XVII. SHOP NOTES

A. STARK CELL FOR MICROWAVE SPECTROSCOPY

In designing a Stark cell for microwave spectroscopy the problem is essentially one of introducing the insulated Stark electrode into the cell in such a way that the transmission loss coefficient for the waveguide is not appreciably increased. The structure should have high symmetry and mechanical rigidity so that under the influence of the electrostatic forces that exist with high Stark field the Stark sample cell or portions of it will not experience undue mechanical vibration at the Stark modulation frequency (1).

For several years we have used a Stark modulation cell that has a reasonable precision in the determination of the Stark field and is easy to build. (See Figs. XVII-1 and XVII-2.) A piece of X-band waveguide is sawed in two pieces through the H-plane. Or two pieces of waveguide of the required length can be converted to two channels by a roughing process – sawing, milling, planing, and so on. The two channels are then filed, by a hand operation, until the inside depth of each channel is constant. The filing operation is facilitated by using a steel depth block that rests within the open waveguide channel and filing the sidewall down to the required height. The sealing sidewalls are then solder-plated and soldered to one of the channels. The septum, with the small lucite insulators sprung on its edges, is lowered into place. The Stark septum can be soldered to vacuum electrodes in the sidewall at this time (Fig. XVII-2). The top half of the waveguide cell is then fitted into place and both halves held tightly together with a series of clamps. Next, the top half is fastened to the top of the sealing sidewall by soldering. If the soldering proves to be slow, the lucite insulation can be protected by clamping a cold plate on the sealing sidewall so that the region near the insulation will be kept below a temperature that will damage the lucite. Care must be taken so that a vacuum seal is produced. Flanges are then mounted on the ends of the guide, and the microwave transmission cell is sealed by one of any number of ways; for example, with

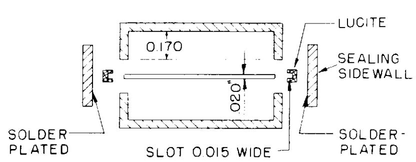

Fig. XVII-1. Stark cell assembly.

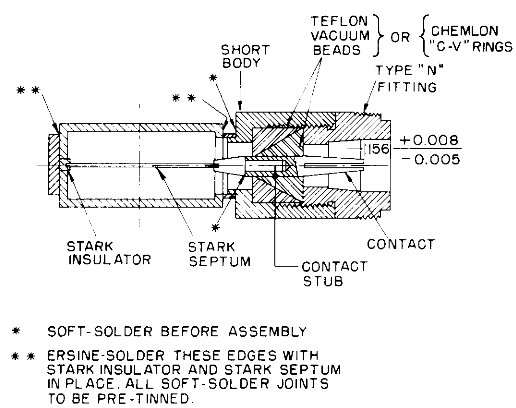

Fig. XVII-2. Detail of Stark cell with insulated vacuum connector.

mica windows sealed to flat brass flanges with beeswax and resin, or sealed with any of the two-component sealing resins.

This method of fabricating a Stark cell produces one that has tightly held insulation and septum that eliminate the guide noise caused by geometric modulation of the structure. Since the dielectric is out of the electromagnetic field, additional dielectric loss is small. Furthermore, since the discontinuities in the insulation do not produce reflection, the transmission characteristic of the cell is very flat and without resonances. Even at a wavelength of 6 mm the transmission shows none of the "wiggles" that are characteristic of multimode transmission. The loss factors for a brass guide 6 feet long, at 3 cm, 1.25 cm, and 6 mm are 1.2 db, 1.8 db, and 3.0 db, respectively. The computed values are 0.72 db, 0.72 db, and 1.0 db.

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References

1. M. W. P. Strandberg, Microwave Spectroscopy (Methuen and Co., Ltd., London, 1954), Chapter 12.