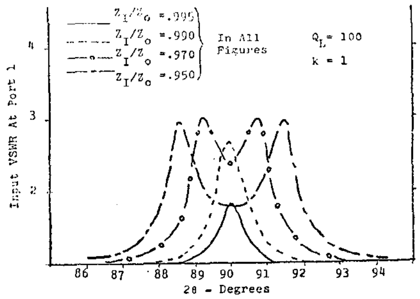


Fig. 2—Input VSWR as a function of $Z_I/Z_0$ ($Q_L=100$).

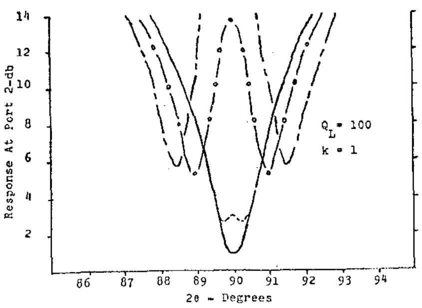


Fig. 3—Port 2 response ($Q_L=100$).

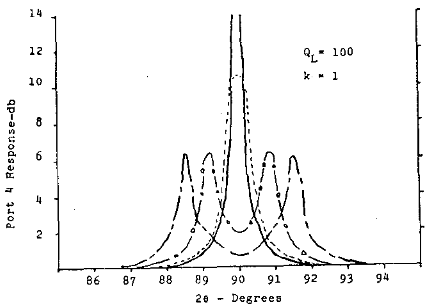


Fig. 4—Port 4 response ($Q_L=100$).

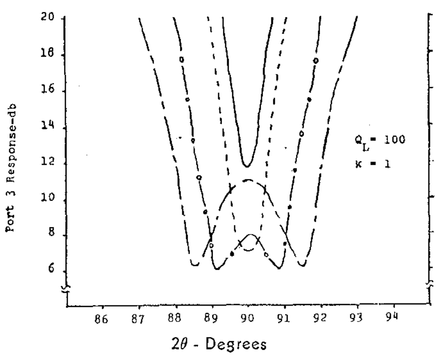


Fig. 5—Port 3 response ($Q_L=100$).

Plots such as those shown in Figs. 2–5 are of value in two possible ways. If a particular type of discontinuity such as a dielectric post exists in the loop sides, then a knowledge of the discontinuity equivalent circuit permits calculation of $Z_I$ and $\beta_I$ used above. Thus the discontinuity effects are readily taken into account, and the resulting frequency response is predictable. Secondly, plots of the above form can serve as aids to empirical adjustment by comparing the measured response to the predicted. In this case the required assumption is that the variation of $Z_I$ is negligible over the frequency band of interest.

In summary, equations for the transmission and reflection coefficients for the single resonator traveling wave filter have been presented for the case where the loop sides have an arbitrary characteristic impedance. It has been shown that when $Z_I \neq Z_0$ ideal directional filter characteristics are not attainable.[2] The effects on frequency response are in qualitative agreement with those observed experimentally. Also $\beta_I \neq 2\theta$ cause a predictable frequency shift.

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[2] F. S. Coale, "A Traveling-Wave Directional," IRE TRANS. ON MICROWAVE THEORY AND TECHNIQUES, vol. MTT-4, pp. 256–260; October, 1956.

## A Wall-Current Detector for Use with Beam Waveguides*

A crystal detector mount which is well suited for use with beam waveguides[1] of either the refracting or reflecting type is based on the same concept as the wall-current detector of deRonde.[2] The geometry of one form of the detector is shown in Fig. 1.

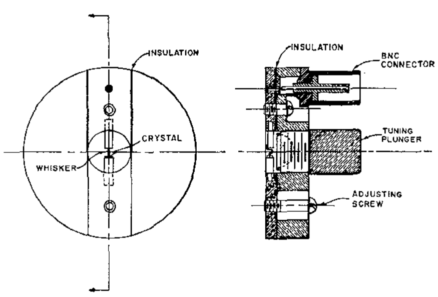


Fig. 1—Schematic drawing of a wall-current detector for use with beam waveguides.

Radiation incident on the detector with its magnetic intensity horizontally polarized causes a vertical surface current to flow, some of which passes through the rectifying junction mounted across the circular aperture. A tuning plunger mounted behind the rectifying junction is used in the conventional manner to tune the detector. A dielectric lens may be used directly in front of the detector to concentrate the incident radiation on the diode.

A detector of this type has been used for making measurements on a 70-Gc beam waveguide. Using relatively crude assembly techniques it is possible to construct units with an output voltage of the order of 15 millivolts per milliwatt of power in the radiation beam, which has a minimum cross-sectional area of approximately 6 square centimeters.

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[1] G. Goubau and F. Schwering, "On the Guided propagation of electromagnetic wave beams," IRE TRANS. ON ANTENNAS AND PROPAGATION, vol. AP-9, pp. 248–256; May, 1961.

[2] F. C. deRonde, "A Universal Wall-Current Detector," presented at Millimeter and Submillimeter Conf., January 7–10, 1963, Orlando, Fla.

## Solution of the Fourier Heat Flow Equation in Waveguides Filled with Lossy Dielectrics*

The temperature distribution within a waveguide filled with a lossy dielectric, and propagating a specified mode, may be conveniently obtained by the Green's function method. Such a solution is useful for describing the temperature distribution in vacuum windows, for example.

The temperature distribution in the steady state is given by Fourier's equation

$$\kappa \nabla^2 T + p = 0 \tag{1}$$

where $\kappa$ is the thermal conductivity and $T$ the temperature of the material. A spontaneous source of heat power per unit volume $p$ is supposed. In the example considered here, the heat power is presumed to be generated by some mechanism as molecular friction due to oscillation of the dipolar material attempting to align itself with the electric field of an RF wave. This heat will establish a thermal gradient in the dielectric material as it flows toward a heat sink, which will constitute a boundary condition on the differential equation. We will not consider temperature variations along the axis of the waveguide, which is equivalent to assuming that the loss per unit length along the axis is small. Therefore we will only require a solution of Poisson's equation (and a Green's function) in two dimensions.

To illustrate the explanation we consider the case of the cylindrical TE-11 mode, for which the field description is given to sufficient accuracy by the solution of the homogeneous wave equation (1):

$$E_r = \frac{2E_0}{k_c r} J_1(k_c r) \sin \phi j \exp j(\omega t - \beta z)$$

$$E_\phi = 2E_0 J_1'(k_c r) \cos \phi j \exp j(\omega t - \beta z) \tag{2}$$

where $E_0$ is the maximum field intensity at the origin. Thus, the heat power source function is given by

$$p(r, \phi) = \frac{\sigma E^2}{2} = \frac{\sigma E_0^2}{2} [J_0^2(k_c r) + J_2^2(k_c r) - 2J_0(k_c r) J_2(k_c r) \cos 2\phi] \tag{3}$$

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