charge effects are to be expected with an input pulse longer than the collection time. Larger currents show a greater gain than normal, and may initiate breakdown if excessive.

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[1] Provisional patent filed.

A Film Radiometer for Centimetre Wave-lengths

THERMAL methods for the measurement of power at centimetre wave-lengths normally involve a substitution process in which the high-frequency power is assumed to be identical in magnitude with the d.c. power causing the same rise in temperature or change in resistance. While in some techniques this assumption results in no appreciable error, it is a general limitation of thermal methods that the high-frequency and d.c. powers are not dissipated in precisely the same manner. This feature of existing methods is particularly evident at low power-levels, of the order of 1 milliwatt, at wave-lengths of 3 cm. and less. Although a calibration of centimetre-wave milliwattmeters can be made against standard equipment operating at higher power-levels, this operation requires much auxiliary apparatus and attenuation measurements of high precision. There is a need, therefore, for further convenient power-measuring techniques at the milliwatt-level in which the limitations inherent in existing methods are avoided. It seems probable that a form of film radiometer or bolometer, in which the ideal of accurate substitution of d.c. power for high-frequency power is approached very closely, will fulfil these requirements; the results of some preliminary experiments in the development of such an instrument are summarized in this communication.

Very few direct measurements of power at centimetre wave-lengths using resistive films appear to have been made, and the only published information of which I am aware relates to extended films placed along the axis of a waveguide[1,2]. It has been known for some time, however, that a thin transverse film having a surface resistivity equal to the wave impedance of the waveguide forms a reflexion-less termination when followed at a distance of $\lambda_g/4$ by a perfect reflector (λ_g being the wave-length in the guide), and a modification of this arrangement is described below.

The problem of ensuring equivalent heating effects of high-frequency and d.c. power is obviously still considerable in a resistive film extending across the waveguide; fortunately, it is still possible to terminate a rectangular waveguide in its characteristic impedance by the use of a relatively narrow strip extending across the waveguide from the centre of the broad face. Such a strip is located in a region of very nearly uniform transverse electric and magnetic fields for the dominant or H_{01} mode, and the difficulty of attaching suitable d.c. connexions is at the same time much reduced. In the present experiments, a strip 0·35 cm. wide of surface resistivity 180 ohms per square has been used in a standard 3-cm. band waveguide, so giving a d.c. resistance of approximately 500 ohms between top and bottom edges of the strip. Impedance measurements confirm that the strip behaves, to a close approximation, as a pure shunt resistance. In addition, with the reflecting plunger fixed at a distance of $\lambda_g/4$ at a mid-band wave-length of 3·2 cm., an input-voltage standing-wave ratio of 0·9 or better can be achieved over a 10 per cent band-width by preliminary adjustments of width of film. The strip is insulated from the waveguide at one end and can be connected in a d.c. circuit for calibration purposes.

Theoretically, either changes of resistance or a rise in temperature can be observed; so far, only the latter quantity has been determined by the simple method of attaching a single copper – eureka thermocouple to the centre of the strip with the wires of the couple fixed at right angles to the electric field of the H_{01} mode. A similar thermocouple is placed on the external wall of the waveguide close to the strip, and a steady-state deflexion of about 10 cm. per mW. is obtained on a galvanometer scale after a period of one to two minutes.

Preliminary comparisons, at power-levels of 2–3 mW., with other calibrated equipment have shown that the errors in a d.c. calibration of the instrument are probably not more than a few per cent. Further experiments, using metallic films deposited on mica, are in progress in order to investigate the full possibilities of this form of film radiometer, and a complete account of the work will be published in due course.

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J. A. LANE

Radio Research Station,
Slough. Oct. 26.

[1] Collard, J., *Proc. Inst. Elect. Eng.*, IIIA, **93**, No. 9, 1399 (1946).
[2] Gordon-Smith, A. C., *Proc. Inst. Elect. Eng.*, B, **102**, 685 (1955).

Metal-catalysed Hydrolysis of Thiophosphoric Esters

STUDIES on the hydrolysis of parathion (O-O-diethyl-O-*p*-nitrophenylphosphorothionate) and E.P.N. (thiono-benzene phosphoric acid O-ethyl-O-*p*-nitrophenylester) at *p*H 7 showed unexpectedly that traces of some metal ions, for example, cupric ions, have a marked catalytic effect.

At *p*H 7·8–8·6, at which the measurements were made, the catalysis of the hydrolysis by hydroxyl ions is negligible, so that we have primarily reaction with water. The reaction was followed at 40° C. by measuring as a function of time the optical density of the liberated nitrophenolate in a Beckman spectrophotometer *D.U.*

Assuming a reaction of the first order, we obtain from the general formula for the velocity constant ($k = (1/t) \ln a/(a-x)$), $k = (1/t) \ln (D_\infty - D_0)/(D_\infty - D_t)$, where D_0, D_t and D_∞ are the optical densities at times 0, t and infinity[1].

The buffer solution used was borax–hydrochloric acid (conc. borax $\pm$ 0·03 mol./l.). Addition of 20 per cent ethanol in the case of parathion and of 40 per cent for E.P.N. was necessary because of the limited solubility of these compounds in water. Great care was taken to avoid impurities, as it proved that metals even catalysed in concentrations of 10^{-8} mol./l.

The reagents used were analytical grade; we are indebted to the American Cyanamid Co. and the Dupont de Nemours Corporation for providing