

# REPRODUCTION OF MACHINE-STAMPED PIERCED BRASS DECORATION BY PHOTOETCHING PROCESSES

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By the early 19th Century, the use of stamped-brass and wood inlays inset into furniture surfaces was common. These original strips were made with steel dies under great pressure in rolling mills. The resulting designs were often quite complex and were extremely uniform in shape. The only evidence of workmanship of risk is a variation in the widths of the strips. This occurred originally since these strips were fitted into grooves in the wood that were cut by hand and it was necessary for the cabinetmaker to file the brass border edges of the strips to fit the somewhat irregular grooves.

Options for replacing missing portions of strips during conservation treatment include: hand cutting; having a die (or dies) custom-made and strips stamped; the use of toned gold leaf applied on a photo-transferred size (although this author is not aware of this technique having been used); and photoetching. Hand cutting of the brass and wood may be useful for very small losses. However, larger areas will immediately appear different from the original due to imprecision of hand cutting and to difficulty in reproducing the very sharp and fine points that were created in the original stamping process. It is possible to have the necessary die profiles made and the brass and wood stamped by a diemaker. However, the expense involved can be quite high, if a diemaker who is capable and willing to undertake the project can be found (Note 1).

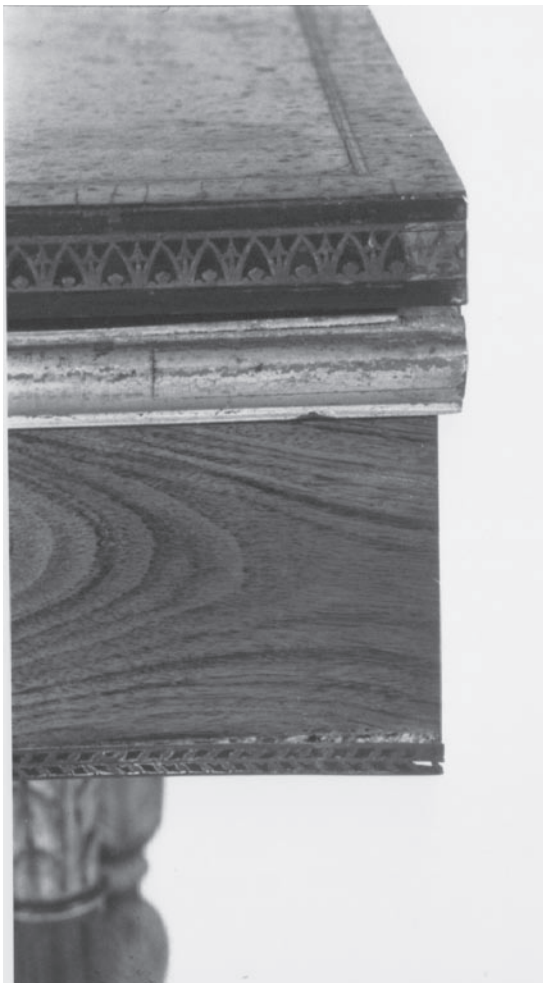
Application of photoetching processes used for the production of circuit boards has been used during conservation treatments with X-radiographically generated images of Boulle marquetry work (Note 2). Such images are very sharp, high contrast and of exact dimensions. This author wanted to explore the potential of adapting this process for the production of machine-stamped inlays using low-tech photographic techniques that would be possible in a small conservation laboratory.

The general photoetching process involves the production of a 1 to 1 high contrast photographic image of a strip of the necessary inlay. Both positive and negative resists are available, so either a positive or negative photograph can be taken. A sheet of brass is coated with resist and exposed through the negative to TN light. The resulting resist image is developed and placed in an etchant bath. The areas of brass not protected by the resist are dissolved, leaving behind the appropriate profile if the conservator's thought process has been correct to account for the various positive/negative considerations (Note 3).

In order to test the feasibility of this process, two different brass inlay profiles missing from a pair of card tables made by Charles Lannuier, c. 1810 were reproduced (Figure 1). They consisted of brass with inset dark rosewood (Figure 2). A strip of each molding was polished to provide maximum contrast. A section of each approximately 8" long was photographed with high contrast negative film in a 35 mm camera. After processing, these images were placed in an enlarger, a strip of 35 mm high contrast negative film unrolled and held in the paper easel and a 1 to 1 enlarged image made. This was now a positive film image (negative of a negative) exactly the size as the inlay.



**Figure 1. One of a pair of card tables, made by Charles Lannuier, NYC, C. 1810. Owned by the Valentine Museum, Richmond, VA. After treatment.**



**Figure 2. Detail of rear side corner showing large inlay at top and small at bottom. Before treatment.**

A negative resist (Kodak KPR) was chosen for use with the positive image. Negative resists are cross-linked and rendered insoluble upon exposure to UV light. Thus, light areas of the photographic image (the original brass parts) are set and the dark areas (the original wooden areas) are unexposed and wash away during development (KPR developer). When etched (ferric chloride), unprotected areas (original wood) are dissolved, leaving behind the protected brass in the form of the original inlay. The negative resist was applied to .005" brass shim stock.

The resist-coated brass was exposed to UV light, the image developed and etched. The strips of etched brass were separated, rinsed and the cross-linked resist on the surface removed with 0000 steel wool. The strips were glued with Acryloid B-48N in toluene to dark rosewood veneer. Because the brass was so thin, the slight recessing of the veneer was not visible. The individual composite inlays were thickened on the wood side with sandpaper, cut to width with a hand plane (held upside down in a vise with the inlays moved over it) and matched at their juncture with original inlay and other new strips with a file. They were glued in place with hide glue. Appendix 1 gives much greater generic detail on the processes involved in photoetching.

The results of this test were very encouraging. Replaced sections can be detected upon very close examination, yet are completely harmonious at normal viewing distances (Figures 3 a&b, 4 a&b). Potential problems, none of which invalidate the overall effectiveness of the process, nor this treatment, include the following. 1) The brass at the mating ends of the strips had a tendency to slightly curl up and out of plane, making the juncture more obvious. 2) The etched brass image was slightly fuzzier than the original, potentially the result of several factors. First, the 35 mm image had to be enlarged to produce a 1 to 1 image of adequate length. Larger format cameras, if available, would reduce this. Second, if contact between the brass sheet and the film during UV exposure is not perfect, "shadows" will be cast, fuzzing the edges of the resist. Third, etching processes are by nature less precise than stamping processes, although if all other factors are done perfectly, magnification may be necessary to detect this.

The time spent to create approximately 30 inches of the narrow strip and 6 inches of the wider strip was about 20 hours. However, much of this was necessary because it was the first time this author had attempted the process. Experience would allow more expeditious production of inlay.

In summary, photoetching of replacement brass and wood machine-stamped inlay is possible and effective with little more than a darkroom and the appropriate materials. The technique allows a wide latitude of choices and can be customized to meet specific needs.



**Figure 3 a. Replaced small inlay (bottom of frieze) from normal viewing distance. After treatment.**



**Figure 3 b. Detail of small inlay. After treatment.**



**Figure 4 a. Large inlay (rear five inches replaced). After treatment.**



**Figure 4 b. Detail of large inlay (rear half replaced). Apparently a juncture of two strips existed here in the original construction, as the channel for the replacement is noticeably smaller. After treatment.**

## Appendix 1

### PHOTOETCHING OF REPLACEMENT BRASS INLAY

- 1) Polish original brass inlay (0000 steel wool works fine). Dust surface, apply coating to saturate surface, e.g. shellac. There must be sufficient light-dark contrast to produce a usable negative.
  - 2) If there are losses of wooden inlay components, these must be inpainted a similar dark color.
  - 3) Photograph the original on high-contrast B&W film. Even bright light on the brass is critical and somewhat difficult to achieve. Experiment with different angles and placements of lights. Most likely, several lights will be necessary. The original can be photographed on the object or if a piece is detached, can be photographed separately. In this instance, it is safest to back the inlay strip to prevent loss of wooden parts.
  - 4) Place the developed negative in an enlarger. Enlarge the image to the exact size of the original. Expose a piece of high-contrast film as you would photographic paper. For strip inlays, 35 mm film can be unwound from its canister and re-rolled after exposure. A safelight can not be used with film unless specified on the manufacturer's literature. The choice of film will depend upon the desired final image. For negative resists, a positive final image will be necessary, while a negative final image will be necessary for positive resists. Process the film.
  - 5) Spot touch-up pin holes and any other defects in the dark areas of the full-size photographic image (positive or negative). A rapidograph pen on the emulsion side of the film works well.
  - 6) The photographic image will be transferred to the brass plate by exposure of the photoresist emulsion with UV light. An 8x10 contact printing box outfitted with a UV light works well. A similar shop-made box and glass top will work. Unless absolute contact between the film and the brass plate can be guaranteed, best results will be achieved with only one light source. Multiple sources can cause a fuzzing of the image. Mask the sides of the film strip so the final image will be only slightly larger than the necessary finished strip width. Attach the film to the glass directly over the UV light with the emulsion up. Mask off the rest of the light box top so no UV light will pass through (more on this later).
  - 7) Choose the appropriate piece of brass. .005" works well (shim stock). Thicker brass will require much longer etching times, more etchant and may result in significant undercutting (the etchant eats horizontally as well as vertically).
- Optional: Mount the brass to a piece of plexiglass with wax or wax-resin. This holds the brass flat and allows handling without risking fingerprints or damage to the emulsion. It also protects the back of the brass from etching. However, it may not allow a close contact with the film during exposure.
- 8) Polish the brass surface to receive the emulsion (0000 steel wool). Degrease the surface, e.g. acetone.

The emulsion adheres best on a slightly acid surface. Swab it with dilute HCl (10%) and rinse well with water. Dry thoroughly.

9) Pour a little liquid emulsion (KPR-negative or positive) on the brass. Tip and tilt the brass until the surface is covered completely. A pipette shaft can be used to help even the emulsion. Stand the brass in a near vertical position and let the emulsion dry. This must be done in the dark or with yellow or orange photographic safelights.

10) The emulsion needs to be soft-baked to remove excess solvent. If a low temperature oven can be brought into the darkroom, bake the copper at 80 C for 10 or 15 minutes and let it cool. It is ready for exposure. If an oven is not feasible (remember, the brass can not be taken into visible light), a hot air gun directed over the plate for 10 minutes seems effective. Do not let it get too hot, especially if wax was used to hold it to plexi.

11) Use one brass plate for test exposures. Start with a 1 minute exposure, doubling each succeeding one. The plate can be moved over only one strip width after each exposure if the top of the box and the negative have been masked (otherwise, the whole plate would be exposed, not just a narrow strip). Thus, only one plate will be necessary for testing. For the contact box tested with one small fluorescent UV bulb at about 8 inches from the film, 10 minute exposures seemed to be sufficient.

12) Develop the plate in the proper developer (consult the manufacturer's literature). With KPR, the areas hit by TN light are cross-linked and rendered insoluble. Areas that are beneath the dark areas of the film or are not exposed wash away. 2 minutes in the developer is sufficient. The manufacturer suggests two developer baths of 1 minute each. If dissolved emulsion is redeposited on the brass, etching will not be even.

13) Dry the plate. Do not rinse. Note: the resultant resist "image", is very thin and is transparent, making it difficult to see on the brass. Do not despair (as did the author), as the plate will work just fine. Obviously, if you did something wrong and no image appears, you must start over.

14) Large areas of unimportant brass and the back of the plate (if not mounted on plexi) will have to be coated with liquid resist and allowed to dry. Light soft-baking can follow. This reduces the surface area of brass that has to be etched and helps prevent premature exhaustion of the etchant.

15) For brass and other copper alloys, ferric chloride is the appropriate etchant. Place the brass with developed resist in the etchant and agitate. A magnetic stirrer can be used. For the etching I did with .005 brass, initial penetration occurred in less than an hour, but final etching was not complete for about 2 hours. As the etchant dissolves the brass, it becomes less effective. Also, clearing of used etchant from the recesses is slower than from the surface. For large areas of brass, the etchant may have to be changed as it becomes exhausted.

16) When etching is complete, rinse the brass well under running water.

Optional: For brass mounted on plexi, rinse in appropriate solvent to remove the wax.

Optional: Brass can be soaked in a solution of 3% benzotriazol to help assure that chlorides left by the etchant are removed. BTA can also be put in the coating over the completed brass after installation on the object.

17) Since the brass is so thin, it can be adhered directly to the species of veneer that was used for the original. The wood can be thickened to the same as the original and inset after attaching the brass. Coatings can be applied to fill the very slight voids, although the thinness of the brass makes these almost impossible to see. One possible adhesive is concentrated Acryloid B-48N in an appropriate solvent. This material is formulated for adhesion to metals and can be used also as a final coating to protect the brass.

18) Supplier:

KTI Chemicals Incorporated  
2 Barnes Industrial Road  
Wallingford, CT 06492  
203-265-9242

1) Bigelow, Deborah and Fuller Tamsen. "The Conservation of a Nineteenth-Century Sideboard Table;" Preprints of Papers Presented at the Fifteenth Annual Meeting, Vancouver BC. Washington, DC: American Institute for Conservation, pp. 1-21. This article contains a discussion of reproducing brass/wood inlay by stamping with custom-made die.

2) Strang, Thomas. "Restoration of a Boulle Desk Using Photofabrication Techniques;" Art Conservation Training Programs Conference, Fogg Art Museum, 1984. pp. 27-38.

3) Photofabrication Methods with Kodak Photoresists. Rochester, NY: Eastman Kodak Company, 1979. This booklet discusses both positive and negative resists and provides all the technical information necessary for reproduction of inlays, although, as is to be expected, it is aimed at industry, not the conservation field.