MEASURING THE LINEARITY OF RADIO-ASTRONOMY RECEIVERS*

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A convenient practice which is frequently adopted in observational radio astronomy is to express all aerial temperatures in terms of the temperature produced by a " point source " of known flux density. A difficulty with this procedure is that, with large telescopes and modern low-noise receivers, the aerial temperatures due to any of the better-known discrete sources are usually comparable with or greater than the receiver noise temperature. Under these circumstances, if the receiver response law is of the form

$$D = f(T_0 + T_a)$$

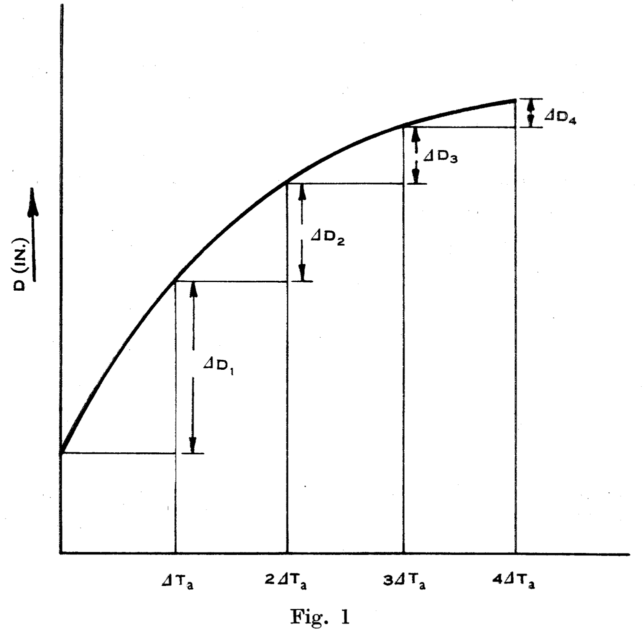

Fig. 1

(where D is recorder deflection, T_0 is receiver noise temperature, and T_a is aerial temperature) the relation between T_a and D is in general non-linear, and in order to calibrate the receiver throughout its dynamic range we need to determine the form of the function f.

In principle this can be done by injecting a series of noise signals of known relative amplitudes at the receiver input and measuring the resulting recorder deflections. In practice, especially at high frequencies where the noise source is

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usually a discharge tube of fixed output and the signal must be varied by introducing various attenuators at the receiver input, the method is inconvenient and the results usually unsatisfactory.

The following method, however, which is simple and quick, does not require changing the receiver from its normal operating condition and does not require that an operator be at the (often remote) front end of the receiver while measurements are made.

The method requires a noise source directionally coupled to the line joining aerial and receiver. The receiver is set in its normal operating condition with the attenuation between noise generator and directional coupler adjusted so that the " noise step " is about one-quarter or less of full-scale recorder deflection. The magnitude of this noise step on the recorder is then measured at a number of input temperature levels.

This can either be done by turning the noise generator on and off while the aerial tracks a " cold " part of the sky, and then is pointed in a succession of directions such that the recorder deflection increases by roughly equal increments or, alternatively, a normal drift scan through a discrete source is taken, followed by a second scan through the same source with the noise generator turned on.

In either case we can construct a graph from the results giving incremental gain $\Delta D/\Delta T_a$ (in arbitrary units of T_a) as a function of recorder deflection. From this, a second graph can be drawn, relating T_a and D as shown in Figure 1. If the aerial is now pointed at a calibrating source of known flux density, the abscissa scale may be determined.