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[54] **PROCESS FOR FORMING SOLDERABLE COATING ON ALLOYS**

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[52] **U.S. Cl.** ..... **204/40;** 29/194; 29/196.3; 29/199; 117/50; 117/71 M; 117/131; 204/32R; 204/34; 204/44

[51] **Int. Cl.** **C23b 5/50;** C23b 1/00; B23p 3/00

[58] **Field of Search** ..... 204/32 R, 33, 34, 40, 44; 29/194, 196.3, 199; 117/71 M, 131, 50

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[57] **ABSTRACT**

A process for applying a tenaciously adhering coating on alloy articles or base metal articles by utilizing successive electroplating of copper and silver strikes to produce a tenaciously adhering electroplated base for receiving a copper-silver alloy coating that is still solderable after having been subjected to extreme temperature conditions.

7 Claims, No Drawings

PROCESS FOR FORMING SOLDERABLE COATING ON ALLOYS

BACKGROUND OF THE INVENTION

This invention relates generally to electroplating a solderable surface on an article. More specifically, the invention involves a multiple step process for providing a tenaciously adhering electroplating base on an alloy article. The invention may be considered as two processes. A first general process which will produce solderable coatings on alloy articles but with less than 100% yield of articles and a second more limited process that enables one to have substantially 100% yield of articles even under extreme environmental conditions. However, it should be understood that one wishing to use the process may not require a substantially 100% yield and in those cases the general process without refinements need not be followed. Also, in some cases the plated articles will not be required to withstand extreme operating and test conditions. For example, two of the conditions are that lead coating frames must withstand a baking cycle of about 900° F. and still be solderable. One of the problems is that subjecting an article to a high temperature baking cycle causes the coating to blister or peel off which renders the article useless.

The nickel-iron, ferrous and copper alloys and Kovar (trademark for nickel cobalt iron alloys) alloys are preferred in lead frames for electrical circuits. However, in order to use such nickel-iron alloy articles in a lead frame, it has been necessary to place a solderable coating on the surface of the article so that electrical leads can be soldered or fastened to the alloy lead frame. To date there has not been any process which is suitable for rack plating of lead frame articles.

One of the prior art techniques has been to place a gold strike on the alloy article and then electroplate silver over the gold strike. However, the high cost of gold has all but precluded this technique. A suggested substitute has been to electroplate with another material, however, to date, no other suitable materials or process are available that produces a solderable coating which adheres to the nickel-iron alloy.

The present invention is a process of coating an article with a number of different layers of material after thoroughly cleaning the surface of the article.

SUMMARY OF THE INVENTION

Briefly, the present invention is the discovery that a process of applying a tenaciously adhering solderable coating to a nickel-iron alloy requires a thorough cleaning of the article followed by forming base layers to receive a final layer of solderable material. More specifically, the process involves cleaning the article to remove organic and inorganic material, applying a copper strike, applying a silver strike which is followed by electroplating a solderable coating such as copper silver on top of the silver strike.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In order to silver plate alloy, the following procedure was followed:

First, the article was anodically cleaned with about 6 volts in an alkaline solution having a concentration of about 2.2 lbs. of an alkaline cleaner per gallon of water for at about 3 minutes at a temperature of about 150°

F. The alkaline material can be any suitable alkaline cleaner such as potassium hydroxide or sodium hydroxide. A more thorough discussion of the concept of anodic cleaning can be found in the 1971 "Metal Finishing Guidebook and Directory," page 190. The purpose of the first step is to remove any organic material on the article.

Second, the article is spray rinsed or washed to remove any alkaline solution on the article.

Third, the article is pickled in a solution of about 20% hydrochloric acid for about 30 seconds at about 75° F. The purpose of this step is to remove any oxides and neutralize any alkaline solution on the article.

Fourth, the article is spray rinsed to remove any residue materials on the article.

Fifth, the article now in a cleaned condition is placed in a solution containing about 2.2 pounds of potassium cyanide per gallon of water for about 3 minutes and subjected to anodic cleaning at 6 volts. This step leaves the article with an active metal surface. However, any suitable cleaning solution is acceptable, for example, chelating agents or sodium gluconate could also be used in this cleaning process. The process of anodic cleaning is well known in the art and no further discussion is necessary but those wishing to obtain greater detail on anodic cleaning may refer to the 1971 "Metal Finishing Guidebook and Directory."

Sixth, the article is removed and spray rinsed to remove any residue material from the previous step.

Seventh, the article which is now thoroughly cleaned can now be subjected to the plating steps of the present process by first immersing the article in a copper strike solution. A typical suitable copper strike solution contains about 2.5 ounces of copper cyanide per gallon of water and about 6 ounces of potassium cyanide per gallon of water. The alloy article is immersed for about 1 minute at about 120° F. and given a copper strike at about 1.5 volts. The copper strike solution is monitored to determine the ratio of the free potassium cyanide to the copper. Results have indicated that the yield is higher if the ratio is about 1 to 1, however, the process still produces acceptable plated articles if the ratio is not maintained at the 1 to 1 ratio. During the application of the copper strike a dummy article is also plated at about 1.5 volts. The "dummy" article is an article which is similar to the article being plated but is only used as a copper plating sink. It is not understood why the dummy article is required but it has been observed that the use of the dummy article insures that the yield of properly plated articles is close to 100% whereas without the dummy article the yield of usable articles will greatly fluctuate from run to run. Another feature which has been found useful is to place a woven bag around the anode during the plating cycle. The bag acts as a filter to keep crud and other material from forming and collecting at the anode.

Eighth, the article with the copper strike is then removed and spray rinsed to remove any residue material on the article.

Ninth, the article is immediately placed in a silver strike solution. A typical suitable silver plating solution contains about 0.3 ounces of silver cyanide per gallon of water, about 0.3 to about 0.37 ounces of copper per gallon of water and about 12 ounces of potassium cyanide per gallon of water. The alloy article is plated for about 1 minute at about 75° F. and at about 1.5 volts. It is important to the process to prevent the silver from

immersion coating the article. The immersion coated silver is undesirable because it does not adhere well to the copper strike. In order to avoid this problem, it was discovered that the silver ion concentration in the solution should be kept low and the electroplating voltage should be applied to the article before immersing the article in the electroplating solution. While there is no absolute limit as to ion concentration, good results are obtained if the ion concentration is maintained less than about 0.5 ounces per gallon of water, however, good results have been obtained with as high as 1 ounce per gallon of water. This procedure prevents the natural tendency of the silver to immersion plate the copper. In addition, it has been also found beneficial if the alloy article is maintained in a wetted condition during the intermediate step.

Tenth, after the silver strike is applied, the article is removed and a solderable coating in this case, silver, was electroplated on the article in a solution containing about 6 ounces of silver cyanide per gallon of water, about 0.1 ounces to about 0.4 ounces of copper cyanide per gallon of water and about 15 ounces of potassium cyanide per gallon of water.

Eleventh, after the article has been plated with silver, it is removed, rinsed and dried.

In the above example the various plating solutions and cleaning solutions were selected as being illustrative of the known solutions. Further plating and cleaning solutions can be found in the 1971 "Metal Finishing Guidebook and Directory". It should be pointed out that these specific steps of themselves, i.e., anodic cleaning, alkaline cleaners, pickling and the rinsing are all steps which are well known in the art. Also, the yield of articles from this process has been found to be close to 100% if a number of supplementary steps and a "dummy" article are placed in the copper cyanide solution. However, the heart of the present invention is the process of applying a silver strike by limitation of the concentration of the silver ions in the silver strike solutions, as well as applying the electroplating voltage to the article before inserting the article into the silver strike solution. The importance and significance of the concentration of ions is that if the concentration of ions is too high and if no voltage is applied to the article before insertion of the article into the silver strike solution, the article will immersion plate with silver. The immersion plated silver has been found to be undesirable because it does not adhere well and tends to flake off of the article thereby rendering the article inoperative. Thus, the process of the present invention may be more aptly described as a process of applying a solderable coating to alloy by first cleaning the article to remove organic and inorganic materials and then applying a copper strike to the article followed by removing the article with the copper strike thereon and maintaining the article in a wetted condition followed by electroplating a silver strike to the article insuring that the electroplating voltage is applied to the article before inserting the article in the silver strike solution. The article can then receive a solderable coating electroplating base material on the silver strike.

While variations of the solution and temperature are within the skill of those in the art, it is important that the concentration of the silver strike solution is not in excess of about one ounce of silver cyanide per gallon of water if the temperature is about 75° F. and the voltage is about 1.5 volts with a time of about one minute. However, those skilled in the art will recognize that the voltage, temperature and time of plating are all related and that changes in these parameters can still produce acceptable plated articles.

While the process has been described with respect to an alloy, it should be pointed out the process is also usable with base metals, however, with base metals and some alloys the problems of obtaining a tenaciously adhering coating are not as difficult as with alloys such as the nickel iron alloys. In addition, not all the article will flake or peel if the plated article is subjected to a high temperature baking cycle. But we have found the number of unacceptable articles increases as the article is subjected to higher temperature baking cycles.

We claim:

1. The process of applying an electroplating base to an alloy article comprising the steps of:

cleaning the article to remove organic and inorganic materials;

electroplating a copper strike to the alloy article;

removing the article with the copper strike thereon while maintaining the alloy article in a wetted condition followed by electroplating a silver strike to the alloy article by applying an electroplating voltage to the alloy article and then inserting the alloy article into a copper-silver electroplating solution to thereby produce an electroplating base for applying a solderable coating.

2. The process of claim **1** wherein the concentration of the silver during the electroplating of silver in the silver strike solution is less than one ounce per gallon of electrolyte.

3. The process of claim **1** wherein the alloy article is anodically cleaned prior to copper striking in order to remove any materials on the surface of the alloy article.

4. The process of claim **3** wherein the alloy article is further acid pickled to remove any oxide on the surface of the alloy article.

5. The process of claim **4** wherein the alloy article is further cleaned by subjecting the article to a second anodic cleaning.

6. The process of claim **1** wherein a "dummy" article and an alloy article are simultaneously plated with copper in the same electroplating bath.

7. The process of producing substantially a 100% yield of articles comprising the invention of claim **6** including the step of monitoring and maintaining the ratio of free potassium cyanide to copper at about 1.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,878,065 Dated April 15, 1975

Inventor(s) John M. Carr and Pat F. Mentone

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In claim 1, lines 5-6 should read as follows:

electroplating a copper strike to the alloy article in an electroplating bath; removing the article with the copper strike thereon from the electroplating bath

Signed and Sealed this

twenty-sixth Day of *August 1975*

[SEAL]

Attest:

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