COPPER PLATING OF SMALL AREAS IN LARGE CAVITIES

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Summary

After completion of the two additional Alvarez cavities for the Unilac heavy-ion accelerator, experience on the electrolytic copper plating of the circumferential welding seams is reported. The same procedure could be used, if a small area of a previously copper-plated cavity surface turns out to be imperfect or an additional flange hole has to be machined into the wall at a later demand.

Introduction

In an earlier publication[1] it was outlined in detail how the new Alvarez cavities for the Unilac extension differ from the original design concept. In fact, the 10 cavity sections were fabricated mostly to closer tolerances in diameter than the required $^{+1}_{-0}$ mm and if not so, the diameter was corrected for by shrinkage when applying intensionally heavy welding seams in joining the cavity sections.

It was found to be important to process in advance sample plates of the identical steel quality, which then was used for rolling the cavity sections. In applying the earlier used processing steps, the plating did not stick properly. It was discovered that the selected, less expensive steel quality contained cromium impurities in the order of .3%, which prevented the adhesion of the usual nickel strike. After the initial electrolytic cleaning an additional processing step was introduced, by means of an etching in a 20% H_2SO_4 solution at 20 A/dm^2 and after the Watt's nickel bath was complemented by 250 g/l of $NiCl_2$, an excellent adhesion was obtained: even after a heat treatment by a welding torch, the copper deposit could not be removed, unless a tensile strength of 30 to 35 kp/mm^2 was applied, which is in the usual value for solid copper.

The Seam Plating

After the completed Alvarez tank arrived from the manufacturer, who joined the plated and paint protected cavity sections, the few circumferential welding seams had to be plated. It was done in six sequential steps, covering section-wise the circumference. The cavity was turned, such that the bath container (Fig. 1) could be pressed by an adjustable stem to the cavity wall in a vertical position (Fig. 2), tilted slightly upwards, as to be seen in Fig. 3. The container was manufactured from plastic plates and was sealed to the cylinder wall by an elastomer string 15 mm in diameter. The protecting paint was cleared off the sealing and plating area. No leakage did occur from the plating container, which had a weight of 200 kg when filled up. From the open top, different anode plates could be brought inside and the supply hose for the fluid as well. At the bottom the drain hose was connected via a valve and compressed air was blown from the bottom into the bath, developing air bubbles flushing up the cavity wall. For each electrolyte a separate pumping unit was used, supplying the fluid from a reservoir via a hose until the bath container was sufficiently filled. The final copper bath had to be drained out and filled in again every 20 min in order to maintain the concentration of the organic additives correctly and to avoid a temperature rise of the fluid in excess of 35°C. Two bath containers were

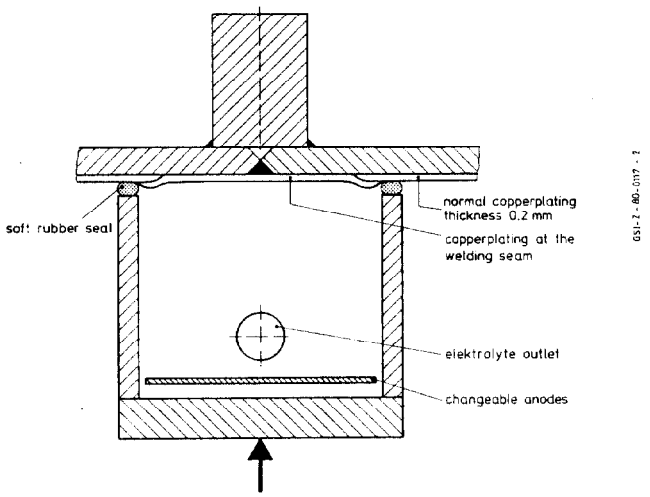

Fig. 1. Cross section of the bath container.

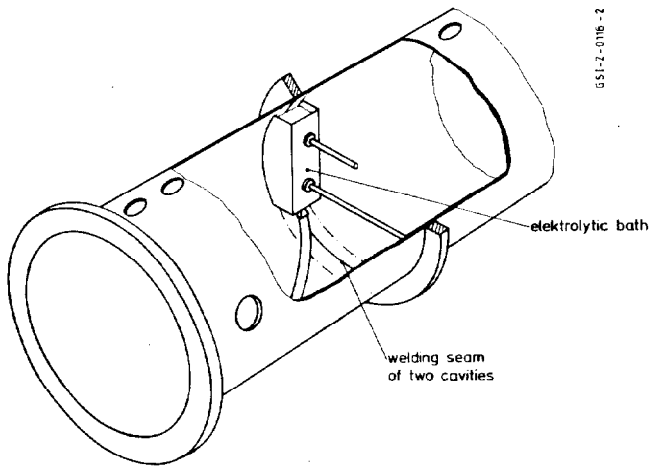

Fig. 2 . Bath container attached to the cavity wall by a threaded stem.

in use simultaneously to allow for interlacing sequential processing steps. The whole activity was covered by two persons, plating 48 sectional areas in 12 shifts. The transition seam between the previously plated copper layer and the here described overplated area occasionally had to be straightened and polished on the top and bottom line.

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Fig. 3 . View of the container in proper orientation.

Following is a listing of the detailed processing steps:

1. The surface is cleaned by solvents to remove dirt, oil and grease.
2. Electrolytic cleaning in a basic cleaning solvent (Derovit N *), at 12 A/dm^2 for 10 min, the surface to be treated being the cathode, the anode was a stainless steel plate.
3. Rinse.
4. Activation/etching bath, 20% H_2SO_4 for 15 min, no current.
5. Rinse.
6. Nickel strike 250 g/l $NiCl_2$, 100 g/l HCl, 5 A/dm^2 for 30 min.
7. Rinse.
8. Activation/etching bath (cf. 4.) without current for 2 min.
9. Rinse.
10. Acid copper bath, 260 g/l $CuSO_4$, 80 g/l H_2SO_4, 60 mg/l Cl, organic additives following the recipe of Cupatierbad 80L *, 5 A/dm^2 for 4 h, resulting in 0.2 mm copper deposit.
11. Rinse.
12. Activation/etching bath (cf. 4.) for 20 s.
13. Rinse.
14. Flush inner and outer surface with methanol.
15. Wipe plated surface with methanol and chalk powder in order to prevent tarnishing.

* Trade names of Riedel Company, Bielefeld, W. Germany

[1] D. Böhne, H. Gaiser, E. Malwitz, Cavity and Drifttube Technology for the Upgraded Unilac, Proceedings of the 1979 Linear Accelerator Conference, BNL Report 51134.