STEEL FACING OF COPPER PLATES
(ACIÉRAGE DE PLANCHES DE CUIVRE)

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Abstract:

Copper plates used in artistic etchings have a limited number of printings, as they wear out by the friction of the inks and tarlatan when the plate is cleaned. Some inks are more abrasive than others. Dry points and aquatints are the most delicate copper plates. In spite of what is generally thought, the press does not damage the plate.

In 1857 Garnier invented the steel facing of copper plates using an electrolytic bath.

The aim of this paper is to discuss the different procedures for steel plating and recommend an effective but easy method for single users or small shops.

Before explaining the iron plating methods, I will show two other metal plating options.

Nickel plating

Nickel can be used to plate copper. The usual bright nickel baths are not suitable as they have levellers and fine details can be lost. As with iron, a high pH increases the hardness of the deposit. But the anodes are not dissolved, so it is not necessary to use nickel in the anodes.

Here is a bath that gives a very hard nickel deposition, bright but without levelling action:

Nickel sulphate $NiSO_4.7H_20$ 210 g/l
Nickel chloride $NiCl_2.6H_2O$ 60 g/l
Ammonium sulphate $(NH4)_2SO_2$ 50 g/l
Ammonia to get pH = 8,5
Temperature: 25 to 80ºC
Intensity: 2 to 10 A/dm^2

The disadvantage of this bath is that the nickel content decreases with use.

The removal of the nickel layer is quite difficult. It can be done in an electrolytic bath containing sulphuric acid, or with special chemical baths.

Chrome plating

Chrome is very hard.

To get a bright deposition, the temperature and the current have to be accurately set. The current has to be very high (i.e 17 A/dm2 at 50ºC), and the bath has to be well ventilated as there is production of gas that carries chromic acid which is very irritating.

As the contain of chrome decreases with use, it is necessary to analyse frequently the bath and add chromic acid if needed.

I do not think that it is suitable for a domestic o small shop use.

One advantage of chrome is that it can be removed with muriatic acid.

Iron plating

With the right electrolytic procedure, the iron deposition is very hard, this is why it is called “steel” plating. This is due to hydrogen absorption, the deposition becomes bright and has high internal tension.

The advantages of iron are that the procedure is cheap and simple, the current density is low and the iron layer can be removed very easily.

High pH (alkaline) baths

As with nickel, a high pH causes a hard and bright layer. But when pH is increased beyond 7, the iron sediments in form of iron hydroxide and it is not possible to increase the pH. A way to circumvent this is to use organic iron compounds.

The following bath is due to Rudolf Christian Böttger (1806-1881). I have tested it and gives a very hard and bright plating. No stirring of the bath is needed.

In 800 cm^3 of water:
- 80 g of Rochelle (Seignette) salt
- 40 g of potassium ferrocyanide

In 200 cm^3 of water:
- 12 g of iron sulfate

Mix both solutions.

Then solve the blue sediment adding caustic soda while stirring the solution. If it is concentrated at 50% you will need about 28 cm^3.

23 to 27ºC, 1 A/dm^2

The bath is, despite its age, the best of all the many I have tried. Unfortunately, being alkaline, does not attack the anode, so the iron content decreases rapidly with the use, and the bath has to be replaced frequently. It is not easy to add iron to the bath.

There are modern baths using a chelating agent as sodium gluconate (E576), working at high pH, but they have the same problem of the iron contains decreasing with use. However, it is easier to add iron to the bath than in the case of the Böttger bath. And it is easier to prepare. Either the bath has to be renewed completely from time to time, or an analysis or the iron contains has to be preformed often to know how many iron sulphate has to be added.

This is a composition of a bath of this type[1]:

Iron sulphate ($FeSO_4.7H_20$) 20 g/l
Sodium gluconate ($NaC_6H_{11}O_7$) 50 g/l

25ºC, 0,17 A/dm2. pH = 12, adjusted using a sodium hydroxide (NaOH) solution. Less than 1,4 V.
The efficiency of the bath is about 58%.
RECOMMENDED BATH

The following bath is simple and cheap, produces a bright and hard deposition and only needs a low intensity of current. This is a traditional bath at which it is advisable to add some brightener. Use preferably distilled water.

Ammonium chloride (NH_4Cl) 100 g/l
Iron sulphate ($FeSO_4.7H_20$) 40 g/l
Brightener option:
- Methanol 6 cm^3/l
or
- Sodium saccharin 3 g/l

The brightener is not indispensable, especially if the bath is stirred.

[1] "Electroplating of iron from alkaline gluconate baths". E. A. Abd El Megjuid et al.. Science Direct.

A bath using only ammonium chloride, without iron sulphate, works nearly as well.

Using a Hull cell, I found that the ideal current density at 23ºC is 0,5 A/dm^2.

Without stirring the bath if the current surpasses 0,7 A/dm2 the deposition becomes grey and softer. I do not recommend less than 0,2 A/dm^2.

Time: At least 30 minutes at 0,5 A/dm2 to get a reasonable iron thickness. This would allow about 40 prints of a dry point. Increase the time if you need more prints.

Temperature: about 23 to 27ºC. At a higher temperature the hardness decreases. At a low temperature the efficiency is low and deposition is irregular. If your container is not too big, you can use an aquarium heater, available at a very low price up to 100W.


Water heater

Stirring the bath: It is highly recommended to stir the bath during the electrolytic process. This can be done slowly by hand with a piece of plastic or wood. Stirring the bath, the deposit is more uniform, the current can be increased to 1 A/dm^2, and the time is halved.

This can be done automatically using small pumps or even injecting air bubbles, using aquarium equipment.

Power supply

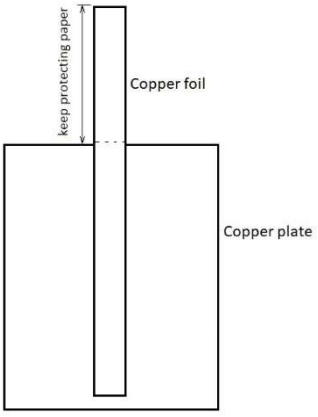
There is no need to a high voltage power supply. 0 to 5 V is enough. A variable current limit is necessary. The maximum current depends on the biggest copper plate you will steel face. For example, if the maximum size is 20 x 30 cm, the current you need is 2 x 3 dm^2 x 0,5 A/dm^2 = 3 A (or 6 A if you want to reach 1A/ dm^2).

Power supplies are available in any electronic shop. See an example in the figure on the right.

Attaching the electrode

The plate needs an electrode to which connect the current. The classic way to do this is to sold a copper or brass strip to the back of the plate. But, if the plate does not weight too much, there is a simpler way using copper tape with conductive adhesive.

This is available in electronic shops, as Farnell, Mouser, etc. under the name “copper foil shielding tape” or “cooper foil with conductive adhesive”. The recommended width is 25 mm. In case of big plates two bands can be used. The foil has a protecting paper in the adhesive side that has to be removed, but only the part that is attached to back of the copper plate.



Before pasting the copper foil to the back of the etching, ensure that this is very clean. Then press well the adhesive tape against the plate.

How to clean the plate.

Remove any trace of ink using a strong solvent, as trichloroethylene.

If there are some ink that refuses to leave, use a paint stripper gel. It has to be left on the plate for some time and then remove it and use the solvent again.

When the plate looks perfectly clean, it still needs a final cleaning.

Use rubber or plastic gloves. You need to be near a water source.

Take a very clean rag or kitchen paper and rub with it the etched face of the copper plate with a mixture of ammonia and fine powder of calcium carbonate (whiting or “Spanish white”).

Clean the plate with a water jet. The remaining water should form an even layer on the plate. If it forms drops or there are dry spaces, the plate is not clean enough, repeat the cleaning process.

Then put the plate for some seconds in a solution of muriatic acid that will remove the remaining calcium carbonate and any oxidation of the copper.

Clean de plate with a jet of water.

Now the plate should look with a clear and uniform copper colour and the water should form an even film over it. Otherwise repeat the cleaning.

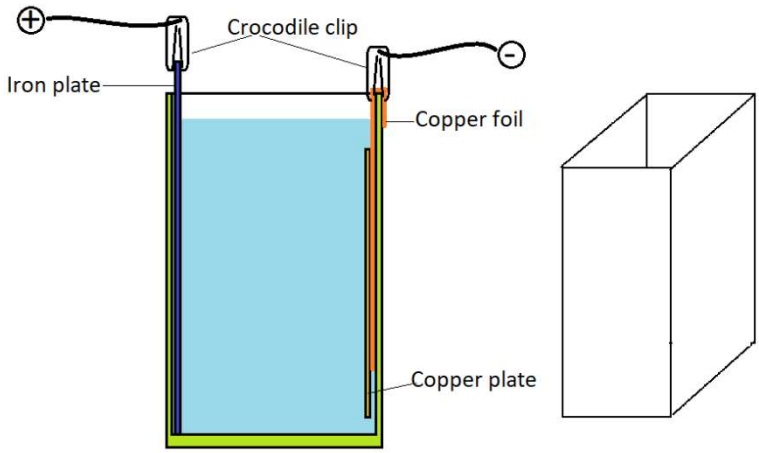
Plating

Use a plastic or crystal container. The ideal shape is the one shown to the right of the figure below. A fish tank can be a good choice. A width from 10 to 20 cm will be adequate.

The iron plate has to surpass the height of the container as shown in the figure. Use iron as pure as possible. It has to be very clean, use emery paper.

Put the copper plate vertically in the bath hanging from the copper tape (or tapes). Fold the tape over the edge of the container and fix and connect it using a "crocodile clip" (or "alligator clip", available in electronic shops). See figure.

The iron anode has to be connected to the positive of the power supply. Use a "crocodile clip".



Set the output voltage of the power supply to a voltage a little higher than 2 V (i. e. 3 V) and the current to 0. If the distance between the iron and copper plates is to long, the voltage should be increased to reach the rated current. A distance of about 10 cm is ideal.

Increase the output current of the power supply until it reaches the rated current.

Stir gently the bath, as explained above.

When the time has elapsed, switch off the power supply, disconnect the plate, rinse it with a lot of water. Dry well the plate with cloths. And ideally, finish the drying process with a hair dryer. Remove the copper tape. To avoid the iron rusting apply oil or a varnish.

Removing the iron from the copper plate

To store a plate for a long time, it is advisable to remove the iron as, if it rusts, some attack to the copper could happen. When during the printing process the copper begins to appear, the iron layer has to be removed and the plating process, repeated.

The plate has to be cleaned as well as when it was plated. Then submerge the plate in muriatic (hydrochloric) acid. While in the bath, use a brush to remove any sediment on the plate.