This invention relates to improvements in chemical solutions used for the brightening of aluminum.

A major object of the invention is to provide an improved bright dip solution which eliminates the objectionable fuming which is unavoidable during use of certain types of brightening solutions.

A more specific object is to provide an improved solution which is particularly effective for surface brightening of aluminum or aluminum alloy metals while substantially eliminating corrosive brown nitrogen oxide fumes from both the bath and the work in transfer.

A further object is to provide an improved bright dip solution which may be used in plant areas not equipped with elaborate exhaust conducting systems and which not only permits improved working conditions, but eliminates the danger of attendant exhausted acid fumes which are injurious to health and which frequently damage adjacent property.

A further object is to provide an improved bright dip solution which may be operated at optimum effectiveness within temperature ranges which result in conservation of nitric acid and substantially lower operating costs by reduction of acid waste through boil-off and fuming.

A further object is to provide an improved brightening solution of the phosphoric acid base type which is not critical in operation and is effective for processing of a wide range of aluminum alloys, with less pitting and reduced sludging.

Other objects will be in part obvious and in part pointed out more in detail hereinafter.

The invention accordingly consists in the features of construction, combination of elements and arrangement of parts which will be exemplified in the construction hereafter set forth and the scope of the application of which will be indicated in the appended claims.

Various chemical solutions have been proposed for the brightening of aluminum surfaces to improve the appearance and specular reflectivity thereof, such solutions acting when hot, to etch or otherwise polish the surface of aluminum immersed therein for short time periods. The action, while fully not understood, is chemical rather than electro-chemical in nature and such solutions are not intended to serve as electrolytes. One of the most effective types of such solutions comprises a major percentage of phosphoric acid and a minor percentage of nitric acid and when maintained within certain temperature ranges, a quite satisfactory bright finish is obtained on the surfaces of aluminum and certain aluminum alloys immersed therein.

The brightening action of such solutions has heretofore been accompanied by substantial fuming, and the removal of those dangerous and destructive fumes has required the installation of costly duct-type ventilating systems. Since the duct material is attacked by the acid fuming problem is presented both in maintaining the ducts in satisfactory condition and in proper disposal of the fumes which must be removed to the exterior of a plant, since such fumes are relatively heavy and descend to cause damage to adjacent property. In view of the above problems, there has arisen an urgent need for an effective non-fuming brightening solution which offers the superiority of performance of the phosphoric and nitric acid bath type above mentioned, but without the attendant highly objectionable fuming which has heretofore characterized the use of that type of solution. While some measure of success has been obtained by substituting other ingredients for the above acids, and some reduction of fuming has been obtained, it has been obtained at the cost of substantially reduced brightening action, hence the problem, rather than being solved, has heretofore merely been by-passed.

The present invention permits the use of the highly effective brightening solutions, preferably consisting of about 85 percent (30° Baume) phosphoric acid and an added minor percentage of nitric acid, while eliminating fuming in temperature ranges which maintain the effectiveness of the brightening action. This highly desirable objective results from the discovery that the fuming action is eliminated during use of the solution within certain temperature ranges by the addition of either carbamide (carbonyldiamide), 2,4,6-triamino-s-triazine (cyanurictriamide), or dicyanamidine in percentages defined below, which serve as highly effective fume inhibitors.

A brightening solution may, for example, consist of 85 percent by weight (59° Baume) phosphoric acid to which is added 5 to 10 fluid ounces of commercial 42° Baume (67 percent by weight) nitric acid, the balance being water, such solution being maintained during use at temperatures varying between 160° F. and 230° F. The lowest boiling point of the acids therein limits the upper temperature range, but optimum results are usually obtained at temperatures around 200° F. or above. While highly effective for its intended purpose, the use of such a solution is accompanied by the vigorous fuming above mentioned, but it has been found that such fuming may be very substantially reduced, if not eliminated, by the addition of a very minor percentage of either 2,4,6-triamino-s-triazine, or carbamide, or dicyanamide, or a combination thereof. The optimum percentage by weight, of either or all such inhibitors is .05 to 3 percent by weight of the brightening solution. It has further been found that by combining 2,4,6-triamino-s-triazine, carbamide, and dicyanamide with certain other additives in the percentages listed below, fuming may be totally eliminated when the acid solution with its inhibitors is held within the temperature range of about 190° F. The invention therefore contemplates, within the minor percentage limits defined, the addition of either of the above fume inhibitors, a combination of any two, or a combination of all three, or the combination of any one or more with other brightening radicals. Solution No. 1 is particularly effective for brightening wrought aluminum alloys containing less than 0.5 percent copper or 0.5% silicon.

Additive No. 1

<table>
<thead>
<tr>
<th>Additive</th>
<th>Percent by weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbamide</td>
<td>24.5</td>
</tr>
<tr>
<td>2,4,6-triamino-s-triazine</td>
<td>8.0</td>
</tr>
<tr>
<td>Sodium nitrate</td>
<td>45.0</td>
</tr>
<tr>
<td>Sodium sulphate</td>
<td>20.0</td>
</tr>
<tr>
<td>Ferrous sulphate</td>
<td>1.7</td>
</tr>
<tr>
<td>Desiccated copper sulphate monohydrate</td>
<td>0.8</td>
</tr>
</tbody>
</table>

The additive is used at 3-4 ounces per gallon of 85 percent (59° Baume) phosphoric acid solution at about 200° F., to which has been added 4 to 6 fluid ounces per gallon 42° Bé nitric acid. Treating time—1 to 2½ minutes.

Solution No. 2 will brighten high purity aluminum (purity 99.99% by itself or alloyed with up to 2% pure magnesium) while preventing fuming.
<table>
<thead>
<tr>
<th>Additive No. 2</th>
<th>Percent by weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,4,6-triamino-s-triazine</td>
<td>42.00</td>
</tr>
<tr>
<td>Carbamide</td>
<td>50.45</td>
</tr>
<tr>
<td>Copper sulphate monohydrate</td>
<td>4.40</td>
</tr>
<tr>
<td>Manganese sulphate, 75-80%</td>
<td>1.05</td>
</tr>
<tr>
<td>Ferrous sulphate</td>
<td>1.05</td>
</tr>
<tr>
<td>Desiccated nickel sulphate</td>
<td>100</td>
</tr>
</tbody>
</table>

Additive No. 2 is used at 2.3 ounces per gallon of 85 percent phosphoric acid solution at 190°-220° F. to which has been added 5 to 10 fluid ounces per gallon 42° Bé nitric acid. Treating time—1 to 3 minutes.

While the above acid percentages have been found particularly effective within the specified temperature ranges, those percentages are subject to variations depending upon the type of aluminum to be polished and the desired result and some departure therefrom is possible while maintaining the non-fuming effect of the 2,4,6-triamino-s-triazine, carbamide or both. The immersion period will also vary with the type of aluminum and the operating temperature.

Both of the above additive compositions completely eliminate the corrosive brown nitrogen oxide fumes from the bath and from the work in transfer. Since the solutions prepared with the above additives work well in the 20% nitric solution, which is substantially below the boiling point of nitric acid, a very stable bath results which remains stable even during extended shutdown periods. The reduced consumption of nitric acid above mentioned results in a bath which is less critical to operate, with good drainage characteristics, and a transfer time as high as 35 seconds.

Due to reduction of critical properties, there is less pitting of the work under treatment, and very little sludging, with no tendency of emulsification. There is also less etching of the work under treatment during transfer. Under certain conditions a very low initial magnitude of fuming may be noted, but as the fumes inhibitors start to react, such fuming quickly disappears.

As will be apparent to persons skilled in the art, various modifications and adaptations of the structure above described will become readily apparent without departure from the spirit and scope of the invention, the scope of which is defined in the appended claims.

I claim:

1. A non-fuming solution for brightening aluminum at a temperature of about 190-230° F. consisting essentially of approximately 85.0 percent by weight phosphoric acid, approximately 2.0-5.0 percent by weight nitric acid, and water, containing about 0.25-3.0 percent by weight of a fume inhibiting additive selected from the group consisting of carbamide, dicyanodiamide, and 2,4,6-triamino-s-triazine, and combinations thereof.

2. A non-fuming solution for brightening aluminum at a temperature of about 190-230° F. consisting essentially of approximately 85.0 percent by weight phosphoric acid, approximately 2.0-5.0 percent by weight nitric acid, and water, containing as a fume inhibiting additive about 0.05-3.0 percent by weight of carbamide.

3. A non-fuming solution for brightening aluminum at a temperature of about 190-230° F. consisting essentially of approximately 85.0 percent by weight phosphoric acid, approximately 2.0-5.0 percent by weight nitric acid, and water, containing as a fume inhibiting additive about 0.05-3.0 percent by weight of dicyanodiamide.

4. A non-fuming solution for brightening aluminum at a temperature of about 190-230° F. consisting essentially of approximately 85.0 percent by weight phosphoric acid, approximately 2.0-5.0 percent by weight nitric acid, and water, containing as a fume inhibiting additive about 0.05-3.0 percent by weight of 2,4,6-triamino-s-triazine.

5. An aluminum brightening composition consisting of about 85 percent phosphoric acid solution to which is added 5 to 10 fluid ounces of 42° Bé concentrated nitric acid and 2 to 4 ounces per gallon of solution of dry additives consisting of, on a dry weight basis, 24.5 percent carbamide, 8 percent 2,4,6-triamino-s-triazine, 45 percent sodium nitrate, 20 percent sodium sulphate, 17 percent ferrous sulphate and 8 percent monohydrate copper sulphate, said solution and additives being maintained at a temperature within the range of 190° to 220° F.

6. A non-fuming solution for brightening aluminum at a temperature of about 190-230° F. consisting essentially of approximately 85.0 percent by weight phosphoric acid, approximately 2.0-5.0 percent by weight nitric acid, and water, containing as a fume inhibiting additive in amounts of about 2.3 ounces per gallon, said additive consisting of, on a dry-weight basis, 50.45 percent by weight carbamide, 42.0 percent by weight of 2,4,6-triamino-s-triazine, 4.4 percent by weight monohydrated copper sulfate, 1.05 percent by weight manganese sulfate (75-80 percent), 1.05 percent by weight ferrous sulphate and 1.05 percent by weight nickel sulphate.

7. The method of brightening aluminum which is characterized by substantial freedom from fuming comprising providing an aluminum brightening solution consisting essentially of approximately 85.0 percent by weight phosphoric acid, approximately 2.0-5.0 percent by weight nitric acid, and water, containing about 0.05-3.0 percent by weight of a fume inhibiting additive selected from the group consisting of carbamide, dicyanodiamide, and 2,4,6-triamino-s-triazine, and combinations thereof; heating said solution to a temperature on the order of 190-230° F.; and maintaining an aluminum workpiece in said heated solution for a period of time sufficient to provide the desired finish on the surface thereof.

8. The method of brightening aluminum which is characterized by substantial freedom from fuming comprising providing an aluminum brightening solution consisting essentially of approximately 85.0 percent by weight phosphoric acid, approximately 2.0-5.0 percent by weight nitric acid, and water, containing as a fume inhibiting additive about 0.05-3.0 percent by weight of carbamide; heating said solution to a temperature on the order of 190-230° F.; and maintaining an aluminum workpiece in said heated solution for a period of time sufficient to provide the desired finish on the surface thereof.

9. The method of brightening aluminum which is characterized by substantial freedom from fuming comprising providing an aluminum brightening solution consisting essentially of approximately 85.0 percent by weight phosphoric acid, approximately 2.0-5.0 percent by weight nitric acid, and water, containing as a fume inhibiting additive about 0.05-3.0 percent by weight of dicyanodiamide; heating said solution to a temperature on the order of 190-230° F.; and maintaining an aluminum workpiece in said heated solution for a period of time sufficient to provide the desired finish on the surface thereof.

10. The method of brightening aluminum which is characterized by substantial freedom from fuming comprising providing an aluminum brightening solution consisting essentially of approximately 85.0 percent by weight phosphoric acid, approximately 2.0-5.0 percent by weight nitric acid, and water, containing as a fume inhibiting additive about 0.05-3.0 percent by weight of 2,4,6-triamino-s-triazine; heating said solution to a temperature on the order of 190-230° F.; and maintaining an aluminum workpiece in said heated solution for a period of time sufficient to provide the desired finish on the surface thereof.

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