X. MICROWAVE COMPONENTS

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A. STRIP ABOVE GROUND PLANE TRANSMISSION SYSTEM

In order to study and evaluate some of the new ideas continuously being introduced in the microwave field, the Research Laboratory of Electronics has recently organized a Microwave Laboratory.

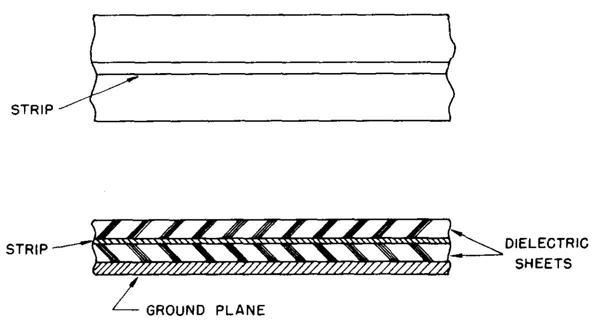

Fig. X-1
The strip above ground plane transmission system.

One of the first problems studied was the microwave printed circuit (1, 2, 3). The transmission system shown in Fig. X-1 was investigated. This system consists of a conducting strip separated from a ground plane by a dielectric sheet. The upper dielectric sheet was used mainly for holding the strip. Polystyrene, teflon, and synthane were used as dielectrics. A pure TEM mode of propagation was assumed in all calculations. Measurements were made in the X and S bands with the equipment shown in Fig. X-2. In this apparatus the probe can be moved in both the longitudinal and transverse directions.

The substitution method (4), the line voltage-distribution method (2), and the two-probe power reversal method (5) were used to measure the insertion loss. The measured attenuation of the system was found to be of the same order of magnitude as that of a coaxial cable. The measured wavelength along the strip was longer than that calculated under the assumption of TEM propagation. Some results are shown in Table 1. Some typical measured patterns of the fields both in the transverse and the longitudinal directions are shown in Figs. X-3, X-4, and X-5. These results indicate that the assumption of propagation of the TEM mode alone is, at best, only an approximation.

The following rf components were developed (see Fig. X-6): (a) transition to the coaxial cable, (b) transition to the x-band waveguide, (c) x-band ring structure, (d) x-band power divider, (e) x-band crystal holder, (f) silicon crystal, and (g) x-band balanced mixer.

A new application of the quarter-wavelength technique for the printed circuits is illustrated in Fig. X-7. The movable short circuit in this tuning device can be placed at such a distance from the strip, that the left part of the tuner presents an effective open circuit. The single strip tuners, the variable quarter-wavelength transformers,

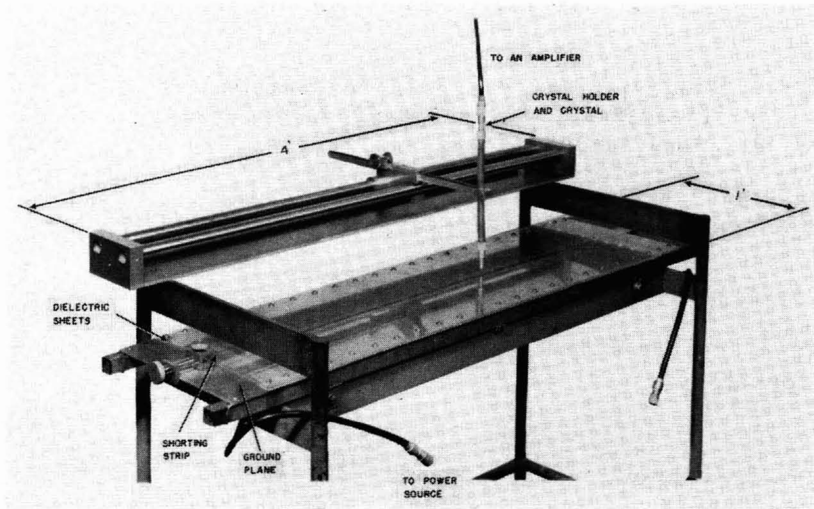

Fig. X-2
The standing-wave detector.

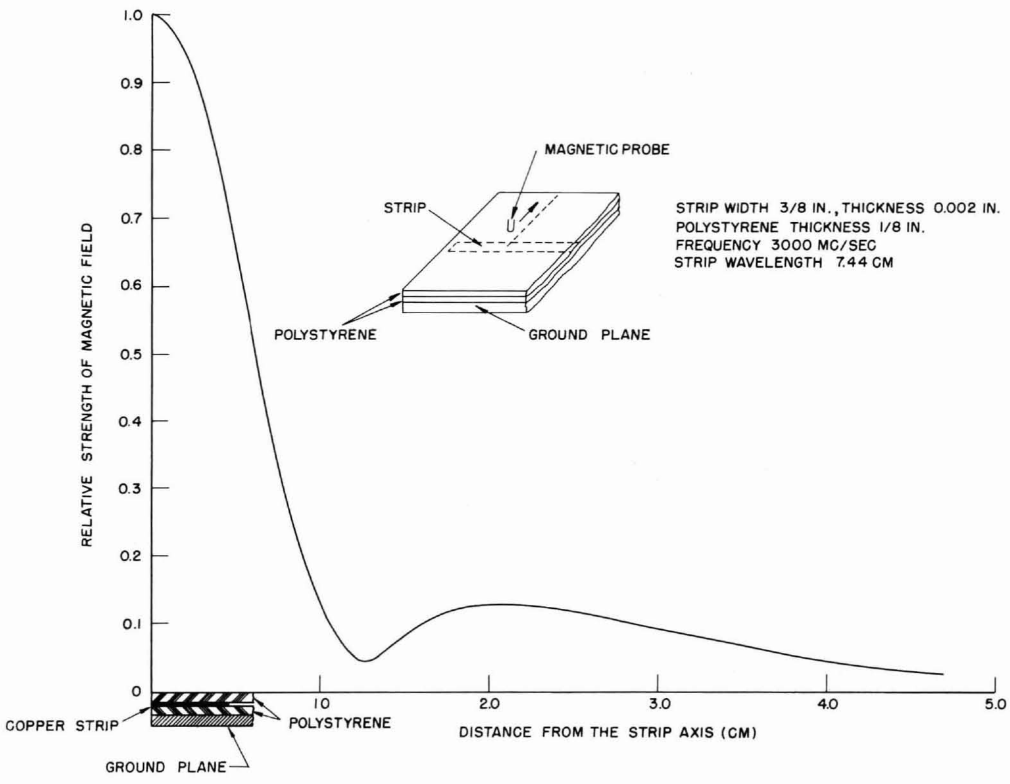

Fig. X-3

Relative strength of magnetic field in the transverse direction for strip above ground plane transmission system.

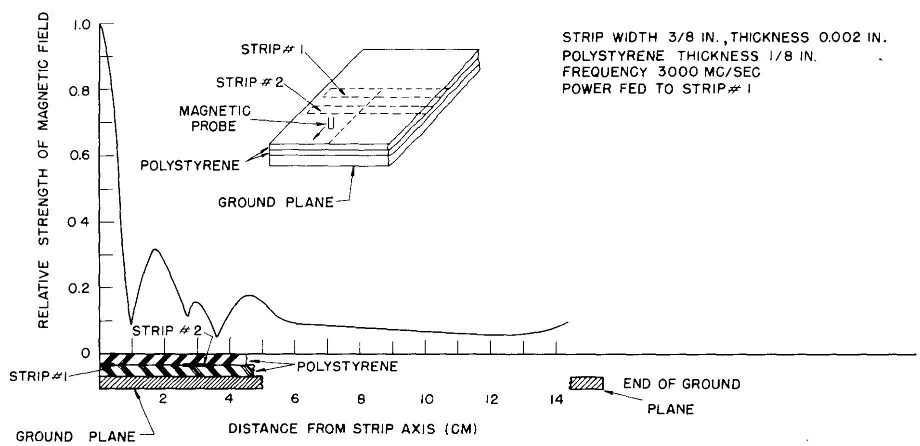

Fig. X-4

Magnetic field distribution for two parallel strips above ground plane transmission systems.

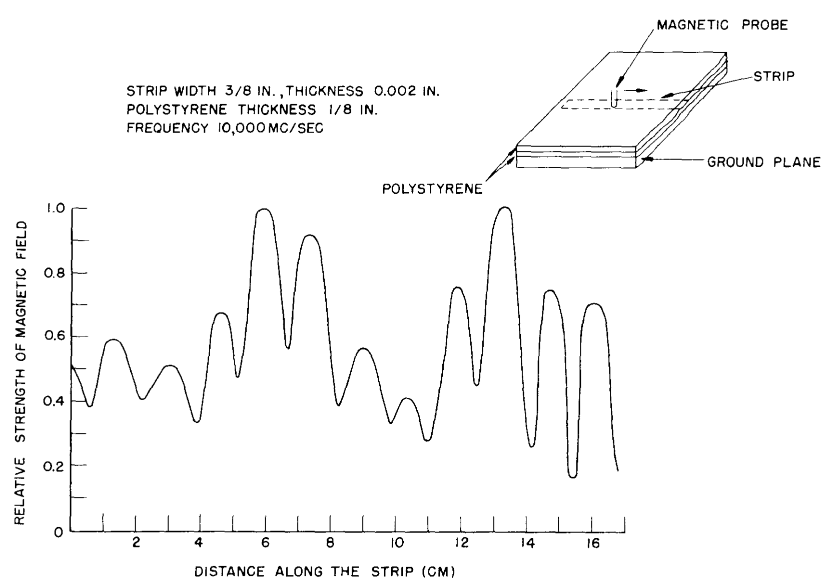

Fig. X-5

Distribution of magnetic field in the longitudinal direction for the strip above ground plane transmission system.

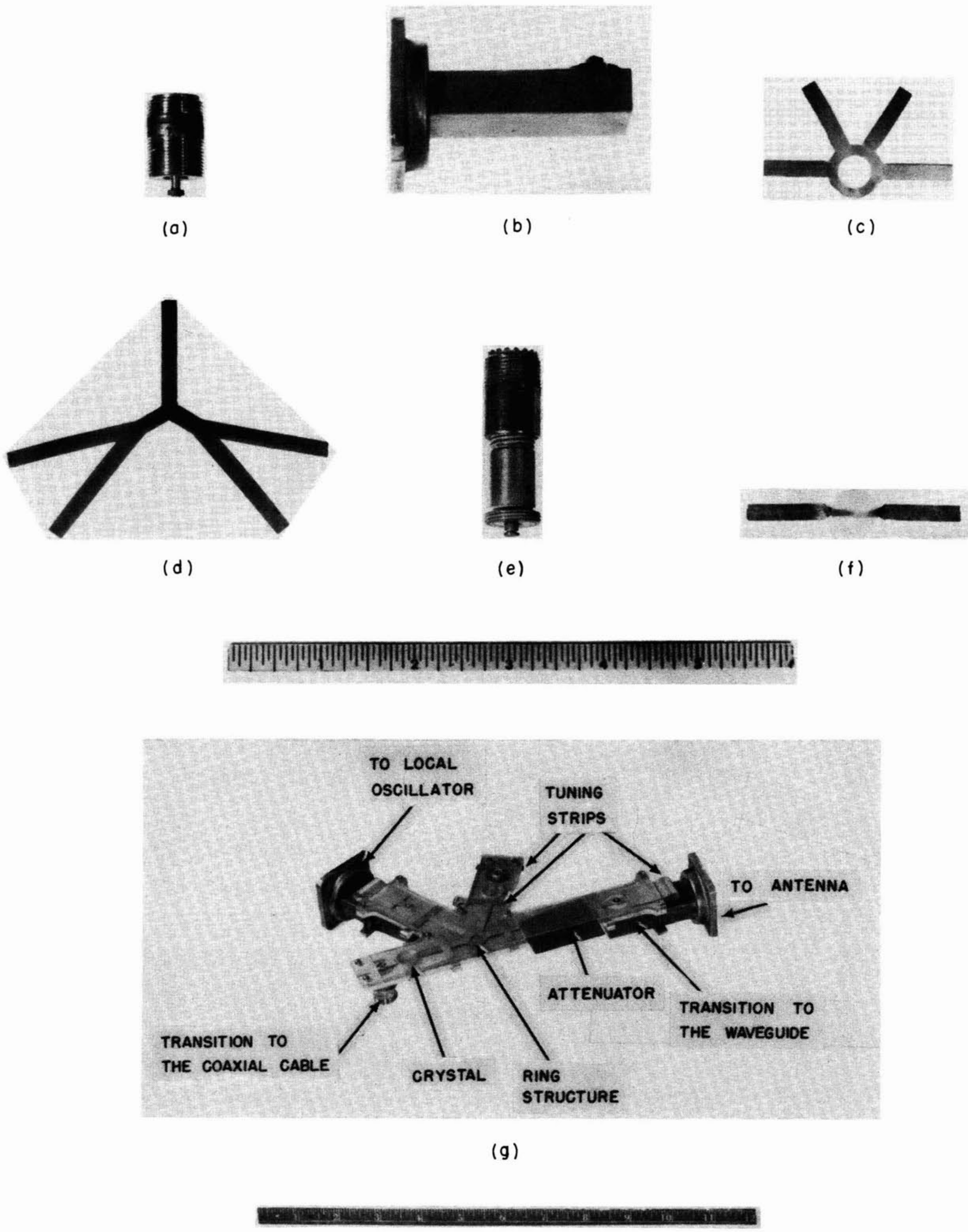

Fig. X-6
Radiofrequency components developed in the laboratory.

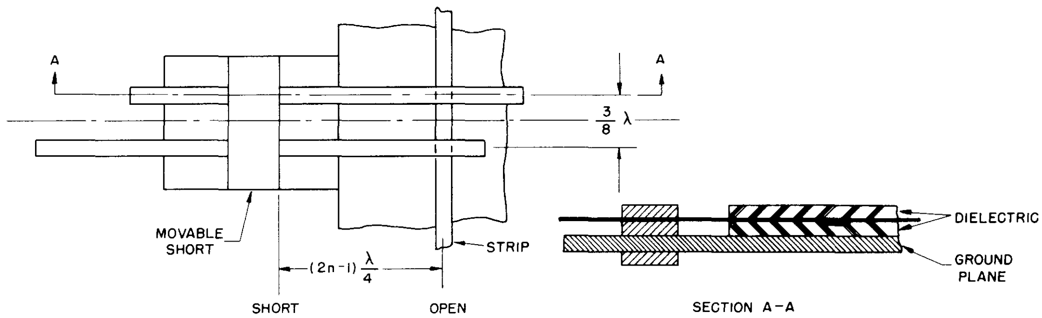

Fig. X-7
Double strip tuner ("H"-tuner).

Table 1

The Strip Wavelength For Strip Above Ground Plane Transmission System

Frequency (Mc/sec)	Strip width (inches)	Dielectric material	Thickness of dielectric material (inches)	Measured strip wavelength (cm)	Calculated strip wavelength for TEM propagation	Remarks
3000	0.56	Polystyrene	0.13	7.15	6.26	
3000	0.38	Polystyrene	0.13	7.44	6.26	
8762	0.38	Polystyrene	0.13	2.52	2.15	
9200	0.21	Teflon	0.06	2.85	2.05	
8815	0.38	Polystyrene	0.1	2.42	2.13	No upper dielectric sheet

and the variable directional couplers using the above idea were investigated.

Different types of loads, attenuators, tuning devices, and antennas were investigated. The performance of these devices indicate their practicability.

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References

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