Correspondence

Improvement of the Wall-Current Detector

Since the publication by de Ronde,[1] the construction of the wall-current detector has been modified, resulting in the following improvements:

1) The frequency characteristic has become flatter, within 1.5 db instead of 3 db.
2) The identity of the frequency characteristic for two detectors has become better, within 0.1 db instead of 0.2 db.
3) The sensitivity has become higher, a minimum sensitivity of 10 mv/mw for 1N26 for a detector load of 1 MΩ at a level not exceeding 10 mw.

Due to the modification, the reflection coefficient has become twice as large—$|R| \leq 0.01$ instead of ≤ 0.005—which is still rather low.

The new construction can be seen in Fig. 1. Only the modifications are indicated. Fig. 2 shows the frequency characteristic obtained by the old and new construction, both used with the same sweep oscillator and diode.

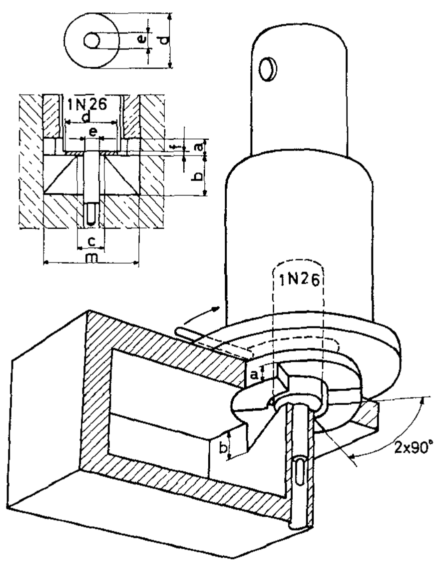

Fig. 1—Internal construction of the improved wall-current detector. $a=2.0$. $b=4.0$ $c=\phi 3.0$. dimensions of mica disk. $d=\phi 5.5$. $e=\phi 1.6$. $f=0.1$. All dimensions in mm.

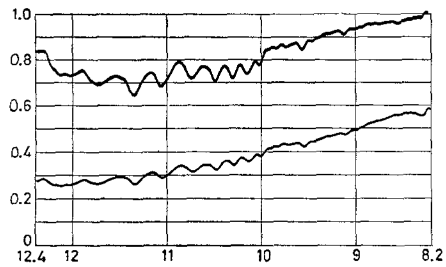

Fig. 2—Frequency characteristic of first and improved wall-current detector for the 8.2–12.4 Gc band. 1.0 corresponds to 100 mv dc voltage of the 1N26 diode over a 1 MΩ load. Lower curve: first wall-current detector. Upper curve: improved wall-current detector.

Influences on the Frequency Characteristic

With the old construction, the sensitivity diminished at higher frequencies. It is reasonable that this will be improved with the *new construction*, especially the dimensions b, c and m. The sensitivity will become higher when b and m are larger. If they are too large, resonance starts at the highest microwave frequency. This can be damped more or less by increasing the losses in the LC circuit, formed by the opening in the wall and the condenser C of the 1N26 diode. The simplest way proved to be to increase the losses of C, which could be done artificially by inserting a small disk of mica—coated with a resistive layer—in front of this condenser. 500 Ω per square proved to be the best value for this layer. It improved the identity slightly and enlarged the sensitivity around the center of the X band. With a lower value a flatter frequency characteristic is obtained, but it has so much influence that the identity is easily spoiled. It will be evident that maximum identity between two detectors is obtained when close tolerances for the dimensions of the LCR circuit are maintained. The inner conductor of the diode is in spring contact with the wall, which for this purpose is split. With the rotary part of the compensation circuit,[1] the slope of the frequency characteristic can be varied about 10 per cent.

If the same absorbing disk had also been used in the old construction, the same flatness, however, but about half the sensitivity of the improved wall-current detector, could have been achieved. As the influence of the resistivity on the frequency characteristic is much greater, this solution is not preferable if maximum identity is wanted.

Concluding, we may say there is no point in trying to get an absolutely flat frequency characteristic as any sweep oscillator has a different response. Influences *from outside* the wall-current detector on the frequency characteristic are the load and the energy level. Both vary the impedance Z_D of the diode and in this way influence the characteristic. A load not smaller than about 50 kΩ, and a level not exceeding 10 mw, are necessary to obtain the above mentioned results of flatness, identity and sensitivity. Higher precision has therefore been achieved by automatic measurement, of which a publication will follow.[2] If one wall-current detector has been used as a leveler, the output of a H/P 686 C sweep oscillator, measured with another detector, could be flat within ±0.1 db.

A Total Reflection Wall-Current Detector

Besides a wall-current detector with hardly any reflection, one with total reflection has been made. By placing a wall-current detector in the middle of the end wall of a quarter wavelength-short, and with $b=0.5$ mm, about the same frequency characteristic has been obtained. In addition, the sensitivity has become about four times as high, which corresponds to the double current for square-law detection. Such a detector might be very useful to investigate the transmission properties of n-ports which may be very important for automatic measurements.

F. C. de Ronde
Philips Research Labs.
N. V. Philips Gloeilampenfabrieken
Eindhoven, The Netherlands

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[1] F. C. de Ronde, "A universal wall-current detector," IEEE Trans. on Microwave Theory and Techniques, vol. MTT-12, pp. 112–117; January, 1964.

[2] F. C. de Ronde, "A precision X-band reflectoscope. Automatic full-band display of reflection coefficient," to be submitted for publication in IEEE Trans. on Microwave Theory and Techniques.

Multiband Cavity for High Temperature Plasma Measurements

The design of microwave cavities for investigating high temperature arc plasmas must provide for adequate cooling, vacuum sealing, high Q, minimum disturbance to gas flow and general versatility. In a typical plasma experiment[1,2] (shown in Fig. 1) ionized argon gas flows through a one centimeter circular pipe formed by a stack of insulated water cooled copper disks. Ionization is maintained thermally by an electric arc burning along the pipe axis. The heat transferred to the walls may be 100 w/cm^2 and central temperatures exceed 8000°K at currents in the neighborhood of 100 a. The cavity is located in the stack so that the gas flow is along its axis.

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[1] H. W. Emmons, "Recent developments in plasma heat transfer," in "Modern Developments in Heat Transfer," Academic Press, Inc., New York, N. Y.; 1963.

[2] H. W. Emmons and R. I. Land, "Poiseuille plasma experiment," *Phys. Fluids*, vol. 5, pp. 1489–1500; December, 1962.