$$
\left.\begin{aligned}
&\frac{\varepsilon' - \left(\frac{\lambda}{\lambda_c}\right)^2 - j\varepsilon''}{\varepsilon_g' - \left(\frac{\lambda}{\lambda_c}\right)^2 - j\varepsilon_g''} = \frac{(T_2 - T_1) + (X_1' - X_2')}{(T_2 - T_1)X_1'X_2' + (X_1' - X_2')T_1T_2} \\
&T_i \equiv \frac{\Gamma_i + j\cot\frac{2\pi}{\lambda_g}x_{oi}}{1 + j\Gamma_i\cot\frac{2\pi}{\lambda_g}x_{oi}} \\
&X_i'(l_i) \equiv \frac{X + \tanh\gamma_g l_i}{X\tanh\gamma_g l_i + 1} \\
&\varepsilon_g' - j\varepsilon_g'' \equiv \left(\frac{\lambda}{2\pi}\right)^2\left[a_g - \left(\frac{2\pi}{\lambda_g}\right)^2\right] + \left(\frac{\lambda}{\lambda_c}\right)^2 - j\frac{a_g}{\pi\lambda_g}\lambda^2 ,
\end{aligned}\right\} \quad (3)
$$

where λ_g denotes the resultant attenuation by the wall loss, the slot, the air loss and the junction loss, and X the loss of the terminating plate.

By use of this equation, the effect of the loss of the terminating plate on the sample length and the electrical position of the terminating plate is discussed.

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3. New Approximate Methods of Dielectric Measurement in the Centimeter Wave Region

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Many dielectric measurements using the wave guide in the centimeter wave region have been based on the approximation of the complicated implicit expression containing ε^*. T. W. Dakin and C. N. Works have given electromagnetic-theoretically the approximate form of the method by S. Roberts and A. von Hippel, and circuit-theoretically W. H. Surber and G. E. Crouch the approximate method which needs the continuous deformation of the sample.

The authors have derived both electromagnetic-theoretically and circuit-theoretically the fundamental equation which is very practical for dielectric measurement of low loss material as the approximation of the fundamental equation of methods given in the previous paper (This Bulletin, **31**, 108 (1953)):

$$
\begin{aligned}
&\frac{\beta_d}{\beta_g}\left[(\coth\alpha_d D - \tanh\alpha_d D)\cos^2\left(\beta_d D + \tan^{-1}\frac{\beta_d K}{\beta_g}\left(+ \tanh\alpha_d D\right.\right.\right] \\
&= \left(\Gamma - \frac{1}{\Gamma}\right)\cos^2\frac{2\pi}{\lambda_g}x_0 + \frac{1}{\Gamma}(\equiv S) \quad \alpha_d \ll \beta_d , \qquad (1)
\end{aligned}
$$

from which many methods follow.

In these methods Γ (VSWR) and x_0 (the position of E_{min} measured from the face of the sample) in the air column before the sample (length D) are measured for various values of l (the length of the air column behind the sample), and α_i and β_i denote the attenuation and the propagation constant in the air column ($i = g$) and those in the sample ($i = d$) respectively, and $K \equiv \tan\beta_g l$.

We plot S (the right side of (1)) against l with measured values of Γ and x_0 and determine l_a and l_t corresponding to S_{max} and S_{min}, and then α_d and β_d are determined in a great many methods. Especially the expressions we have used for the experiments are of the following form:

$$\alpha_d = \frac{1}{D}\tanh^{-1}\sqrt{\frac{S_{min}}{S_{max}}} \quad \text{and} \quad \beta_d = \beta_g\sqrt{S_{max}\,S_{min}}. \tag{2}$$

The values of ε' and ε'' can be determined by substituting α_d and β_d calculated by any one of the methods into the following expression:

$$\varepsilon' = \left[1-\left(\frac{\lambda}{\lambda_c}\right)^2\right]\left(\frac{\beta_d}{\beta_g}\right)^2 + \left(\frac{\lambda}{\lambda_c}\right)^2 \text{ and } \varepsilon'' = 2\left[1-\left(\frac{\lambda}{\lambda_c}\right)^2\right]\frac{\alpha_d}{\beta_d}\left(\frac{\beta_d}{\beta_g}\right)^2. \tag{3}$$

Our experiments with the frequency 9450 Mc/sec have been performed on $C_{15}H_{31}CH_2OH$ and ebonite by the method (2). The reasonable values of dielectric constant ε' have been obtained: $\varepsilon' = 2.33$ and $\varepsilon' = 2.72$.

Practically, in place of the graphical determination, we can use the values of l such that $x_0 = n\lambda_g/2$ and $x_0 = (2n+1)\,\lambda_g/4$ and the corresponding measured values of Γ and the corresponding values of S. This simplification is justified by use of Schelkunoff's correspondence.

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4. Study on High Dielectric Constant Ceramics. (XIX)

The Modes of Vibration about Langevin Type $BaTiO_3$ Ceramic Vibrator

Kiyoshi ABE, Tetsuro TANAKA and Akira KAWABATA

(Abe Laboratory)

Langevin type vibrators using $BaTiO_3$ ceramics have been studied and put to use already. But the important problems about the mode of vibration or the supporting method of vibrator, have been left alone because no suitable means of investigation was found. In order to obtain some concept about these problems, the amplitude distribution and the phase relation of the vibrating surface were measured by a piezo-electric type pick-up. Fortunately, fairly interesting results were obtained, which will be described here.

Method of Measurement:

A small pick-up having the construction of Langevin type consisting of $BaTiO_3$ ceramics and brass was used. It is 6 mm in diameter, 5.5 mm in thickness, and