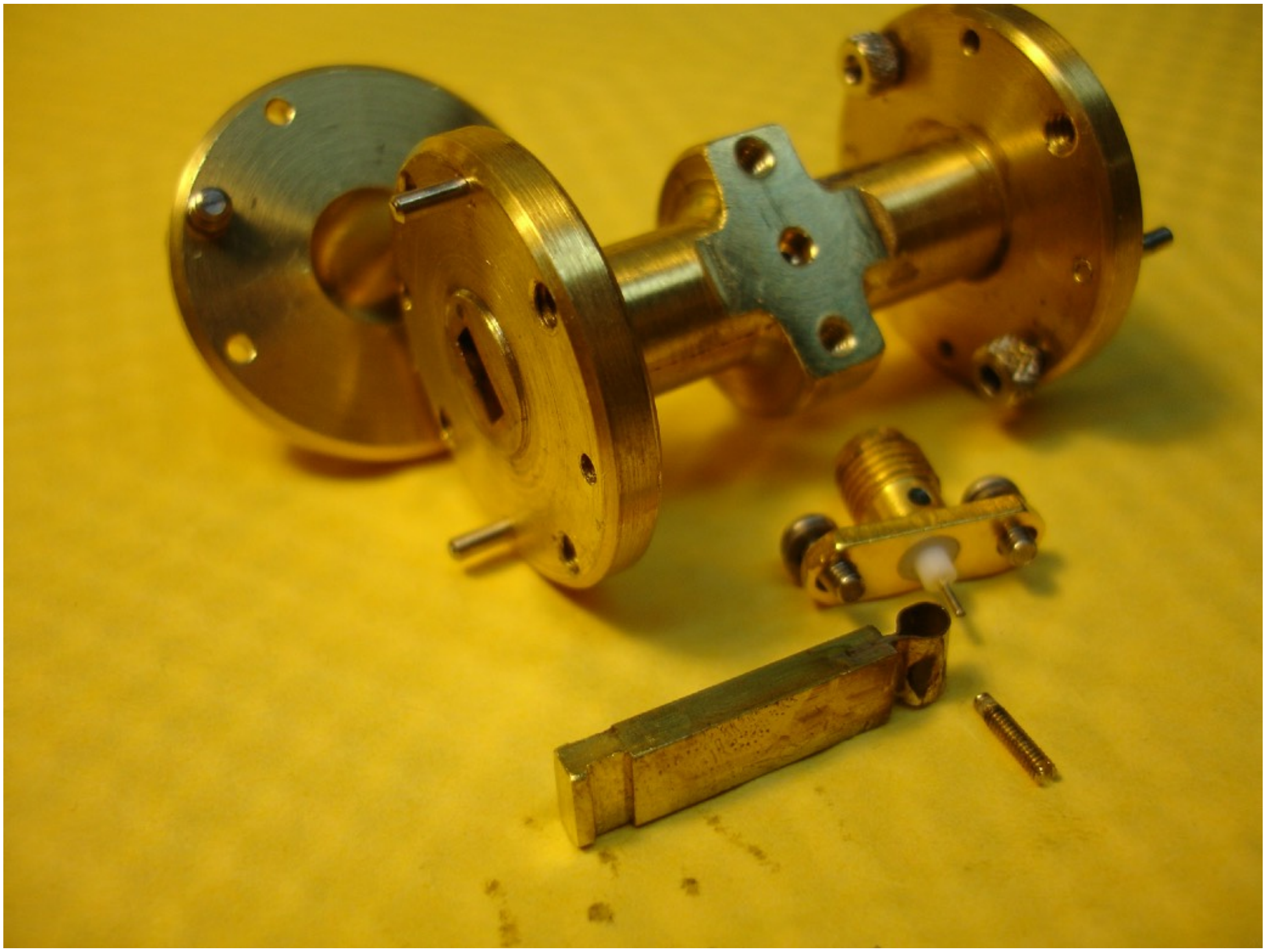
Fabrication of External Mixers for EIP Counters

After acquiring a Phase-Matrix 598A counter with range extension to 170 GHz, I decided to fabricate a set of external mixers to cover the counter's range. As I received a factory 26.5 GHz to 40 GHz mixer with the counter, only mixers for the 33–50 GHz, 50–75 GHz, 75–110 GHz, and 110–170 GHz bands were needed.

<u>Summary of Construction</u>

For simplicity, I chose to use Russian 3A123A "80 GHz" diodes that have been available on eBay. These are housed in ceramic cylinders about 1/16-inch diameter by 1/16-inch high with gold ends or more exactly about 1.3 mm diameter by 1.2 mm high.

I soldered these diodes to the ends of brass 0-80 setscrews by first applying rosin flux and a small amount of soft solder to the end of the screw. Next, I drilled and tapped multiple holes for 0-80 screws in a short length of 1/2-inch square aluminum bar stock and enlarged the upper part of the openings slightly to accept the diameter of the diodes. The setscrews were installed in the block and adjusted so that the tips were about 1/16-inch below the top of the bar. The cathode ends of the diodes were lightly fluxed before being placed in the openings above the screws. The aluminum bar was then heated on a hotplate and the temperature raised to just above the melting point of the solder. At that point the tops of the diodes were pressed down with the point of a wooden stick to seat and center them on the screws.



Bodies of the mixers were constructed from ¾-inch round brass bar stock (1-1/8-inch for WR-22) by milling deep slots the width of the waveguide and the depth so as to center the waveguide in the rod. Rectangular brass plugs, the length of the rods, were then machined to fill the slots after leaving room for the waveguide. A section of the desired waveguide was then fluxed and inserted in the rod, followed by the brass plug. With this assembly held together with C-clamps, it was heated with a torch and silver-soldered. This resulted in a brass cylinder with a waveguide through its center.

Following soldering, ends of the assembly were faced in a lathe and the outer diameter finished on one end and then the other while held in a lathe chuck. The diameter was further machined down to create a flange on the input end and to provide access for the flange screws. A flat was milled for the SMA connector and a center pilot hole the size of a 0-80-tap drill* drilled completely through the assembly. The upper part of the hole was then enlarged in steps to accept the SMA insulator and provide clearance through the upper waveguide wall for its probe. Mounting holes for the SMA connector were also drilled and tapped. Turning the mixer body over, the opening for the diode screw was tapped. Finally, both ends of the mixer body were accurately drilled and tapped with a suitable flange drill jig for 4-40 screws and alignment pins.

Sliding back-shorts were constructed by first cutting a strip of 0.003-inch copper foil to the inside width of the waveguide. This was then tightly bent around the shank of drill bit chosen so that the finished diameter would be a few thousandths larger than the inside height of the guide. A sliding brass bar was then machined so as to be the height and width of the waveguide and a horizontal slot cut into one end into which the shorting-loop was soft-soldered. Finally, end caps with standard flange drillings were machined to keep the back-short adjusting bars from being disturbed.

This method of back-short construction was chosen because it is fairly straightforward for all guide sizes. Friction-contact is sufficient to keep them in place unless sharply jarred. Locking setscrews with nylon tips could easily be added. This construction allows the loop short to be removed and replaced with a micrometer type with standard waveguide flange, should it be desirable to peak performance.

Gold-plated terminal pins on the two-screw SMA connectors were shortened sufficiently to place the ceramic portion of the diode in the center of the guide. The cut ends were then lapped with a stone and silvered before installation. The setscrew carrying the diode was then inserted and advanced until making contact with the probe from the SMA connector while being monitored with an ohmmeter. Finally, a 1 kHz modulated weak signal, at the geometric mean frequency of the waveguide, was applied to the mixer and the back-short adjusted to maximize output while the SMA jack was monitored with an HP 415E standing wave detector.

When tested for sensitivity, all completed mixers, except that for 110-170 GHz unit, were found to meet EIP factory sensitivity specifications. However, the 110-170 GHz mixer (WR-6) only functioned to about 130 GHz. I believe the reduced sensitivity of this mixer was attributable to reflection caused by the diode's approximate one-ohm shunt reactance at 130 GHz and from the relatively large opening in the waveguide required for the diode. An improvement would be to assemble a whisker diode in the guide, perhaps with parts taken from a 1N26 or 1N53, after first grinding the silicon die and stud down to a diameter of about 0.02-inch.

Bruce Hunter, KG6OJI