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PROCESS FOR GOLD PLATING CHROMIUM
ALLOY STEELSHiram Stanhope Lukens, Philadelphia, Pa., as-
signor to C. Howard Hunt Pen Company, Cam-
den, N. J., a corporation of New JerseyNo Drawing. Application December 16, 1937,
Serial No. 180,135

3 Claims. (Cl. 204—12)

This invention relates to a process for gold plating chromium alloy steels such, for example, as so-called "stainless steel." The invention, moreover, is especially useful in the manufacture of pen points, in which connection the method is described hereinafter.

It is noted that the conditions of use of a pen point (for example, small quantities of hydrochloric or other acids which are sometimes found in commercial inks; and also sulphur in the compound of which fountain pen barrels are composed), are such as to require a highly acid resistant or corrosion proof article which is at the same time durable and of gold surface and appearance.

It has been common to employ solid gold pen points for use in fountain pens, since solid gold pens have the required degree of corrosion and acid resistance, the necessary toughness and, obviously, the desired gold surface and appearance. However, solid gold pen points are quite expensive, and the present invention provides a gold plating method, applicable to a chromium alloy steel, which method provides a gold deposit which is highly adherent and of good surface texture and appearance, the resultant article being highly corrosion resistant in service.

In my copending application Serial No. 77,571, filed May 2, 1936 (which copending application is a continuation of my application 707,502, filed January 20, 1934, issued May 5, 1936 as Patent No. 2,039,326), there is disclosed a series of method steps for gold plating stainless steel, which briefly are as follows:

First the pens are formed from a chromium alloy steel containing, for example, 18% chromium, 8% nickel and the balance iron. While not essential, I prefer to use an alloy for this containing about 2½% molybdenum or some other similar ingredient adapted to increase corrosion or acid resistance, particularly with respect to hydrochloric acid, which is sometimes present in small percentages in commercial inks.

The pens are then treated in a hydrochloric acid bath, containing from about 25% to about 50% hydrochloric acid.

The pens are thereafter rinsed in a dilute hydrochloric acid rinse containing, for example, about 10% to about 15% hydrochloric acid.

The succeeding step involves immersion of the pens in a bath having a relatively low hydrogen ion concentration and made up of ingredients substantially as follows:

1 gallon water.
½ oz. sodium gold cyanide.
8 ozs. sodium cyanide.
1 pt. hydrochloric acid.

posited on the pen. For the gold cyanide, other gold salts such as gold chloride may be used.

Finally, a second gold film may be applied on top of the first, this being deposited from an alkaline gold plating solution containing, for example:

1 gallon water.
½ oz. sodium gold cyanide.
2½ ozs. sodium cyanide.

For convenience, the foregoing method is summarized as follows:

(1) The formation of pens from chromium alloy steel.

(2) Treatment in hydrochloric acid bath.

(3) Treatment in hydrochloric acid rinse.

(4) Acid gold plating.

(5) Alkaline gold plating.

As stated in said copending application Serial No. 77,571, the hydrochloric acid plating bath (step 4) not only plates gold on the pens but also removes any oxide present on the surface thereof. This bath thus constitutes a combined acid electro-pickle and electro-gold plating bath, which is claimed herein.

So far as I have been able to determine, the action of the combined electro-pickle and gold plating bath is as follows:

Upon immersion of the pens in the bath, the flow of current, in the presence of acid, produces a vigorous action tending to dissolve any oxide film from the surface of the metal and simultaneously with the dissolving, or immediately thereafter, the bath deposits gold on the metal. Possibly the oxide dissolving action merely progresses until bare metal is exposed to receive electro-deposited gold. Adherent gold plating thus occurs before any appreciable reformation of the oxide film.

Whatever the reasons, the combined electro-pickling and plating bath secures an adherent gold deposit on a chromium alloy steel.

While I have also used hydrocyanic acid, as a means for dissolving the oxide film in an electro-pickle, the action thereof is not as good as hydrochloric acid, and I therefore prefer the latter. It may be, of course, that still other acids might possibly be employed for the purpose.

I have found that I may eliminate the first two hydrochloric acid washes, and I prefer to do this since it simplifies the process.

I prefer also to subject the pens to a thorough cleaning action in an alkaline (for example, potash) cleaning solution prior to the time they are subjected to any acid or plating baths. In the cleaning bath an electric current is passed to and from the pens and the cleaning solution.

I complete the article by plating in the alkaline gold plating solution (step 5 above) since I am

Upon the flow of current, a film of gold is de-

thereby enabled to secure a better surface texture and color.

In addition, completion of the article in this way (by alkaline gold plating) appreciably increases the corrosion resistance of the article.

As pointed out in the aforementioned Patent No. 2,039,326, it seems that since the protective film of the base metal is removed and replaced by a plate which is well known to be porous, the final product would be subject to difficulties similar to those encountered with prior gold plated pens. Possibly the reason why my improved pen resists tarnishing or corrosion through the gold plate is because the oxide film reforms in the pores of the plating.

So far as I have been able to determine, the action of the entire process is substantially as follows:

First, as already pointed out above, the acid plating bath (constituting a combined acid electro-pickle and gold plating solution) removes any oxide which may be present and obtains a direct bonding of some gold to the bare metal. The metal in the pores of the plating at this time, however, apparently remains in an unoxidized condition, since tests show that such pens are substantially more subject to corrosion than the completed article (the article after the following alkaline gold plating).

Second, in spite of the gasification which takes place at the surface of the article in the final plating solution, the oxide is built up or redeveloped in the pores of the plating and at the same time additional gold is deposited.

It has been the common belief that after removal of the chrome oxide film, the unoxidized condition can only be maintained in the presence of some medium having an actively reducing effect. In other words, it has been assumed that exposure of a chromium alloy steel article after removal of the oxide film, will result in substantially instantaneous reformation of that film.

I have found that this belief is incorrect, since tests show that chromium alloy steel articles may be treated to remove the oxide, as by means of a hydrochloric acid electro-pickle (of about the same composition as the acid gold plating solution mentioned above without any gold present), and may then be exposed to the atmosphere, to water or other media for substantial periods of time, even days, without redeveloping the oxide film. This latter point is evidenced by the fact that such exposed articles may be electroplated in a manner giving the high adherence of plate which is characteristic of the direct bond between the plating metal and the article.

Whatever the reasons, I have found that completion of pen points in accordance with this invention by employing a final plating in an alkaline gold plating solution, gives a very high degree of corrosion resistance, particularly with respect to attack by acids or other conditions encountered in pen point use.

Summarizing, it will be seen that essentially the foregoing process steps accomplish three things of major importance.

(a) Removal of the chrome oxide film by the action of a hydrochloric acid electro-pickle.

(b) Plating of some gold in a manner to secure direct bond of the gold to the base before reformation of the oxide.

(c) Redeveloping the oxide film on the bare metal through the pores existing in the plating and at the same time building up the gold plate.

Step (b) above may be accomplished in another way.

For example, after treating the pens in a hydrochloric acid electro-pickle, the pens are subjected to alkaline gold plating in a solution containing the following ingredients in about the proportions indicated:

1 gallon water.
 $\frac{1}{2}$ oz. sodium gold cyanide.
 $2\frac{1}{2}$ ozs. sodium cyanide.

When operating in this way the gold content of a plating bath should be at least sufficient to give about .35 gram of metallic gold per liter of solution. Preferably also the cathode connection to the pens is completed prior to immersion thereof into the bath, this being especially important in instances where the cyanide content is relatively high, since, in the upper ranges, the cyanide has a tendency to increase the rapidity with which the oxide film is redeveloped.

Apparently in this process there is sufficient time lag in redevelopment of the oxide upon immersion of the pens into the plating bath to permit the direct bonding of some gold to the metal of the article prior to substantially any redevelopment of the oxide. After the initial gold is directly bonded deposition is continued and the plating bath redevelops the oxide in the pores.

Summarizing this second process, it will be seen that its essentials involve:

(a) Removal of the chrome oxide film by the action of a hydrochloric acid electro-pickle.

(b) Plating of some gold in a manner to secure direct bond of the gold to the base before reformation of the oxide.

(c) Redeveloping the oxide film on the bare metal through the pores existing in the plating and at the same time building up the gold plate.

In accordance with this process, the last two items above (b and c) are both accomplished in the single gold plating solution, provided, of course, that the proper conditions of gold content are maintained and the pens are immersed in the bath with the cathode connection completed thereto in order to make sure that gold will be deposited immediately upon entrance of the pens into the bath.

This application is a continuation in part of my copending application Serial No. 77,571 aforesaid.

I claim:—

1. In the manufacture of a corrosion-resistant gold covered article, the steps of forming the article from a chromium alloy steel, removing the oxide film which normally forms and is present on the surface of the metal of which the article is formed by subjecting the article to a hydrochloric acid electro-pickle, and electro-depositing from aqueous solution a thin gold coating on said surface, the initially deposited metal of said coating being directly bonded to the base metal prior to appreciable reformation of the oxide film thereon and continuation of the deposit of said coating being effected from an aqueous alkaline cyanide gold plating solution.

2. In the manufacture of a corrosion-resistant gold covered article, the steps of forming the article from a chromium alloy steel, removing the oxide film which normally forms and is present on the surface of the metal of which the article is formed by subjecting the article to a hydrochloric acid electro-pickle, and electro-depositing from aqueous solution two thin gold films on said surface, the first of said films being deposited

from an acid solution and being directly bonded to the base metal prior to appreciable reformation of the oxide film thereon, and the second film being electro-deposited from an aqueous alkaline cyanide gold plating solution.

3. The method of applying a thin gold plate to a chromium alloy steel article to produce a corrosion-resistant gold covered article, which

method essentially consists in removing the oxide film which normally forms and plating gold on the metal by subjecting the article to the action of a combined electro-pickle and gold plating bath containing gold, cyanide and hydrochloric acid, and continuing plating with an aqueous alkaline cyanide gold plating solution.

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