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APPLICATION NOTE ON AN AUDIO-FREQUENCY CURVE TRACER USING A CATHODE-RAY TUBE

A method of obtaining the frequency response characteristic of an audio-frequency amplifier is to apply a constant voltage at a number of frequencies to the input of the amplifier under test and to measure the corresponding voltage outputs. The results may be plotted, point by point, on semilog paper. Although the equipment for this method is relatively simple, the process is tedious and time consuming, particularly if the number of frequencies to be investigated is large.

Automatic recording equipment for tracing the frequency response characteristic of a-f amplifiers is available. The general principle of operation is to feed the output of an a-f oscillator to the input of the amplifier under test; the output of the amplifier operates a stylus which traces the frequency characteristic of the amplifier. The vertical deflection of the stylus may be proportional to the voltage output of the amplifier; the horizontal deflection is proportional to the logarithm of the frequency. In this type of equipment, it is important that the frequency of the oscillator's output voltage be proportional to the logarithm of the angular motion of the dial. In practice, this proportionality is maintained by providing means for calibrating the oscillator at a given point on the dial.

This Note describes a simple, inexpensive means for tracing automatically the frequency response characteristic of an a-f amplifier on the screen of a cathode-ray tube. The only equipment necessary is an a-f oscillator of conventional design, a cathode-ray tube, and a rectifier-amplifier system, shown in Fig. 1.

Description of Curve Tracer

Referring to the circuit of Fig. 1, it is seen that the output of the a-f oscillator connects to a resistance-capacitance network and to the input of the amplifier under test. The output of the resistance-capacitance network (the voltage across R) is proportional to the output voltage of the oscillator and approximately proportional to the logarithm of the oscillator frequency. Hence, for constant oscillator output voltage, the voltage across R varies only with frequency and is independent of the calibration of the oscillator. The voltage across R is rectified by one section of a 6H6; the rectified output is filtered by R_1C_1 and is applied to the input of a single-stage d-c amplifier. The output of the amplifier furnishes the voltage for the horizontal deflecting plates of the cathode-ray tube. Thus, the d-c voltage applied to these plates is proportional to the logarithm of the frequency.

The signal from the output of the amplifier under test is rectified by the second half of the 6H6; the rectified output is amplified by a 6J7; the d-c output of the 6J7 is applied to the vertical deflecting plates of the cathode-ray tube. The vertical deflection of the spot on the screen is directly proportional to the output voltage of the amplifier under test. To operate the device, it is only necessary to turn the oscillator dial through the frequency range of interest for the spot to trace the frequency characteristic of the amplifier.

The action of the resistance-capacitance network is interesting. The values of components were chosen so that a curve of output voltage vs frequency is a straight line on semilog paper over the frequency range of interest. A measured voltage characteristic of the network is shown in Fig. 2. The characteristic is nearly a straight line from 20 to 10,000 cycles. The curve becomes flat outside this frequency range, a condition which indicates constant deflecting voltage.

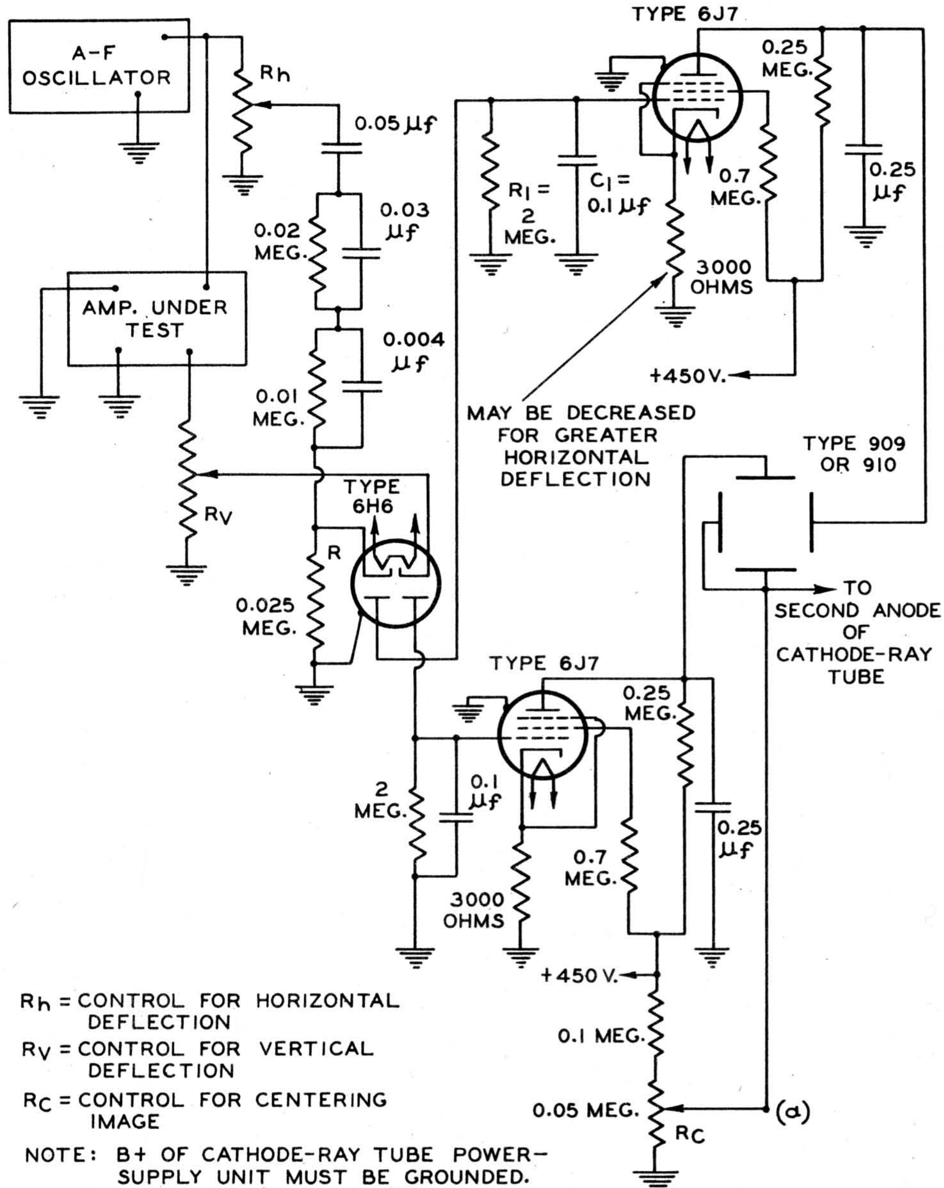
A long-persistence screen is used in the cathode-ray tube. This type of screen permits the entire trace to be observed for some time after the actuating signals are removed.

The time constants of the d-c amplifier restrict the time required to make a trace. When the oscillator dial is turned through a desired range too quickly, the trace will not show rapid changes in output due, for example, to resonant conditions in the amplifier. For the values shown in Fig. 1, about 30 seconds is required to make a trace.

The oscillograms in Figs. 3A and 3B show typical results. Fig. 3A shows the effect of disconnecting the voice coil of the speaker from an amplifier. Resonant frequencies are indicated by the peaks. Fig. 3B shows the effect of by-passing high audio frequencies with a tone control. Quantitative data may be obtained by calibrating the ordinate in terms of volttage and the abscissa in terms of frequency, as shown in these figures.

This curve tracer is suitable in the laboratory for determining quickly and with fair accuracy the effect of changes in amplifier design. It is also suitable for production testing of a-f amplifiers because of the relatively short time in which a characteristic can be obtained. A single test yields data on the gain of the amplifier throughout a frequency range of interest. The accuracy of the results is ample for most practical applications.

CIRCUIT OF CURVE TRACER



R_h = CONTROL FOR HORIZONTAL DEFLECTION

R_V = CONTROL FOR VERTICAL DEFLECTION

R_C = CONTROL FOR CENTERING IMAGE

NOTE: B+ OF CATHODE-RAY TUBE POWER-SUPPLY UNIT MUST BE GROUNDED. VOLTAGE FROM POINT (a) TO GROUND MUST BE ADDED TO CATHODE-RAY TUBE POWER-SUPPLY VOLTAGE TO OBTAIN TRUE VALUE OF SECOND ANODE VOLTAGE.

FIG. 1

NETWORK CHARACTERISTIC

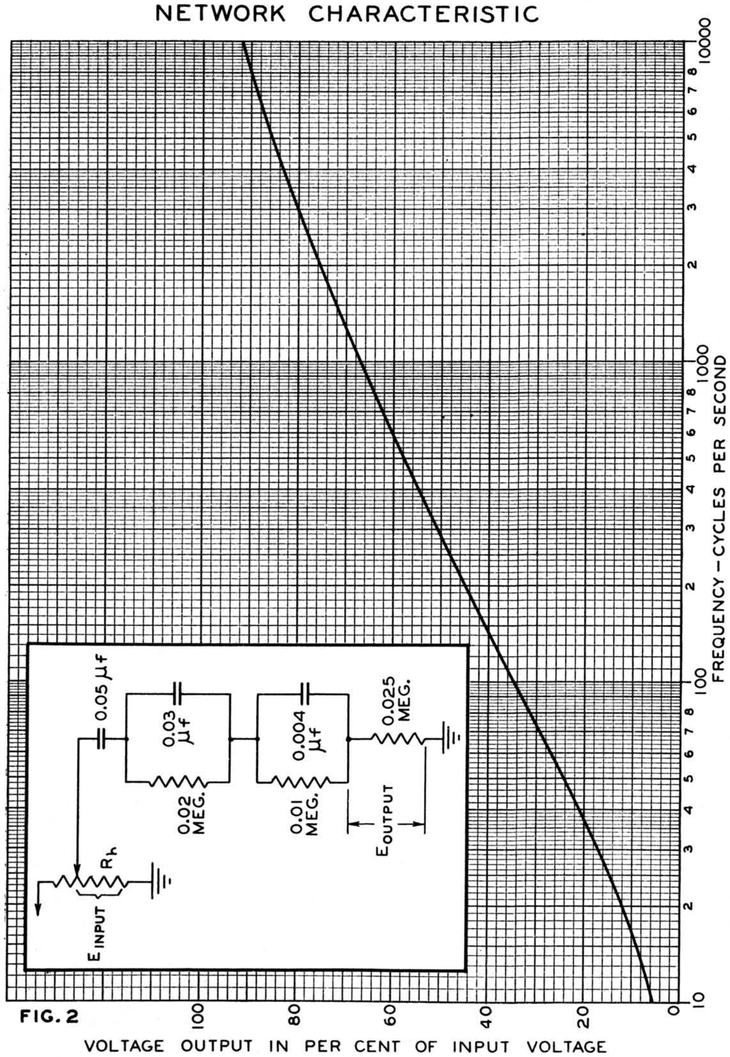


FIG. 2

TYPICAL FREQUENCY RESPONSE CHARACTERISTICS FROM CURVE TRACER

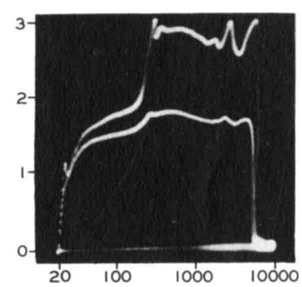


FIG.3A-CURVES SHOWING EFFECT OF SPEAKER LOAD

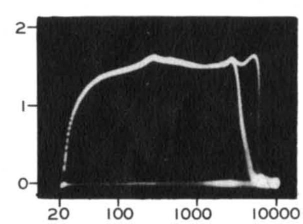


FIG.3B-CURVES SHOWING EFFECT OF TONE CONTROL