Finishers' Think Tank Revisited—II

By John Laurilliard, CEF
Compiled by Dr. James H. Lindsay, AESF Fellow

Pyrophosphate Copper

Q: Because of waste-treatment problems, we would like to eliminate all cyanides from our plating shop. The last remaining cyanide solution in the shop is the Rochelle copper strike used prior to acid copper plating. What can we use?

A: Anyone who has used a cyanide copper strike as an initial plate is going to miss it when it's gone. Cyanide strikes are very forgiving of poor cleaning practices by the operator. The plater relies on the cyanide strike to function as a final cleaning operation.

On properly cleaned steel parts, a nickel strike in a Watts-type bath can be used in place of a copper cyanide strike. After striking with nickel using 2.2 to 3.3 A/dm^2 (20 to 30 A/ft^2) for 2 to 3 min, the parts should be connected with a jumper to the cathode bar before immersion in the acid copper bath. Another substitute for a cyanide strike is based on a pyrophosphate formulation. The copper concentration is 7.5 to 10 g/L (1.0 to 1.33 oz/gal) and the pyrophosphate is maintained between 150 and 300 g/L (20 to 40 oz/gal), giving a pyrophosphate-to-copper ratio of 25:1. Tartaric acid at 10 g/L (1.33 oz/gal) is sometimes added to the bath. The pH is maintained at 8.8 to 9.2 with pyrophosphoric acid and potassium hydroxide. The bath is operated at 16 to 32°C (60 to 90°F) with a cathode current density of 0.22 to 0.86 A/dm^2 (2.0 to 8.0 A/ft^2). With agitation, a cathode current density of 2.2 A/dm^2 (20 A/ft^2) may be used.

Bright Dip

Q: Is there any way to determine if a cadmium- or zinc-plated part has been bright dipped in a chromic acid solution?

A: The presence of a chromate film on zinc or cadmium plate may be verified by a chemical spot test using a solution consisting of the following, added in the order listed: 40 mL of distilled water, 60 mL of glacial acetic acid, 1 g of diphenylcarbazide, 15 mL of concentrated hydrochloric acid, 90 mL of sodium hypochlorite (5% available chlorine) and 5 mL of hydrogen peroxide (100 vol).

Dissolve the diphenylcarbazide in a mixture of glacial acetic acid and distilled water. Add the hydrochloric acid, mix and slowly add the hypochlorite solution. Finally, add the peroxide slowly, and mix. Age for 24 hr in an open bottle before using. Keep in a loosely stoppered bottle to allow escape of chlorine. When testing a zinc- or cadmium-plated part, two standard plated parts also should be tested for comparison. One standard part should be plated, but not bright dipped, while the second should be plated and bright dipped. A spot of test solution is deposited on each of the two standards and the test piece. If the test piece has been passivated in a chromic acid-type bright dip, the spot of test solution turns red. Several minutes may be necessary for development of color.

Blistered Silver

Q: I have been having a serious problem with blistering of silver-plated stainless steel. The silver is 25-μm thick (0.001-in. thick) over a nickel strike. The parts do not blister until they are heated at 500°C (932°F). What am I doing wrong?

A: I am not sure you are doing anything wrong. If the blistering is due to inadequate adhesion of the ‘‘as-deposited” silver, a mechanical adhesion test such as the “chisel” test probably will reveal the poor adhesion. For thicker silver deposits that must be ground to size after plating, a shot-peen test is very sensitive in revealing poor adhesion.

If the as-deposited silver is poorly adherent it could be due to improper cleaning, insufficient activation of the stainless steel basis metal or too high a current in the silver strike, causing a burned deposit. Although you did not mention what type of atmosphere was used during the post-plate bake, it should have been either an inert or nonoxidizing atmosphere. When silver plate is heated in air at about 500°C (930°F) it is normal that it will blister. The blistering is caused by the ability of oxygen to diffuse readily through silver at elevated temperature. The maximum solubility of oxygen in silver occurs at approximately 500°C. It is postulated that, during the high-temperature bake while oxygen is diffusing through the silver, hydrogen and oxygen meet at the silver/basis metal interface and form steam (water; H_2O), which is not soluble in silver, causing blisters.

The amount of hydrogen that enters the basis metal during cathodic activation or silver striking may affect the severity of blistering. The less hydrogen, the less blistering. Silver thickness also affects blistering. Thicker deposits have larger blisters.

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Baked-on Coating

Q: I need a quick, easy way to remove baked-on molybdenum disulfide coatings.

A: There are several methods to remove heat-cured molybdenum disulfide dry-film lubricants, none of which is quick or easy. The simplest way to remove the coating is by grit blasting with mild abrasive such as walnut shells or peach pits. Aluminum oxide at low pressure might be required for more difficult coatings. At high temperatures, highly alkaline solutions such as those for steel blackening or alkaline descaling will degrade or dissolve molybdenum disulfide. A highly effective process for removing organic coatings from steel is a boiling solution of chromic acid at a concentration of 480 g/L (4 lb/gal).

Grinding of Hard Chromium

Q: I operate a small job shop for plating hard chromium. I subcontract the grinding of the chromium but lately have had several jobs ruined by faulty grinding. I would like to set up and do my own chromium grinding. Can you recommend proper grinding practice?

A: The techniques for grinding hard chromium are comparable to those for grinding other hard materials:

1. Frequent and correct dressing of the grinding wheel is one of the most important considerations in the grinding of chromium plate. Diamond dressing should remove approximately 50 to 75 μm (2 to 3 mils) of the grinding wheel surface to remove worn abrasive grains and expose fresh, sharp grains. The more often the wheel is dressed, the less depth of removal is required.
2. The workpiece/grinding-wheel contact surface should be flooded continuously with copious amounts of water-soluble grinding fluid.
3. Wheel speed should be approximately 6,000 surface ft/min (sfm) but should be consistent with the type of part being ground and the characteristics of the grinding wheel.
4. The depth of cut should not be too great. Rough-grind at the rate of 13 μm (0.5 mil) per pass to within approximately 25 μm (1 mil) of final dimensions, then reduce the depth of cut per pass to 5 to 8 μm (0.2 to 0.3 mil) to the final dimensions.
5. For outside-diameter (OD) cylindrical grinding, use an aluminum oxide wheel with a medium-sized grit, medium density and a vitrified-type bond.

In summary, use plenty of coolant, take your time, use the proper wheel for the type of work being ground, and keep it sharp and cutting. If you have never done any grinding, I suggest you hire people with grinding experience. You will save a lot of heartache, time and money.

Anodizing Racks

Q: With the soaring cost and scarcity of titanium, I would like to go back to using aluminum racks for my anodizing process. What aluminum alloy would you recommend?

A: Even with the high initial cost, titanium might still be a bargain. I think you must consider the long and relatively trouble-free life of the titanium rack vs. the short life of the aluminum rack, with annoying problems and production loss due to dissolved or damaged contact points. If you must use aluminum, one choice might be 2024. This requires a much thinner anodic coating than other alloys, and therefore less material is removed during stripping operations. Another consideration would be to use a coated aluminum spline with titanium contact tips.

Wood's Nickel Strike

Q: I own and operate a small plating job shop and recently quoted for cadmium-plating a very large quantity of stainless steel fittings. I have never plated on stainless steel, and one of my suppliers said I have to plate with "Wood's nickel" first. I cannot find any information on the process. Can you supply any details?

A: Don't feel bad. There is very little specific information on the Wood's nickel strike available in the standard electroplating texts. There is no mention of the strike in the indices of the three editions of *Modern Electroplating*, nor in the *Electroplating Engineering Handbook* (1971). [There is additional information in the 4th edition of the *Electroplating Engineering Handbook* (1984), page 233 - *JHL.*]

The nickel strike was developed by Donald Wood, who published the article, "A Simple Method of Plating Nickel on Stainless Steel," in *Metal Industry*, July, 1938. The simple bath consists of 240 g/L (132 oz/gal) of nickel chloride and 125 cc/L (16 fl. oz/gal) of 22° Be' hydrochloric acid. The solution is operated at room temperature and at 5.0 to 7.5 A/dm^2 (50 to 75 A/ft^2) for 1 min. The cathode efficiency is approximately 15%. The nickel concentration is not critical, but too low a concentration of hydrochloric acid will adversely affect the throwing power and adhesion on stainless steel.

Because of the great difference between anode and cathode efficiencies, the metal concentration will tend to increase while the hydrochloric acid concentration will decrease. Weekly determinations of acid and nickel content should suffice, but frequent analysis for acid may be required for a heavily used solution. It may be necessary to withdraw some solution to make room for acid additions or to keep the nickel concentration down. Partial substitution of insoluble carbon anodes may tend to minimize or slow the rise in nickel concentration.

The Wood's nickel strike also finds application when plating on assemblies composed of more than one basis metal. Many problems associated with activation and initial coverage of such assemblies can be eliminated with the strike.

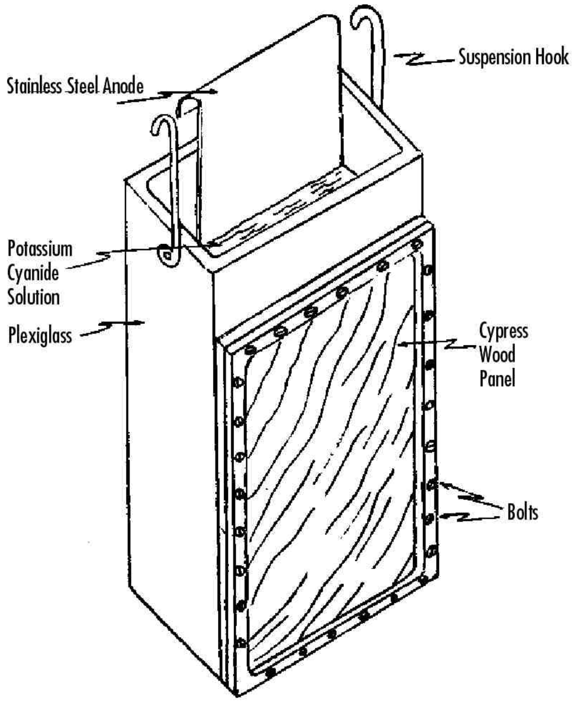
Silver Plating Cell

Q: Last week, $20,000 worth of silver anode balls was stolen from our barrel silver-plating facility. To remove the temptation and avoid future thefts, I would like to eliminate the use of silver anodes. Can you furnish any information on how I can accomplish this?

A: Silver, as well as many other metals, can be plated without the use of soluble anodes by substituting insoluble or inert anode materials. The type of inert material depends on the type of plating solution involved. For silver cyanide solutions, a 304 stainless steel sheet material serves well. However, simply pulling out the silver anode baskets and inserting stainless steel sheets is not the whole answer. The prolonged use of insoluble anodes in silver cyanide solutions will result in severe degradation of the solution. Cyanide oxidation will occur at the stainless steel anode with the formation of cyanates, carbonates, formates and other cyanide decomposition products. Additionally, if the current density is high enough, oxygen will be liberated with a resultant reduction of hydroxide in the solution. Eventually the reduced hydroxide concentration will allow the formation of dark-brown, insoluble cyanogen polymerization products at the anode, which will adversely affect throwing power and other deposit characteristics.

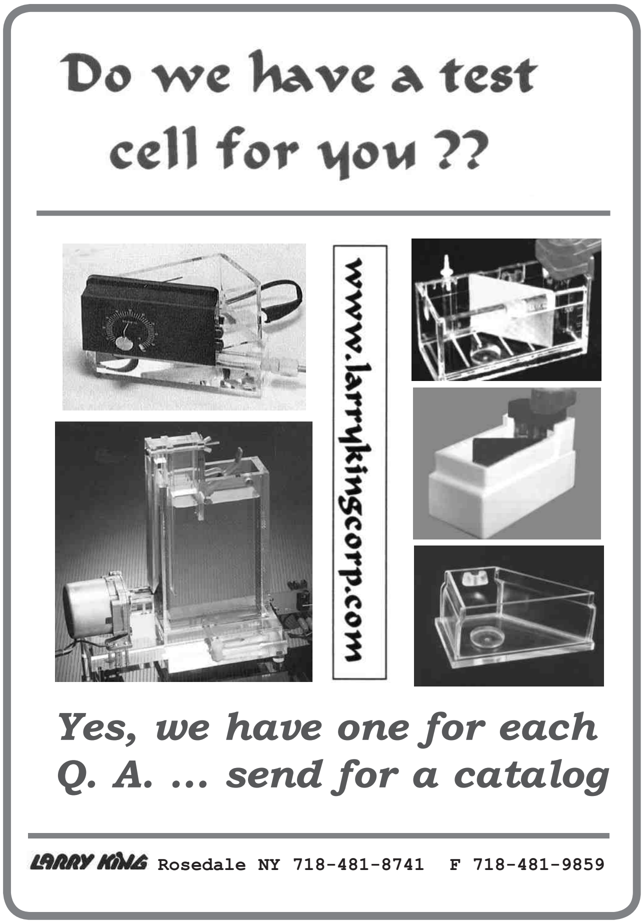
The secret to using insoluble stainless steel anodes in a cyanide solution is to place the stainless steel anode inside a cell with a conductive window or diaphragm. The conductive diaphragm performs the same function as a porous pot. It will permit the flow of current but not of metal ions. The cell can be made any convenient size to suit the application. Typical dimensions would be 61.0 × 17.8 × 7.6 cm (24 × 7 × 3 in). The conductive window or diaphragm is made from presoaked deresinized cypress wood, 30.5 × 15.2 × 0.3 cm (12 × 6 × 1/8 in). The cell material can be plexiglas, polypropylene, fiberglass or other non-contaminating material. Do not allow panels to dry because cracking or warping will occur. In use, the cell is filled with a solution of 120 g/L (16 oz/gal) of potassium cyanide and 15 g/L (2 oz/gal) of potassium hydroxide, and then hung on the anode bar. A stainless steel anode is inserted and also hung from the anode bar, as shown in the accompanying figure.

The cell solution must be monitored and replaced or replenished when necessary. The current passed through the cypress diaphragm is approximately 10 A/dm^2 (93 A/ft^2). For a 35.6 × 76.2 cm (14 × 30 in) plating barrel, at least four cells on each anode rod will be more than sufficient to pass 200 A during plating. Of course, it must be realized that this technique requires frequent additions of silver cyanide to maintain the silver concentration in the bath. Preferably, additions are made on the basis of ampere-hours used. Full details on the construction and use of these cells can be found in the October 1952 issue of *Plating* and the March 1957 issue of *Metal Finishing*.



Diaphragm cell for plating with insoluble silver anodes.

The edited preceding article is based on material compiled and contributed by John Laurilliard, CEF, as part of the Finishers Think Tank series, which began its long run in this journal 25 years ago. It dealt with everyday production plating problems, many of which are still encountered in the opening years of the 21st century. As we have often said, much has changed ... but not that much. The reader may benefit both from the information here and the historical perspective as well. For many, it is fascinating to see the analysis required to troubleshoot problems that might be second nature today. In some cases here, words were altered for context. **P&SF**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