Correspondence

Klystron Noise

In my paper "Crystal Checker for Balanced Mixers"[1] I gave data on the excess noise of typical klystrons. Since that paper was prepared, further data has been obtained that permits an expansion of Fig. 6.

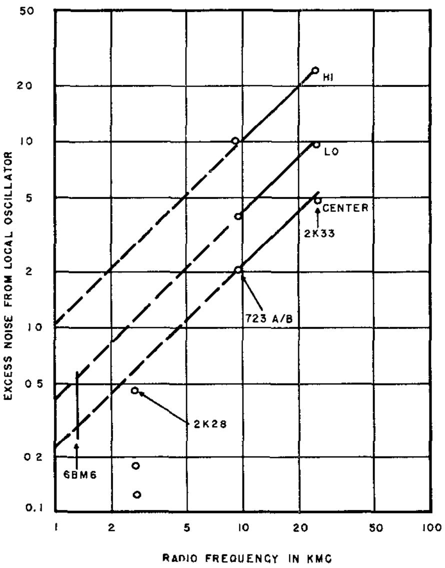

Fig. 1—30-mc excess noise of typical klystrons. (Same as Fig. 6 of original paper except for addition of 2K28 data.)

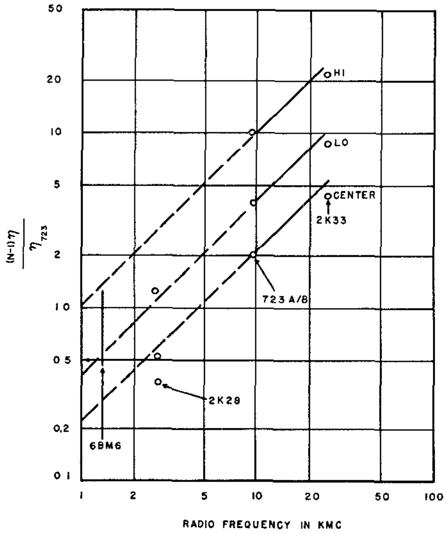

Fig. 2—30-mc excess noise of typical klystrons multiplied by the efficiency ratio η/η_{723}.

Measurements were made on a 2K28 at 2800 mc. Fig. 1 is a revision of Fig. 6 to show the new data. It is seen that the new points fall below the interpolated curves given originally, although the relative vertical spacings are about the same as those predicted by interpolation. The data in Fig. 1 seem to fit the empirical relationship

$$N - 1 \cong K \frac{f}{\eta},$$

where $N-1$ is the excess noise power at a particular intermediate frequency, K is a constant, and η is the efficiency of converting beam power to cw power.

If one arbitrarily multiplies the data in Fig. 1 by the ratio of the efficiency of the particular klystron to that of the 723A/B, the nearly linear relationship of Fig. 2 is obtained.

If the empirical relation is valid, Fig. 2 can be used to predict the approximate performance of other klystrons by spotting the operating frequency on the figure, or an extension thereof, and multiplying by the ratio of efficiencies, η_{723}/η.

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[1] *Trans. I.R.E.*, vol. MTT-2, pp. 10–15; July, 1954.

A Practical Method of Locating Waveguide Discontinuities

In the maintenance of ultra-high frequency equipments utilizing waveguide, one of the more difficult troubles to diagnose and correct is that of the high standing wave ratio. The question always arises as to whether the antenna or the waveguide is at fault. Sometimes a visual inspection of the transmission system will disclose the difficulty. Too often, however, the physical layout of the system makes a close inspection impractical. The construction of many antennas, also, does not permit an examination of the radio frequency components without a complex mechanical disassembly, costly in terms of man-hours.

It is desirable, therefore, to determine the approximate location of the discontinuity electronically. On those equipments having a continuously variable-frequency transmitter, a frequency measuring device, and a waveguide probe for sampling the standing wave, this can be done quite easily. On other equipments these features can be simulated by installing, at the transmitter end of the line, a waveguide section equipped with probes for inserting the signal of a variable-frequency, calibrated, test oscillator and for sampling the standing wave.

The usual analysis of a standing wave requires the movement of the probe along the slotted waveguide; the detected voltage progresses through maximum and minimum values in accordance with the standing wave pattern.

If, however, the probe is left at a fixed position and the frequency is varied, the standing wave will move past the probe, its detected voltage rising and falling in the same manner as the *guide* wavelength changes with frequency. It will be shown that the frequency change necessary to move the standing wave a specific number of wavelengths is a function of the distance from the probe to the discontinuity causing the standing wave.

If we let N equal the number of half-guide wavelengths between the probe and the discontinuity, and let L represent the physical distance from the probe to the discontinuity, then

$$N = \frac{2L}{\lambda_g}. \tag{1}$$

Now, if the operating frequency is increased sufficiently to bring one more half-guide wavelength into the distance, L, then

$$N + 1 = \frac{2L}{\lambda'_g}. \tag{2}$$

Subtracting (1) from (2) and rearranging, we have

$$L = \frac{\lambda_g \lambda'_g}{2(\lambda_g - \lambda'_g)}. \tag{3}$$

In making use of this phenomenon to locate a serious discontinuity in a waveguide transmission system, we must determine the guide wavelengths that will give us two successive maxima (or minima) of the standing wave at a fixed probe location, as the frequency is varied.

The guide wavelength is a function of frequency which can be evaluated from the identity

$$\lambda_g = \frac{c}{\sqrt{f^2 - \left(\frac{c}{2b}\right)^2}}, \tag{4}$$

in which

c is free space velocity of propagation,
f is operating frequency,
b is wide inside dimension of the waveguide.

Thus, we are approaching a practical solution to the problem, since the frequencies required to give two successive maxima (or minima) of the standing wave are measurable. Once the frequencies are determined, they are converted to wavelengths in (4); the wavelengths, in turn, are used in (3) to give the distance from the probe to the discontinuity.

In practice, frequency is measured with a calibrated echo box or wave meter. Standing wave voltage is measured with a vacuum tube volt meter equipped with radio frequency probe. (Calibration of this instrument is not necessary since only relative readings of voltage are required to establish the maximum and minimum positions of the standing wave.) If possible, the detector of the vacuum tube voltmeter should be con-

(*Cont'd on p. 46*)