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METHOD OF COATING MAGNESIUM AND ITS
ALLOYS AND ARTICLE SO COATED

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This invention relates in general to an improved method of treating surfaces of magnesium and magnesium base alloys to produce protective coatings thereon. The invention is particularly concerned with the production of relatively thin, adherent coatings on magnesium and its alloys, characterized by the fact that the coatings exhibit an enamel-like appearance and have appreciable resistance to abrasion. The invention is also directed to articles fabricated from magnesium and its alloys, the surfaces of which are provided with the protective coating of this invention.

It is known that magnesium and its alloys readily acquire a natural superficial film on exposure to atmosphere. This natural film, however, does not effectively retard further corrosion of the metal and is not sufficiently resistant to be classified as a non-smudging coating, particularly when structures or equipment fabricated from magnesium or its alloys are subjected to abrasion.

Magnesium and its alloys are finding increased acceptance in the manufacture of rayon and textile equipment, because their light weight is favorable to the high-speed operation of textile machinery. Yarns, fibers, and the like are known to become discolored when rubbed against bare magnesium surfaces, and it is believed that this discoloration, at least in part, results from the smudging characteristics of the natural superficial film present on the magnesium surface.

It is a primary object of the present invention to provide a practical and economical method of forming protective coatings on magnesium and its alloys.

It is a further object of the invention to provide a chemical treatment method for the production of protective coatings on magnesium and its alloys, which coatings exhibit a combination of properties permitting their general use as finishing coatings.

Another object of the invention is to provide an economical method of producing a coating on magnesium and its alloys which is characterized by the fact that it is non-smudging, resistant to abrasion, and readily lends itself to the manufacture of textile bobbins and yarn carriers, as well as photographic film spools and the like.

In its broadest aspect, the method of the present invention comprises treating magnesium or magnesium base alloy surfaces in hot aqueous solutions containing an alkali metal borate, such as borax (sodium tetraborate), and an alkali metal bicarbonate, including ammonium bicar-

bonate. The solution is preferably maintained between about 200 and 212° Fahrenheit, or approximately its boiling point. By suitable selection of the chemical composition and concentration of the aqueous coating solutions, and the time of immersion therein of the articles to be coated, smudge-free, smooth, enamel-like, abrasion-resistant coatings are produced ranging in color from light gray, or tan, to dark-colored coatings with a brown hue.

It has been discovered that equivalent coating results can be obtained using aqueous solutions containing an alkali metal borate and one or more of the alkali metal bicarbonates sodium, potassium, and ammonium, or mixtures of the named bicarbonates. Where the term "bicarbonates" is used in the claims, it will be understood to include the presence of carbonates in the coating solution since sodium and potassium bicarbonates decompose in the heated coating solution to provide available carbon dioxide, and the heated coating solution actually contains, besides the borax, mixtures of carbonates and bicarbonates of sodium and potassium. In coating solutions in which ammonium salts have been substituted for sodium or potassium salts, preferred results are obtained when the ammonium salt is added as commercial ammonium carbonate. Commercial ammonium carbonate decomposes readily and loses ammonia forming ammonium bicarbonate. In fact, commercial ammonium carbonate is usually a mixture in substantially equi-molar proportions of ammonium bicarbonate and ammonium carbamate. Hence the term "bicarbonates" of the alkali metals, including ammonium, embraces the composition of the coating solutions herein contemplated, regardless of whether the salts of potassium and sodium are introduced as bicarbonates, or the ammonium salt is introduced as commercial ammonium carbonate.

The invention, then, is preferably practiced in hot aqueous coating solutions containing borax and added amounts of sodium or potassium bicarbonate, or mixtures thereof, or in aqueous solutions containing borax and added amounts of ammonium carbonate.

Although the invention can be practiced in aqueous solutions of varying chemical compositions and concentrations, and the time of treatment may be varied in accordance with the particular properties and color to be developed in the final coating, it has been discovered that coating solutions, wherein the initial alkali metal bicarbonate or carbonate, or mixtures thereof, is

present in amounts between about 4 to 12 per cent by weight of the solution, and the borax is present in amounts between about 1 to 8 per cent by weight of the solution, give satisfactory results as measured in terms of smooth, enamel-like, non-smudging or abrasion-resistant coatings. Periods of immersion ranging from 5 to 45 minutes have been found to be satisfactory, and by proper selection of the chemical concentration of the coating solution and time of immersion within the composition and time ranges given hereinabove, coatings varying in color from light gray to dark coatings with a brown hue may be produced.

In its essentials, the invention comprises first cleaning the article to be coated in any suitable manner to remove grease or extraneous matter from its surface. Where an exceptionally smooth, enamel-like coating is desired, the article may be first burnished or machined and thereafter cleaned before immersing it in the coating solution. The coatings produced may be buffed lightly to remove any undesired film left on the surface during the coating operation. In all instances the finished coatings are characterized by their smooth, enamel-like finish, free from any tendency to smudge.

As specific examples of the method and article of the present invention, hard, enamel-like, smudge-free coatings have been produced on magnesium base alloy specimens containing between about 1.5 to 2.0 per cent manganese. The treatment of the specimens of this magnesium base alloy comprised first cleaning the same to remove extraneous matter, and then immersing the specimens in the following hot aqueous chemical solutions. The treatment and results are tabulated hereinbelow as follows:

Solution composition in percentage weight			Time of immersion in minutes	Color characteristics of coating
NaHCO ₃	Na ₂ B ₄ O ₇			
4	1		30	Light.
4	2		30	Dark.
4	2		10	Do.
4	4		30	Do.
4	4		10	Do.
6	2		30	Light.
8	2		30	Do.
8	4		30	Do.
8	8		30	Dark.
12	2		30	Light.
12	4		30	Dark.
NH ₄ HCO ₃				
8	4		30	Do.
Na ₂ CO ₃				
5	2		30	Light.
KHCO ₃				
8	2		30	Do.
(NH ₄) ₂ CO ₃				
5	2		30	Dark.
Na ₂ CO ₃		(NH ₄) ₂ CO ₃		
5	4	1	30	Light.

In the above tests, the coating solutions were maintained substantially at their boiling temperature, and all of the coatings produced were smooth, adherent, and enamel-like in appearance, there being no tendency exhibited by any of the coatings to smudge. In general, the coatings produced in accordance with the tests reported herein were relatively thin, with substan-

tially negligible dimensional change in the specimens so coated.

In a plant scale test 8,500 square inches of magnesium surface, in the form of rayon spools fabricated from a magnesium alloy containing 1.5 to 2.0 per cent manganese, was coated in a hot aqueous solution composed of 42 gallons of water, 28 pounds of sodium bicarbonate, and 10 pounds of borax. The solution was maintained between about 210 and 212° Fahrenheit, or approximately at its boiling temperature, and the spools were immersed for a period of 10 minutes. On removal, the spools were rinsed in warm water and dried, and were all found to be provided with a light gray to tan, hard, abrasion-resistant surface coating, which gave satisfactory results in commercial use.

The exact chemical reaction which takes place in the formation of the protective coatings of this invention is not fully understood, nor is any attempt herein made to explain the same. It can be stated, however, that the coatings of this invention in all instances contain a borate and a carbonate.

Where articles are fabricated from magnesium or its alloys and another metal, such as zinc, the protective coating on the magnesium portion of the article serves to prevent corrosion or electrolytic action between the magnesium and the zinc. In general, the protective coatings formed in accordance with the method of this invention inhibit further oxidation of the magnesium where the oxidizing influence is not too severe.

It has been found that the water used for the coating solution of the present invention should be substantially free from chlorides or other halides if the optimum results are to be obtained. If desired, the magnesium article to be coated may be made anode in the coating solutions hereinabove mentioned and satisfactory coatings produced by the electrolytic treatment.

By the term "magnesium" as used in the specification and claims is means commercially pure magnesium and the commercial alloys thereof in which the magnesium content is not less than about 80 per cent of the whole. While the coating methods of the invention function on magnesium alloys falling within the definition given herein, the preferred coatings are produced upon magnesium alloys substantially free from aluminum.

While in describing the invention specific language has been employed in the interest of clarity, it is not intended by the use of such language to exclude any equivalents or variations of the invention as set forth in the appended claims.

What is claimed is:

1. A method of coating articles of magnesium, which comprises treating said articles in a hot aqueous solution containing an alkali metal borate and an alkali metal bicarbonate capable of providing available carbon dioxide in the coating solution.

2. A method of producing a non-smudging, adherent coating on a magnesium surface, which comprises treating said surface in a hot aqueous solution containing an alkali metal borate and at least one of the group consisting of the bicarbonates of the alkali metals and ammonium.

3. A method of producing a non-smudging, adherent coating on a magnesium surface, which comprises treating said surface in a hot aqueous solution containing a mixture of an alkali metal

bicarbonate and carbonate, and an alkali metal borate.

4. A method of producing a non-smudging, adherent coating on a magnesium surface, which comprises treating said surface in a chloride-free, hot, aqueous solution containing a mixture of an alkali metal carbonate, an alkali metal bicarbonate, and an alkali metal borate.

5. A method of producing a non-smudging, adherent, enamel-like coating on a magnesium surface, which comprises treating said surface in a hot, chloride-free, aqueous solution containing sodium bicarbonate and borax.

6. A method of producing a non-smudging, adherent, enamel-like coating on a magnesium surface, which comprises treating said surface in a hot, chloride-free, aqueous solution containing potassium bicarbonate and borax.

7. A method of producing a non-smudging, adherent, enamel-like coating on a magnesium surface, which comprises treating said surface in a hot, chloride-free, aqueous solution containing ammonium bicarbonate and borax.

8. A method of producing a non-smudging, adherent coating on a magnesium article, which comprises treating said article in a hot aqueous solution containing an alkali metal bicarbonate in amounts between about 4 to 12 per cent by weight of solution, and borax in amounts between about 1 to 8 per cent by weight of solution.

9. A method of producing a non-smudging, adherent coating on a magnesium article, which comprises treating said article in a hot aqueous solution containing an alkali metal bicarbonate in amounts between about 4 to 12 per cent by

weight of solution, and borax in amounts between about 1 to 8 per cent by weight of solution, said article being immersed in said solution for a period between about 5 to 45 minutes.

10. A method of producing a non-smudging, adherent coating on a magnesium article, which comprises treating said article in an aqueous solution containing an alkali metal bicarbonate in amounts between about 4 to 12 per cent by weight of solution, and borax in amounts between about 1 to 8 per cent by weight of solution, said solution being maintained between about 200 to 212° Fahrenheit, and said article being immersed in said solution for a period between about 5 to 45 minutes.

11. A magnesium article provided with a relatively thin, enamel-like, smudge-free coating, said coating being a reaction product between the magnesium and a hot aqueous solution of a mixture of an alkali metal bicarbonate and carbonate, and borax.

12. A magnesium article provided with a relatively thin, enamel-like, smudge-free coating, said coating being a reaction product between the magnesium and a hot aqueous solution of a mixture of an alkali metal bicarbonate and an alkali metal borate.

13. A spool for use in the textile industry, said spool being composed of magnesium provided with a relatively thin, enamel-like, smudge-free coating, said coating being a reaction product between the magnesium and a hot aqueous solution of an alkali metal bicarbonate and an alkali metal borate.

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