Project M
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MEASUREMENTS OF WAVEGUIDE WAVELENGTH AND ATTENUATION IN S-BAND STAINLESS STEEL WAVEGUIDE AT 2856 MEGACYCLES

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INTRODUCTION

During August and September of 1961 the waveguide wavelength and attenuation of the stainless steel waveguide used on Project M was measured at the National Bureau of Standards Boulder Laboratories in Boulder, Colorado. The waveguide measured was approximately three feet long and was identified by the following marking:

3.00 o.d. x 1.500 x 0.065 wall T-302
Spec 1550 MOD HT M33294
NTH THINWALL TUBING

The waveguide is made of stainless steel (304 stainless) and is slightly larger in internal dimensions than standard S-band waveguide, and can thus be expected to have a unique waveguide wavelength and attenuation at 2856 Mc.

METHOD USED

The waveguide wavelength was measured by sliding a contacting short in the sample section and positioning the short at nulls as indicated by a differential voltmeter reading the voltage output of a crystal probe fixed in the waveguide ahead of the sample section. Adequate isolation and tuning were provided so that the reflex klystron used as a signal source saw an approximately constant load. The klystron was supplied from batteries and was located in a constant-temperature water cooled cavity. The entire experiment was performed in a constant-temperature room (daily variations less than $3^{\circ}C$). The short was positioned by a rod attached to a lead-screw

mechanism; when a null was located it was marked on the rod with a flat-ground scriber placed against the lapped face of the rod support block. The positions of the scratches on the rod were measured using a "SIP" (Societe Genevoise de Physique) Linear Measurement Machine which had a maximum measurement range of 15 inches.

The attenuation was measured by sliding a contacting short in the sample section when it was arranged as the output waveguide of a three-port tuned reflectometer. Successive maxima and minima were recorded in terms of the attenuation necessary to keep the detector at a constant level; the record obtained was thus a sort of standing-wave pattern at a slope equal to the attenuation of the waveguide. The number obtained was obviously the attenuation per waveguide wavelength; this together with the measurement of waveguide wavelength gave the attenuation per unit length of the waveguide. The measurements were made under the same conditions as were the waveguide wavelength measurements.

RESULTS

Waveguide Wavelength:

At a frequency of 2856 ± 0.1 Mc and a room temperature of 68°F, the waveguide wavelength was found to be:

$$\lambda g = 14.9885 \pm 0.003 \text{ centimeters}$$

For the dimensions of the waveguide used and assuming perfect waveguide with a velocity of light of 2.99793×10^{10} cm/sec, the computed waveguide wavelength is 15.0635 centimeters.

Attenuation:

The value obtained for the two-way attenuation per half waveguide wavelength was 0.0231 ± 0.0004 decibels. Thus the attenuation per foot is

$$\alpha = 0.04698 \pm 0.0009 \text{ db/ft.}$$