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METHOD OF ELECTROPOLISHING AND ELECTROLYTIC SOLUTION THEREFOR

Herbert B. Robinson, Long Beach, Calif., assignor to A. O. Smith Corporation, Milwaukee, Wis., a corporation of New York

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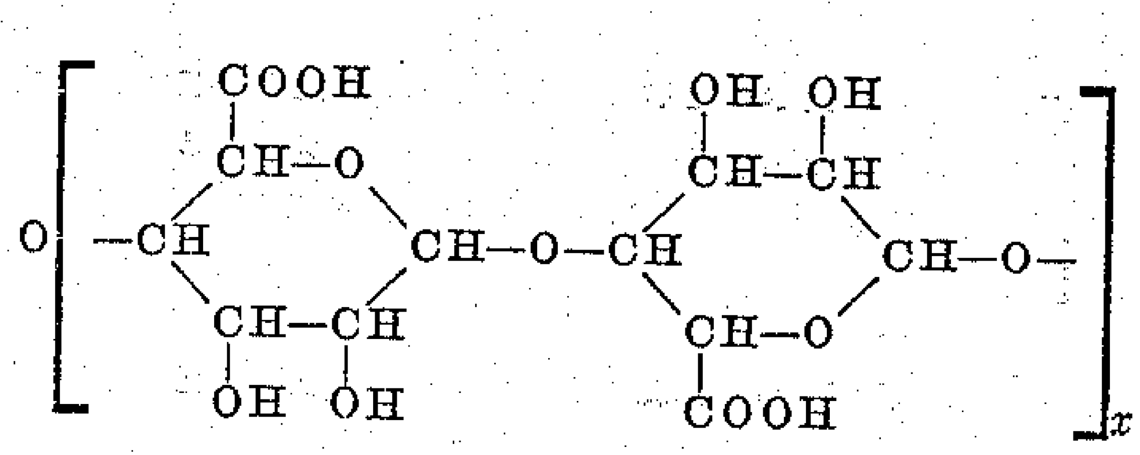
This invention relates to electropolishing and more particularly to an electrolytic solution for use in the anodic treatment of metals to impart polish or luster to the metals.

Electropolishing is a method of achieving new surface qualities and appearance. Electropolishing eliminates scratches, strains, metal debris and embedded abrasive which ordinarily accompany mechanical finishing methods. The electropolished surface has the true grain structure of the metal undistorted by the cold working of mechanical methods.

The present invention is directed to an improved electrolytic solution for use in electropolishnig. According to the invention, the electrolytic solution or bath is composed of a mixture of ortho phosphoric acid and other mineral acids such as sulphuric acid or hydrochloric acid, and contains a small amount of a salt of alginic acid. The resulting solution is a low cost, low energy, room temperature bath having high throwing power and being generally insensitive to current density. In addition, the electrolytic solution of the invention is not hazardous in use for it will not give off poisonous or toxic fumes, nor is it explosive.

The specific mineral acid employed in combination with the phosphoric acid depends on the type of cleaning action desired. For example, if maximum brightening is desired on parts free of heat treatment discoloration or scale, then sulphuric acid may be used as the mineral acid in combination with phosphoric acid. If, on the other hand, removal of heat treatment scale and discoloration is desired along with polishing, then hydrochloric acid may be used.

The salt of alginic acid may take the form of any of the known alginates such as sodium alginate, ammonium alginate and propylene glycol alginate. Alginic acid is a hydrophilic colloidal polymer of anhydro-B-D-mannuronic acid units, the structural formula of which is generally accepted to be:



An electrolytic solution to be used for maximum brightening has the following general formula in weight percent:

	Percent
Ortho phosphoric acid (1.70 sp. g.)	40.0–80.0
Sulphuric acid (1.84 sp. g.)	3.0–42.0
Salt of alginic acid	0.1– 5.0
Water	Balance

A specific example of the electrolytic solution falling within the above range is as follows in weight percent:

	Percent
Ortho phosphoric acid (1.70 sp. g.)	60.0
Sulphuric acid (1.84 sp. g.)	20.0
Sodium alginate	3.0
Water	17.0

This solution or bath has a mild odor suggestive of yeast, has a foam layer which eliminates spray and will not corrode surrounding equipment. A loose, light green film is produced on the workpiece by this solution.

The electrolytic solution as used for cleaning, heat treatment scale and discoloration has the following general composition in weight percent:

	Percent
Ortho phosphoric acid (1.70 sp. g.)	30.0–80.0
Hydrochloric acid (1.16 sp. g.)	1.0–15.0
Salt of alginic acid	0.1– 5.0
Water	Balance

A specific example of the composition falling within the above range is as follows:

	Percent
Ortho phosphoric acid (1.70 sp. g.)	56.0
Hydrochloric acid (1.16 sp. g.)	10.0
Propylene glycol ester of alginic acid	2.5
Water	31.5

This solution produces a dark green film on the workpiece which slowly rinses off with water, has a relatively strong odor of hydrochloric acid and is somewhat corrosive to surrounding equipment.

The alginate as used in the above electrolytic solutions provides a film essential to leveling action and current redistribution which is basic to electropolishing action. In addition, the alginate serves to increase the viscosity of the bath and this helps to maintain the film in place on the material to be polished or cleaned.

Furthermore, the alginate facilitates restoration of the exhausted electrolytic solution as only a small addition, in the range of 1%, of the alginate need be added to the solution to restore the capacity thereof.

The electrolytic solutions of the invention are preferably prepared by initially mixing the acids together and then adding the alginate.

The metal or alloy to be polished or cleaned is employed as the anode in the electrolytic solution and may be a ferrous metal, such as carbon steel or the 200, 300 and 400 series of stainless steel, or may be a nickel or cobalt base alloy.

The cathode in the electrolytic solution may be made of any metal or alloy which will not corrode during idle periods of the process and may take the form of the 300 series stainless steel, lead, or the like.

The process of the invention is run at relatively low temperatures or at room temperature. For example, the electropolishing bath containing sulphuric acid will generally have an operating temperature below 160° F. and in the range of 120° F. to 160° F. A temperature of about 140° F. has proven very satisfactory for this bath. The electrocleaning solution, using hydrochloric acid, operates at temperatures below 100° F. and preferably in a range of 50° F. to 100° F. with a temperature of 75° F. proving very satisfactory.

The electropolishing bath operates at relatively low current densities. The particular current density employed is dependent on the time that the workpiece is maintained in the bath. For example, using a sulphuric acid type bath for electropolishing, a current density of 10 amperes per square foot can be employed for a 30 minute period or a current density of 400 amperes per square foot can be used for a 1 minute period.

With the hydrochloric acid bath it has been found that the current density should initially be in the range of 125 to 150 amperes per square foot and then reduced to about 25 to 30 amperes per square foot after 1 minute. A total time of 2 to 5 minutes is ordinarily sufficient for this operation.

The viscosity of the solution should not be so great that gas bubbles cannot escape from the solution or spotting will result. The viscosity of the bath is reduced slightly with the first work polished, but the decreased viscosity does not reduce the polishing efficiency and the solution is stable for months thereafter.

The solution, during service, will absorb metal and when the amount of metal reaches about 10%, the solution is regenerated. This is done by permitting the metal salts to precipitate or settle out and thereafter decanting the solution. Small amounts of alginate and acid can then be added to the solution to restore the original strength.

Since electropolishing generally follows heat treating of the metal, it is desirable that the electropolishing process be able to cope with discolored or slightly scaled parts, thus saving a vapor-blasting operation and the passivation and inspection necessary to insure that the vapor blasting was complete. To this end, the parts may be initially treated in the hydrochloric acid solution followed by treatment in the solution containing sulphuric acid where the highest quality of finish is required. In some cases, the treatment produced by the solution containing hydrochloric acid may be adequate in itself. After either treatment the dried part is passive.

Prior to the electropolishing treatment, the part or workpiece to be treated is degreased by alkaline cleaning. After the treatment the part may be given a quick dip in a 50% solution of nitric acid followed by a water rinse.

As an example of the operation of the process, a type 431 stainless steel, machined bomb ejector part was heat treated by heating to 1875° F. in a hydrogen atmosphere, air cooling and tempering at 600° F. in air.

The heat treated part was then made the anode in an electrolytic bath composed by weight of 12% hydrochloric acid (1.16 sp. g.), 58% ortho phosphoric acid (1.70 sp. g.), 3% sodium alginate and 27% water. A stainless steel cathode was employed and a current density of 135 amperes per square foot was used for a period of 1 minute and the current density was then reduced to 25 amperes per square foot for an additional 2.5 minutes. The operating temperature of the bath was 75° F.

The part was then removed from the electrolytic solution, rinsed with water to remove the film and placed as the anode in a second bath composed of 20% sulphuric acid (1.84 sp. g.), 60% phosphoric acid (1.70 sp. g.), 3.0% sodium alginate and 17.0% water. A current density of 20 amperes per square foot was used for 5 minutes with the solution at a temperature of 120° F.

The part was then removed, dipped in nitric acid and rinsed with water. The resulting finish was uniformly polished and high in luster.

The present process has particular application where very accurately machined articles are to be cleaned or polished. In some cases the tolerance of the machined article may be in the range of +0.0005" and therefore very little corrosion or abrasion can be effected without taking the article out of the tolerance limits. The hydrochloric acid bath is especially useful for such articles as it is self-limiting, removing only 0.0001" from the surface in the normal cycle of 2 to 5 minutes.

The present process is a low energy process using considerably lesser current densities than conventional

electropolishing process. The electrolytic solution using the alginate has high throwing power and has exceptional ability to remove scale in recesses and other inaccessible places.

Furthermore, the solution is not hazardous or toxic and can be used without excessive precautions as contrasted to electropolishing baths containing perchloric acid or the like, in which definite explosive hazards are inherent.

Various modes of carrying out the invention are contemplated as being within the scope of the following claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention.

I claim:

1. In an electrolytic bath for polishing metal and containing a mixture of ortho phosphoric acid and a mineral acid selected from the group consisting of sulphuric acid and hydrochloric acid, a salt of alginic acid dispersed within the bath in an amount of 0.10% to 5.0% by weight of the bath.

2. In an electrolytic bath for polishing metal, the combination of a mixture of mineral acids with ortho phosphoric acid comprising a major portion of said mineral acids, and a salt of alginic acid selected from the group consisting of sodium alginate, ammonium alginate and propylene glycol alginate, said salt comprising about 0.10% to 5.0% by weight of the bath.

3. An electrolytic solution for cleaning and polishing metal consisting essentially of, about 30.0% to 80.0% of the equivalent of 1.70 specific gravity phosphoric acid, about 1.0% to 15.0% of the equivalent of 1.16 specific gravity hydrochloric acid, about 0.1% to 5.0% of a salt of alginic acid dispersed within the solution and selected from the group consisting of sodium alginate, ammonium alginate and propylene glycol alginate, and the balance water.

4. An electrolytic solution for cleaning and polishing metal consisting essentially of, about 40.0% to 80.0% of the equivalent of 1.70 specific gravity phosphoric acid, about 3.0% to 42.0% of the equivalent of 1.84 specific gravity sulphuric acid, about 0.1% to 5.0% of salt of alginic acid dispersed within the solution and selected from the group consisting of sodium alginate, ammonium alginate and propylene glycol alginate, and the balance water.

5. The method of electropolishing metallic material selected from the group consisting of the 200 series of stainless steel, the 300 series of stainless steel, the 400 series of stainless steel, carbon steel, nickel and nickel base alloys, and cobalt and cobalt base alloys which comprises passing an electric current from said metallic material as the anode through an aqueous solution of a mixture of ortho phosphoric acid, a salt of alginic acid and a mineral acid selected from the group consisting of sulphuric acid and hydrochloric acid, said derivative of alginic acid being present in an amount of about 0.1% to 5.0% by weight of said solution, and continuing to pass said current with sufficient density for a sufficient length of time to remove scale and discoloration and to brighten and smooth said metallic material.

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