ELECTROLYTIC POLISHING METHOD

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FIG. 1

FIG. 2

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ELECTROLYTIC POLISHING METHOD

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This invention relates to electrolytic polishing and more especially to a method and apparatus for effecting the polishing treatment.

A further object of the invention is the provision of a simple and practical method for electrolytically polishing stainless steel, in which products and articles of the steel are effectively polished in an acid electrolyte under thoroughly satisfactory conditions of operation, and without risk of damage to the article.

Another object of this invention is the provision of a reliable method for polishing stainless steel, in which the polishing action is effective and well suited for rapidity achieving a polished surface.

A further object of my invention is that of providing a readily useful method for electrolytically polishing stainless steel, which is simple and easy to practice with the result of producing a good surface finish.

Another object of this invention is the provision of satisfactory and reliable apparatus for electrolytically polishing stainless steel, which is practical to install and easy to operate.

A still further object of my invention is that of providing electrolytic polishing apparatus which is useful for operation on alternating electrical current.

Other objects of this invention in part will be obvious and in part pointed out hereinafter.

The invention, accordingly, consists in the features of construction, features of operation, and in the several steps and the relation of each of the same to one or more of the others as described herein, the scope of the application of which is indicated in the following claims, and in the accompanying drawings, Fig. 1 schematically illustrates an electrolytic polishing system on apparatus for effecting the practice of my invention, and Fig. 2 illustrates, in detached section, a modified form of my apparatus.

As conducive to a clearer understanding of certain features of my invention, it may be noted at this point that the stainless steel has hereof been subjected to any one or more of a variety of polishing operations to condition the metal surface. As a class, these steels are defined as comprising 10% to 35% or more chromium, with or without nickel, and with or without supplemental additions of manganese, silicon, cobalt, copper, molybdenum, tungsten, vanadium, columbium, titanium, sulphur, and the like, for special purposes, and a balance substantially all iron. These are produced in the form of products and articles which, depending upon the specific composition and condition of the metal, have valuable properties for making them of the stainless steels, for example, are not susceptible to hardening treatment while others can be hardened in this manner or be brought back to a relatively soft condition by annealing. In certain instances the steels are worked as by cold or hot rolling, drawing, or machining, or fabricated by cutting, punching, twisting, welding or the like to give products and articles having a particular shape, whether simple or intricate in physical form.

Often, it is desirable to polish the metal and for many purposes mechanical rubbing or buffing methods are resorted to, to give the polished effect. These methods, however, frequently prove to be too expensive or not at all practical when relied on for giving a polished stainless steel product, such as where the metal surface is in the hardened condition, and a uniform surface finish is desired. There are occasions too where mechanical buffing operations or the like are not at all suitable for polishing the steel, because of shape or contour of the steel surface and inaccessibility of certain portions or zones thereof for buffing.

The prior art introduces electrolytic polishing as a means for treating the surface of stainless steel, with treatment offering many advantages, from the standpoint of time required for achieving a polish and better access to the work surface. In many of these practices, the stainless steel product or article is made the anode of an electrolytic bath, such as the citric acid, sulphuric acid bath disclosed in the Ostrofsky Patent 2,335,354, or a phosphoric acid, sulphuric acid bath as disclosed in the Faust Patent 2,334,698, and is subjected to anodic action of direct electrical current. A cathode of lead or the like is employed to oppose the work electrically in the bath. An electrolytic polishing action is effective between the bath electrodes to remove a minute surface layer of metal or film from the stainless steel, thus to produce a polished surface.

Alternating electrical current has been given consideration as a possible means for promoting electrolytic polishing action. A process for electrolytically polishing stainless steel articles and products by alternating current in nitric acid or both nitric and acetic acids in fact is described in the Feld Patent 2,442,591. In many stainless steel fabricating and finishing shops, for example, alternating current is available for light and for operation of power tools. This current, accordingly, often is convenient for the purpose of electrolytic polishing treatment. In view of contrast, the use of direct current polishing equipment, frequently introduces the problem of providing a suitable source of direct current supply and space in the plant for installation of this source. Direct current supply equipment usually is of a relatively expensive kind and thus represents a substantial cost outlay from the standpoint of purchase, while installation and maintenance thereafter become factors which add quite an amount to expense of the polishing treatment. In electropolishing small quantities of stainless steel, for example, as by batch polishing at irregular intervals, the cost of expensive rectifying equipment often is not justified or the maintenance of batteries sometimes is not practical.

A further object of my invention, accordingly, is the provision of a method and apparatus for electrolytically polishing any of a wide variety of stainless steels in an electrolytic operating from alternating current supply, and to advance the prior art in this respect.

Referring now more particularly to the practice of my invention, I electrolytically polish stainless steel in an acid bath, employing an alternating current power supply and a polishing electrode substantially in contact with the tantalum. In this, the stainless steel itself and the tantalum electrode oppose each other as electrodes of the bath, while connected with the alternating current supply. The tantalum electrode and composition of the acid bath apparently are so correlated as to rectify the alternating current and to achieve satisfactory polishing of the stainless steel on the uni-directional current thus obtained. In this, the electrolytic bath seems to conveniently afford oxidizing conditions for producing a stable oxide film on the tantalum electrode surface by chemical reaction. The oxygen oxide film resists flow of like half-cycles of the alternating current and admits the remaining half-cycles in favor of promoting uni-directional current flow and a consequent polishing action on the stainless steel. Surprisingly enough, the polish achieved, especially for the higher current densities, is superior to that had with direct current. Moreover, the amount of metal removed is more exactly controlled since it is in direct proportion to the treating current, a circumstance not true of direct current polishing. Thus, for example, with current values of 1, 2, 3 and 4 amperes per square inch alternating current, I find proportionate increases in metal removal, while with direct current, each additional square inch removes somewhat more metal than 1 and 3, a little more than 2, but 4 removes nothing further. Apparently, in my process the intermittent uni-directional current breaks up the polarized film which seems to form on the surface of the metal being treated. In any event, I note that superior results are achieved.
I find that electrodes substantially containing tantalum give a satisfactory result with alternating current when any number of electrolytes is employed for maintaining rectification and carrying the polarizing current. Among these electrolytes are those principally consisting of sulphuric acid and water, and those principally consisting of phosphoric acid, sulphuric acid and water. Other examples of electrolytes which I often employ in conjunction with tantalum electrode for maintaining polarisation and the resulting uni-directional dislocation polishing action, are those principally consisting of citric acid, sulphuric acid and water, or phosphoric acid, butyl alcohol and water. A more general group of electrolytes which are satisfactory for present purposes are aqueous solutions containing aliphatic carboxylic acid and a soluble compound having a sulphate radical yielding sulphate ions. On other occasions, I employ an electrolyte principally consisting of such acids as phosphoric acid substantially alone in water.

In employing the polishing electrolyte, I immerse the tantalum electrode to effective position and make the stainless steel work the opposing electrode in the polishing system. Thus, for example, I provide an electrolytic polishing tank or vat 10 (see the accompanying drawing) lined with a suitable substance such as lead for resisting attack of the acid electrolyte. The tantalum electrode of the system conveniently forms a portion of the vat lining of illustratively is a readily removable electrode 11a. Mounted to the vat wall or over the vat so as to pass to a suitable depth in the electrolyte.

On occasions, the tantalum electrode is made of substantially pure tantalum, and in other instances of a tantalum-columbium alloy such as an alloy consisting approximately 33% tantalum, 33% columbium, and the remainder substantially all iron. As a further example, one tantalum electrode may be in the form of a tantalum-columbium alloy containing about 95% tantalum, and the remainder substantially all tungsten.

One or several tantalum electrodes serve in the electrolyte vat 10 as discrete impalps and is highly effective in electrolytically polishing the stainless steel work 12 while the latter is immersed in the polishing solution. The power supply connections illustratively include a voltage source and transformer 14 connected to the terminals of the transformer secondary winding 14a. Thus, with the electrolyte deposited in suitable quantity in the vat 10 and with the electrodes 11 and 12 immersed, the apparatus is highly effective for electrolytically polishing. With the apparatusrectifying action, the uni-directional current passed through the electrolyte between the electrodes in vat 10 as discrete impalps and is highly effective in electrolytically polishing the stainless steel work 12. During this time, benefit often is had by maintaining the electrolyte in a heated condition, this for example by a suitable heating coil such as an electrical resistance type coil or a steam or hot water coil 15. In employing an electrical resistance coil or any other type of electrical heating unit, I often supply the electrical current to the heating unit from the source of alternating current. If desired, the heating unit may be of a type which is operatively connected with the input side of transformer 13, thus to operate in parallel with the electrodes 11 and 12.

The electrolytic polishing treatment which I provide is applicable for electrolytically polishing any of a variety of stainless steels such, for example, as the 18% chromium, 8% nickel stainless steels, or electrolytically utilizing one of the stainless chromium grade which are annealed or hardened by heat treatment. Also any of a great number of stainless steel articles and products such as wire, rod, plate, sheet, strip, or more complex articles of the steel, as for example, hardware, grilles, bowls, urns, tableware, surgical and dental instruments, are successfully polished in accordance with my invention. The resulting products have a satisfactorily polished surface which is conducive to a pleasing appearance, this being easily and successfully achieved by the polishing operations promoted from alternating current supply. In this, it will be appreciated that polishing operations are made easy in view of the fact that the stainless steel work and the tantalum electrode may be connected to either terminal of the alternating current outlet. There is no danger of obtaining ruined products by reversal of the electrodes relative to the alternating current supply. Both the stainless steel and the tantalum electrode respond in the desired manner even should the respective power input terminals be reversed.

My electrolytic polishing method also has utility for the batch polishing of stainless steel articles such as screws, bolts, nuts, washers, as where these articles are to be polished on a holding rack having separate electrodes. In this, for example as shown in Fig. 2, the stainless steel work 12a is supported on an electrically conductive foraminous bottom of the rack 16a, this bottom representing one electrode of the electrolytic polishing system. The other electrode conveniently is the tantalum electrode in the form of a perforated sheet 16a, overlying the stainless steel work in an electrically insulated position relative to the same. By connecting the several electrodes to an alternating current outlet and immersing the rack, with a batch of work thereon, in a suitable electrolyte, a successfully electrolytic polishing action is initiated.

My electrolytic polishing method also imparts a successful electrolytic polish when the stainless steel is continuously fed through the electrolyte as one electrode thereof. Under these conditions, the stainless steel work illustratively is in the form of wire. The tantalum electrode conveniently is a fixed electrode which occupies an effective position to one side of the path of continuous feed of the stainless steel work. Thus, by moving the work through the bath at a sufficient velocity the fixed tantalum electrode effectively rectifies the alternating current and, upon such fixed electrode the stainless steel ensues rapidly enough to give a finished surface on the work.

As further illustration of the practice of my invention, I now set forth several examples of polishing baths and corresponding operating conditions, where the stainless steel work is opposed and successfully polished with the use of a tantalum electrode.

Example I
Good results were had by treating low-carbon 17% 19% of the alternating current contain 14% to 18% of the alternating current in a.glycolic acid, 25.1% sulphuric acid and the remainder substantially all water. The treatment involved 10 volt alternating current supply to the bath electrodes and a current density of about 1 amperc per square inch of the immersed stainless steel, the treating time being 7 minutes.

Example II
A low-carbon, straight chromium stainless steel containing 14% to 18% chromium was successfully polished in a glycolic acid, sulphuric acid bath of the character noted in Example I. The treatment involved 8 volt alternating current supply to the bath electrodes and a current density of about 1 amperc per square inch of the immersed steel, the treating time being 7 minutes.

Example III
A low-carbon 14% to 18% chromium steel of straight chromium grade was electrolytically polished with good results in an electrolyte containing about 36.7% citric acid, 21.7% sulphuric acid and the remainder substantially all water. The polishing was achieved on 8 volt alternating current supply to the bath electrodes and on 1 amperc per square inch of the immersed steel, the treatment time of 7 minutes being utilized.

Example IV
A low-carbon 17% to 19% chromium, 8% to 10% nickel stainless steel when electrolytically polished in a bath containing approximately 36.7% citric acid, 21.7% sulphuric acid and the remainder substantially all water, had a satisfactory finish. For this, 10 volt alternating current was supplied the bath electrodes, giving a cur-
An electrolyte containing about 67% phosphoric acid, 15% butyl alcohol and the remainder substantially water gave good results in use for electrolytically polishing both straight chromium and chromium-nickel stainless steels. In one instance, low-carbon, 14% to 18% chromium stainless steel was polished in 7 minutes in this bath from 8 volts alternating current input and with a current density of 1 ampere per square inch. In another instance, a low-carbon, 17% to 19% chromium, 8% to 10% nickel stainless steel was electrolytically polished in 7 minutes using 10 volts alternating current input and a current density of 1 ampere per square inch.

The electrolytic polishing process which I provide is rapid and economical of performance and is quite adaptable to continuous, batch or mass production of polished stainless steel products of good surface quality. It is successfully used for polishing stainless steels either of low-carbon, or high-carbon grade and of otherwise different alloy composition. The equipment needed is easy to install and is effective toward the achievement of thoroughly satisfactorily polished products. Also, the tantalum electrode employed tends to endure extensive use, this durability being enhanced by the oxide film which forms on the surface thereof and the protection to the underlying metal which this film affords in the electrolyte. The bath acid has no great deteriorating effect upon the electrode, nor does the electrolytic action in the stainless steel polishing operation.

Thus it will be seen that in this invention there is provided a method and apparatus for electrolytically polishing stainless steel in which the various objects hereinbefore noted together with many thoroughly practical advantages are successfully achieved. It will be noted that the process gives polished stainless steel products in a simple and effective manner with operations promoted from a source of alternating current.

While several types of useful tantalum electrodes have already been disclosed herein, it will be understood that the electrode may be provided in any of a variety of forms. Sometimes, the electrode is of copper having a tantalum facing or cladding. In this instance, the copper portion conveniently is covered with sheet Bakeelite for protection against the stainless steel polishing bath, and so as to leave the tantalum exposed and fully effective. In another embodiment, the core of the electrode may be of copper for such reasons as electrical conductivity, and this core then coated with tantalum by welding by use of a metalizing gun to cover the copper.

It will also be understood that while considerable emphasis has been placed upon the importance of my process and apparatus in the field of electrolytically polishing stainless steel, I also at times polish other and different metals in accordance with the principles herein disclosed, such as copper, aluminum, carbon steel, nickel silver, Monel, Inconel and Chromel.

As many possible embodiments of my invention and as many changes may be made in the embodiments hereinbefore set forth, it is to be understood that all matter described herein or shown in the accompanying drawing is to be interpreted as illustrative and not as a limitation.

I claim:

1. In the controlled polishing of a stainless steel product to achieve uniform rate of metal removal the art which comprises; immersing the product to be polished and an electrode substantially containing tantalum in an aqueous electrolytic polishing bath consisting essentially of aliphatic carboxylic acid and sulfuric acid; making the stainless steel product and said electrode the opposing terminals of the electrolytic bath; and supplying alternating current to the bath terminals for polishing the steel.

2. In the controlled polishing of a stainless steel product to achieve uniform rate of metal removal the art which comprises, immersing the product to be polished and an electrode substantially containing tantalum in an aqueous electrolytic polishing bath consisting essentially of glycolic acid and sulphuric acid; making the stainless steel product and said electrode the opposing terminals of the electrolytic bath; and supplying alternating current to the bath terminals for polishing the steel.

3. In the controlled polishing of a stainless steel product to achieve uniform rate of metal removal the art which comprises, immersing the product to be polished and an electrode substantially containing tantalum in an aqueous electrolytic polishing bath consisting essentially of citric acid and sulphuric acid; making the stainless steel product and said electrode the opposing terminals of the electrolytic bath; and supplying alternating current to the bath terminals for polishing the steel.

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