Abstracts of Bell System Technical Papers Not Appearing in this Journal

Effect of Grounding on Telephone Interference.[1] J. J. PILLIOD. This paper, presented before the Pittsburgh Section of the Association of Iron and Steel Electrical Engineers in February 1928, is a rather complete although non-mathematical presentation of the inductive effects of power lines on nearby communication circuits. The production of noise on the latter circuits and the production of voltages sufficiently high to be prejudicial to the operators and users of these circuits are separately discussed. Comparisons are drawn between the inductive action of grounded and ungrounded power lines. Although free from mathematics, the paper gives a very good outline of the interference problem and points out the many opportunities presented for cooperative effort both in connection with original design and with reduction of interference on existing lines.

A Modification of the Rayleigh Disk Method for Measuring Sound Intensities.[2] L. J. SIVIAN. The usual procedure is to measure the deflexion of the disk under the influence of a steady sound-field. This paper outlines a procedure which has been found useful when the sound amplitude can be made a suitable function of time. The scheme depends on the fact that the torque which the sound-wave exerts on the disk is a non-linear function of the sound amplitude, being proportional to the square of the air particle velocity. The amplitude of the sound-wave to be measured is modulated with a frequency equal to that of the free vibration of the suspended disk. The measurement requires reading the amplitude of oscillations corresponding to the modulating frequency, rather than a steady deflexion of the disk. The disturbances caused by spurious air currents are largely reduced. In addition, in many practical cases at least, there is a gain in absolute sensitivity. Both theory and experimental verification are given.

Reflection of Electrons by a Crystal of Nickel.[3] C. J. DAVISSON and L. H. GERMER. This is a report of some preliminary results obtained in a new series of experiments in which a beam of electrons exhibits the properties of a beam of waves. In previous experiments (*Phys. Rev.*, 30, 705, 1927) a beam of electrons was directed at normal inci-

[1] *Iron and Steel Engineer*, Vol. V, pages 147–155, April 1928.
[2] *The London, Edinburgh, and Dublin Philosophical Magazine, and Journal of Science*, Vol. 5, No. 29, March 1928, pp. 615–620.
[3] *Proceedings of the National Academy of Sciences*, April 15, 1928, Vol. 14, No. 4, pp. 317–322.

dence against a face of a nickel crystal, and observations were made upon the diffraction beams which issued from the incidence side of the crystal at various critical speeds of bombardment. It was anticipated that if the angle of incidence were made other than zero a beam of electrons would be found issuing from the crystal at a series of critical speeds in the direction of regular reflection, and that the series of critical speeds would change with the incidence angle. This regularly and selectively reflected electron beam which is the analogue of the Bragg x-ray reflection beam has been found, and measurements have been made upon it. In the x-ray phenomenon the wave-length of the reflected beam at maximum intensity is related through a simple formula to the angle of incidence and a dimension of the reflecting crystal. This formula (Bragg's formula) does not obtain in the case of electron reflection because of the refraction of the electrons by the crystal. The departures from the Bragg relation are used to calculate indices of refraction of nickel for electrons of various speeds or wave-lengths.

Introduction to Mathematics of Statistics.[1] R. W. BURGESS. This book (282 pp.) discusses the best elementary methods of statistical analysis from the standpoint of a beginner who has had one year of college mathematics, or some practical statistical experience and the ordinary high school mathematics. "Statistical Analysis" is regarded in this book as the logical process by which large masses of quantitative facts may be classified, summarized, analyzed, and compared so as to yield reliable conclusions.

The topics treated include classification, formation of statistical series, use of ratios and percentages in statistical analysis, meaning and graphic discussion of frequency distributions, averages, index numbers, measures of dispersion, trend lines, analysis of seasonal variation, two-, three-, and four-variable correlation, and the elements of sampling and probability. Emphasis is placed on the type of statistical problems most common in the social sciences, in which the data are subject to a higher degree of variability than in the usual problems in physics or astronomy which require the use of the theory of least squares or the Gaussian "curve of error."

The Use of a Moving Beam of Light to Scan a Scene for Television.[2] F. GRAY. The paper is a discussion of a method of scanning employed in the television system demonstrated a year ago at the Bell Telephone Laboratories. A three-dimensional subject is scanned directly by a

[1] Houghton-Mifflin Company.
[2] *Journal of the Optical Society of America*, Vol. 16, pp. 177–190, March 1928.

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moving beam of light to produce a picture current in photoelectric cells. This method permits the use of a very intense transient illumination and more than one large-aperture photoelectric cell to collect reflected light. These two factors give a highly efficient optical system for producing a picture current at a transmitting station. The image seen at a distant station is the same as if light came out of the photoelectric cells to illuminate the subject and a small aperture lens formed an image of the subject for transmission. The television system transmits only the spacial variations of brightness and not the absolute brightness of the view; consequently, an additional steady illumination of a subject does not affect the reproduced image.

Maintaining High Standards in Products.[1] E. D. HALL. This article presents briefly but clearly the essential features of a method of keeping before the management an accurate picture of the relative quality of manufactured products. Defects are grouped into four classes and given demerit grades that represent the seriousness of the fault. Defects found each month are added, reduced to an average value, and plotted on charts which as a reference base use the average quality of the preceding five years. A method of computing averages for an entire line of products is also given.

Probability and Its Engineering Uses.[2] THORNTON C. FRY. This book of 470 pages on the Theory of Probability is written from the standpoint of the engineer. Its earlier chapters deal with the fundamental mathematical concepts that underlie the theory, and its later chapters develop these concepts in the directions of their application to traffic and trunking problems, curve fitting, and atomic physics.

Among the subjects which receive especial emphasis are: the logical standing of attempts to determine the probability of an event by trial; the physical significance of the fundamental distribution laws, such as the Normal, the Binomial, and the Poisson Law; Pearson's criterion for "goodness of fit"; and trunking problems.

Differential Intensity Sensitivity of the Ear for Pure Tones.[3] R. R. RIESZ. The ratio of the minimum perceptible increment in sound intensity to the total intensity, $\Delta E/E$, which is called the differential sensitivity of the ear, was measured as a function of frequency and intensity. Measurements were made over practically the entire range of frequencies and intensities for which the ear is capable of sensation. The method used was that of beating tones, this method giving the

[1] "Manufacturing Industries," Vol. 16, No. 1, pp. 17–19, May 1928.
[2] D. Van Nostrand Company.
[3] *The Physical Review*, May 1928, Vol. 31, No. 5, pp. 867–875.

simplest transition from one intensity to another. The source of sound was a special moving coil telephone receiver having very little distortion, actuated by alternating currents from vacuum tube oscillators. Observations were made on twelve male observers. Average curves show that at any frequency $\Delta E/E$ is practically constant for intensities greater than 10^6 times the threshold intensity; near the auditory threshold $\Delta E/E$ increases. Weber's law holds above this intensity, the value of $\Delta E/E$ = constant lying between 0.05 and 0.15, depending on the frequency. As a function of frequency $\Delta E/E$ is a minimum at about 2500 c.p.s., the minimum being more sharply defined at low sound intensities than it is at high. This frequency corresponds to the region of greatest absolute sensitivity of the ear. Analytical expressions are given (Eqs. (2), (3), (4), and (5)) which represent $\Delta E/E$, within the error of observation, as a function of frequency and intensity. Using these equations, it is calculated that at about 1300 c.p.s. the ear can distinguish 370 separate tones between the threshold of audition and the threshold of feeling.

Use of the Noble Metals for Electrical Contacts.[1] E. F. KINGSBURY. The paper describes the results of an investigation of the behavior of gold, silver and the platinum metals as electrical contacts in communication circuits. Platinum has heretofore been considered the standard although some alloys of the platinum metals have been used in especially severe conditions. The economic situation has, however, encouraged the use of cheaper substitutes. Heretofore, accurate knowledge has not been available concerning the intrinsic merit of other materials. This problem is complicated by the various forms of discharges and mechanical conditions encountered in practice. The resistance, erosion, and transfer of contacts are discussed for a variety of materials under various circuit conditions and in different atmospheres.

Economic Aspects of Engineering Applications of Statistical Methods.[2] W. A. SHEWHART. This note calls attention to possible applications of modern mathematical statistical theory, to research, design, production, inspection, supply, and other engineering problems. Attention is given to certain general types of problems in the solution of which statistical applications have been made, and to the nature of the possible economies effected thereby. It is reasonable to believe that very definite economic advantages can be obtained in any large industry through such applications.

[1] Technical Publication No. 95, A. I. M. M. E., March 1928.
[2] *Journal of the Franklin Institute*, Vol. 205, March 1928, pp. 395–405.

Evaluating Quality in Heat-Treated High-Speed Steel by Means of the Milling Cutter.[1] J. B. MUDGE and F. E. COONEY. A test of heat-treated high-speed steel in the form of milling cutters, the variables having been reduced to a minimum, and the dulling point of the cutting edges of the tools determined by a recording wattmeter connected in the circuit of the motor of the milling machine. A "deadline" test resulted instead of the usual "breakdown" test.

It was found that:

Cutters of the same steel hardened by the same method check within limits that are sufficiently close for test purposes.

No cast cutter has been found to give results comparable to standard high-speed steel refined by suitable working. Cutters hardened by patented or salt bath processes have not given results comparable to standard high-speed steel hardened by the open fire method.

A Bridge Method for the Measurement of Inter-Electrode Admittance in Vacuum Tubes.[2] E. T. HOCH. A description is given of the Colpitts-Campbell bridge as applied specifically to the measurement of direct admittances in vacuum tubes. Data are given on several tubes.

On Electrical Fields near Metallic Surfaces.[3] JOSEPH A. BECKER and DONALD W. MUELLER. When an electron escapes from a metallic surface it passes through fields which tend to pull it back. Applied fields when properly directed partially neutralize the surface fields and hence reduce the work the electron has to do against these fields. That is why i, the thermionic current, increases steadily with F_a, the applied field. Quantitatively $d(\log_{10} i)/dF_a = (11600/2.3T)Xs$, where T is the temperature of the surface and s is the distance from the surface at which the surface field F_s is equal to F_a. Hence the slope of an experimental $\log i$ vs F_a curve at any F_a yields the value of s corresponding to F_s. For clean or atomically homogeneous surfaces experiment shows that the only force opposing the escaping electron is due to its image field; for composite surfaces other fields, which are ascribed to the adsorbed ions, are superposed on the image field. For 70 per cent thoriated tungsten this "adsorption field" is very large close to the surface and in a direction to help electrons escape; it decreases rapidly in strength as s increases until it is zero at about 15 atom diameters; here it reverses its direction and then increases in strength till it attains a maximum value of 8000 volts/cm. at 75 atom

[1] *Transactions of the American Society for Steel Treating*, February 1928, Vol. 13, No. 2, pp. 221–239.
[2] *Proceedings of the I. R. E.*, April 1928, Vol. 16, No. 4, pp. 487–493.
[3] *Physical Review*, Vol. 31, No. 3, March 1928, pp. 431–440.

diameters; beyond this distance it decreases steadily. The intense field close to the surface accounts for the decreased work function while the reverse field farther out accounts for the poor saturation at ordinary applied potentials.

The photo-electric long wave-length limit should be shifted toward the red by applied fields. This shift should be particularly noticeable for composite surfaces.

Direct Determination of Rubber in Soft Vulcanized Rubber.[1] A. R. KEMP, W. S. BISHOP, and T. J. LACKNER. A modification of the Wijs method is shown to be suitable for determining the rubber content of vulcanized rubber. A procedure for the direct determination of sulfur combined with rubber is also outlined, and the effect of compounding ingredients is shown.

Results of analyses of four reclaimed rubbers by the proposed and difference methods are given for comparison.

Photomicrography and Its Application to Mechanical Engineering.[2] FRANCIS F. LUCAS. This paper was presented at the annual meeting of the American Society of Mechanical Engineers during the week of December fifth, 1927. It discusses the difference between magnification and resolution and stresses the difficulties in obtaining clear-cut photomicrographs at high magnifications. Until comparatively recently 1500 diameters was thought to be the limit.

The ultra-violet microscope should, theoretically, give about double the resolution of one using visible light because of the shorter wavelength, but until recently this has not been the case. The paper explains a mechanical focusing method used in Bell Telephone Laboratories by which a series of photographs are taken with a change in focus of one sixteenth micron between successive exposures. A typical set of four successive exposures at 1800 magnifications is shown.

The photomicrography of steel is gone into at some length, several photographs at 3500 magnifications being shown in illustration. Special importance is laid on the preparation of samples as well as on careful focusing.

[1] *Industrial and Engineering Chemistry*, Vol. 20, No. 4, April 1928, pp. 427–429.
[2] *Mechanical Engineering*, Vol. 50, No. 3, pp. 205–212, March 1928.