Effect of Anomalous Attenuation in a Linear Accelerator

In a recent communication[1], the performance of a travelling-wave linear accelerator has been given. It was shown that, due to the importance of higher terms in the expansion representing the power flow in the accelerator guide, the series impedance is lower than had been previously assumed. This, of course, leads to a reduction in the energy of the accelerator. The series impedance for the guide in question (2 cm. pitch, $a/\lambda = 0\cdot168$ and phase velocity approximately equal to light velocity) has been determined both theoretically and experimentally, and a value of 3·5 megohms/cm.[2] obtained. From this value and experimentally determined data on the position of electron bunching, the energy expected from the accelerator may be calculated for various loading conditions. Such values are shown compared with the measured performance of the accelerator in Fig. 1, and it will be noted that, although agreement at light loading is good, serious discrepancy occurs at higher loading. The discrepancy is attributed to an anomalous attenuation which has been found to occur in the accelerator over a certain range of power flux.

Although measurements of attenuation of the three-metre length of guide and associated components indicate a value of 2·5 db. for all power-levels in the absence of magnetic focusing field, the application of such fields is found to have a considerable effect. In the presence of focusing fields the attenuation, although still of the order of 2·5 db. for power fluxes of a few milliwatts and several megawatts, exhibits a variation with power in an intermediate range. In this particular case, an attenuation greater than 12 db. has been noted for an input power of 250 kW., and as power is increased attenuation falls, approaching 2·5 db. for an input of 3 MW. The effect is apparently not dependent on the gas pressure in the guide, provided that this is reasonably low. It would therefore appear to be additional to the radio-frequency absorption by gas noted by Harvie and Mullett[2] and which has also been observed in the present equipment.

At light loading the power-level in the guide is such that anomalous attenuation may be expected to have little effect. When, however, the loading is increased, the power flux is considerably reduced and anomalous attenuation may be expected to affect performance. The mechanism causing the increase in attenuation is not fully understood, and it is therefore impossible to make an accurate allowance for the effect. If, however, it is assumed that the criterion which determines the value of the anomalous attenuation is the mean of the input and output power fluxes, the calculated performance figures may then be modified. Such modified results are shown in the graph and, clearly, improvement in agreement with the measured performance is obtained at the higher loadings.

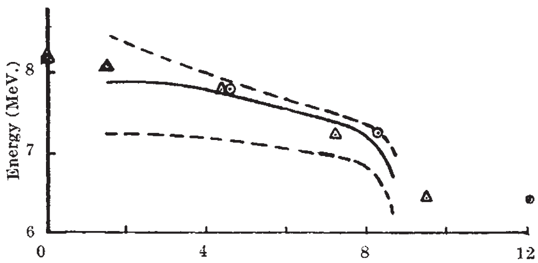

Fig. 1. Comparison of measured and calculated energies: ——, measured energy of peak of spectrum; – – – –, approximate limits of spectrum. Points shown as ⊙ are calculated neglecting anomalous alternation, and △ making an allowance for anomalous attenuation

A similar increase of attenuation has been noted[3,4] in a dielectric-loaded guide by the Linear Accelerator Group at Malvern of the Atomic Energy Research Establishment, and a qualitative explanation of the effect has been suggested in terms of secondary emission and multi-pactor effect inside the corrugations of the guide.

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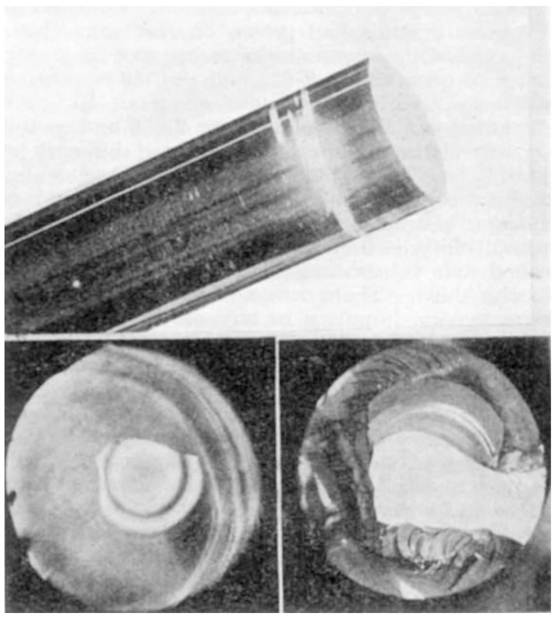
[2] Harvie, R. B. R-S-., and Mullett, L. B., *Proc. Phys. Soc.*, B, 62, 270 (1949).
[3] Mullett, L. B., Clay, R. E., and Hadden, R. J. B., A.E.R.E. Report, *G/R*, 1076.
[4] Hadden, R. J. B., A.E.R.E. Report, *G/R*, 1161.

Transverse Cracks in Glass Rod

In the course of work on crack propagation in brittle fracture, we have been breaking glass rod in tension by the Bridgman[1] technique of applying radial fluid pressure. A few specimens, cut from one 9-mm. diameter 'Hysil' glass rod, contained after fracture transverse cracks which had not been propagated completely across the section, as shown in Fig. 1. The diameter and thickness of the large crack in this specimen can be estimated from the end view (Fig. 2); this was taken with mercury light, and since it shows four interference fringes the crack was about 10,000 A. thick in the centre.

(1)



(2) (3)

(1) Cracks in glass rod (×2½); (2) end view of rod (×3½) (3) fracture surface of crack in (2) (×3½)