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## CORROSION-RESISTANT FERROUS ALLOYS

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The present invention relates to an improved method of polishing articles made of corrosion-resistant ferrous alloys, and more particularly, to an improved method of chemically treating articles of corrosion-resistant ferrous alloys to produce not merely a lustre or sheen on the exposed surface of the article, but instead a mirror finish throughout the external and internal exposed surfaces of the article comparable to that produced on external exposed surfaces by mechanical or anodic electrolytic polishing.

The invention is applicable to the general class of iron-chromium alloys in which the alloying constituents are present in sufficient quantities to substantially passivize the iron, and more particularly to that group of chromium-nickel-iron alloys known as "stainless steels," of which the commercial stainless steel known as "18–8" and containing 18% chromium, 8% nickel and the balance substantially all iron is representative.

A smooth mirror finish on articles of the character described has been found to greatly reduce the corrosive action of chemicals on such surfaces. While it is possible to produce such a finish on articles which have all externally exposed surfaces by mechanical or anodic electrolytic polishing methods, such methods are of little practical value where the article has intricate internally exposed surfaces, such as frequently occur in complex castings of stainless steel. My invention is particularly useful in polishing such castings as the polishing treatment is simultaneously effective in removing scale and "burnt-in" sand from such castings, resulting in a complete resurfacing of the article and the production of a smooth clean passivated mirror finish.

In my improved method the articles to be treated are immersed in a special chemical bath for a predetermined time, varying from a few seconds for thin sheets of stainless steel to about five minutes for relatively large intricate castings of stainless steel. The chemical bath preferably employed is a strong acidic solution having the following characteristics:

1. There must be a substantial percentage of a highly active corrodent or attacking medium which tends to dissolve the metal surface uniformly rather than producing an etching effect. I have found that hydrofluoric acid (HF) is most suitable for this purpose when in the presence of nitric acid, and that it will give a uniform light silvery attack;

2. There must be present a large quantity of a constituent which will produce a strongly oxidizing condition. Nitric acid ($HNO_3$) is preferred for this purpose as it simultaneously produces passivation of the metal surface. Chromium trioxide can be used instead of nitric acid but is definitely not as effective for my purposes; and

3. There must also be included in the chemical bath a lustre or sheen producing constituent, and preferably the chloride of one or more of the following group of metals: cobalt, nickel, iron, chromium or titanium, nickel or iron chloride being preferred in view of their low cost and availability. I have found that without one of these in the bath, the acid corrodent will not produce at the best more than a silvery sheen on the exposed surfaces of the articles and never the desired mirror finish.

For the best results I have found that a bath of the following composition is preferable:

| | Percent by weight |
|---|---|
| Nitric acid ($HNO_3$) | 25 |
| Hydrofluoric acid (HF) | 15 |
| Water ($H_2O$) | 50 |
| A chloride of one or more of the group Co, Ni, Fe, Cr, or Ti | 10 |

The bath should preferably be maintained at a temperature of from 180°–200° F.

While the formula given is indicative of the character of the chemical bath employed in the invention, I have found that the constituents may be varied over a considerable range and still produce substantially the same effect. The quantity of nitric acid employed however should be kept within the range of 10% to 30% by weight of the solution for practical results. Increasing the percentage above this range tends to slow down the bath action too much, while reducing the percentage below this range tends to produce little or no polishing effect. The amount of hydrofluoric acid used should not be over 30% by weight, and preferably less than this value in view of the increasing violence of its action with the higher concentrations. The amount of metal chloride used should be within the range of 5–15% by weight of the solution.

Where a HF-$HNO_3$ acid pickling bath contains nitrates or fluorides of the metals Co, Ni, Fe, Cr or Ti in sufficient quantity, the bath may be made effective as a polishing bath in accordance with my invention by the addition of the proper amount of hydrochloric acid (HCl) to form the corresponding metal chloride or chlorides.

It will be understood that the particular solutions described are given as examples of chemical baths which wholly or partly accomplish the desired result of producing stainless steel ar-

ticles having a smooth clean mirror finish on all of its external and internal surfaces. The scope of the invention is indicated by the appended claims rather than by the foregoing description, and all variations in ingredients falling within the range of equivalency of the claims are intended to be embraced therein.

I claim:

1. The method of forming a smooth mirror finish on the exposed surfaces of a stainless steel article which comprises immersing the article in a chemical bath containing from 10 to 30% by weight of nitric acid, effective amounts up to 30% by weight of hydrofluoric acid, 5 to 15% by weight of a chloride of a metal selected from the group consisting of cobalt, nickel, iron, chromium and titanium, and the balance substantially all water.

2. The method of forming a smooth mirror finish on the exposed surfaces of a stainless steel article which comprises immersing the article in a chemical bath containing approximately 25% by weight of nitric acid, 15% by weight of hydrofluoric acid, 10% by weight of a chloride of a metal selected from the group consisting of cobalt, nickel, iron, chromium and titanium, and the balance substantially all water.

3. The method of forming a smooth mirror finish on the exposed surfaces of a stainless steel article which comprises immersing the article for a period of not more than five minutes in a chemical bath containing from 10 to 30% by weight of nitric acid, effective amounts up to 30% by weight of hydrofluoric acid, 5 to 15% by weight of a chloride of a metal selected from the group consisting of cobalt, nickel, iron, chromium and titanium, and the balance substantially all water.

4. The method of forming a smooth mirror finish on the exposed surfaces of a stainless steel article which comprises immersing the article for a period of not more than five minutes in a chemical bath at a temperature of from 180–200° F. and containing from 10 to 30% by weight of nitric acid, effective amounts up to 30% by weight of hydrofluoric acid, 5 to 15% by weight of a chloride of a metal selected from the group consisting of cobalt, nickel, iron, chromium and titanium, and the balance substantially all water.

5. A stainless steel article which has been simultaneously chemically resurfaced to provide a mirror finish on its exposed surfaces and passivized by treatment in a bath containing from 10% to 30% by weight of nitric acid, effective amounts up to 30% by weight of hydrofluoric acid, 5 to 15% by weight of a chloride of a metal selected from the group consisting of cobalt, nickel, iron, chromium and titanium, and the balance substantially all water.

6. A stainless steel article which has been simultaneously chemically resurfaced to provide a mirror finish on its exposed surfaces and passivized by treatment in a bath containing approximately 25% by weight of nitric acid, 15% by weight of hydrofluoric acid, 10% by weight of a chloride of a metal selected from the group consisting of cobalt, nickel, iron, chromium and titanium, and the balance substantially all water.

7. A chemical bath for the treatment of stainless steel articles to provide a mirror finish thereon which contains from 10 to 30% by weight of nitric acid, effective amounts up to 30% by weight of hydrofluoric acid, 5 to 15% by weight of a chloride of a metal selected from the group consisting of cobalt, nickel, iron, chromium and titanium, and the balance substantially all water.

8. A chemical bath for the treatment of stainless steel articles to provide a mirror finish thereon which contains approximately 25% by weight of nitric acid, 15% by weight of hydrofluoric acid, 10% by weight of a chloride of a metal selected from the group consisting of cobalt, nickel, iron, chromium and titanium, and the balance substantially all water.

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