ELECTROPLATING COPPER ON ALUMINUM

Lucio F. Mondolfo, Sea Cliff, N. Y., assignor
to Reynolds Metals Company, Richmond, Va.,
a corporation of Delaware

No Drawing. Application December 18, 1946,
Serial No. 717,083

5 Claims. (Cl. 204—42)

1. This invention relates to the electroplating of aluminum and has for its object the provision of an improved method of electroplating copper on aluminum. My invention provides an anodizing and electroplating operation carried out with the same solution and advantageously in the same vessel. One of the important features of my invention is the use of an electrolyte including a strong acid by means of which I may form an anodic coating on the aluminum and a deposit of copper over the anodic coating in the same solution merely by using the aluminum as an anode while forming the coating and then as a cathode when depositing the copper.

In accordance with my invention, the article to be plated with copper, with or without preliminary cleaning, and advantageously without the careful and expensive preparation herefore required, is immersed in a water solution of copper sulfate and sulfuric acid for anodizing and plating. In practice, one modification of my invention, a copper plate or body is used as the anode and the aluminum article as the cathode, while forming the anodic coating. Direct current is applied to the electrodes in the usual way and the anodizing is carried on until the desired anodic film or coating is formed on the aluminum article which requires approximately 10 to 30 minutes. The current flow is then reversed, making the aluminum article the cathode and the copper plate the anode. In this phase of the operation, copper is deposited over the anodic coating on the aluminum article.

In another adaptation of my invention, I immerse at least two aluminum articles in the solution and connect them as electrodes or poles to a source of alternating current, preferably of low frequency. In this step of the operation, I form an anodic coating without using direct current. After the desired anodic coating has formed on the articles, the alternating current is switched off and the aluminum articles are preferably connected in parallel. A direct current is then connected to the cathodes and a copper body or plate is used as anode. The copper plating is carried out as described above.

Another variation of my invention which is particularly suited for continuous operations is as follows: I use a vessel containing the solution and the articles are suspended in such a way that one is in the middle of the other two. The article in the center is made the cathode and the articles at the sides are connected in parallel as anodes.

When direct current is passed, the article in the center is plated, the articles at the sides being anodized at the same time. After an appropriate interval (10 to 15 minutes being usually sufficient), the article in the center is removed and one of the articles at the sides; for example, the one at the right side is moved to the center and current is passed again for the same interval of time. At the end of this time the article in the center is again removed, the article at the left side is placed in the center, and a new article is placed on the left side. This operation is repeated at the end of each time interval, moving the articles alternately from the right and left to the center.

This way the operation is continuous and full advantage is taken of the vessel and the current because articles are being anodized and plated at the same time.

If the articles to be plated are relatively flat and are to be plated only on one side, the same arrangement can be used by reversing the connections, so that the article in the center is the anode and the articles at the sides are the cathodes. This way, taking advantage of the low throwing power of the solution, only the side which faces the cathode will be plated; the other side receiving no coating, and remaining anodized and available for successive coloring, if required.

One of the important features of my invention is that I can deposit any desired thickness of copper. When the copper plated on the aluminum article has reached sufficient thickness for the purpose for which it is intended, the article is taken out of the bath and rinsed, and the plating is completed. The adherence of the copper to the aluminum is very good. The plated material can be formed, buffed or heated up to the melting point of the aluminum without any peeling of the copper.

In referring herein to “aluminum,” I intend to include pure aluminum, ordinary commercial aluminum with its usual impurities, and aluminum alloys.

The main advantages of the method are:
1. Very good adhesion of the copper to the aluminum.
2. No expensive or careful preparation of the surface is required before the article is immersed in the bath. If the article is fairly clean, no pretreatment at all is required; if it is very dirty or very greasy, it is better to remove the dirt or grease to minimize undue contamination of the electrolyte, but it is not absolutely necessary.
3. The article is handled only when it is im-
2,495,941

3 mersed in the bath and when it is taken out. No careful handling is required.
4 Only one solution is used so that only one tank is required.
5 The solution to be used for preparing the surface and for plating is cheap and relatively harmless and can be used over and over again.
6 The concentration of solution, current density, time, temperature and voltage are not critical. Relatively wide variations can be tolerated.

In the following example a sheet of 38 alloy of 0.010 gage was plated in the R temper:

<table>
<thead>
<tr>
<th>Direct Current Anodizing</th>
<th>Platting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volts</td>
<td>25</td>
</tr>
<tr>
<td>Amp./sq. ft.</td>
<td>15</td>
</tr>
<tr>
<td>Time</td>
<td>15</td>
</tr>
<tr>
<td>Temperature</td>
<td>100</td>
</tr>
</tbody>
</table>

The solution used contained approximately:
20% Cu sulfate
2% H₂SO₄

After plating the sample was annealed at 650–750° F. for 10 minutes, pickled to remove the scale, buffed and then Erichsen cups were drawn until the sheet fractured without any peeling or cracking taking place on the plating.

I claim:
1. The method of electroplating copper on aluminum which comprises immersing at least two aluminum articles in a water solution of sulfuric acid and copper sulfate, applying an alternating current to the two articles as electrodes and forming an anodic coating thereon, discontinuing the use of alternating current, connecting the articles in parallel as cathodes and anode to a source of direct current and depositing copper on the articles.
2. The method of electroplating copper on aluminum which comprises immersing an aluminum article in a water solution of sulfuric acid and copper sulfate, using the article as the anode and a body of copper as the cathode, applying direct current and forming an anodic coating on the article, reversing the flow of current making the article a cathode and the copper body an anode and depositing copper on the article, whereby a firm deposit of copper of any desired thickness may be applied to the article.
3. The method of electroplating copper on aluminum which comprises immersing at least two aluminum articles in a water solution of sulfuric acid and copper sulfate, applying an alternating current to the two articles as electrodes and forming an anodic coating thereon, discontinuing the use of alternating current, connecting the articles in parallel as cathodes and anode to a source of direct current and depositing copper on the articles.
4. The method of electrolytically treating aluminum articles which comprises placing at least three articles in an aqueous solution of sulfuric acid and copper sulfate, one article which was previously anodized is placed in the center and the other two at the sides, making the article in the center the cathode and the articles at the sides the anodes, the article at the center is plated with copper while the articles at the sides are anodized, moving the article from the center and out of the solution and replacing it with one of the anodized articles and repeating the operation by alternatingly moving the side articles to the center.

5. The method of electrolytically treating aluminum articles which comprises placing at least three flat articles in an aqueous solution of sulfuric acid and copper sulfate, one article being in the center and the other two at the sides, making the article in the center the anode and the articles at the sides which were previously anodized the cathodes, and plating the articles at the sides facing the anode with copper and anodizing the opposite faces of the anode.

LUCIO F. MONTDOLOF.

REFERENCES CITED
The following references are of record in the file of this patent:

UNITED STATES PATENTS

<table>
<thead>
<tr>
<th>Number</th>
<th>Name</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,497,169</td>
<td>Cunningham</td>
<td>May 20, 1923</td>
</tr>
<tr>
<td>1,534,799</td>
<td>Holt</td>
<td>Apr. 21, 1925</td>
</tr>
<tr>
<td>1,735,920</td>
<td>Setch et al.</td>
<td>Nov. 13, 1929</td>
</tr>
<tr>
<td>1,933,301</td>
<td>Auerbach</td>
<td>Oct. 31, 1933</td>
</tr>
<tr>
<td>1,947,921</td>
<td>Fischer</td>
<td>Feb. 20, 1934</td>
</tr>
<tr>
<td>2,190,018</td>
<td>Körpin</td>
<td>Apr. 2, 1940</td>
</tr>
</tbody>
</table>

FOREIGN PATENTS

<table>
<thead>
<tr>
<th>Number</th>
<th>Country</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>290,903</td>
<td>Great Britain</td>
<td>of 1927</td>
</tr>
<tr>
<td>434,482</td>
<td>Great Britain</td>
<td>of 1938</td>
</tr>
</tbody>
</table>

OTHER REFERENCES

Chemical Abstracts 29 (1935), 2450.