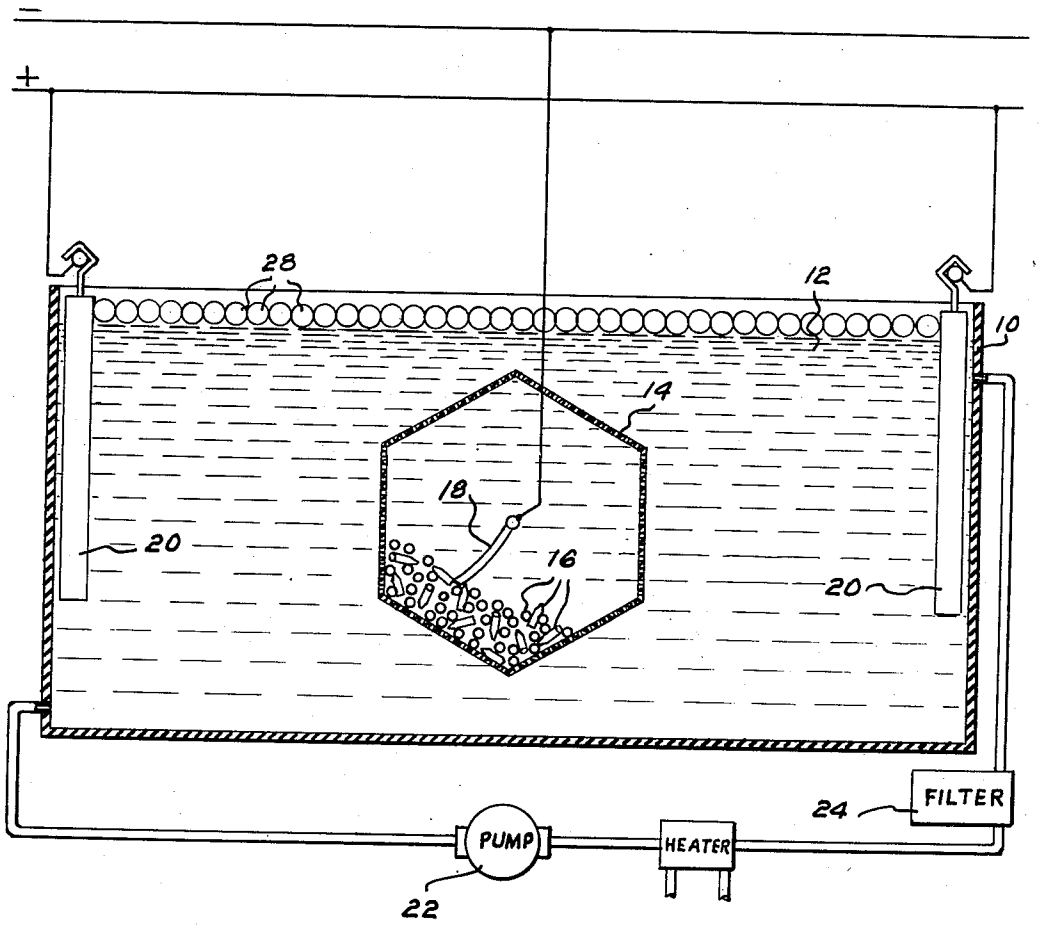
June 14, 1955 R. E. HARR 2,710,832

ELECTROPLATING OF IRON

Filed March 28, 1952



INVENTOR
R. E. HARR
BY E. F. Kane
ATTORNEY

United States Patent Office 2,710,832 Patented June 14, 1955

2,710,832

ELECTROPLATING OF IRON

Russel E. Harr, Downers Grove, Ill., assignor to Western Electric Company, Incorporated, New York, N. Y., a corporation of New York

Application March 28, 1952, Serial No. 279,009

13 Claims. (Cl. 204—43)

This invention relates to baths for and methods of electroplating articles, and more particularly to baths for and methods of electroplating iron on copper articles.

In plating coatings of iron on copper articles, such as, for example, copper soldering irons, with baths of ferrous ammonium sulfate, large quantities of precipitates are formed in the electrolytic baths. Such precipitates are two types, a solid type of which may be successfully filtered without clogging the filters, and a slimy, gelatinous type which clogs the filters. Past known addition agents are unsuccessful in stopping formation of the slimy precipitates.

An object of the invention is to provide new and improved baths for and methods of electroplating articles.

Another object of the invention is to provide new and improved baths for and methods of electroplating iron on copper articles.

A further object of the invention is to provide baths for and methods of electroplating iron on copper articles in which the formation of filter-clogging types of precipitates is prevented.

In one method illustrating certain features of the invention, a copper article is plated with iron in a ferrous ammonium sulfate plating solution having a pH value of 4.9 to 5.4 at a temperature in the range of from 140° F. to 150° F. having from about two to about four ounces per gallon of ammonium fluoborate to prevent the formation of slimy precipitates so that clogging of filters used in the process is prevented.

A complete understanding of the invention may be obtained from the following detailed description of a bath and a method forming specific embodiment thereof, when read in conjunction with the appended drawing, in which the single figure is a schematic view of an apparatus for practicing a method forming a specific embodiment of the invention.

Referring now in detail to the drawing, there is shown therein an electroplating tank **10** containing an electrolyte **12** composed essentially of ferrous ammonium sulfate solution with a small amount of ammonium fluoborate, in which a rotatable barrel **14** of a conventional, horizontal type composed of insulating material is completely submerged to immerse copper articles **16** in the electrolyte. The articles are contacted by a cathode **18**, and iron anodes **20** are immersed in the bath. The bath is operated at a temperature preferably within the range of from about 140° F. to about 150° F., and the electrolyte is continuously circulated through the tank **10** without turbulence by a pump **22**, which pumps the solution through a filter **24** of a well-known type, and thence back to the tank. Plastic balls **28** are floated on the surface of the electrolyte to reduce evaporation losses, and to reduce oxidation of the solution from contact with the air.

The electrolyte may consist essentially of an aqueous solution of forty ounces per gallon of ferrous ammonium sulfate. The electrolyte should have from about two to about four ounces per gallon ammonium fluoborate added to the solution, and sufficient sulphuric acid is added from time to time to maintain the pH value of the solution within the range of from 4.9 to 5.5.

In one successful use of the method described hereinabove, the copper articles were cleaned in a nitric acid solution to remove copper oxides from the surfaces thereof, were dipped in an ammonium fluoborate solution to remove insoluble complexes and, while still wet, were placed in an electrolyte consisting of a solution of forty ounces per gallon of ferrous ammonium sulfate with two ounces per gallon of ammonium fluoborate added to the solution. The starting pH value was 5.3, and the temperature of the electrolyte was maintained within the range of from about 140° F. to about 150° F. The articles were rotated in the barrel **12** and were plated for a period of twenty hours. The cathode-anode voltage was about 4.5 volts with the anodes spaced about seven inches from the barrel **12**, which was six inches in diameter. By the end of each run the pH value had risen about 0.15 and required about 1.67 c. c. of sulphuric acid per gallon of electrolyte to bring the electrolyte back to its starting pH value. The electrolyte was continuously withdrawn from the tank **10** and filtered, and at the end of the run, the filter was not appreciably clogged and there was a complete absence of the slimy, gelatinous type of precipitates which occur whenever the ammonium fluoborate is absent. The ammonium fluoborate also reduced the tendency of the solution to climb the walls of the tank so that the solution did not wet the outer sides and the top of the tank. Thus, loss of solution by evaporation was substantially reduced, and the messiness and danger for the operators was eliminated. Dense, tenaciously adherent iron platings of a thickness about 0.012 inch, free from brittleness were formed on the copper articles.

While in the method described hereinabove, the electrolyte contains only iron as the metal to be plated, the fluoborate salt is an excellent addition agent to copper-iron ammonium sulfate electrolytes for plating copper and iron on another metal to prevent formation of gelatinous precipitates and is widely useful to prevent such precipitates wherever iron is present in acid electrolytes.

It is to be understood that the above-described arrangements are simply illustrative of the application of the principles of the invention. Numerous other arrangements may be readily devised by those skilled in the art which will embody the principles of the invention and fall within the spirit and scope thereof.

What is claimed is:

1. An electroplating bath, which comprises an aqueous acid solution including as a major component ferrous ammonium sulfate and having a small amount of ammonium fluoborate added thereto in concentration sufficient to prevent formation of slimy precipitates.

2. An electroplating bath, which comprises an aqueous acid solution of ferrous ammonium sulfate and a small amount of ammonium fluoborate in concentration sufficient to prevent formation of slimy precipitates.

3. An electroplating bath, which comprises an aqueous acid solution of ferrous ammonium sulfate and from two to four ounces per gallon of ammonium fluoborate.

4. An electrolytic bath, which comprises an aqueous acid solution composed essentially of ferrous ammonium sulfate and ammonium fluoborate, the concentration of the ferrous ammonium sulfate being about forty ounces per gallon and the concentration of the ammonium fluoborate being in the range of from about two ounces to about four ounces per gallon.

5. An electrolytic bath, which comprises an aqueous acid solution including ferrous ammonium sulfate and ammonium fluoborate, the concentration of the ammo-

nium fluoborate being sufficient to substantially reduce the formation of slimy precipitates.

6. The method of electroplating articles, which comprises electroplating iron on copper articles in an aqueous acid ferrous ammonium sulfate bath having added thereto ammonium fluoborate in concentration sufficient to prevent the formation of slimy precipitates therein, and filtering the solution.

7. The method of electroplating articles, which comprises electroplating iron on copper articles in an aqueous acid ferrous ammonium sulfate bath having added thereto ammonium fluoborate in concentration sufficient to prevent the formation of slimy precipitates therein, and continuously recirculating the solution through a filter.

8. The method of electroplating iron on copper articles, which comprises electroplating copper articles in a bath of an aqueous solution of ferrous ammonium sulfate at a concentration of about forty ounces per gallon and ammonium fluoborate within the range of from about two ounces per gallon to about four ounces per gallon, adding sufficient sulphuric acid from time to time to maintain the pH value of the solution between 4.9 and 5.5, keeping the solution at a temperature within the range of from about 140° F. to about 150° F., continuously flowing the solution through the bath, and continuously filtering the solution.

9. The method of electroplating iron on copper articles, which comprises electroplating copper articles in a bath of an aqueous solution of ferrous ammonium sulfate and ammonium fluoborate within the range of from about two ounces per gallon to about four ounces per gallon, maintaining the pH value of the solution between 4.9 and 5.5, and continuously filtering the solution.

10. The method of preventing slimy precipitates in a bath composed essentially of an aqueous solution of ferrous ammonium sulfate, which comprises adding to the solution from about two to about four ounces per gallon of ammonium fluoborate to prevent the formation of slimy precipitates, adding sufficient sulphuric acid to the mixture to make its pH value in the range of from 4.9 to 5.5, and maintaining the temperature of the bath sufficiently high to minimize formation of slimy precipitates.

11. An electroplating bath, which comprises an aqueous solution including as a major component ferrous ammonium sulfate and having a small amount of ammonium fluoborate added thereto in concentration sufficient to prevent formation of slimy precipitates, the pH of the mixture being in the range of from about 4.9 to about 5.5.

12. An electroplating bath, which comprises an aqueous acid solution of ferrous ammonium sulfate and from two to four ounces per gallon of ammonium fluoborate, the pH of the mixture being in the range of from about 4.9 to about 5.5.

13. An electrolytic bath, which comprises an aqueous solution composed essentially of ferrous ammonium sulfate and ammonium fluoborate, the concentration of the ferrous ammonium sulfate being about four ounces per gallon and the concentration of the ammonium fluoborate being in the range of from about two ounces to about four ounces per gallon, the pH of the resulting mixture being in the range of from about 4.9 to about 5.5.

References Cited in the file of this patent

UNITED STATES PATENTS

1,544,579	Herr	July 7, 1925
1,912,430	Cain	June 6, 1933
1,952,793	Ewing	Mar. 27, 1934
2,457,798	Ferguson	Jan. 4, 1949
2,523,160	Struyk et al.	Sept. 19, 1950