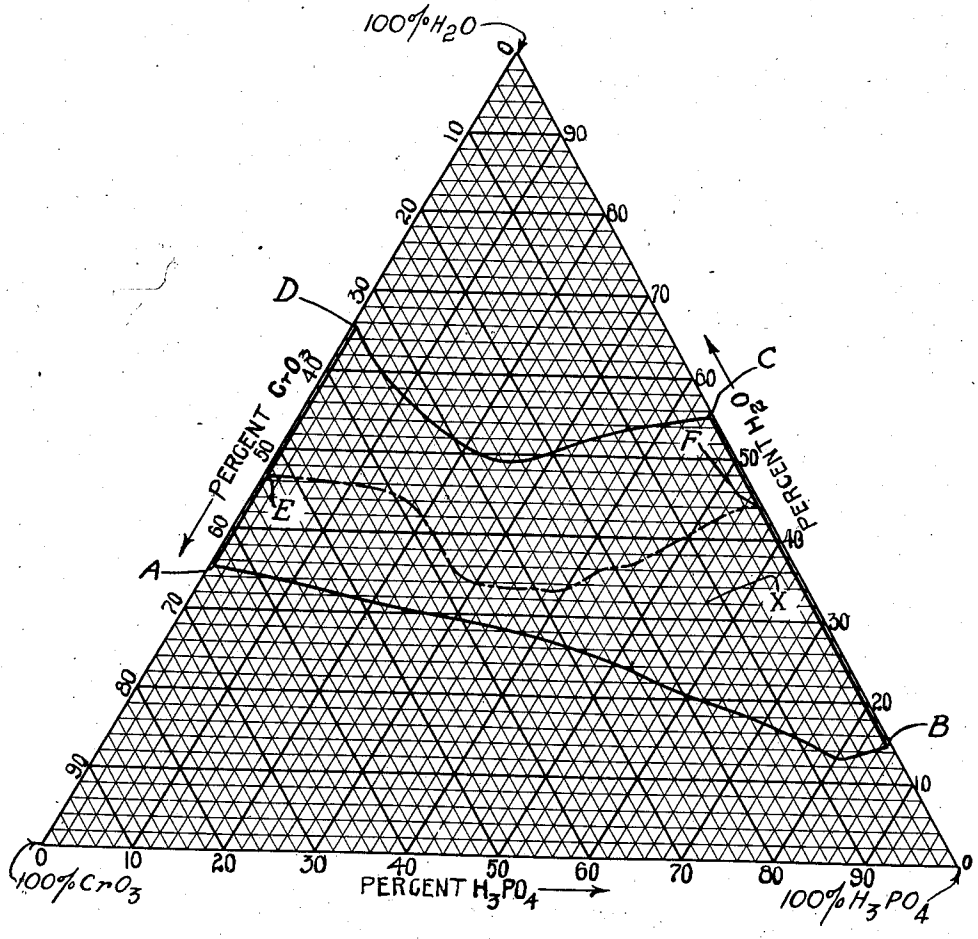
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METHOD OF ANODICALLY POLISHING STAINLESS STEEL

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METHOD OF ANODICALLY POLISHING STAINLESS STEEL

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This invention relates to a method of and an electrolyte for anodically polishing stainless steel. More particularly the invention relates to an aqueous electrolyte comprising phosphoric acid, chromic acid and water and to the use of such electrolyte in the anodic polishing of stainless steel.

Various compositions of electrolyte have heretofore been proposed for use in the anodic treatment of stainless steel. With the exception, however, of the electrolytes disclosed and claimed in my copending application Serial No. 218,388, filed July 9, 1938, most of the compositions proposed have proved unsatisfactory for effecting highly lustrous, mirror-like finishes on stainless steel.

By the term "stainless steel," it is meant to include straight chromium and chromium-nickel ferrous alloys, having a minimum chromium content of about 12% and generically known as stainless steels, stainless irons or rustless irons. I have now found that an aqueous electrolyte comprising phosphoric acid, chromic acid and water, as the essential ingredients, can be satisfactorily used in the anodic polishing of stainless steel. If the relative proportions of these essential ingredients of the bath be kept within certain limits, which I have determined, very satisfactory polishes can be produced in the case of stainless steel, while at the same time producing surfaces having relatively superior characteristics to those obtainable by mechanical polishing or buffing operations.

It is therefore an important object of my invention to provide an electrolyte containing phosphoric acid, chromic acid and water within certain limits as to their relative proportions, for use in the anodic polishing of stainless steel to impart thereto a highly lustrous surface.

It is a further important object of this invention to provide a method of anodically polishing stainless steel and the like using an electrolyte of novel composition that is operative throughout a wide range of anode current densities and temperatures.

Other and further important objects of this invention will become apparent from the disclosures in the specification and the accompanying drawing.

This invention (in its preferred form) is illustrated in the drawing and hereinafter more fully described.

On the drawing:

The figure represents a triaxial diagram showing the relative proportions of phosphoric acid, chromic acid and water for compositions of electrolytes coming within the scope of my invention.

In the accompanying diagram, the respective sides of the triangle indicate the percentages of phosphoric acid (H_3PO_4), of water (H_2O), and of chromic acid (CrO_3), from 0 to 100%. On the basis of experimental data, I have determined the relative proportions of phosphoric acid, chromic acid and water that give compositions of electrolyte that are operative for the anodic polishing of stainless steel. The area representing operative compositions of electrolyte is defined on the accompanying diagram by the solid lines AB, BC, CD and DA. Within the area so defined, any composition selected will be found to be operative in the method hereinafter described for the anodic polishing of stainless steel.

In order to get the best polishing results, however, I have found that the range of proportions of phosphoric acid, chromic acid and water should be kept within somewhat narrower limits and these narrower limits are represented on the accompanying diagram by the area defined by the lines AB, BF, dot and dash line FE and line EA. The preferred compositions of electrolyte, with respect to the relative proportions of phosphoric acid, chromic acid and water, lie within this second area, which is wholly enclosed within the broader area first defined.

The reading of a triaxial diagram such as the accompanying one is well understood but the following will be given for purposes of illustration. The point on the diagram represented by the letter A, for instance, indicates a composition comprising a small but significant proportion, say 0.1% of phosphoric acid, 65% of chromic acid and the balance, or slightly less than 35%, water; the point indicated by the reference letter B a composition comprising 85% of phosphoric acid, a small but significant proportion, say 0.1% of chromic acid and the balance, or slightly less than 15%, water; the point indicated by the reference letter C a composition comprising 44% of phosphoric acid, say 0.1% of chromic acid and the balance, somewhat less than 56%, water; and the point represented by the reference letter D a composition comprising say 0.1% of phosphoric acid, 34% of chromic acid and the balance, somewhat less than 66%, water. The maximum phosphoric acid content is 85% and the minimum about 0.1%; the maximum chromic acid content 65% and the minimum about 0.1%; and the maximum water content about 66% and the minimum about 13%. The preferred composition limits are from 0.1 to 85% phosphoric acid,

from 0.1 to 65% chromic acid, and from 13 to 47% water.

While the triaxial diagram shows the relative proportions of phosphoric acid, chromic acid and water in a system consisting of only these three components, suitable baths of these three ingredients may also include other ingredients, such as other acids and/or salts. From the diagram, however, the relative proportions that phosphoric acid, chromic acid and water should bear to each other may be determined for operative and preferred ranges of composition, regardless of what other non-essential ingredients may be present in the bath.

Thus, for instance, in making up an electrolyte for the anodic polishing of stainless steel, one might select the point X on the triaxial diagram as being a bath of preferred composition. The composition represented by the point X would be 56% phosphoric acid, 12% chromic acid and 32% water. During the continued use of such a bath in the electropolishing of stainless steel, the bath composition would necessarily change, owing to the anodic dissolution into the bath of chromium, nickel and iron from the stainless steel undergoing polishing. There might also be some change in the water content, such as an increase due to absorption by the bath of moisture from the air, or a decrease due to evaporation of water from the surface of the bath, to decomposition of water by electrolytic action, or to loss of water from the bath by entrainment thereof in gases given off from the bath.

Notwithstanding such changes in its composition as may occur during continued use, if the relative percentages of phosphoric acid, chromic acid and water, expressed as percentages by weight of the total weight of only these three ingredients in the bath composition, remain within the area defined by the lines AB, BF, FE and EA, the bath will continue to operate satisfactorily. Even if the bath composition be so altered during continued operation that it falls within the less preferred area defined by the lines EF, FC, CD and DE, on the accompanying diagram, the bath will continue to function, although not so satisfactorily.

Consequently, where the relative percentages of phosphoric acid, chromic acid and water in a given bath composition lie within either the preferred or less preferred areas defined on the accompanying triaxial diagram, such bath composition is intended to come within the scope of my invention, even though it may contain other acids than phosphoric and chromic and even though it may contain a substantial quantity of metallic salts.

Instead of chromic acid, soluble chromates and bichromates may be substituted therefor and are to be considered the equivalent of chromic acid on a stoichiometric basis. The term "chromic acid equivalent," as used in this specification and in the claims, is therefore intended to include chromic acid itself (CrO_3) and stoichiometrically equivalent weights of soluble chromates and bichromates.

Similarly, in place of orthophosphoric acid, other phosphoric acids, such as meta- and pyrophosphoric acids, may be used and are to be considered as included within the term "phosphoric acid."

In the method of anodically polishing stainless steel, rustless iron and the like, using a bath of a composition indicated as suitable by reference to the accompanying triaxial diagram, the stainless steel, or an article having a surface of stainless steel, is made the anode in a bath of the selected composition and an electric current is passed therethrough of sufficient density and for a sufficient length of time to produce the desired high degree of luster, or polish, on the metal surface. By employing an electrolyte having a composition within the preferred area defined on the accompanying triaxial diagram, a highly lustrous, mirror-like surface can be readily obtained. The highly lustrous surface obtainable by my method, using an electrolyte of preferred composition, is an important feature of my invention and one that sharply distinguishes it from prior art finishes produced in the electrolytic cleaning of stainless steel.

The formation of highly polished and lustrous surfaces is undoubtedly associated with the presence of a polarizing film over the surface of the metal during the process of anodic dissolution. The nature of this film is such that selective attack on the various phases present in the stainless steel, rustless iron or the like, is minimized. Anodic dissolution apparently takes place at a relatively high rate and at a high anodic polarization value, with the result that the anodic dissolution of the metal acts to level the crystal surfaces thereof and to produce a mirror-like finish. These conditions do not prevail in the simple electrolytic cleaning treatment known to the prior art.

In order to obtain the best results in a reasonable length of time, it is preferable to use relatively high current densities, such as those of the order of magnitude of from 100 to 1000 amperes per sq. ft. It will be understood, however, that lower current densities, even as low as 50 amperes per sq. ft., may be employed with consequent prolongation of the time of treatment. Higher current densities, up to as high as 2000 or 3000 amperes per sq. ft., may also be used, but such high current densities imply, in general, large currents, which require more expensive equipment. The length of time to effect the desired results depends upon the magnitude of the current densities employed and to some extent upon the particular analysis of the stainless steel, rustless iron or the like to be polished, and also upon the character of the surface of the alloy initially. Rough surfaces, of course, require a longer time to polish than relatively smooth ones.

With any of the compositions of electrolyte lying within the preferred area defined by the lines AB, BF, FE and EA, on the accompanying triaxial diagram, excellent polishes are obtained on 18–8 chromium-nickel, 24–12 chromium-nickel, and straight chromium stainless steel, when the stainless steel is made the anode therein at current densities of 500 amperes per sq. ft. and the treatment carried out for a period of 1½ to 12 minutes, employing a bath temperature lying within the range of 80 to 175° F. In general, the temperature may be maintained at any point between room temperature and the boiling point of water but temperatures of around 100° F. are found very satisfactory.

From the foregoing description of my invention, it will be apparent that I have provided a novel composition of electrolyte and a method whereby the same may be used to produce highly lustrous polishes on stainless steels, rustless iron and the like. My electrolyte and method avoid the disadvantages of the old methods of mechanically polishing and enable the production of

stainless steel and rustless iron articles having surfaces that are free from mechanical strain, dragging and "piling," and which are superior to those obtainable by mechanical polishing methods.

It will, of course, be understood that various details of the process may be varied through a wide range without departing from the principles of this invention and it is, therefore, not the purpose to limit the patent granted hereon otherwise than necessitated by the scope of the appended claims.

I claim as my invention:

1. The method of anodically polishing stainless steel, which comprises making the stainless steel the anode in a solution comprising as predominant ingredients, from 0.1 to 85% of phosphoric acid, from 0.1 to 65% of CrO_3, and from 13 to 66% of water, all of the percentages being by weight of said solution and the relative percentages of said three solution ingredients lying within the area defined on the accompanying diagram by the line AB, the straight line BC, the line CD and the straight line DA, and passing an electric current therethrough of sufficient density and for a sufficient period of time to effect a polishing of said stainless steel.

2. The method of anodically polishing stainless steel, which comprises making the stainless steel the anode in a solution containing, as predominant ingredients, from 0.1 to 85% of phosphoric acid, from 0.1 to 65% of CrO_3, and from 13 to 47% of water, all of the percentages being by weight of said solution and the relative percentages of said three solution ingredients lying within the area defined in the accompanying diagram by the line AB, the straight line BF, the line FE and the straight line EA, and passing an electric current therethrough of sufficient density and for a sufficient length of time to effect a polishing of said stainless steel.

3. The method of anodically polishing stainless steel, which comprises making the stainless steel the anode in a solution containing, as predominant ingredients, from 0.1 to 85% of phosphoric acid, from 0.1 to 65% of CrO_3, and from 13 to 47% of water, all of the percentages being by weight of said solution and the relative percentages of said three solution ingredients lying within the area defined in the accompanying diagram by the line AB, the straight line BF, the line FE and the straight line EA, and passing an electric current therethrough of between 100 and 1,000 amperes per square foot at a bath temperature between 80° and 175° F. for a sufficient period of time to effect a polishing of said stainless steel.

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