

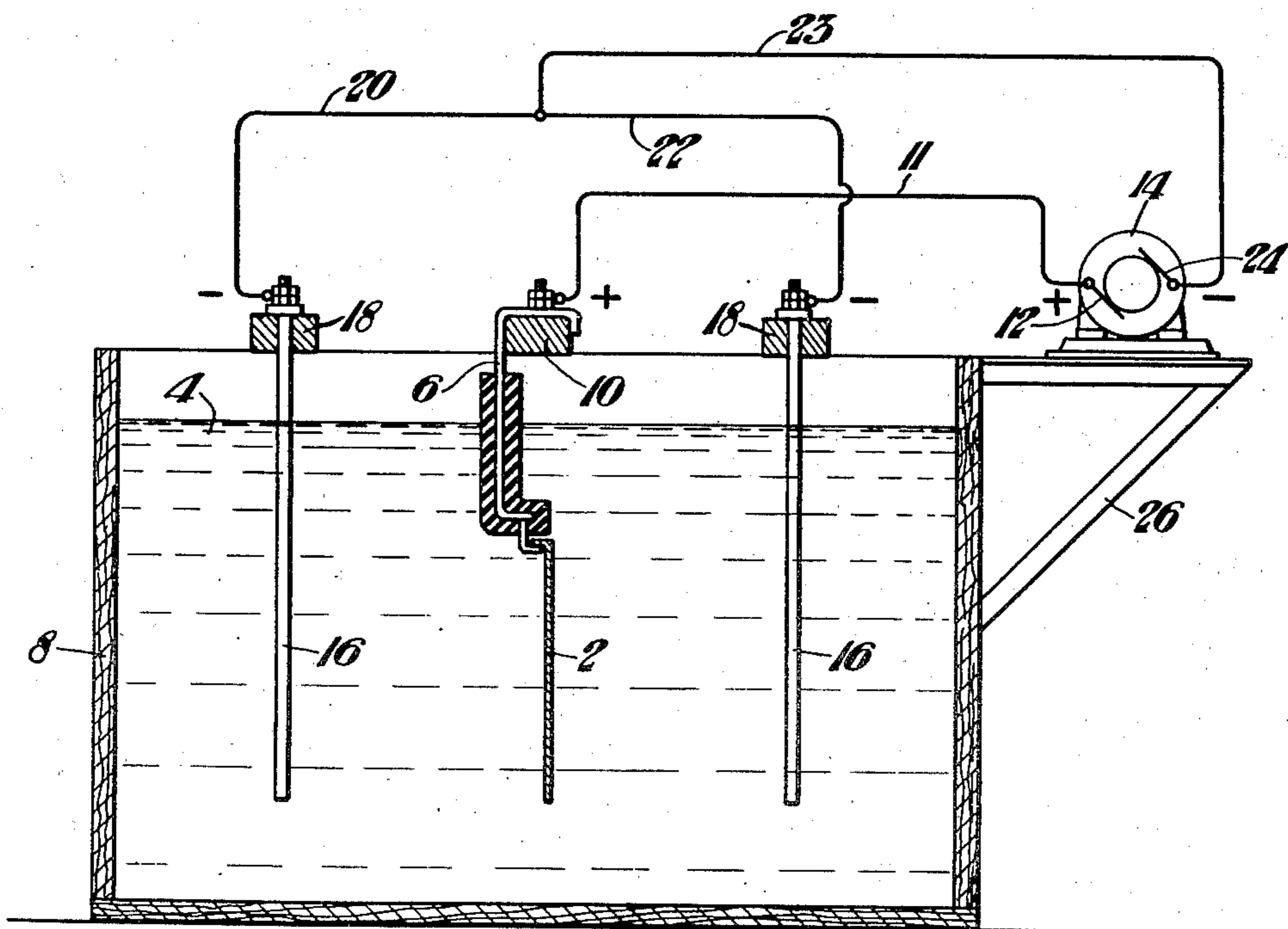
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G. J. BECKWITH

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ELECTROPOLISHING STAINLESS STEEL

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Inventor:
GLENWOOD J. BECKWITH,
by: *John E. Jackson*
his Attorney.

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ELECTROPOLISHING STAINLESS STEEL

Glenwood J. Beckwith, Brecksville, Ohio, assignor
to The American Steel and Wire Company of
New Jersey, a corporation of New Jersey

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The demand for highly lustrous ferrous alloys of the class known as "stainless" steels is increasing daily, owing to the increasingly widespread use of such materials as ornamental and sanitary finishes and fittings in the innumerable applica-
5 tions of stainless steel.

However, the production of the lustrous finishes to meet popular demand is attended with difficulty.

At the time when stainless steel was becoming introduced on the market, a good metal surface, whitened by pickling was the only material that was available practicably. But as the use of such steels increased, there arose a demand for highly lustrous surfaces, which were applied for orna-
10 mental purposes and which were obtained by purely mechanical operations of grinding, polishing, and burnishing.

The appearance of such lustrous surfaces for ornamental uses whetted further the demand therefor, both from ornamental and utilitarian viewpoints; and the mechanical procedures heretofore employed proved to be inadequate to supply the demand.

Consequently, investigators turned to chemical, and then to electrochemical means for producing the desired surface finishes. Chemical methods, while producing finished surfaces satisfactory for many purposes, nevertheless were actually inferior to the finishes produced by mechanical means. Although the cause of such failure is not known definitely, it may lie in the selective action of the relatively weak solutions necessary to produce a bright finish on inherent differences in the surface of the metal.

Consequently, considerable attention has been given to electrolytic processes for producing the requisite finish. Highly concentrated solutions in themselves have no ability to produce bright surfaces. However, when such solutions are electrolyzed, it has been found that finishes may be obtained that are highly improved over those produced by straight chemical methods, and which allegedly are comparable to the finish produced by mechanical means.

In such electrolytic procedures, the stainless steel article is made an anode in an electrolyte which usually is a highly concentrated solution of sulphuric, or chromic, or phosphoric acid, or mix-
50 tures of sulphuric and phosphoric acids, sulphuric and citric acids, or sulphuric and hydrofluoric acids. A phosphoric acid electrolyte has been considered to be satisfactory in the past, such electrolyte being made up of four parts of con-

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centrated orthophosphoric acid by volume to one part of water.

Now, the present invention is based upon the discovery of a procedure wherein there are produced on stainless steel articles, lustrous finishes that are very substantially superior even to those produced by the procedures outlined above.

The present invention is based upon the discovery of an inert, or inhibitor material, which, when introduced into the electrolyte, obviates pitting of the metal surface and also obviates any selective action of the electrolyte on any part of the metal surface.

In the operation of any electrolytic polishing procedures, however, certain factors always are present.

Thus, it is well known that electrolytes are more conductive at elevated temperatures than they are at room temperatures. Many polishing baths, however, must be operated at, or only slightly above, room temperature, in order to avoid an undulated or, in some cases, a pitted surface.

Also, it is well known that certain organic materials serve to inhibit pitting by polarization phenomena, as is true, for example, in the chemical pickling of steels. But such materials do not so operate in the presence of an electrolyzing current, with the treated article as an anode in the bath.

In accordance with the present invention, it is found that pyridine possesses excellent properties for attaining the desired results. Pyridine has been used previously in a straight chemical descaling acid bath, but its behavior in the electrolytic bath is different from other inhibitors, it providing an excellent protection for articles being electropolished.

While the concentrations of such chemical inhibitors are low, if such concentrations of pyridine are increased in an electropolishing solution, an immediate effect is noted upon the electrolyte and the resultant polishing effect.

Thus, the movement of the gas bubbles from the article being treated is slowed down greatly, and there is noted a change in the surface tension of the electrolyte. A foamy blanket appears on the surface of the bath similar to that on a chemical pickling bath when a "foamy" inhibitor is added. The slowing up of the gases in the bath alleviates the characteristic acid spray from the surface thereof and the air-liquid, "extra-bright" meniscus pattern on partially submerged articles disappears.
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Pyridine derivatives, as well as pyridine itself, produce similar results.

In practice, it is found that an optimum electrolyte and working characteristics which produce brilliant finishes on stainless steels are:

Bath composition by volume

	Per cent
Orthophosphoric acid (85% grade)-----	80
Sulphuric acid (60° Baumé)-----	15
Pyridine-----	5

Operating characteristics

Current density-----	5 amps. per square inch
Voltage-----	7 to 12 volts
Temperature-----	180-215° F.
Time-----	2 to 4 minutes, depending on the kind of stainless steel being treated

The above bath operates very successfully without sulphuric acid, but in practice the presence of sulphuric acid is preferable, since it adds to the metallic brilliance of the finish. Too much sulphuric acid, however, tends to overcome the non-pitting effect of the pyridine and disturbs the polarization equilibrium. When no sulphuric acid at all is used in the bath, the surface is extremely smooth, but is found to have a bluish cast especially on the "rustless" type of steel, which is a straight chrome alloying steel containing from approximately 12% to approximately 17% chromium. The electrolyte may contain at least 50% by volume of a phosphoric acid of 85% grade and approximately 5% by volume of pyridine, the balance being water.

In operation, the temperature should be held substantially constant at a definite selected value, and the current density controlled accordingly, since a fluctuation of either produces a slightly different degree of polishing in a given time. The foregoing conditions are found, however, to produce excellent polished surfaces and by proper manipulation and control, markedly superior results over raw acid electrolytes are obtained.

The time of the treatment obviously is dependent upon the amount of brilliance desired on the finished article, and the condition of its initial surface. In general, the polishing action under the conditions herein disclosed is very rapid.

The voltage is kept preferably within the limits shown, since higher voltages tend to overheat the solution due to a given input to secure a given current density, and higher voltages also tend to increase the sparking hazard, which is more or less dangerous in connection with a foamy electro-polishing inhibitor.

A current density higher than 5 amps. per square inch enhances the polish, but is uneconomical and tends to overheat the solution.

The accompanying drawing illustrates a diagrammatic sectional elevation of an apparatus for carrying out the present invention.

In the single view of the drawing, the article 2 to be polished is hung into the bath 4 on a hook or clamp 6 capable of carrying the current required. The bath 4 is contained in a suitable container 8 which may be composed of chemical brick, or other suitable material.

The article 2 forms an anode and its suspending hanger 6 engages a copper bus-bar 10 which is connected by current lead 11 to the positive terminal 12 of a suitable current generator 14.

Cathodes 16 of suitable material are spaced properly around the article 2, these cathodes being connected through bus-bars 18 and leads 20,

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22, 23 to the negative terminal 24 of the generator 14, which for convenience is shown as being mounted on a shelf projecting from the cell.

The bus-bars form permanent connections and are conveniently located above the level of the electrolyte to avoid excessive action of electrolyte spray thereon.

In operating, it is highly important that a uniform flow of current be obtained from all parts of the surface in order to avoid shaded or undulated areas. Also, the hanger 6 is designed to assure an even distribution of current over the entire area of the anode 2 being polished. The hanger 6 is insulated in all parts exposed to the bath except on the area making intimate contact with the article being polished in order to prevent dissolution of the hanger and wastage of current.

It will be understood, of course, that the invention is not limited to the use of a phosphoric acid bath, or a mixture of phosphoric acid and sulphuric acid, containing pyridine, as has been expressed preferentially herein, it having been found that the addition of pyridine to any of the electrolytes enumerated herein, both to those containing mineral acids alone and mixtures of mineral acids with organic acids (e. g., citric acid), likewise has a beneficiating effect. It may be noted, however, that the preferred composition herein set forth produces the high polish on both stainless steels containing both chromium and nickel as well as straight chromium-containing steels, the latter usually requiring a little longer time under the conditions set forth above, for example about four minutes for straight chrome-steels containing 12% and 17% chromium as against two minutes for chrome-nickel steel containing 18% chromium and 8% nickel.

As has been mentioned previously herein, both pyridine and soluble pyridine derivatives may be employed. Among such may be mentioned specifically, conyryne, piperidine, or any other water-soluble pyridine composition. Pyridine and these components of pyridine may be referred to as "pyridine-base compounds" which expression therefore is used generically in the claims.

Likewise, there may be employed other soluble phosphate-ion producing materials in addition to orthophosphoric acid. Thus, metaphosphoric acid, or pyrophosphoric acid may be employed.

The process therefore is quite flexible in its production of its desirable results.

I claim:

1. A method of anodically polishing stainless steel, characterized by immersing the said steel in an electrolyte consisting of approximately 5% by volume of pyridine, approximately 80% by volume of 85% orthophosphoric acid, and approximately 15% by volume of 60° Baumé sulphuric acid, and making the said steel the anode in an electrolytic circuit including the said electrolyte, with the electrolyte current at a sufficient density per unit area of said steel to effect polishing.

2. The process of producing highly polished surfaces on corrosion-resistant chromium steels, which consists in making the steel an anode in an aqueous electrolyte containing approximately 80% by volume of phosphoric acid of 85% grade, approximately 15% by volume of 60° Baumé sulphuric acid, and about 5% by volume of a pyridine compound, providing suitable cathodes to assure uniform current flow from all parts of the steel anode, maintaining the electrolyte at temperatures between approximately 180° F. to approximately 215° F., and passing a current

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through the resulting cell at a current density of substantially 5 amps. per square inch of anode surface and a voltage of from about 7 to about 12 volts.

3. The process of producing highly polished surfaces on corrosion-resistant chromium steels, which consists in making the steel an anode in an aqueous electrolyte consisting of approximately 80% by volume of phosphoric acid of 85%

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grade, together with approximately 15% by volume of 60° Baumé sulphuric acid, and about 5% by volume of a soluble pyridine compound, providing suitable cathodes to assure uniform current flow from all parts of the steel anode, and passing a current through the resulting cell of sufficient density and for a sufficient length of time to effect a polish on the said steel surface.

GLENWOOD J. BECKWITH.