

UNITED STATES PATENT OFFICE

2,650,157

BRIGHTENING ALUMINUM

William C. Cochran, New Kensington, Pa., assignor to Aluminum Company of America, Pittsburgh, Pa., a corporation of Pennsylvania

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9 Claims. (Cl. 41-42)

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This application is a continuation-in-part of my prior application Serial No. 773,921, filed September 13, 1947, and entitled Brightening Aluminum, now abandoned.

This invention relates to the brightening of aluminum surfaces to improve their appearance and specular reflectivity, and has special reference to brightening treatments in which a chemical solution is employed without application of external electromotive force. As used herein, the term "aluminum" includes pure aluminum, commercial aluminum containing the usual impurities, and aluminum base alloys.

Brightened aluminum articles have wide utility for various applications where a pleasing decorative appearance is desired, particularly where a high degree of specularly is desired. Usually aluminum articles are brightened by anodic treatment of the articles in one of several well known electrolytes. Electrolytic treatments require expensive electrical equipment, and also are not conveniently employed for treating small articles or a variety of different articles. Many efforts have been made to brighten aluminum articles in simple chemical solutions, but so far as is known, no such treatment has met all requirements, particularly for the production of surfaces of high specularly.

It is an object of this invention to provide an economical and convenient method of brightening aluminum articles which will produce pleasing surfaces of uniform brightness and high specularly. Another object is to provide a simple chemical treatment for brightening aluminum articles, especially one that is capable of producing surfaces of high specularly. These and other objects will be apparent in the following description of the invention.

I have discovered that aluminum articles may be readily brightened by simply immersing them for a short time in certain hot aqueous solutions containing phosphoric acid and nitric acid. A bright finish may be produced, and the specularly of the finish is most striking if the surface is initially smooth, although the procedure is effective in improving the specularly of surfaces initially rough. As will be explained hereinafter, I have also found that acetic acid, sulfuric acid, or both may also be included in the solutions. However, careful selection of the amounts of the various components of the solutions must be made in order to provide suitable solutions.

Solutions in accordance with the invention must comprise, as the essential components thereof, on a weight basis referred to the total

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weight of phosphoric acid, nitric acid and water therein, about 68 to 85 per cent phosphoric acid (H_3PO_4), about 1 to 10 per cent nitric acid and about 11 to 28 per cent water. The stated water content of the solutions just referred to, and also of those hereinafter referred to, is the entire water content thereof, whether added with the acids or separately. For optimum results such solutions comprising about 73 to 83 per cent phosphoric acid, about 2 to 5 per cent nitric acid and about 14 to 23 per cent water should be employed.

Solutions consisting essentially of the three components specified above, within the limits stated, are very effective for brightening aluminum articles. However, solutions in which the components specified above constitute but two thirds to three quarters of the total have proved effective. For example, one additional substance that may be included in the solutions is acetic acid, which may be present in amounts by weight up to about one third of the total weight of phosphoric acid, nitric acid and water in the solution. Further, sulfuric acid may be present in amounts by weight up to about one half the total weight of phosphoric acid, nitric acid and water in the solution. Sulfuric acid especially appears to be an economical diluent for the solutions. Both acetic acid and sulfuric acid may be present, but the combined amount thereof by weight should be limited, as a maximum, to about one third to one half the total weight of phosphoric acid, nitric acid and water in the solution.

It should be observed that both the composition of the solution and the temperature at which it is employed are very important. It is only when phosphoric acid and nitric acid are mixed in certain proportions, with an appropriate amount of water, that the brightening solutions of my invention are produced. Further it is only when such solutions are employed at temperatures above about 70° C. that they are effective for improving the brightness and specularly of aluminum surfaces.

To obtain the best results the solution used should be moderately agitated and maintained at a temperature between about 70 and 110° C. It is preferable to maintain the solution at a temperature within the upper portion of this range, but below 100° C., for example 90° C.

The period of immersion will vary with the type of aluminum being treated and the temperature of the solution; generally from about ¼ minute to 5 minutes is adequate. Shorter periods of time are often sufficient; longer periods

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of time do not appear to produce superior results. A single immersion in the solution is, of course, ordinarily sufficient.

Although the aluminum articles may be immersed in the solution without any previous treatment, it is advisable to clean them thoroughly with a solvent, so as to remove superficial foreign material such as grease or grime, before immersion in the brightening solution. Further, the articles may be buffed or mechanically finished before cleaning and brightening treatments are employed.

While articles made of various commercial aluminum, and aluminum base alloys may be treated in the solution with beneficial results, finishes of high specularity are obtained on articles of high purity aluminum, 2S (commercially pure aluminum), 3S (a manganese containing alloy) and 52S (a magnesium containing alloy), for example. Further, marked improvement in specularity of surfaces may be effected by treatment in the solution, even though the articles treated be unsuited to the production of finishes of highest specularity.

The improved finish obtainable through use of my invention is illustrated in the following comparative tests, wherein three different solutions were employed to brighten a number of aluminum panels of various composition, prepared by various preliminary treatments. In these tests, Solution No. 1 was prepared according to the present invention; Solution No. 2 is typical of those known prior to my invention; and Solution No. 3 is typical of those used for electrolytic brightening of aluminum.

Solution No. 1

	Per cent by weight
Phosphoric acid	80.5
Nitric acid	3.5
Water	16

Solution No. 2

	Per cent by weight
Nitric acid	5
Hydrofluoric acid	0.25
Water	94.75

Solution No. 3

	Per cent by weight
Fluoboric acid	1.8
Water	98.2

Test panels of No. 2 reflector sheet (surface composed of high purity aluminum containing 0.03 to 0.06 per cent copper, and a maximum of 0.15 per cent of impurities), 2S aluminum (commercial aluminum with not more than 1 per cent of impurities), 3S aluminum alloy (an aluminum alloy containing about 1.2 per cent manganese) and 52S aluminum alloy (an aluminum alloy containing about 2.5 per cent magnesium and 0.25 per cent chromium) were provided for treatment in each solution.

One series of panels was merely solvent cleaned before brightening (unbuffed panels indicated in the following tables); the other series of panels was rough buffed, cleaned in a sulfuric acid-chromic acid solution, and "color" buffed before brightening (buffed panels indicated in the following tables). The panels brightened in Solution No. 1 were separately immersed therein for a period of 3 minutes with the solution at a temperature of about 93° C. Those treated in Solution No. 2 were immersed for 4 minutes with the solution at a temperature of about 99° C. The

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panels electrolytically brightened in Solution No. 3 were separately made anode therein for a period of 10 minutes, with the solution at a temperature of about 32° C., and with an applied voltage of about 14. These latter panels were also given a "smudge remover" treatment in a hot solution of phosphoric acid and chromic acid.

The panels were rinsed and dried after the treatment in the solutions. Those which had been immersed in Solution No. 1 have far greater specularity than those immersed in Solution No. 2, and usually equaled (and in some cases exceeded) the specularity of those treated electrolytically in Solution No. 3. While the differences in brightness and specularity of the panels are readily apparent to the eye, they were more accurately established by quantitative measurements of luminous apparent reflectance obtained by use of a standard Hunter Multipurpose Reflectometer, which is described in the National Bureau of Standards Journal of Research, vol. 25, pages 581-618, November 1940. Luminous apparent reflectance measurements are found to be one of the best measures of the specularity of aluminum surfaces; low values indicate a high degree of specularity, and high values indicate a low degree of specularity. The results obtained by such measurements were as follows:

52S PANELS—UNBUFFED

	Treated in Solution No.	Luminous Apparent Reflectance
1		.0231
2		.1000

3S PANELS—UNBUFFED

1	.....	.0201
2	.....	.0596

2S PANELS—UNBUFFED

1	.....	.0176
2	.....	.0577

2S PANELS—BUFFED

1	.....	.0180
2	.....	.0442
3	.....	.0203

NO. 2 REFLECTOR SHEET—BUFFED

1	.....	.0161
2	.....	.0381
3	.....	.0152

The low luminous apparent reflectance values for Solution No. 1 clearly reveal the very great effectiveness of this solution for producing brightened aluminum surfaces of high specularity. In fact, the specularity of surface of a group of panels treated in Solution No. 1 was improved by as much as 10 to 80 per cent as determined from luminous apparent reflectance measurements, the improvements being readily apparent to the eye in each case (and usually markedly so). By other tests it was observed that all of the panels treated in Solution No. 1 exhibited a total reflectivity for white light of at least 87 per cent, whether previously buffed or not. These results are typical of many I have observed.

While I have successfully employed a very great number and variety of solutions within the

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limits of composition therefor mentioned above, I cite, as additional examples of solutions found suitable for the practice of my invention, the following:

Solution No. 4

	Percent by Weight	
	of Solution	of First 3 Components
Phosphoric acid.....	70	82.5
Nitric acid.....	2	2.5
Water.....	13	15
Acetic acid.....	15	-----

Solution No. 5

	Percent by Weight	
	of Solution	of First 3 Components
Phosphoric acid.....	61	72.5
Nitric acid.....	8	9.5
Water.....	15	18
Sulfuric acid.....	16	-----

Solution No. 6

	Percent by Weight	
	of Solution	of First 3 Components
Phosphoric acid.....	50	72.5
Nitric acid.....	8.5	9.5
Water.....	12.5	18
Acetic acid.....	6	-----
Sulfuric acid.....	25	-----

It will be understood that brightened aluminum surfaces produced in accordance with the invention may be suitably protected by lacquers, by the formation of oxide coatings thereon, or by other known finishing procedures, if desired.

I claim:

1. The method of chemically brightening a surface of an aluminum article which comprises immersing said article in a solution having as the essential components thereof, on a weight basis referred to the total weight of phosphoric acid, nitric acid and water therein, about 73 to 83 per cent phosphoric acid, about 2 to 5 per cent nitric acid and about 14 to 23 per cent water, the solution being maintained at a temperature above about 70° C., wherein the specularity of the surface of the aluminum article is improved as determined from luminous apparent reflectance measurements obtained by use of a standard Hunter Multipurpose Reflectometer.

2. The method of chemically brightening a surface of an aluminum article which comprises immersing said article in a solution having as the essential components thereof, on a weight basis referred to the total weight of phosphoric acid, nitric acid and water therein, about 73 to 83 per cent phosphoric acid, about 2 to 5 per cent nitric acid and about 14 to 23 per cent water, the solution being maintained at a temperature

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between about 90 and 100° C., wherein the specularity of the surface of the aluminum article is improved by at least 10 per cent as determined from luminous apparent reflectance measurements obtained by use of a standard Hunter Multipurpose Reflectometer.

3. The method of claim 1 wherein the article is immersed for a period of about ¼ to 5 minutes.

4. The method of claim 1 wherein the solution also contains acetic acid in an amount by weight up to one third of the total weight of phosphoric acid, nitric acid and water therein.

5. The method of claim 1 wherein the solution also contains sulfuric acid in an amount by weight up to one half of the total weight of phosphoric acid, nitric acid and water therein.

6. The method of claim 1 wherein the solution also contains acetic and sulfuric acids in a combined amount by weight up to one half of the total weight of phosphoric acid, nitric acid and water therein.

7. The method of chemically brightening a surface of an aluminum article which comprises immersing said article in a solution consisting of about 73 to 83 per cent phosphoric acid, about 2 to 5 per cent nitric acid and about 14 to 23 per cent water, on a weight basis, the solution being maintained at a temperature above about 70° C., wherein the specularity of the surface of the aluminum article is improved as determined from luminous apparent reflectance measurements obtained by use of a standard Hunter Multipurpose Reflectometer.

8. The method of chemically brightening a surface of an aluminum article which comprises immersing said article in a solution consisting of about 73 to 83 per cent phosphoric acid, about 2 to 5 per cent nitric acid and about 14 to 23 per cent water, on a weight basis, the solution being maintained at a temperature between about 90 and 100° C., wherein the specularity of the surface of the aluminum article is improved by at least 10 per cent as determined from luminous apparent reflectance measurements obtained by use of a standard Hunter Multipurpose Reflectometer.

9. The method of chemically brightening a surface of an aluminum article which comprises immersing said article for about three minutes in a solution consisting of about 80.5 per cent phosphoric acid, about 3.5 per cent nitric acid and about 16 per cent water, on a weight basis, the solution being maintained at a temperature of about 90° C. to 100° C.

WILLIAM C. COCHRAN.

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Disclaimer

2,650,157.—*William C. Cochran*, New Kensington, Pa. BRIGHTENING ALUMINUM. Patent dated Aug. 25, 1953. Disclaimer filed Mar. 27, 1956, by the assignee, *Aluminum Company of America*.

Hereby disclaims the terminal part of the term of said patent subsequent to Jan. 3, 1956.

[*Official Gazette May 1, 1956.*]

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