DISTORTION

By "CATHODE RAY"

What Do We Really Mean By It?

IF there had been any doubt about there being a great many people intensely interested in what our American friends call "hi fi," that doubt was dispelled last autumn by Mr. Briggs when he sold the full capacity of the Royal Festival Hall (sitting and standing) in the first four days, on an announcement that he was going to demonstrate loudspeaker reproduction in comparison with direct musical performances. It has been necessary to arrange a second house. And I remember being mightily astonished when the Editor told me how many copies of the Williamson amplifier reprint had been sold. All this being so, there is naturally a demand for some scale of measurement for comparing one piece of sound-producing equipment with another. The advertisement copy writers' "perfect reproduction," "no trace of distortion," "impeccable fidelity," "thrilling tone," etc., cut no ice at all with *Wireless World* readers. They very rightly want some definite figures of performance.

So most of the advertisements nowadays say "distortion at 12 watts output is not more than 0.3%," or whatever it may be. That is certainly an improvement in principle, but we may be forgiven for asking some questions. Is 0.3% good, bad or indifferent? If another make of amplifier distorts 0.3% at 12 watts can its fidelity be assumed to be the same? If it were 0.1% how much better would it sound? And if it were 1%—or 5%—how much worse?

Twenty-five to thirty years ago people were already taking quite a lot of interest in this matter of fidelity of sound reproduction, but the data then consisted of a graph of output against frequency—what is usually called a frequency characteristic. If it was in an advertisement, the scales were chosen so as to make the graph look as nearly as possible like a horizontal line drawn with a ruler. The thing was then described as "distortionless." To the best of my recollection, percentages were not mentioned. "Distortion" was generally understood to mean frequency distortion—the unequal amplification of different frequencies. The reason for this was that the most obvious shortcoming of the very early gear was its frequency characteristic, which consisted of a violent peak in the middle or upper middle, and very little else.

So far as amplifiers were concerned, it was a fairly easy development to obtain their frequency characteristic curves and to improve their design so as to flatten out the peak into a nearly level plateau extending over the useful frequency range. And so began an era in which high-fidelity enthusiasts vied with one another in smoothing out the last fraction of a decibel (a unit which by then had come into vogue) often regardless of the vastly greater irregularities in the characteristics of the loudspeaker and the room in which it was heard. There *is* a good reason for aiming at a very level amplifier characteristic, but even now some enthusiasts may not realize that it is not the avoidance of frequency distortion as such (for on that count a peak of the order of one decibel is quite unimportant) but the obtaining of maximum undistorted output. If one narrow band of frequencies is amplified 1db more than others, as shown in Fig. 1, the whole level of output has to be lowered 1db (e.g., from 10 watts to 8 watts) in order to avoid overloading. In other words, moderate frequency distortion is bad, not as frequency distortion but as a potential cause of overloading or non-linearity distortion.

Non-Linearity

As time went on and gross frequency distortion was eliminated, the possibilities of appreciable improvement of sound by further levelling out of frequency characteristics dwindled. "Distortion" ceased to be frequency distortion and became non-linearity distortion (commonly but illogically called "non-linear distortion"). Now this is where we must be clear about the meanings of terms. "Non-linearity" means lack of straightness or proportionality of a characteristic, expressed as a graph. The particular characteristic understood in this connection is the input/output characteristic of any part of the equipment. Ordinary resistors are linear, because the voltage across them is directly proportional to the

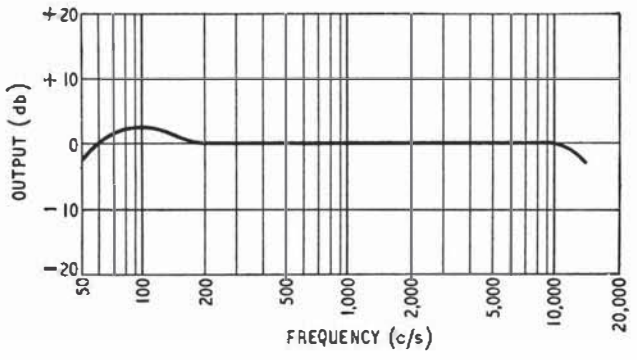

Fig. 1. Example of frequency distortion that is quite negligible as such, but should be avoided if the maximum undistorted power output is desired.

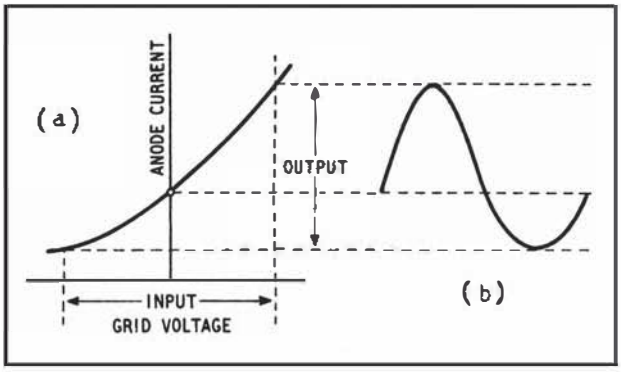

Fig. 2. Typical valve characteristic (a) with the curvature somewhat exaggerated we hope, showing the resulting distortion of a sine wave (b).