Diagnosis of Distortion

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The "Difference Diagram" and Its Interpretation

AT the outset it should be emphasized that this article is not concerned with the *measurement* of distortion; it deals with a method of *diagnosis* aimed at recognizing, locating and removing the source of any distortion which is found.

The diagnosis is made by examining an oscilloscope trace which represents all the defects of the apparatus which is being tested. By comparing the outline of this picture with certain standard shapes, examples of which are given here, the various sources of distortion can be recognized. For example, typical overload conditions can be recognized at a glance (Figs. 10 and 11). In other photographs the distortion conditions have been artificially exaggerated to bring out the characteristic features.

The technique adopted to generate these pictures can be summarized briefly as follows:—

A pure sine wave signal is applied to the test object (an amplifier, for example) and also to the X-plates (horizontal axis) of an oscilloscope.

The distorted output signal is applied to the Y-plates after passing through a network which subtracts the pure fundamental wave and leaves only the distortion terms, together with any hum, hum-modulation or circuit "noise." Before being applied to the Y-plates this "difference" signal is amplified, generally 30 to 100 times.

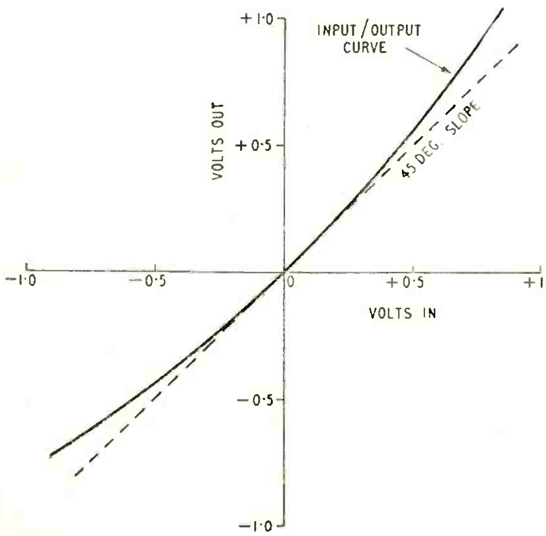
When the phase of the X-signal is suitably adjusted the trace shown on the oscilloscope closes into a curved line which is a representation of the transfer characteristic of the circuit tested with all its defects enormously magnified (see Figs. 1 and 2). Because this display is produced by a subtraction process the term "difference diagram" has been chosen for it.

The technique has the special merit that transient or slowly changing distortion conditions can be observed. Moreover, although it is not put forward as a measuring technique, it is possible to read off from the difference diagram the magnitude of the primary distortion terms with useful accuracy, a procedure which is necessary when correlation with standard harmonic analyses is required.

Since distortion components as small as 0.1 per cent can be recognized under good conditions, this method of diagnosis is applicable to amplifiers, oscillators, and the like, which have to meet even the most stringent performance specifications.

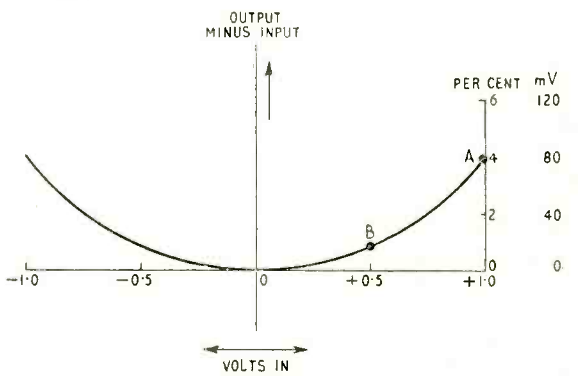
The equipment required is relatively simple and can be assembled from apparatus generally available in an audio-frequency laboratory.

Details of Apparatus. To understand the difference diagram, consider first the typical input/output transfer characteristic of a single-valve amplifier shown in Fig. 1. The curve for an ideal amplifier is represented by the dotted line with a slope of 45 degrees, and the difference (i.e., vertical intercept) between these two curves represents the departure of the system from the ideal conditions. In Fig. 2 this difference is shown, plotted in the form which has been called the difference diagram.



Left: Fig. 1. Ideal (dotted) and actual transfer characteristic of an amplifier.

Below: Fig. 2. "Difference diagram" corresponding to Fig. 1.



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