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Attention: Mr. A. L. Essex
Contracting Officer

Subject: Monthly Progress Report No. 6
Contract NAS 5-9006



Gentlemen:

This report covers the period from April 10 to May 10, 1965. Microscopic examination of the lapped, ground, and replated precision flat packs and retesting for helium leakage located points of maximum leakage at the corners. Welding studies established machine settings required for welding gold-plated Kovar covers to the precision flat packs. Preferential bonding occurred at the corners because of the flat-pack geometry. The addition of a ductile interleaf and increased welding time resulted in good bonding over the entire periphery. Metallographic evaluation of a sample without an interleaf revealed unequal thicknesses of plating on the covers and the frames of the flat packs. Assembly of the 28-kilocycle ultrasonic ring welder for higher-frequency welding studies is almost complete, and the terminal coupler has been fabricated.

## Problem of Waviness and Nonparallelism

Effort was made to determine why 11 of the 21 replated precision flat packs leaked (see Monthly Progress Report No. 5, dated April 10, 1965, first paragraph on page 2). These 21 flat packs had been ground on the back surface after being lapped on the land (picture frame) surface in an effort to provide flat and parallel surfaces for ultrasonic ring-welding. After they were replated with gold by Zell Products Incorporated, Zell found that 8 packages were hermetic and 11 leaked (2 were rejected because of unsatisfactory gold plating).*

Since the flat packs had been hermetic before being lapped and ground, grinding stresses may have caused the leaking. The 11 packages that leaked were examined microscopically and retested for helium leakage to determine where leaking occurred and whether it was in fact due to the grinding operation.

* Letter from Mr. D. Anchutz, Zell Products Incorporated, Norwalk, Connecticut; April 6, 1965.

This microscopic examination showed that the outer surface of the glass substrate was porous in all specimens examined, including leak-tight packages; hence no conclusions could be drawn. Small cracks in the glass seal were observed at the corners of 2 of the packages that leaked.

Leak-testing was accomplished with a VEECO Model MS-9AB mass spectrometer. After a vacuum had been drawn on the packages, helium was directed through a hypodermic needle over the exposed surfaces and the sites of maximum leak signal were observed. In all cases maximum leaking occurred at the corners, either through the glass seal or at the boundary between the glass and the Kovar metal.

Further investigation is required to determine whether leakage was caused by the grinding operation. Future samples will be tested for hermeticity both before and immediately after grinding.

## Ring-Welding Covers to 3/8-Inch Square Flat Packs

Gold-plated Kovar covers were ring-welded to the precision flat packs that leaked to determine suitable welding machine settings for bonding. Machine settings were varied from 1900 to 2500 watts electrical input power to the transducers, 275 to 300 pounds clamping force, and 0.35 to 0.6 second welding time. Bonding occurred between the gold platings preferentially at the corners of the packages; bonding over the entire land surface did not occur.

Subsequently, welding the precision flat packs (both hermetic and leaking) was investigated utilizing each of these interleafs: a 0.0005-inch thick gold interleaf, a 0.00015-inch thick gold interleaf, and a 0.0003-inch thick 1100-H14 aluminum alloy interleaf. The best bonding was achieved with the 0.0005-inch gold interleaf. Bonding was still somewhat better at the corners.

Measurements of thickness variations, both on the lapped and ground flat packs and on the covers, showed a just-detectable variation (less than $\pm$ 0.0001 inch). It seemed probable, therefore, that preferential bonding was not caused by thickness variations, but rather by the geometry of the flat packs. Ultrasonic power delivered to the corners of a square is greater than that delivered to the midpoints of the sides (see Appendix A to Monthly Progress Report No. 4, dated March 12, 1965). This minor difficulty had been anticipated.

The practical solution lies in a slight increase in the thickness of the ductile plating and adjustment of the welding machine settings so that the long radius areas of the weld are exposed to modestly excess power. The thickness of the ductile layer was increased by insertion of a 0.0005-inch gold interleaf. (The addition of an interleaf may have been critical because of the thinness of the gold plating on the frame; see next section, on metallographic examination.) Exposing the diagonal radius areas to excess power was investigated briefly by progressively increasing the welding time.

Good welds were achieved at a welding time of 1.5 seconds (2000 watts and 275 pounds clamping force). Attempts to peel the covers from the packs resulted in fracture through the glass substrate.

The three remaining leak-tight flat packs were welded at machine settings of 2000 watts, 275 pounds, and 1.5 seconds with a 0.0005-inch gold interleaf. Clearly the 1.5-seconds weld interval is excessive. However, one of the three specimens proved to be hermetically sealed within the limits of the VEECO Model MS-9AB mass spectrometer ($2.5 \times 10^{-5}$ cc helium per second). One leaked slightly and one leaked considerably.

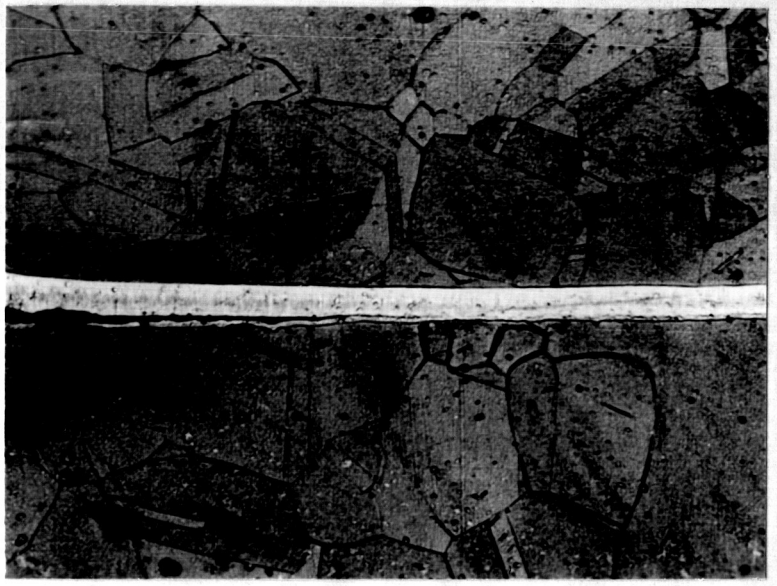
## Metallographic Examination of Flat Pack Closures

A sample from the group of flat packs welded without an interleaf to determine welding machine settings was selected for examination of the microstructure of the cover bond. The sample was bonded reasonably well on only one corner. This area was sectioned for metallographic evaluation.

In the bonded area, complete bonding was found between the gold-plated surfaces of the window frame and cover. No voids were observed.

The photomicrographs in Figure 1 show a section of the bond. The locale of the bond is the shadowy line close to the frame. In the top photomicrograph it can be observed from the area adjacent to the bond zone that the gold plating on the cover is much thicker than on the re-plated picture frame. Measurement of the observed difference in plating thicknesses in this section showed that the plating on the cover is 0.0006-inch thick and the plating on the frame is 0.0001-inch thick. The average plating thicknesses on both parts was reported to be approximately 200 microinches (0.0002 inch) in a private communication from Zell. The difference measured in this section is presumed to be consistent over the entire surfaces of the cover and picture frame, in this sample and in other samples. The thin layer on the picture frame, being restrained by the more rigid Kovar substrate, cannot yield and plastically deform to the same extent as the thicker coating on the cover, which can display more bulk behavior.

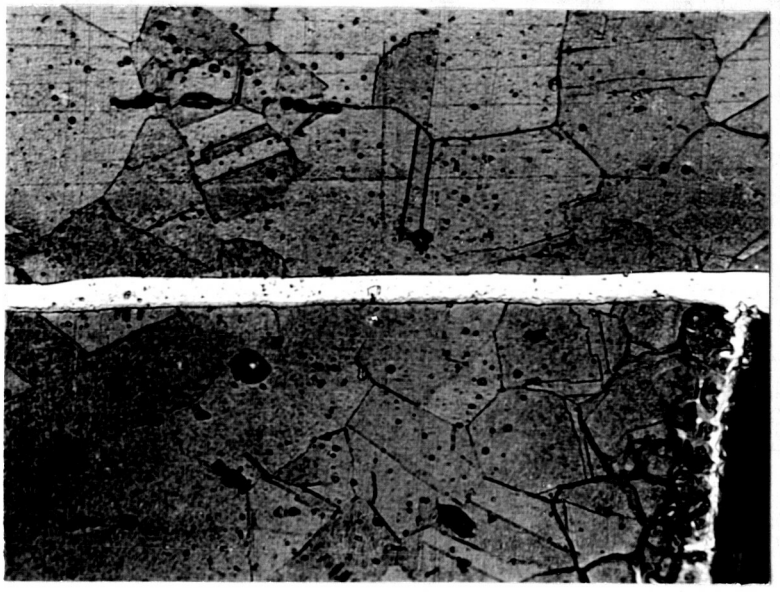
Closures made with a 0.0005-inch gold foil interleaf between the picture frame and cover were not completed in time for metallographic examination during this report period. These samples are being prepared for microscopic examination.



Cover

Edge of bond area showing difference in plate thickness

Frame



Cover

Bonded gold-plated surfaces

Frame

Figure 1

PHOTOMICROGRAPHS OF BOND AREA IN TYPE "A" FLAT PACKS

Etchant: 2% Nital, and Cyanide/Persulfate
Magnification: 500X

## Higher Frequency Welding

A 28-kilocycle ring welder is nearly ready for use in these studies. Modifications to a basic torsional reed system are complete, and a matching terminal coupler has been fabricated. Support hardware to permit mounting this array on a standard spot-welding machine frame are in final stages of fabrication. As soon as these parts are complete, the welding system will be assembled on the machine frame and higher frequency welding initiated.

## Future Work

During the next report period, the following work will be performed:

1. The samples welded during this period that incorporated a 0.0005-inch thick gold interleaf will be evaluated metallographically.

2. Another group of Westinghouse Type A flat packs will be ground on the back surface. This group will not be lapped since it is anticipated that a 0.0005-inch gold interleaf will conform to the land surface irregularities during welding.

3. Zell will be contacted for information concerning the modifications to their tooling to improve parallelism of the flat packs.

4. Components of the 28-kilocycle system will be mounted on an existing welding machine frame and higher frequency welding studies initiated.

Yours very truly,

P. G. Luckhardt

P. G. Luckhardt
Contract Liaison

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