The Stub to Plate Weld in Quarter Wave Resonators - An Investigation.

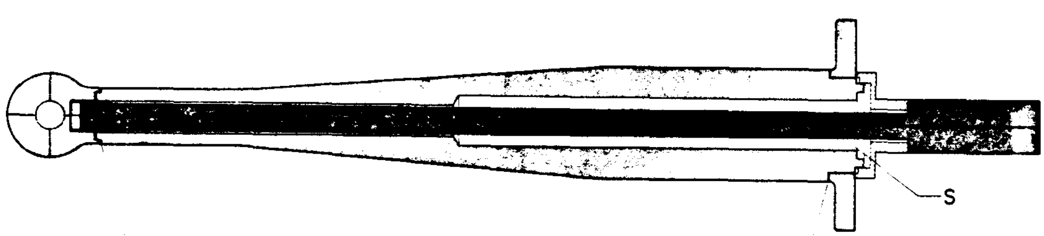
M. Malev, J.S. Sokolowski*, D.C. Weisser
Australian National University, Canberra, Australia.

* On leave from the Weizmann Institute of Science, Rehovot, Israel.

Abstract

Cracks in the internal weld between the stub and end plate of quarter wave resonators have been reported by the Weizmann Institute and Washington University. This join in the resonators being built at ANU was redesigned and the electron beam welding jigging altered. Extensive testing of the resulting weld has been carried out. This testing includes, in various orders 1) the "normal" cleaning, 2) "Dye Checking" TM, after vigorous etching, 3) lead plating and polishing sequence and 4) temperature cycling between room temperature and 77°K. These tests are in progress at this writing.

Cracks in the internal weld between the stub and end plate of quarter wave resonators have been reported by the Weizmann Institute and Washington University. Even before these problems became known, we decided to increase the width of the step joining these pieces from 1 mm to 5 mm. More importantly, it was decided to use a draw bar to squeeze the stub between the end plate and donut, as shown in the figure. This bar is mounted in the chuck of the electron



beam welder and allows the internal plate to stub weld to be done before any external welding. This assures a strong joint. The weld chosen penetrates 1.7 mm as opposed to the 1 mm possible in the previous design. A similar weld joins the stub to donut and this too is accomplished with the draw bar keeping the joint under compression. Evidence of this compression is that the finished weld is convex. This greatly simplifies polishing.

After these internal welds 1 and 2 were done, the assembly was placed vertically into the resonator can. A mandril positioning and locking the donut was inserted. Tack welds then secure the stub to plate from the outside and a cosmetic weld seals the gap against contamination during polishing.

At this stage, the electron beam welder broke down and we had the time to further check the plate to stub weld for cracks. It should be noted that this weld had not yet been subjected to stress that would occur during the final deep external welding. Nevertheless, this weld was Dye Checked, TM, showing no flaws. It was then cleaned, lead plated and chemically polished. No flaws were seen. Afterward, it was severely etched and then Dye Checked again. No flaws. Finally, the joint was brought to liquid nitrogen temperature then heated to 80°C and re-Dye Checked. No flaws.

Subsequently, the whole assembly was polished in preparation for final welding. When packing the stub assembly for shipment, it was convenient to use temporarily, an obsolete aluminum draw bar to ease handling. Upon unscrewing this, the draw bar shaft seized into the copper at point S. Removal of the draw bar required four men each on a 60 cm lever arm unscrewing the thread. Indeed this was only just possible when the draw bar was cooled with liquid nitrogen. After running out of threads, the draw bar was finally removed using a wheel puller pressing down on the end plate.

These exertions resulted in an unplanned weld test. The plate to stub weld was fine but the donut to stub weld had stretch marks. We therefore hope that this extreme test validates the plate to stub welding procedure.

It may be of some interest to describe the repair of the stub to donut weld. The proper copper draw bar was inserted to restress the weld. The weld was done at 15 ma instead of the original 12 ma to assure a complete remelt of the failed volume. This was followed by our standard cosmetic weld which is accomplished by starting with the beam focussed well above the surface just welded. The focus is slowly brought down toward the surface and held just as melting occurs. One pass is usually sufficient to produce an excellent surface finish. In this case, that was not true, and so the operator continued the weld for a second pass. This weld is the best looking one we've seen. The fact that the normal first pass didn't sufficiently smooth the surface might suggest residual fissures even after the primary weld. These observations might well imply that less vigorous treatment of stretched welds, by swaging for example, might not be adequate.