

The conception of this unit and its development into a practical transmission meter was by J. K. Hilliard, *Transmission Engineer*; the design and construction of the automatic recording unit was under the direction of G. M. Sprague, *Engineer*, and the new type of drive and warble unit was developed by O. L. Dupy, *Recording Engineer*, all of the Sound Department, M-G-M Studios.

This equipment has proved a very valuable tool in the measurement of filters, equalizers, calibration of microphones, acoustic response of loud speakers, and in the standardization of review rooms. The characteristics of prints, printers, and noise and signal components from film have also been studied at length to great advantage.

A CURVE-PLOTTING TRANSMISSION METER*

L. A. AICHOLTZ**

The most important feature of the transmission recording meter described here is the compressor circuit. Fig. 1 shows the complete measuring system, comprising an oscillator, at the center, the compressor circuit at the left, and the recording meter at the right. The object next to the meter is a device made to hold a 630 microphone and either a 705 or D-97689 Western Electric headphone for making routine microphone and headphone measurements.

The oscillator is an RCA serviceman's oscillator, with a few refinements and a new panel which mounts the synchronous motor drive and other accessories. The recording meter is an Esterline Angus recording milliammeter, also with synchronous motor drive.

The purpose of the compressor circuit (Fig. 2) is to obtain a current in the recording meter having a straight-line relationship in decibels to the input signal. If for this purpose we employ a vacuum tube V_2 having its input circuit arranged like the familiar grid-leak-and-condenser detector, the bias for this tube, normally at zero, will increase negatively for any input signal, up to a value that is approximately equal to the positive peak value of the input signal, and the plate current will decrease accordingly. Fig. 3 shows that for minimum signal the plate current is maximum.

If, then, the tube used has a grid voltage-plate current characteristic that is logarithmic, the change of d-c. plate current will bear the desired relation to the a-c. signal. The best vacuum tubes available for this purpose are the so-called "super control" or variable- μ tubes, such as the RCA type 58. If one such tube is used in position V_2 the input signal-output characteristic will be as shown by curve OA of Fig. 3. Note that this curve is reasonably straight over a range of 10 or 12 decibels. However, a much greater range is desired, and it is possible to employ a second tube for this purpose, so connected as to place its response curve at the position BD . The departures from linearity of the two tubes are

* Presented at the Spring, 1937, Meeting at Hollywood, Calif.; received May 18, 1937.

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then nearly balanced out, and we obtain the long and more or less straight curve *OC*.

Referring to Fig. 2, this is accomplished by V_3 , whose plate current also passes

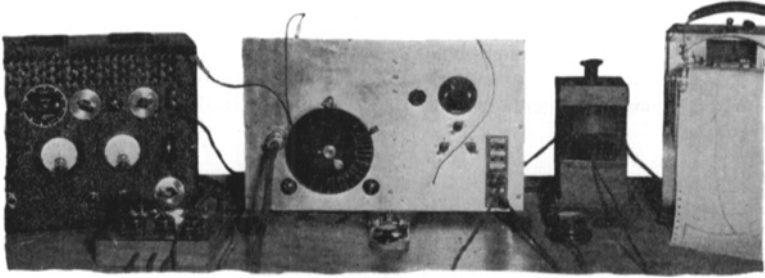


FIG. 1. Complete measuring set-up.

through the recording meter. Its input signal is kept small compared to that of V_3 , so that it does not contribute any reduction of the total plate current until the signal voltage is high enough to reach the knee of curve *OA*. The input signal of V_3 is controlled by the "overlap" adjustment.

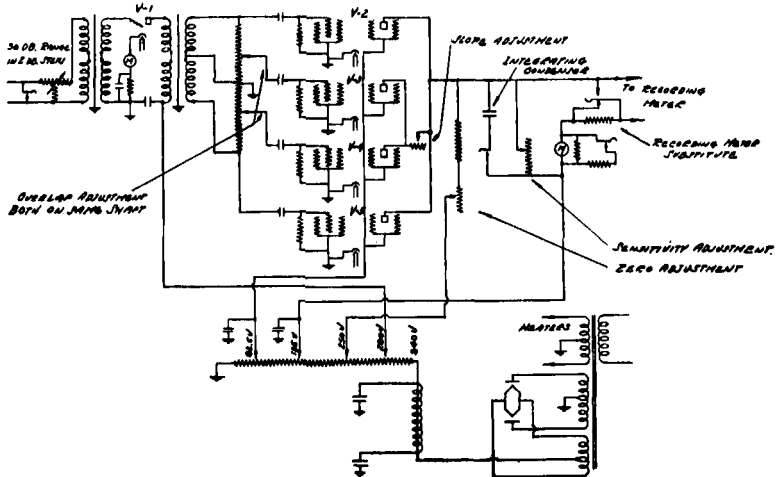


FIG. 2. Compressor circuit.

The unwanted steepness of the upper part of *OC* (Fig. 3) results from the continued slight rise of *OA* beyond the point of overlap. Compensation is attained by introducing a resistance in the plate circuit of V_3 which we call a "slope" adjustment, and which causes this second tube to contribute proportionately less

as the signal voltage rises. The resulting overall curve *OD* is the experimental calibration of the instrument. When these two adjustments are at their optimum, the instrument provides a linear response over a 30-db. range. The slope adjustment resistance is in the portion of the plate circuits common to V_3 and V_4 (Fig. 2).

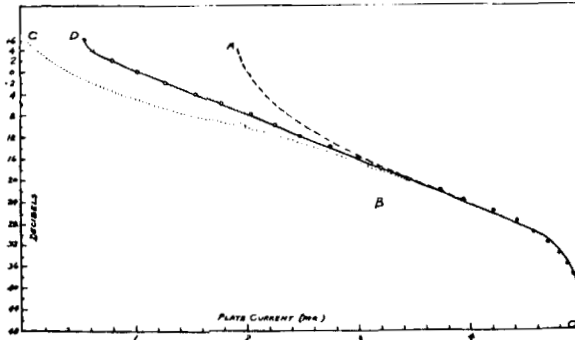


FIG. 3. Calibration of compressor circuit.

As mentioned above the device responds to the peak value of input signal. In cases where the signal wave-form is asymmetrical the meter response will be different according to the poling of the various circuits under test. To avoid errors that might inadvertently arise from such cause, the circuit is made symmetrical by adding V_5 and V_6 in push-pull relationship to V_2 and V_3 .

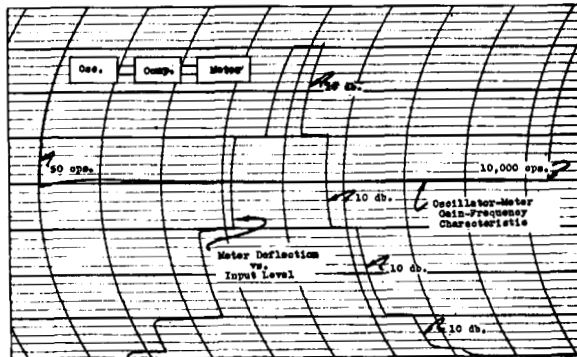


FIG. 4. Meter calibrations and response in 10-db. steps.

Other features of the circuit include a visually read panel meter in series with the recording meter; a substitute resistance to keep the visual meter sensitivity standard when the recording meter is out of circuit; a doubling shunt to protect the visual meter during line-up; a common sensitivity adjustment for both meters; an adjustable biasing current common to both meters, to adjust the meters to

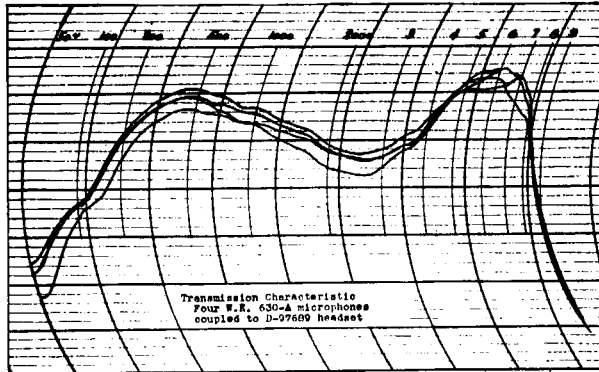
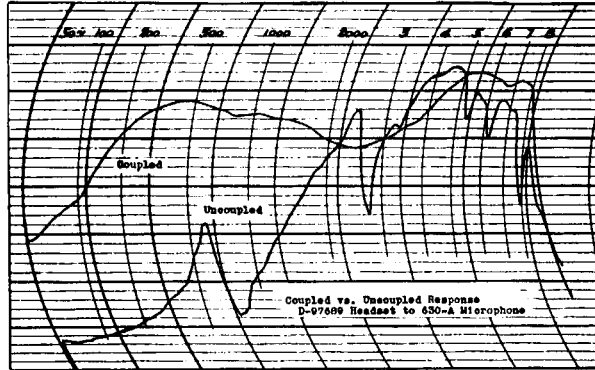
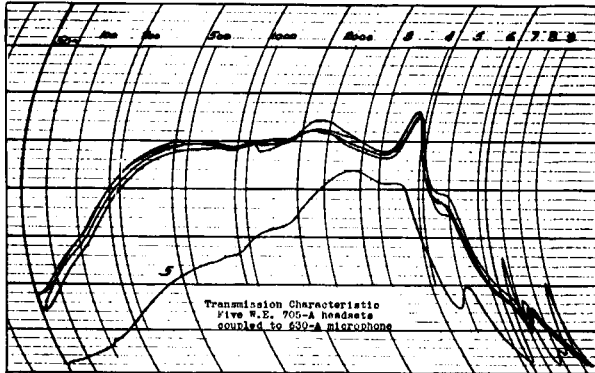


FIG. 5 (Upper). Transmission characteristics of headsets.
 FIG. 6 (Center). Effect of coupling between headset and microphone.
 FIG. 7 (Lower). Transmission characteristics of microphones.

full scale for zero signal; and a large-capacity shunt condenser may be inserted across both meters in order to obtain a partially integrated result with a rapid sweep frequency when making acoustic measurements. This integration accomplishes much the same result in avoiding standing-wave patterns as would a warble tone at discrete frequencies.

Fig. 4 shows the meter calibration, and also the response in 10-db. steps, of which 3 steps are linear. To demonstrate some of the duties performed by this meter, Fig. 5 shows a series of curves run on five 705 Western Electric headphones, the first four being regarded as normal, while the fifth, due to rough handling, is obviously defective.

The measurements were made by placing the headphone in close contact with a Western Electric 630-A microphone, and sealed with a rubber coupling approxi-

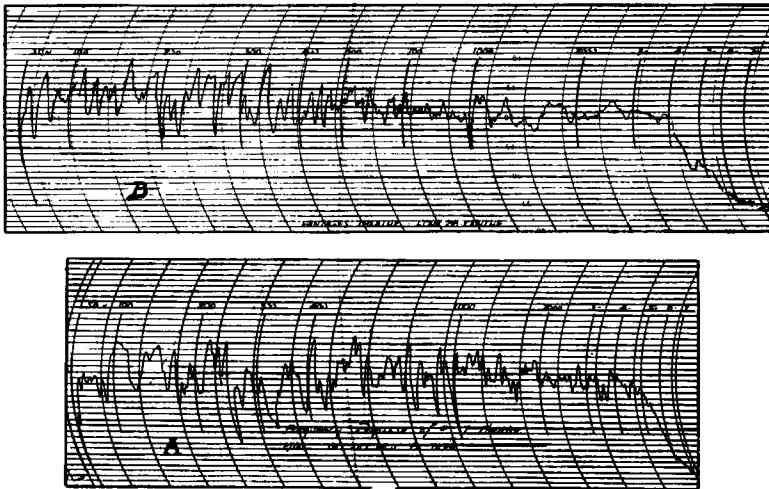


FIG. 8. Acoustic curves of (A, lower) review room and (B, upper) Pantages Hollywood Theater.

mately $\frac{1}{2}$ inch thick. The device to hold headphone and microphone for these curves is shown in Fig. 1 next to the recording meter.

Fig. 6 shows the effect of air leakage when the rubber seal between the headphone and microphone is omitted.

Fig. 7 is a comparison of several 630-A microphones using the seal between microphone and headphone. We also find this equipment very useful in balancing the acoustic characteristics of review rooms.

Curve A of Fig. 8 shows an acoustic run in our review room No. 7. This was made by placing a microphone near the rear of the theater, and from a continuous frequency film run on the projector a chart of the acoustic output was made on the recording meter.

Pantages Theater in Hollywood is now being used as our yard-stick for sound

quality, and curve *B* (Fig. 8) shows the acoustic run made in the 26th row center of the main floor. This curve is $\frac{1}{6}$ longer than curve *A*, due to the fact that the recording meter motor was operated on 50-cycle supply for curve *A* and 60-cycle for curve *B*. An integrating condenser of 50 μf was used in each case.

These runs are not intended to prove or disprove any theory about the characteristic of headphones, microphones, or theaters, but are intended as means of making routine checks of equipment and to correlate listening tests with actual measurements.

A CURVE-PLOTTING TRANSMISSION METER*

L. D. GRIGNON**

The need for a curve-plotting transmission meter has frequently been felt by every engineer in acoustics and transmission work, but up to the present the available meters have had very definite limitations as to characteristics or price. Following is a description of a meter constructed at a reasonable cost and having certain desirable characteristics.

One great advantage of a curve-plotting transmission meter is the saving of time effected when a great many measurements are to be made, such as tests of various circuits or circuit combinations, acoustic runs at various points in a room, or routine tests of many individual pieces of equipment. In deciding upon the requirements of such a meter it is apparent that a linear decibel scale should be used, and, further, the frequency coördinate should be logarithmic; in other words, coördinates similar to those of the semi-log plotting paper used by engineers for plotting transmission characteristics. Having such a set of coördinates, preliminary inspection of curves may be made without resorting to a transparent calibrating scale. This practice would not be strictly necessary if paper rolls having a frequency scale printed thereon were readily available, and provided that some such scale could satisfactorily be made standard by the users of similar meters.

Oscillator Drive.—A Western Electric 13-A oscillator being the only one available at the moment, a design was produced wherein a small motor of $\frac{1}{70}$ hp. drives the oscillator condenser through a gear reduction system, a friction wheel, and an odd-shaped cam to convert the angular frequency scale of the oscillator to a frequency scale that is logarithmic with respect to time. The gear ratio and chart speeds were selected to obtain a scale the length of a piece of Codex No. 3115 semi-log plotting paper. The gear reduction system consists of one set of worm gears and one set of bevel gears having ratios of 80:1 and 4:1, respectively, or a total reduction of 320:1, placed in a duralumin housing. A long spring provides a minimum of pressure against the cam where pressure is least needed and increases the pressure as the friction wheel arrives at the smaller cam radii. The approximate cam design was obtained by computation and graphical methods, and the cam was then cut slightly larger than the calculated dimensions. By

* Presented at the Spring, 1937, Meeting at Hollywood Calif.; received May 21, 1937.

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