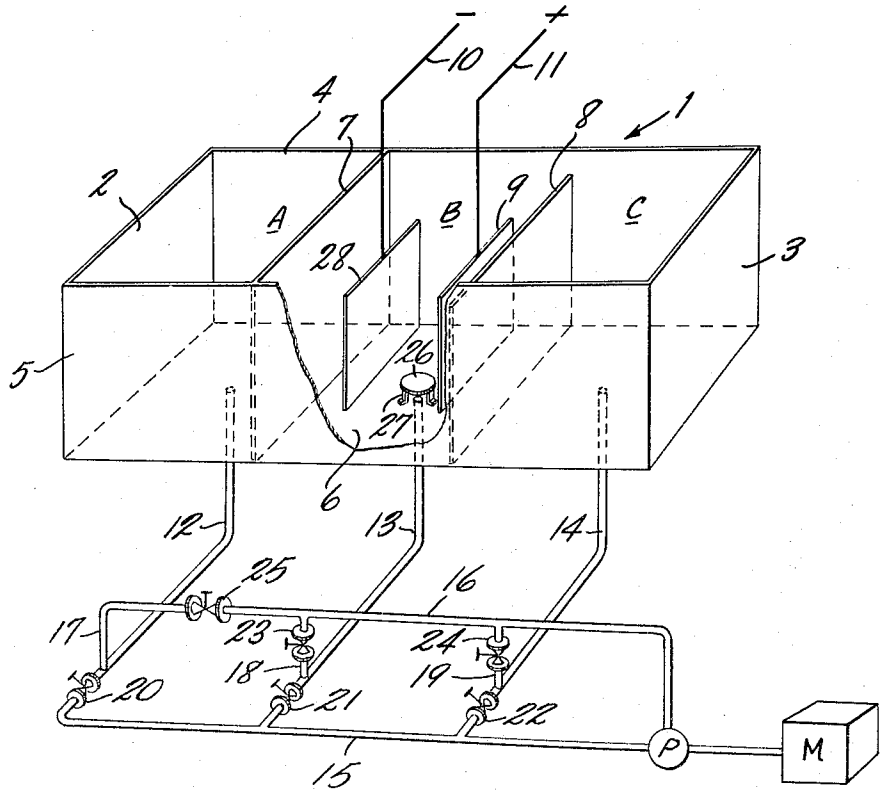
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ELECTROPLATING PROCESS AND APPARATUS

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ELECTROPLATING PROCESS AND APPARATUS

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The present invention pertains to an electroplating process and apparatus, and more particularly to a process and apparatus for the cathodic etching and copper striking of stainless steel articles.

Heretofore, in the electroplating of metallic articles with a metallic coating it has been the practice to remove the grease and dirt adhering to the article by treating the article with a conventional degreasing solution. The surface of the article may then be roughened, for example, by making it the anode in an electrolytic solution. The article is then made the cathode in an etch solution to further prepare the surface of the article for the metallic coating by etching the article and forming a film of nascent hydrogen thereon. After the cathodic etching of the article, it is transferred from the etch solution and immersed in a strike solution wherein it is also made the cathode in order to form a strike coating thereon. After the preliminary strike or flash coating is applied to the article, it is transferred to an electroforming unit wherein the article is again made the cathode in order to apply thereon the final metallic coating.

This present practice in regard to the electroplating of articles with a metallic coating suffers from the very serious drawback in that during the step of transferring the article from the cathodic etch solution to the strike solution, the film of hydrogen thereon is dissipated. Since this film of hydrogen is necessary in order to obtain a strong, firmly bonded strike coating, the dissipation of the hydrogen film is highly disadvantageous and presents a considerable problem to the electroplating industry.

It is, therefore, the object of the present invention to provide an electroplating process and apparatus in which there is no loss of the hydrogen film formed on the article by the cathodic etching of the article and which accordingly makes it possible for the first time to produce a strong adherent strike coating upon an article.

In the drawing, there is shown a perspective view partly in section of an embodiment of the apparatus of the invention.

In general, the process of the invention comprises treating an article in an etch solution while the article is a cathode to form thereon a hydrogen film. The etch solution is then displaced with a solution of the metal ions which are to form the strike coating while the flow of current is continued at a lower voltage and current density. While the etch solution is being displaced by the strike solution and after displacement thereof, the cathodic article is struck with the desired metallic coating.

In particular, the process of the present invention comprises etching an article, such as a stainless steel article formed from the well known iron-chromium alloy, with an etch solution, such as a sulfuric acid solution, while the article is a cathode. The etch solution is then displaced upwardly from its container by a strike solution, such as an aqueous solution of copper sulfate, whose minimum specific gravity is greater than the maximum specific gravity of the etch solution. During the displacement of the etch solution by the strike solution the current density and voltage are lowered, but the flow of current is continued so that the lower portion of the article is being struck with the metallic coating while the upper portion of the article is being etched by the etch solution and is having a hydrogen film formed thereon due to the stratification of the two solutions. After the etch solution has been completely displaced by the strike solution, the flow of current is continued at the lower current density so that the cathodic article is struck with the metal ions present in the strike solution. Accordingly, during the process there is no dissipation of the hydrogen film on the article between the etching step and the striking step.

Turning now to the apparatus of the invention, it comprises in general a tank having at least three compartments. Overflow means are provided to connect two of the compartments to one another. Means are also provided for transferring fluids from one compartment to another.

In particular, the apparatus of the invention comprises an acid resistant tank subdivided into three compartments by two partitions. One of these partitions extends from the base of the tank to the top of the tank while the second partition extends from the base of the tank but terminates below the top of the tank so that fluid may overflow from one compartment to the other over the lower partition. The center compartment is provided with at least one anode, such as a lead anode, and with the article to be etched and struck which is made the cathode. Each of the three compartments are connected one to the other by means for transferring fluids from one compartment to the other which means are a system of pipes, valves, and a pump driven by a motor so that by opening and closing valves fluids may be pumped from one compartment to another as desired.

Referring now to the drawing, the apparatus of the invention comprises an elongated rectangular acid resistant tank 1 having end walls 2 and 3 and side walls 4 and 5 all connected to a base 6. The tank 1 is subdivided into three compartments A, B, and C by partitions 7 and 8. Partition 7 between compartments A and B extends from the base 6 to the top of side walls 4 and 5, while partition 8 between compartments B and C also extends upwardly from the base 6 but terminates below the top of side walls 4 and 5, i.e., partition 8 has a height less than that of partition 7.

The center compartment B is provided with one or more lead anodes 9 connected by a positive lead 11 to a source of electricity and with an article 28 to be plated which serves as the cathode and is also connected to the same source of electricity by negative lead 10.

Compartments A, B, and C have connected to the bottoms thereof lines 12, 13, and 14 respectively which lines are all connected to an input manifold 15 running to the intake side of a pump P driven by a motor M. The output side of pump P is connected to an output manifold 16 which is joined to each of lines 12, 13 and 14 by feed lines 17, 18 and 19 respectively.

Line 12 is provided with a valve 20 interposed therein between feed line 17 and input manifold 15. Line 13 is provided with a valve 21 interposed between feed line 18 and the input manifold 15. Line 14 is provided with a valve 22 interposed between feed line 19 and input manifold 15. Feed lines 18 and 19 are provided with valves 23 and 24 respectively. Output manifold 16 is provided with a valve 25 interposed between feed lines 17 and 18.

Above the connection of line 13 to the base of compartment B there is a baffle plate 26 supported on the bottom of compartment B by supports 27.

In the operation of the apparatus, end compartment A

of tank 1 is filled with an aqueous strike solution of copper sulfate having a minimum specific gravity of 21° Baumé. The center compartment B of tank 1 is filled with a 20% etch solution of sulfuric acid whose maximum specific gravity is 16° Baumé, i.e., the copper sulfate strike solution in compartment A has a specific gravity greater than the specific gravity of the sulfuric acid etch solution in compartment B. Compartment C of tank 1 is empty and all six valves 20 through 25 are closed so that there is no flow of fluids through any of the lines 12 through 19.

The lead anode 9 is immersed in the sulfuric acid etch solution in compartment B and so is the stainless steel article 28 which is made the cathode. A current density of approximately 200 to 250 amperes per square foot is applied to the cathodic stainless steel article 28 to cause the cathodic etching thereof and to form thereon a film of hydrogen.

After the elapsed etching time, the voltage is dropped to 1½ to 2 volts. Valves 20 and 23 are then opened and the motor M started to drive pump P and transfer the copper sulfate strike solution from compartment A to compartment B via line 12, valve 20, input manifold 15, pump P, output manifold 16, feed line 18, valve 23, and line 13. The copper sulfate strike solution entering the base of compartment B is deflected by baffle plate 26 so as not to agitate the sulfuric acid etch solution in compartment B. The continued flow of the heavier copper sulfate strike solution into compartment B upwardly displaces the sulfuric acid etch solution therefrom and causes the sulfuric acid etch solution to overflow from compartment B over the top of lower partition 8 and into empty compartment C. After the sulfuric acid etch solution has been completely displaced from compartment B into compartment C by the heavier copper sulfate strike solution, valves 20 and 23 are closed and the motor M and pump P stopped. The flow of electric current is continued until the desired thickness of the copper strike coating has been applied to article 28.

In this manner, the hydrogen film formed on the stainless steel article 28 during the cathodic etching is not dissipated prior to the striking of the article 28 with the copper sulfate strike solution and hence a strong, firmly bonded strike coating of copper is applied to the stainless steel article 28. After suitable elapsed time for copper striking, stainless steel article 28 is removed from compartment B and transferred to an electroforming unit wherein the final copper coating is applied thereto.

The copper sulfate strike solution in compartment B is returned to compartment A by opening valves 21 and 25 and starting motor M to drive pump P. The copper sulfate strike solution in compartment B flows to compartment A via line 13, valve 21, input manifold 15, pump P, output manifold 16, valve 25, feed line 17, and line 12.

After the copper sulfate strike solution has been emptied from compartment B and returned to compartment A, valves 21 and 25 are closed and valves 22 and 23 opened in order to return the sulfuric acid etch solution from compartment C to compartment B. The sulfuric acid etch solution is returned from compartment C to compartment B via line 14, valve 22, input manifold 15, pump P, output manifold 16, valve 23, feed line 18, and line 13. When the sulfuric acid etch solution has been emptied from compartment C and returned to compartment B, the motor M and pump P are stopped and valves 22 and 23 are closed.

After the purification of the copper sulfate strike solution now in compartment A and the sulfuric acid etch solution now in compartment B, the apparatus is ready for use again.

It will be appreciated in view of the above discussion that the invention provides a process and apparatus wherein an article may be cathodically etched and have formed thereon a film of hydrogen which film is not dissipated prior to plating the article with a metallic strike coating because the article to be struck is first immersed completely in an etch solution, then the upper portion of the article remains immersed in the etch solution while the lower portion thereof is progressively immersed in a strike solution, and subsequently the article is completely immersed in a strike solution due to the upward displacement of the etch solution by the heavier strike solution. The invention, therefore, provides means for procuring a strong, firmly bonded strike or flash coating of metal upon an article.

It will be further appreciated that the apparatus of the invention may take many forms other than the preferred embodiment illustrated in the drawing. Thus, the apparatus may comprise several parallel tanks 1 and may contain one or more anodes and cathodes within compartment B. Furthermore, the tank 1 may be subdivided into more than three compartments, if desired. Moreover, the cathode and anode need not be placed in compartment B, but they could be placed in any of the three compartments and suitable means, such as piping and valves, provided for the overflow of the etch solution and the transfer of fluids from one compartment to the other. For example, the anode and cathode can be placed in compartment C containing an etch solution while compartment A contains a strike solution and compartment B is empty. The etch solution in compartment C can then be caused to overflow over partition 8 into compartment B by displacement thereof with the strike solution in compartment A entering into the base of compartment C.

Furthermore, the process of the invention need not be restricted to the copper striking of a stainless steel article by using a copper sulfate strike solution. Other suitable strike solutions, such as copper cyanide, can be used equally as well. In addition, the process of the invention need not be restricted to the copper striking of stainless steel articles, but it may be applied in general to the striking of any metallic article with any desired metallic coating, provided, of course, the process is capable of being performed electrolytically.

Many other variations and modifications in the process and apparatus of the invention will be readily apparent to those skilled in the art. Accordingly the process and apparatus of the invention are to be limited only within the scope of the appended claims.

I claim:

1. An electroplating process comprising etching a stainless steel article in a sulfuric acid etch solution in an electroplating tank while the article is a cathode, upwardly displacing the sulfuric acid etch solution from said tank by flowing into said tank a strike solution containing copper ions and having a specific gravity greater than the specific gravity of the sulfuric acid solution, and striking the cathodic article with the copper ions.

2. An electroplating process comprising etching a stainless steel article in a sulfuric acid etch solution in an electroplating tank while the article is a cathode, upwardly displacing the sulfuric acid etch solution from said tank by flowing into said tank a copper sulfate strike solution having a specific gravity greater than the specific gravity of the sulfuric acid solution, and striking the cathodic article with copper ions.

3. An electroplating process comprising immersing a stainless steel article in a sulfuric acid etch solution in an electroplating tank while the article is a cathode to etch the stainless steel article and form thereon a film of hydrogen, upwardly displacing the sulfuric acid etch solution from said tank by flowing into said tank a solution of copper sulfate having a specific gravity greater than the specific gravity of the sulfuric acid solution while continuing the flow of electric current at a reduced current density, and plating the cathodic stainless article with a strike coating of copper.

4. An electroplating apparatus consisting essentially of a tank; two partitions in the tank subdividing the tank into a strike solution supply compartment, an etch solution compartment, and an overflow compartment, the partition separating the etch solution compartment from the overflow compartment having a height less than that of the other partition to form the sole overflow means; a pump connected to an input manifold and an output manifold, said input manifold being connected by base lines to the base of each compartment and said output manifold being connected by feed lines to each of said base lines; and a valve in each of said base and feed lines; whereby etch solution in the etch solution compartment can overflow the lower partition into the overflow compartment by the upward displacement thereof of heavier strike solution pumped from the strike solution supply compartment and whereby both solutions can be subsequently pumped back sequentially to their original compartments.

5. The apparatus of claim 4 containing a cathode and an anode within said etch solution compartment.

6. The apparatus of claim 4 having a baffle plate over the outlet of the base line connected to the base of the etch solution compartment.

References Cited in the file of this patent

UNITED STATES PATENTS

2,093,238	Domm	Sept. 14, 1937
2,285,548	Wesley	June 9, 1942
2,363,973	Kennedy et al.	Nov. 28, 1944
2,519,945	Twele et al.	Aug. 22, 1950
2,560,966	Lee	July 17, 1951
2,721,562	Irvine	Oct. 25, 1955
2,762,763	Kenmore	Sept. 11, 1956

FOREIGN PATENTS

733,110	Great Britain	July 6, 1955

UNITED STATES PATENT OFFICE

CERTIFICATION OF CORRECTION

Patent No. 2,962,427 November 29, 1960

Leo K. Kosowsky

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 74, after "stainless" insert -- steel --.

Signed and sealed this 9th day of May 1961.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents