The GENERAL RADIO EXPERIMENTER

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ELECTRICAL COMMUNICATIONS TECHNIQUE AND ITS APPLICATIONS IN ALLIED FIELDS

NEW DEVELOPMENTS IN ELECTRON OSCILLOGRAPHY

FEW laboratory instruments have undergone more changes in recent years than the cathode-ray tube. All of these changes have been in the direction of longer life, lower cost, and increased simplicity of accessories, combining to produce equipment of so compact and inexpensive a nature as to open up new fields to this type of oscillography.

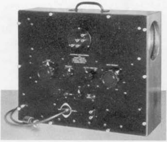
The cathode-ray type of oscillograph is, of course, old, but early tubes combined short life and high price with a complication of accessory apparatus—even including a vacuum pump in some early models—which limited the use of cathode-ray tubes to those laboratory applications where this type of oscillograph was absolutely necessary, and the tubes were almost never used outside of the laboratory.

Cheaper tubes of longer life were an early by-product of television experiments. Among the first of these to be popularized for general laboratory use was the von Ardenne tube announced with the necessary accessory apparatus by the General Radio Company. While these tubes were far more satisfactory for laboratory applications than earlier types, the cost was still relatively high in view of the tube life and the assembly left some considerable room for further refinements, although for the first time cathode-ray tubes became extensively used for general oscillography.

Further developments in this country have resulted in a line of high-vacuum tubes at greatly reduced cost which have been produced by several manufacturers. In an effort to make cathode-ray equipment further available for general testing work, the General Radio electron oscillograph was announced, which included in a single unit a cathode-ray tube and power supply.* This popular unit which could be carried about conveniently has been extensively used in schools and plants, replacing mechanical-element types of oscillograph in certain types of work.

Many types of oscillograph applications require a sweep circuit to obtain a time axis. Recent developments in tubes and circuits have permitted a

*The General Radio *Experimenter* for June-July, 1933.



The new Electron Oscillograph (TYPE 687-A) includes sweep circuit and power supply

greatly simplified type of sweep circuit, and we are now announcing the TYPE 687-A Electron Oscillograph and Sweep Circuit* which includes sweep circuit, power supply, and tube in a single portable unit entirely operated from the alternating-current line.

The significance of this development can best be appreciated by a comparison with the earlier two- and three-unit equipment which could not be conveniently carried by one person and required a great deal of setting up and connecting before the equipment was ready for use. The new apparatus is as convenient to use as a voltmeter. It requires only connection to the line and to the source of voltage which is being examined. This simplicity will undoubtedly increase the popularity of the cathode-ray tube for general oscillography. From the most complicated and inconvenient type of oscillograph it has become the simplest, most portable, and easily operated. All of these improvements are accompanied by a large reduction in cost and increase in life.

The oscillograph is ideally suited to measurements of modulation with a sinusoidal waveform. The oscillograph may also be used with a linear sweep for providing a continuous check upon modulation, since a single glance at the modulation envelope pattern will show whether or not overmodulation is taking place.

The oscillograph can be used without the sweep circuit for measuring percentage modulation by means of the familiar trapezoidal patterns. This allows an accurate measurement under steady state conditions.

The TYPE 687-A Electron Oscillograph and Sweep Circuit uses a 5-inch tube with electrostatic deflecting plates. The construction and theory of such tubes have been discussed in previous issues of the *Experimenter*.† While the linear sweep circuit is included in the equipment, switching is provided so that the instrument can be used either with or without a sweep circuit. Both pairs of deflecting plates are brought out and are available for external connections, permitting operation of either pair of plates balanced or unbalanced to ground.

The sweep circuit is of the stabilized type, which can be made to lock in step with a recurrent waveform. This feature allows careful visual study, or photographic reproduction, of recurrent audio-frequency waveforms and other phenomena.

The tube supplied as initial equipment is the General Radio TYPE 687-P1 Electron Oscillograph Tube (RCA-905 or equivalent). The impedance of the deflecting-plate circuits is about 15 micromicrofarads. The deflection sensitivity for vertical deflection is about 75 d-c volts per inch. The sensitivity

*U. S. Patent 1,707,594.

†May and June, 1932, and November, 1933.

for the horizontal deflecting plates is about 90 d-c volts per inch.

Mechanically, the equipment is assembled in a carrying case of convenient dimensions with handle, making it easily portable.

Dimensions: (Length) 19⅝″ by (width) 8¼″ by (height) 17¾″ over-all.
Weight: 37¼ pounds.
Price: $180.00, including all tubes.
Code Word: CRISP.

[NOTE: The TYPE 687-A Electron Oscillograph and Sweep Circuit was designed by H. H. Scott and E. Karplus.
—EDITOR]

NEW ACOUSTIC RESPONSE RECORDER

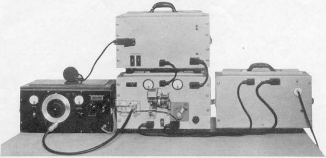


FIGURE 1. The high-speed level recorder. At the left is a General Radio TYPE 613-B Beat-Frequency Oscillator, in the center is the recording unit and its associated amplifier, and at the right a battery box

"TO supplement and augment their theoretical information, engineers have had to seek the aid of instruments. As has been the case with most work in acoustics, recent or otherwise, and because the field is a comparatively unexploited one, instruments have had to be developed especially for the purpose. One of the devices that has just become available is the high-speed level recorder,* which has already proved its value in conducting measurements of reverberation time and frequency response. Its name suggests its purpose: it automatically records sound intensity levels as they fluctuate at a point.

"Figure 1 is a photograph of the meter, designed by the Bell Telephone Laboratories, set up for synchronous operation with a beat-frequency oscillator. Excluding the oscillator, there are three separate units: the recording unit proper, its associated amplifier, and a battery box. The record is impressed on a moving waxed paper strip by a stylus which follows the changes of the sound intensity. The speed of the paper may be varied in three steps from 3/64 inch per second to 3 inches per second. The stylus also may be adjusted to follow changes of intensity from 45 decibels per second to as much as 360 decibels per second. By driving

*WENTE, E. C., BEDELL, E. H., and SWARTZEL, K. D.: "A High-Speed Level Recorder for Acoustical Measurement," presented at the May, 1933, meeting of the Acoustical Society of America.

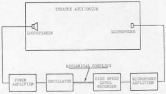


FIGURE 2. Schematic diagram of the acoustic response measuring equipment

the paper and the oscillator frequency control synchronously, the horizontal axis may be made proportional to the frequency instead of to the time.

"Figure 2 is a schematic drawing of the recorder as it is used for determinations of loudspeaker response in auditoriums. It is obvious that by means of such an arrangement measurements can be made expeditiously and automatically, and that, therefore, very complete information concerning the performance of a loudspeaker in a given auditorium can readily be obtained. Figure 3 is an example of such a study. The sound intensity level at a point in a theater is given as a function of the frequency from 0 to 10,000 cycles. It will be noted that the response falls off above 4000 cycles. In this

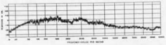


FIGURE 3. Typical frequency response characteristic

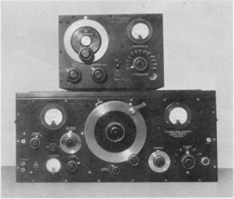
particular instance, the loudspeaker input circuits were adjusted to produce such an effect in order to avoid accentuation of the (high-frequency) surface noise very prominent in the older recordings. By conducting several such tests at representative points in a theater, valuable information concerning the distribution of sound energy, the over-all response of the system, resonances, and peculiarities of the auditorium may be ascertained."

The oscillator (at the left) is a General Radio TYPE 613-B Beat-Frequency Oscillator whose main tuning control is driven from the high-speed level recorder in the center by a flexible shaft.

[EDITOR'S NOTE—This description is from a paper "Acoustical Requirements for Wide-Range Reproduction of Sound," by S. K. Wolf of Electrical Research Products, Inc., New York, appearing in the April, 1934, issue of the *Journal* of the Society of Motion Picture Engineers. The quoted material and the three illustrations are reprinted through courtesy of the *Journal*.]

NEW YORK ENGINEERING OFFICE

IN order that engineering information may be more readily available to our clients in the New York Metropolitan area we have opened an office at 90 West St., New York City. The telephone is Cortlandt 7-9382. While Mr. Myron T. Smith of our general engineering staff at Cambridge will be at the New York office a large part of the time, other engineer members of our Cambridge staff will be there from time to time. Correspondence regarding general matters should continue to be sent to Cambridge, Massachusetts.

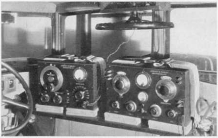


Small size standard-signal generator built by Jansky and Bailey for field intensity survey work. The calibrated attenuator is the same one used in the General Radio Type 603-A Standard-Signal Generator shown in the cabinet beneath the Jansky and Bailey unit

Jansky and Bailey field car No. 3; C. M. Jansky, Jr., at the right, M. M. Garrison at the left

"COVERAGE SERVICE A SPECIALTY"

BROADCASTING stations sell time on the air on the basis of coverage, *i.e.*, the number of listeners in the station's service area. C. M. Jansky, Jr., and S. L. Bailey, consulting engineers, operating as the firm of Jansky and Bailey, Washington, D. C., were among the first to advocate the field intensity survey as a method of putting coverage determinations on a scientific measurable basis. The accompanying photographs show some of the equipment used by Jansky and Bailey.



The interior of field car No. 3 showing the signal generator unit at the left and a receiver at the right. The hand wheel for orienting the loop is shown at the top of the photograph

ANTENNA MEASURING SET*

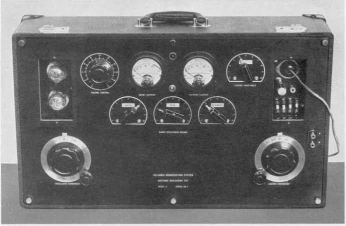


FIGURE 1. Front view of the CBS antenna measuring set

"THE impedance of the transmitting antenna and its transmission line are two of the most important constants in the equipment of a radio broadcasting station. Knowing these values, it is possible for the engineer to determine the power actually delivered to the antenna by the transmitter, the constants of the coils or condensers necessary to tune the antenna to resonance, and the proper method to follow in coupling together the antenna, the transmission line, and the transmitter. These problems must be solved during the lining-up period of a radio station.

"In the case of a low-powered transmitter, a cut and try procedure is satisfactory. But when the radio engineer is faced with the installation of a modern, high powered radio transmitter which must operate at the highest efficiency possible, the requirements are more rigid. Approximations which might be overlooked in the adjustment of a smaller transmitter would then result in the loss of many kilowatts of valuable radio-frequency power and the probability of burnout or damage to expensive equipment.

"To date there has been available no compact field equipment for use in antenna and transmission line work. Due largely to this lack of equipment, radio engineers familiar with this type of work require anywhere from two to eight weeks to properly adjust the radiating equipment of a high powered broadcast transmitter. Furthermore, if the problem is complicated by the requirements of a directive antenna system, or the reduction of harmonic radiation, longer periods of adjustment may be necessary before the station is ready for year-in and year-out operation. Therefore, engineering expenses of such work become quite appreciable.

"With the engineering of a large number of radio transmitters under the supervision of New York headquarters, the technical department of the Columbia Broadcasting System found it necessary to develop a convenient and accurate antenna measuring set.

"The set is designed to measure the impedance of any antenna from 0.1 to 0.9 wavelengths long, giving the resistive and reactive components. It may also be used to determine the characteristic impedance and the electrical length of two-wire or concentric tube radio-frequency transmission lines. And, what is probably the greatest time saver, this unit also measures the terminating impedance at the antenna end of the transmission line. All of these values must be determined to properly engineer a large broadcast installation."

The set is also designed to measure the impedance of any radio-frequency network whose resistive component does not exceed 1000 ohms. The frequency range is 500 kc to 1800 kc and the unit is a-c operated.

Mr. Lodge's article in *Radio Engineering* shows a wiring diagram and gives instructions for making measurements of resistance and reactance with the unit. The use of the equipment for measuring the surge impedance of transmission lines is also discussed.

Mr. Lodge incorporated a large number of General Radio laboratory accessories in the design of this instrument.

*Abstract from "Antenna Measuring Set" by W. B. Lodge of the Columbia Broadcasting System appearing in *Radio Engineering* for April, 1934.

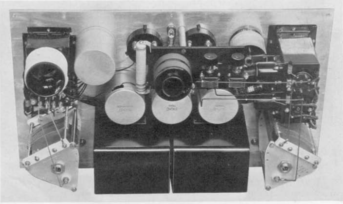
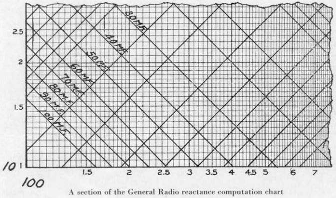


FIGURE 2. Behind the panel of the antenna measuring outfit. Note in particular the General Radio TYPE 539 Condensers, the TYPE 510 Decade-Resistance Units, and the General Radio power-transformer and rectifier-filter units

HELP IN COMPUTING REACTANCE-RESONANCE PROBLEMS

The June, 1928, issue of the General Radio *Experimenter* included a graphical chart by means of which the reactance of a condenser or an inductor could be determined for any frequency. Separate copies of this chart were printed and there still remains a fair quantity available for distribution.

Anyone desirous of obtaining one of these charts, which is printed on a sheet of heavy bond paper 12 inches x 18 inches, can secure it by writing the Advertising Department, General Radio Company. First come first served.



A section of the General Radio reactance computation chart

The General Radio Company mails the Experimenter, without charge, each month to engineers, scientists, and others interested in communication-frequency measurement and control problems. Please send requests for subscriptions and address-change notices to the

GENERAL RADIO COMPANY

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