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METHOD OF POLISHING METALS

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This invention relates to a method of polishing metals to impart thereto a lustrous, mirror-like polish.

It has heretofore been common practice to polish metals by a mechanical operation, either on automatic polishing and buffing machines, or manually, or by a combination of automatic and manual operations. In addition to the considerable cost of mechanical polishing and buffing operations, particularly where the final buffing operations have to be performed manually, there are some drawbacks in the mechanical polishing of metals which are inherent because of the properties of the metals themselves. Some metals, such as stainless steels, for instance, are relatively poor conductors of heat, in consequence of which the high speeds of the polishing or buffing wheels tend to burn the surfaces thereof. This greatly limits the speed at which the polishing operations may be carried out.

Furthermore, in the mechanical polishing of metals, the surfaces exhibit a tendency to "pile," with the result that the polished surfaces so produced are cold worked and strained. Such surfaces are characterized by the presence of a layer of amorphous or pseudo amorphous materials. Also, in any commercial polishing process, the surface will be found to be marked by microscopic scratches.

Mechanical polishing has the further objection that it involves a considerable amount of comparatively highly paid labor. In the case of stainless steel, for example, mechanical polishing is one of the most expensive steps in the finishing operations, so that polished stainless steels have heretofore sold for a price which is very high in comparison with the material cost. The cost of mechanical polishing is also a major item in the manufacture of chromium plated articles, particularly articles of irregular shape that must first be polished, then nickel plated and finally buffed before the application of the chromium plate.

While electrolytic methods for the treatment of metals and alloys to clean or etch the surfaces of the metals are well known, such methods have been directed mainly to those purposes and not to the production of polished surfaces. The patent to Burns et al. No. 1,658,222, dated February 7, 1928, for instance, refers to the anodic electrocleaning of ferrous metals preparatory to nickel plating and alleges that a "smooth, polished and uniformly etched surface" may be produced by an electrochemical cleaning action. By following the procedure disclosed in this patent, how-

ever, I have been unable to obtain a brightly polished surface but merely a surface that is somewhat brighter than that obtainable by the usual pickling processes.

Similarly, although the Blaut et al. Patent 2,115,005, dated April 26, 1938, purports to describe an electrochemical cleaning process that will produce a "burnished" surface, I have been unable to obtain by following the procedure therein disclosed such a highly lustrous polish as is readily produced by the use of the electrolytic solution of my present invention.

I have now found that a superior polishing effect may be produced more readily and at a lower cost than was heretofore possible through the use of an electrolytic solution consisting essentially of sulfuric acid and an organic compound capable of forming a complex ion with a metallic component of the metal or alloy undergoing treatment. Sulfuric acid alone is not sufficient to produce the polishing effect characteristic of my process, but this effect can be obtained by the use in conjunction with sulfuric acid of any one of a wide variety of organic materials, such as glycerol, glycyrrhiza and soluble glycols.

It is therefore an important object of my invention to provide an electrolytic solution for use in the anodic treatment of metals to impart thereto a highly lustrous surface directly and without requiring any subsequent mechanical buffing or polishing operations.

It is a further important object of my invention to provide a method for the electrochemical treatment of metals to produce thereon surfaces that are highly lustrous and free from the scratches and "piled" layers characteristic of mechanically polished surfaces of metals, such as stainless steels.

It is a further important object of this invention to provide an electrolytic solution consisting essentially of sulfuric acid and an organic compound capable of forming a complex ion with iron, which solution may be used in the polishing of metals to impart thereto highly lustrous surfaces at a cost considerably less than that entailed by mechanical operations, while at the same time producing surfaces having relatively superior characteristics to those obtainable by mechanical polishing or buffing operations.

Other and further important objects of this invention will become apparent from the following description and appended claims.

The method to which this invention pertains involves making the metal to be polished an

anode in an electrolytic bath of suitable composition and passing a current of sufficient density and for a sufficient length of time to produce a high lustre or polish on the metal. By employing the electrolytic solution of my present invention, results are obtained that transcend the mere electrolytic cleaning process, in that there is produced a highly lustrous or polished surface. This high lustre is an important feature of my invention and one that sharply distinguishes it from prior art finishes produced in the electrolytic cleaning of metals.

The electrolytic solution that I have found to possess the most general applicability comprises a mixture of sulfuric acid and an organic compound capable of forming a complex ion with a metallic component of the metal or alloy undergoing treatment, such organic compounds including a wide variety of organic materials, such as glycerol, soluble glycols, ammoniated glycyrrhizin and glycyrrhiza extract or liquor. Certain alcohols, such as methanol, may be advantageously used in conjunction with mixtures of sulfuric acid and any one or more of the foregoing organic compounds. The electrolytic solutions so produced are effective in producing lustrous surfaces when employed in accordance with the method of this invention in the treatment of iron and its alloys, nickel and its alloys and copper.

The formation of highly polished and lustrous surfaces, which is a distinguishing feature of my invention, 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 of the various phases present in the metal or alloy is minimized. Anodic dissolution apparently takes place at a relatively high rate at 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 treatments known to the prior art.

In the electrolytic solution of my invention the sulfuric acid content may be widely varied, as from 1 to 90%, but is preferably in excess of 50% and not over 90%. Where another mineral acid, such as ortho phosphoric acid, is mixed with the sulfuric acid and organic compound, the total acid concentration should likewise lie within the range of 50 to 90%. The higher concentration of total acid is more particularly required, when water is present, if a good polish is to be obtained, while the lower concentrations of acid may be satisfactorily used in an electrolytic solution containing practically no water. An example of the latter case is an electrolytic solution comprising 94% of glycerol, 1% of sulfuric acid and 5% of ammonium chloride.

In order to obtain the best results, in a reasonable length of time, it is preferable to use relatively high current densities of the order of magnitude of from 300 to 1,000 amperes per sq. ft., although it will be understood that lower current densities may be employed with consequent prolongation of the time of treatment. Higher current densities than indicated by the foregoing range may also be used, although such high current densities are necessarily more costly because of the higher cost of electrical energy. 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 metal to be polished and the character

of its surface initially. Rough surfaces, of course, require a longer time to polish than relatively smooth ones.

The treatment depends to some degree on the previous heat treatment, if any, of the metal. The condition of the various phases present in the metal influences the character and degree of the attack upon the grain boundaries, and in some cases it is necessary to increase the current densities in order to obtain satisfactory polishes.

The following examples will serve to illustrate preferred compositions of my electrolytic solutions and the conditions under which such solutions produce satisfactory polishes. Unless otherwise stated, all percentages will be understood to indicate percentages by weight, rather than by volume.

EXAMPLE 1

Bath composition

	Per cent
Sulfuric acid.....	60
Ammoniated glycyrrhizin.....	0.01
Methanol.....	0.55
Water.....	Balance

With the above bath, excellent polishes are obtained on 18-8 chromium-nickel 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. This time suffices to produce a very brilliant surface at a bath temperature of 80 to 175° F.

EXAMPLE 2

Bath composition

	Per cent
Sulfuric acid.....	50
Glycerol.....	40
Water.....	10

This bath, when employed with current densities of 300 to 1000 amperes per sq. ft. for the anodic treatment of 18-8 and 24-12 chromium-nickel, and straight chromium stainless steel, develops a very brilliant surface. The time required at temperatures of 90 to 200° F. ranges from 3 to 9 minutes, depending somewhat upon the current densities used and the original state of the surface of the metal.

EXAMPLE 3

Bath composition

	Per cent
Sulphuric acid.....	16
Phosphoric acid.....	13
Glycerol.....	56
Water.....	15

The foregoing bath is very satisfactory for the polishing of 18% straight chromium stainless steel at current densities of around 1000 amperes per sq. ft.

EXAMPLE 4

Bath composition

	Per cent
Sulfuric acid.....	1
Ammonium chloride.....	5
Glycerol.....	94

This bath produces a good polish on Monel metal at current densities of 750 to 1000 amperes per sq. ft. if the treatment is carried out for 1 minute at 86° F.

EXAMPLE 5*Bath composition*

	Per cent
Sulfuric acid.....	33
Glycerol	33
Water	34

A bath of the foregoing composition produces a satisfactory polish on nickel and German silver when they are treated anodically therein at current densities of 1000 to 2000 amperes per sq. ft. for 10 seconds at 96° F.

EXAMPLE 6*Bath composition*

	Per cent
Sulfuric acid.....	50
Glycerol	40
Hydrochloric acid.....	2
Water.....	Balance

The foregoing bath produces a surface of high lustre on ordinary steel at 50 amperes per sq. ft. for 2 hours at 45° F.

From the foregoing description of my invention, it will be apparent that I have provided a novel and effective way of producing highly lustrous polishes on stainless steels, nickel and its alloys, and plain carbon steels. My method avoids the disadvantages above enumerated of the old method of mechanical polishing and enables the production of metal articles having surfaces that are free from mechanical strain, dragging and "piling," and which are superior to those obtainable by mechanical polishing methods.

This application is a continuation-in-part of my application Serial No. 218,388, filed July 9, 1938, entitled "Polished metals and a method of making the same."

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 electropolishing metals selected from the group consisting of iron and its alloys and nickel and its alloys and German silver which comprises passing an electric current from the metal as the anode through a solution consisting of about 50% sulfuric acid and 40% glycerol by weight, the balance being largely water, the current being of sufficient density and being continued for a sufficient length of time to effect the polish on said metal.

2. The method of electropolishing a metal or alloy selected from the group consisting of iron and its alloys, nickel and its alloys and German silver, which comprises passing an electric current from a metal or alloy selected from the group named as the anode through a solution of about 33% sulfuric acid, 33% glycerol and 34% water, all percentages being by weight, and continuing to pass said electric current while of a sufficient density for a sufficient length of time to effect the polish of said metal or alloy.

3. The method of electro-polishing a metal or alloy selected from the group consisting of iron and its alloys, nickel and its alloys, and German silver, which comprises passing an electric current from the metal or alloy selected from the group named as the anode through a solution of from about 33 to 50% sulfuric acid and from about 33 to 40% glycerine by weight, the balance being largely water, and continuing to pass such electric current while of a sufficient density for a sufficient length of time to affect the polish of said metal or alloy.

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