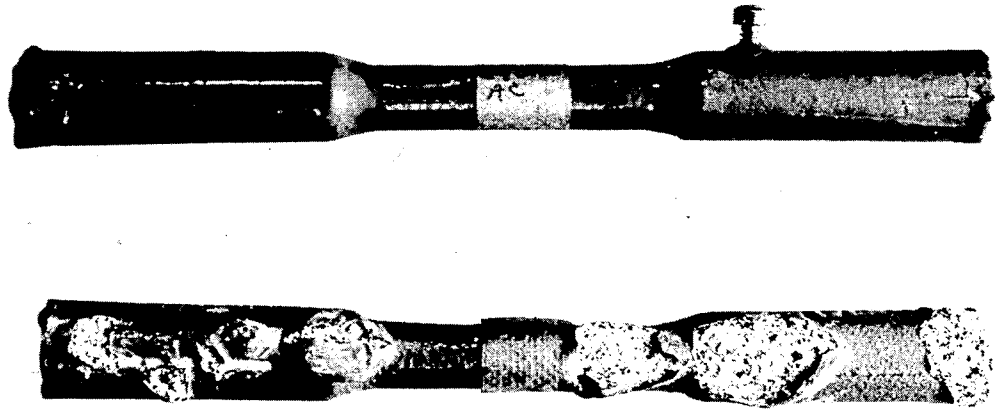


FIG. 1

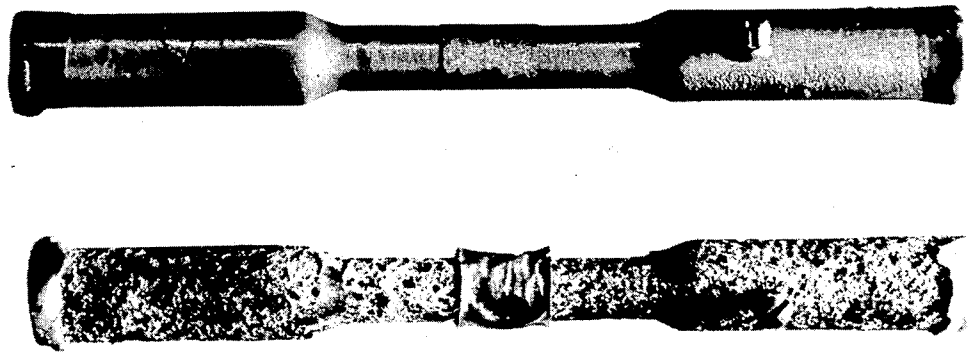


FIG. 2

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METHOD OF COATING MAGNESIUM METAL TO PREVENT CORROSION

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ABSTRACT OF THE DISCLOSURE

The corrosion of magnesium metal articles is prevented by applying a phenolic resin primer containing zinc chromate to the surface of the metal which, prior to the application of said resin primer, is cleaned in an alkaline bath.

BACKGROUND

This invention relates to the treatment of magnesium metal and magnesium-base alloys to provide the same with a protective corrosion-resistant coating and, more particularly, to an improved coating composition and method of forming the coating.

Specifically, the invention provides a new and highly efficient method for applying a hard, tough and highly flexible resinous material to articles of magnesium and magnesium-base alloys and composite metal structures containing such articles which undergo corrosive deterioration while immersed in salt water or exposed to salt splash conditions.

Known methods of protecting magnesium against corrosion include the application of organic coatings. However, the previously used coatings, although representing definite progress in the art, have not been entirely successful. All attempts to lessen corrosion of magnesium have only been satisfactory to improve the corrosion resistance without eliminating it.

There is, accordingly, a need for a more convenient method of preventing the corrosion of magnesium, whether in the atmosphere, the sea, or the earth.

The present invention meets this need. The method of practicing the invention is made clear in the ensuing description and is specifically defined in the appended claims.

SUMMARY

The invention is based on the discovery that on cleaning the magnesium metal article with an alkaline solution, as hereinafter more fully set forth, the application to the clean surface of a resin primer obtained by adding at least 3 ounces of zinc chromate to a suitably plasticized water-insoluble, liquid phenolic resin, provides a corrosion-inhibiting film, which can be used as a final finish and which provides an excellent base for subsequent painting.

A critical feature in the method of the present invention is the cleaning operation that precedes the application of the coating. Best results are achieved when the magnesium metal article to be coated is treated for a short time by immersion in an alkaline solution at 180° F. to 212° F.

DETAILED DESCRIPTION

The invention utilizes a resin primer which consists essentially of a water-insoluble liquid phenolic resin. The phenolic resin can be conveniently produced by condensing a phenol and formaldehyde in the presence of a catalyst, such as morpholine. The mole ratio is about .75 mole of formaldehyde per one mole of phenol. The reaction is catalyzed with 1% morpholine based on the weight of the phenol. The condensation reaction is carried out at 60° C.

and is terminated at the point where the resulting resin is soluble in alcohol.

Heretofore, the poor flexibility characteristics of phenolic resins has limited considerably the scope of usefulness of such resins in coating applications. The phenolic resins of the present invention are therefore plasticized with 10–20% polyvinyl butyral to give greater flexibility to the primer.

Substantially the same result as that set forth herein can be gained by the use of other plasticizers. Some of the lower polymers of acrylic acids form salts which are relatively flexible and these classes of resins may be advantageously employed to plasticize more inflexible resins as exemplified by the hardened phenolic resins.

The condensation reaction product of a phenol and formaldehyde which, when plasticized with polyvinyl butyral, or the like, yields the phenolic resin of this invention, is conveniently dissolved in a water-immiscible solvent. The solvent employed can be any organic solvent in which the phenolic resin is soluble. Commonly employed as solvents are toluene, xylenes, denatured ethyl alcohol, isopropanol, aromatic hydrocarbon mixtures such as "Solvesso," and also various aliphatic, naphthenic and aromatic naphthas.

The phenolic resin is preferably applied to the magnesium metal article from a solvent solution as by spraying, or roller coating, or dipping, as desired. Thus the magnesium metal article may be dipped in a tank containing a 20% solution of phenolic resin in an organic solvent of the aforesaid type. For purposes of this invention the coating solutions may contain from about 20 to about 50% by weight of resin, based on the combined weight resin and solvent.

The resultant coating is adapted to be advantageously cured by heating. Generally the curing cycles are conducted at temperatures on the order of about 250° F. to about 400° F. until the coating cures to a hard, infusible state and is insoluble in most of the known solvents. If desired, pigments and other such modifiers can be added to the phenolic resins in suitable amounts as is well known in the art.

As noted, the phenolic resins can be conveniently produced by condensing a phenol with formaldehyde. Among phenols suitable for reaction with formaldehyde are the tri-functional phenols, that is phenols having at least 3 unsubstituted positions, illustrative of which are the following: phenol; meta-substituted phenols such as the alkylated phenols exemplary of which are m-cresol, m-ethyl phenol, m-n-propyl phenol, m-isopropyl phenol, m-sec.-butyl phenol, m-tert.-butyl phenol and the like; meta-substituted alkoxy phenols such as m-methoxy phenol, m-ethoxy phenol and the like; also suitable is resorcinol.

Formaldehyde in any of its available forms, i.e. Formalin and para-formaldehyde can be used.

DETAILED DESCRIPTION OF METHOD

In carrying out the invention, the magnesium metal article to be coated is cleaned in an alkaline solution heated to 180° F.–212° F. for a period of 2 minutes. The alkaline bath, kept at a pH of about 11, contains per gallon of water:

4–8 ounces of sodium hydroxide
0–2 ounces of trisodium phosphate
0–2 ounces of sodium carbonate

On entering the bath, hydrogen bubbles can be seen coming from the surface of the metal so that at the end of 2 minutes the metal is not only free from grease and mill scale, but has a skin left thereon formed of a magnesium hydride without any free hydrogen. The magnesium metal article is then dried, as by oven baking at

300° F. for 5 minutes which insures that all loose oxides and residual products causing corrosion are eliminated. A preferred method of applying the coating is to quench the metal, at room temperature, in a bath containing a solution of the uncured phenolic resin in an organic solvent and zinc chromate in the proportion of 3 ounces as a minimum to as high as 16 ounces per gallon of resin. This has the effect of pulling the resin into fine cracks and defects in the surface of the metal. The coated article is then oven dried at 300° F. for 15 minutes. This allows the solvent to evaporate from the coating film which becomes fully set.

One or more coats may be used. One coat generally suffices for atmospheric conditions, but to secure protection in salt water it is desirable to use 2 to 3 coats.

When zinc chromate is combined with the phenolic resin in the manner described, there results an improved corrosion protection over the use of the phenolic resin alone. It is believed that if the magnesium metal part is scratched to the bare surface and exposed to corrosive influences, e.g. aqueous salt solution, a leeching effect is obtained whereby the zinc compounds reacts with the magnesium to prevent corrosion on the uncovered surface and creepage under the coating.

The method of the present invention has been described in some detail, and it will be evident to those skilled in the art that for some reason the combination of a clean magnesium hydrided surface with the resin primer specified herein provides a corrosion-inhibiting film having outstanding properties, including excellent paint bonding characteristics.

DESCRIPTION OF CORROSION TESTS AS SHOWN IN PHOTOMICROGRAPHS

Corrosion tests were carried out on magnesium metal samples, in the form of bars. In each case, one bar was coated with the resin primer that forms the subject of the present invention and one comparison bar was provided with a conventional corrosion-resistant coating. Each coated bar was thoroughly air-dried and then subjected to a salt spray test in which a 5% solution of sodium chloride at 100° F. is continuously sprayed on the bars during certain test periods.

The bars coated with the resin primer of the present invention were continuously sprayed during a test period of 1000 hours. By way of comparison, identical bars provided with a conventional corrosion-resistant coating were dried and subjected to the salt spray test referred to above during test periods of 24 hours and 48 hours respectively.

Visual inspection of the exposed or tested bars coated with the resin primer of the present invention showed no attack of the magnesium metal. The comparison bars having the conventional corrosion-resistant coating showed severe attack of the magnesium metal.

The results of the tests are illustrated in the accompanying figures, where

FIG. 1 is a photomicrograph showing the bar on the top coated with the resin primer of the present invention not corroded on being subjected to 5% salt spray for 1000 hours, and the bar at the bottom, provided with a conventional corrosion-resistant coating, severly corroded on being subjected to the same salt spray test for 24 hours.

FIG. 2 is a photomicrograph showing the bar on the top coated with the resin primer of the present invention not corroded on being subjected to 5% salt spray for 1000 hours, and the bar at the bottom, provided with a conventional corrosion-resistant coating, severly corroded on being subjected to the same salt spray test for 48 hours.

The composition and method of the invention having been thus described, modifications thereof will be apparent to those skilled in the art and the invention is to be considered limited in scope only by the scope of the hereinafter appended claims.

What is claimed is:

1. The method of inhibiting corrosion of a magnesium metal article which comprises cleaning the surface of said article with an alkaline solution at 180° F.–212° F., drying said cleaned article, and applying to the clean surface of said article a solution consisting essentially of plasticized, water-insoluble uncured liquid phenolic resin in an organic solvent containing zinc chromate in the proportion of 3 ounces by weight as a minimum to as high as 16 ounces per gallon of resin, and drying the coated article at temperatures in the range of 250°–400° F. to allow the solvent to evaporate therefrom and the coating to become fully set.

2. The method of claim 1 wherein the magnesium metal article is cleaned in an alkaline bath kept at a pH of 11.

3. The method of claim 1 wherein said coated article is oven dried at 300° F.

4. The method of claim 1 wherein the phenolic resin is a condensation product of phenol and formaldehyde plasticized with 10–20% polyvinyl butyral.

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