Abstracts of Technical Articles from Bell System Sources

Reverberation Time and Absorption Measurements with the High Speed Level Recorder.[1] E. H. BEDELL and K. D. SWARTZEL, JR. It has been common in reverberation theories to neglect the effect of the stationary wave pattern in a room and to assume a logarithmic decay of the sound energy. In many cases this assumption of a constant decay rate is not fulfilled, and in particular it is well known that the decay curves as obtained with available instruments, which indicate either the pressure or the velocity at a point in the sound field, show marked fluctuations in the decay rate. The rate of decay, in general, varies during the decay period, from point to point in the room, and may depend upon the position of the sound source, and the location of absorbing materials. Very rapid fluctuations in the decay rate have commonly been averaged out by the measuring apparatus itself, either by making the indicating instrument sluggish in its action, or by measuring the average intensity over finite time intervals during the decay period. The slower, and perhaps more important, deviations from linearity in the decay curves have been either reduced, or averaged out, by a number of expedients. Among these are the use of rotating sound reflectors, or vanes, to break up the stationary wave pattern in the room; the use of frequency modulated, or warble, tones in place of a constant single frequency; moving the microphone to a number of positions in the room; and moving the sound source. Hunt has given some quantitative data on the effect of the warble tone, but similar data on other methods of smoothing out the decay curves are not available. This paper presents some data on the relative value of the above methods of improving the measured decay curves, and on the use of a motor driven rotating switch to connect in rapid sequence a number of microphones, placed in different parts of the room, into the measuring apparatus, for obtaining on a single curve a space average of the time decay pattern. Since many of the deviations from linearity in the decay curves have a "period" of 30 db or more, we should expect the accuracy of our values to be a function of the range through which the decay is measured, particularly when the range is not large compared to the period of the deviations. This effect is discussed for three values of the decay range, 30, 60 and 90 db.

[1] *Jour. Acous. Soc. Amer.*, January, 1935.

Standardization of Noise Meters.[2] R. G. McCURDY. A brief review of the present status of standardization of noise meters and measurements, and progress made to date by the technical committee on noise meters and noise levels of the American Standards Association.

A Rotating Mirror Oscilloscope.[3] R. F. MALLINA. When studying sound it is sometimes useful to project the wave-form of electrical or acoustical phenomena on a screen. A rotating mirror in combination with a vibrating mirror and a light source provide a convenient means of showing such waves. The problem of building an instrument for such a purpose is comparatively simple if a small screen is used in a dark chamber. However, when the screen is large enough to be viewed by a dozen or more persons, many difficulties arise.

The paper describes how the various parts of the apparatus may be coordinated in order to produce a comparatively bright, clearly defined wave with a small incandescent lamp in a room of average illumination. The vibrator used in the apparatus may be so constructed that its response is either inversely proportional to or independent of the frequency.

Shot Effect and Thermal Agitation in an Electron Current Limited by Space Charge.[4] G. L. PEARSON. The space current in a thermionic vacuum tube is not a steady flow of electricity but is subject to minute irregular fluctuations. The two most fundamental causes for these fluctuations are the random distribution of instants of emission of the individual electrons and the distribution of these electrons in velocity. The random emission produces shot noise which may be reduced by the space charge surrounding the cathode, while the velocity distribution produces thermal noise and is dependent upon the temperature of the cathode.

Although plausible theories of these effects have been given they have never been checked by accurate experiments because of the difficulties involved. By using two electrode tubes capable of producing a large space charge such measurements have now been made and are reported in this paper.

Simple Theory of the Three-Electrode Vacuum Tube.[5] H. A. PIDGEON. The physical principles upon which the operation of the three-element vacuum tube depends are presented in simple form and the terms

[2] *Elec. Engg.*, January, 1935; *Indus Standardization*, January, 1935.
[3] *Jour. S.M.P.E.*, December, 1934.
[4] *Physics*, January, 1935.
[5] *Jour. S.M.P.E.*, February, 1935.

usually applied to the tube, its operation as an amplifier, and a simple approximate method for computing the power output and percentage of distortion are explained.

No new material is presented in the paper although some of it is presented from a somewhat different point of view from that usually found in the literature. An effort has been made to present in reasonably compact form the essential features of the subject most useful to engineers interested in vacuum-tube applications.

The subjects discussed include: the portion of electron theory upon which the fundamental principles of vacuum-tube operation are based; space charge, the three-halves power law, temperature and voltage saturation; characteristics of the three-element tube; definition and physical significance of the terms plate resistance, transconductance, and amplification factor; dynamic characteristics, power output, and distortion; various means of coupling the vacuum tube to its associated circuits; and means for testing vacuum tubes for adequate thermionic emission.

Coaxial Communication Transmission Lines.[6] S. A. SCHELKUNOFF. A non-mathematical discussion of the mechanism whereby energy may be transmitted over long distances at high frequencies by the use of "coaxial conductors" is presented in this paper. A coaxial system consists of a cylindrical conducting tube within which a smaller conductor is coaxially placed. Such conductors, which reduce interference and crosstalk, are applicable for the transmission of telephone, telegraph, and television signals over a very wide range of frequencies.

Some Aspects of Quality Control.[7] W. A. SHEWHART. The object of this paper is to make clear what is meant by quality in a practical objective way that is subject to experimental verification and to consider some aspects of the problem of control. As a basis for judging the quality of current product it is necessary to obtain first of all adequate information, in the most efficient manner, on which to render a judgment. This can be accomplished by providing an inspection specification which is distinct from the design specification. One specifies the quantity and kind of evidence that is required as a basis for judging whether or not the quality of the product will attain its goal; the other specifies the goal. Certain elements of uncertainty must be allowed for in setting the goal. The discussion closes by pointing out the necessity of keeping a running report or record of the

[6] *Elec. Engg.*, December, 1934.
[7] *Mech. Engg.*, December, 1934.

evidence used in judging the quality of current product as a part of any scientific plan of making use of hindsight as well as foresight in controlling quality.

The Ionizing Effects of Meteors.[8] A. M. SKELLETT. It is shown that a meteor of average velocity has enough energy to cause ionization of atmospheric gases by impact. Recent experimental work by Frische and others on collisions of ions is interpreted as supporting the hypothesis that meteoric collisions do result in ionization. The afterglow of nitrogen is considered as a possible example of the process by which a meteor train remains glowing for a period of minutes and the coincidence of the region in which such trains are generally observed and of the E region of the upper atmosphere is pointed out. The spectra of bright meteors, while not showing atmospheric lines, are shown not to be inconsistent with the above hypothesis.

The behavior of the transatlantic short-wave radio telephone circuits of the American Telephone and Telegraph Company, during 1930, 1931, and 1932, is examined for possible meteoric effects. It is concluded that, in general, a rather large shower is necessary to affect them appreciably. This was to be expected since these circuits are normally under a continuous bombardment by random meteors. It seems possible that a certain degree of the variability (rapid fading, etc.) of received signals over such paths is due to this bombardment.

Results of radio pulse studies of the upper atmosphere, particularly by Schafer and Goodall, which are strongly suggestive of meteoric ionization, especially at times of special meteoric activity, are (1) sudden increases in ionization in the E region lasting for a period of minutes or less, and (2) increases of longer duration with maxima coincident in time with those of observed meteoric activity. Such tests made during the Leonid shower of November, 1932, were successful in correlating sudden increases in ionization in the E region with the visual observations of a number of bright meteors passing overhead. For the brightest meteor observed, the ionization increased to a value in excess of summer noon conditions.

It is pointed out that meteoric showers might take place in the F region which would be unobservable by ordinary visual means.

Taking into account the energy spent by the meteor in ionization, a mass for the brightest meteor, for which correlative data was obtained is roughly calculated to be 0.3 gram. Its estimated brightness was -1 magnitude.

The recombination coefficient at the height of the E region is calcu-

[8] *Proc. I.R.E.*, February, 1935.

lated from the rate of decrease of ionization after the passage of a meteor, to be less than 0.2×10^{-8} cubic centimeters per second.

Small Sapling Method of Evaluating Wood Preservatives.[9] R. E. WATERMAN and R. R. WILLIAMS. Permanence and toxicity are probably the most necessary characteristics of a wood preservative. Ease of injection, freedom from corrosive properties, cleanliness, cost, and the like are all important, but no material can be considered unless it displays a high degree of resistance to wood-destroying fungi and unless this toxic potency persists when the treated wood is exposed to the weather for long periods of time. The problem under discussion is that of appraisal of wood preservatives for these two characteristics within a reasonably short time.

In order to expedite tests of the permanency of pole preservatives, use is made of groups of small pine saplings treated with the preservative in question and set in the ground as miniature telephone poles. In these specimens weathering is relatively rapid on account of the large ratio of surface to volume, and poorly preserved material begins to decay in one or two years. Analyses and toxicity tests as well as observations of decay are made periodically. Seven years' experience indicates that the comparative preservative values of various salts, creosotes, oils, etc., may be estimated relatively cheaply, quickly, and with considerable reliability by this method.

A High Speed Level Recorder for Acoustic Measurements.[10] E. C. WENTE, E. H. BEDELL and K. D. SWARTZEL, JR. Two quite accurate means for recording rapid variations in sound intensity in a form suitable for visual inspection have been available for a number of years. One of these is the phonodeik, or one of its variants, and the other is a combination of a microphone and an oscillograph. When properly designed these devices record the actual wave form of the sound. However, for many acoustic measurements, a knowledge of the wave form is of secondary interest, whereas it is important that one should be able to record rapidly varying mean intensities over a wide range of values. From a record of the wave form it is not easy to determine the intensity with any degree of accuracy for a range greater than 20 or 30 db, but in some types of acoustic measurements it is highly desirable that the record cover a range of at least 60 db. Recently several types of instruments have been built which record, on a logarithmic scale, the mean power of the electrical input. These instruments, like that described here, may be used to plot the intensity

[9] *Indus. and Engg. Chem. (Analytical Edition)*, November 15, 1934.
[10] *Jour. Acous. Soc. Amer.*, January, 1935.

level in db as a continuous function of either time, frequency, or any other variable. The adaptability of such level recorders to acoustic measurements depends, among other factors, upon the range and accuracy of the logarithmic scale, and upon the effective speed of the recording mechanism. This recording speed is most conveniently expressed in terms of the rate, in db per second, at which the recorder is capable of following changes in the input power.

The level recorder described here consists essentially of an amplifier and rectifier, the output current of which is held at a substantially constant value automatically by a change in the gain of the amplifier, following changes in input power. The gain is varied by means of motor driven slide wire potentiometers graduated in logarithmic steps, the gain settings of which are recorded.

Some Applications of Modern Acoustic Apparatus.[11] S. K. WOLF and W. J. SETTE. Within the past two years there have been developed at the Bell Telephone Laboratories several electro-acoustic instruments designed to facilitate accurate measurement of a wide variety of acoustic phenomena. Three of these instruments are: an automatic level recorder, a crystal analyzer, and an acoustic spectrometer. Some of the types of acoustic studies for which these modern devices are well adapted may be of general interest and hence specific applications made at Electrical Research Products are described here. These include reverberation measurements, loud speaker response measurements, noise analyses, piano tone analyses, and studies on the singing voice. A brief description of the operating characteristics of the instruments is first given.

[11] *Jour. Acous. Soc. Amer.*, January, 1935.