2.2: MEASUREMENTS OF FIELD STRENGTH ON RESONATOR BOUNDARIES BY PERTURBATION OF RADIATION FIELD

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A new indirect method for measuring the absolute field strength at the boundaries of microwave resonators has been developed. The difference between the new method and the other indirect methods (originally developed by Hansen [1] and Slater [2]), is that while all the other methods are based on the perturbation of the mode-field in the resonator, the new method is based on the perturbation of the radiation-field.

When the mode-field in a resonator is perturbed the result is a change in the imaginary part of the complex resonant frequency. Such a change can be detected by measuring the shift in the angular resonant frequency (ω). On the other hand, perturbing the resonator's radiation-field affects mainly the real part of the complex resonant frequency which is related to the resonator's unloaded Q. Although the shift in the resonant frequency ω, in general, can be measured more accurately than the change in Q (this fact was said to be the main reason for developing the mode-field perturbation methods), it was found that the limiting factor on the accuracy of the mode-field perturbation method is not the accuracy of making the frequency measurements, but rather the approximations made in deriving the perturbation formulas. For instance, in order to make field strength measurements with an error of a few per cent, using the existing mode-field perturbation formulas, the shift in the resonant frequency ω should not exceed a fraction of one per cent. Such a small perturbation imposes severe restrictions on the size and shape of the perturbing object. On the other hand, if the radiation-field method is used, the amount of permissible perturbation may be so large that the change in Q can be one or two orders of magnitude. This large permissible perturbation results in an improvement of the overall accuracy and (or) simplicity of the field measurements.

Our main objective was to determine the strength of the magnetic field over the boundaries of microwave resonators, and the radiation field method, as we developed it, is most suitable for this purpose. In this case the perturbation is accomplished simply by changing the surface impedances of the boundaries; the perturbation formulas are simple and were readily derived from the classical theory of wave propagation in high conductivity media.

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The radiation-field method was used to determine the distribution of the ohmic losses on the walls of re-entrant cylindrical resonators of the type used in high power klystrons. The method was also used to measure the magnetic field strength on the drift tube wall of the klystron resonator. The experimental results were in agreement with the theoretical results obtained by numerical solution of the wave equation.

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1. W. W. Hansen and R. F. Post, "On the Measurement of Cavity Impedance," J. Appl. Phys. 19, 1059-1061 (1948).

2. J. C. Slater and L. C. Maier, "Field Strength Measurements in Resonant Cavities," J. Appl. Phys. 23, 68-77 (1952).