

# Abstracts of Bell System Technical Papers\* Not Published in This Journal

ANDERSON, P. W.<sup>1</sup>

**Concept of Spin-Lattice Relaxation in Ferromagnetic Materials**, Letter to the Editor, *Phys. Rev.*, **88**, pp. 1214, Dec. 1, 1952.

BALASHEK, S., see K. H. Davis.

BAND, W., see R. A. Nelson.

BEACH, A. L., see J. J. Lander.

BELL TELEPHONE LABORATORIES Transistor Teachers Summer School.

**Experimental Verification of the Relationship Between Diffusion Constant and Mobility of Electrons and Holes**, *Phys. Rev.*, **88**, pp. 1368-1369, Dec. 15, 1952.

The relationship between diffusion constant and mobility, called the Einstein relationship has been experimentally verified for electrons and holes in germanium. This has been accomplished by measuring the rate of increase in half concentration width of a pulse of minority carriers moving in an electric field.

BIDDULPH, R., see K. H. Davis.

BRIDGMAN, D. C.<sup>2</sup>

**College Graduates and the Country's Telephone Industry**, *Jl. College Placement*, **13**, pp. 19-27, Oct., 1952.

BULLINGTON, K.<sup>1</sup>

**Radio Transmission Beyond the Horizon in the 40- to 4,000-Mc Band**, *I.R.E., Proc.*, **41**, pp. 132-135, Jan., 1953. (Monograph 2060).

Reliable signals have been received at distances of several hundred miles at frequencies of 500 and 3,700 mc. The median signal levels are 50 to 90

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<sup>1</sup> Bell Telephone Laboratories, Inc.

<sup>2</sup> American Telephone and Telegraph Company.

db below the free-space field, but are hundreds of db (in one case 700 db) stronger than the value predicted by the classical theory based on a smooth spherical earth with a standard atmosphere. Antenna gains and beam widths are maintained to a first approximation and no long delayed echoes have been found.

CLARK, A. B.<sup>1</sup>

**Development of Telephony in the United States**, A.I.E.E., Trans., Commun. and Electronics Sect., **71**, pp. 348-364, Nov., 1952 (Monograph 2045).

The telephone was invented twenty-four years after the founding of the American Society of Civil Engineers and Architects, which society commemorated its Centennial in September, 1952. The telephone was eight years old when the American Institute of Electrical Engineers was founded. Since Bell's invention, the telephone business has grown tremendously and this growth has been greatly dependent on developments in science and engineering. This paper traces, and endeavors to give the significance of, the major developments. Brief mention is made of some developments still in the making and of some ideas as to the future potentialities of the business.

CONWELL, E. M.<sup>1</sup>

**Mobility in High Electric Fields**, Phys. Rev., **88**, pp. 1379-1380, Dec. 15, 1952.

An extension of conductivity theory to high fields, subject to the usual simplifying assumptions, is carried out for the cases in which the change of energy of an electron in a collision can be neglected. This yields a relationship between mobility and relaxation time which is valid over a wide range of fields.

DAVIS, K. H.,<sup>1</sup> R. BIDDULPH<sup>1</sup> AND S. BALASHEK<sup>1</sup>

**Automatic Recognition of Spoken Digits**, J. Acoust. Soc. Am., **24**, pp. 637-642, Nov., 1952.

The recognizer discussed will automatically recognize telephone-quality digits spoken at normal speech rates by a single individual, with an accuracy varying between 97 and 99 per cent. After some preliminary analysis of the speech of any individual, the circuit can be adjusted to deliver a similar accuracy on the speech of that individual. The circuit is not, however, in its present configuration, capable of performing equally well on the speech of a series of talkers without recourse to such adjustment. Circuitry involves division of the speech spectrum into two frequency bands, one below and the other above 900 cps. Axis-crossing counts are then individually made of both band energies to determine the frequency of the maximum syllabic rate energy within each band. Simultaneous two-dimensional frequency portrayal is found to possess recognition significance. Standards are then determined, one for each digit of the ten-digit series, and are built into the recognizer as a form of elemental memory. By means of a series of calculations performed

<sup>1</sup> Bell Telephone Laboratories, Inc.

on the spoken input digit, a best match type comparison is made with each of the ten standard digit patterns and the digit of best match selected.

DICKTEN, E., see R. L. Wallace, Jr.

FELKER, J. H.<sup>1</sup>

**Typical Block Diagrams for a Transistor Digital Computer**, Elec. Eng., **71**, pp. 1103-1108, Dec., 1952 and A.I.E.E. Trans., **71**, pp. 175-182, 1952 (Monograph 2046).

The superior speed capabilities of vacuum tubes have led to their use in computer designs to replace relays. Because of their small size, low power consumption, and long life expectancy, it now appears that transistors will replace tubes as computer elements. Here is a study of binary computer functions in which transistors are employed.

FRAYNE, J. G.,<sup>6</sup> AND J. P. LIVADARY<sup>7</sup>

**Dual Photomagnetic Intermediate Studio Recording**, S.M.P.T.E., Jl., **59**, pp. 388-397, Nov., 1952.

Selected production magnetic tracks are transferred to a recorder which lays down collinear 200-mil push-pull direct-positive variable-area and magnetic tracks. Magnetic stripe is on base of photosensitive emulsion on the opposite edge of film from photo track. The photo track may be used for reviewing, cutting, etc. Re-recording is done from assembled magnetic tracks. This method combines advantages of photo track for editing and provides superior quality of magnetic track.

HAGSTRUM, H. D.<sup>1</sup>

**Electron Ejection from Mo by  $\text{He}^+$ ,  $\text{He}^{++}$ , and  $\text{He}_2^+$** , Phys. Rev., **89**, pp. 244-255, Jan. 1, 1953.

Total yield and kinetic energy distribution have been measured for electrons ejected from atomically clean and gas covered molybdenum by the ions  $\text{He}^+$ ,  $\text{He}^{++}$ , and  $\text{He}_2^+$ , in the kinetic energy range 10 to 1000 ev. Evidence is presented that one electron is excited into the kinetic energy continuum for each incident.  $\text{He}^+$  ion and that the electrons so excited are partially internally reflected at the potential barrier of the metal. The slowest ions observed were found to eject 0.25, 0.72, and 0.13 electron per ion for  $\text{He}^+$ ,  $\text{He}^{++}$ , and  $\text{He}_2^+$ , respectively. Total electron yield is found to be nearly independent of ion kinetic energy up to 1000 ev. This observation and that of the kinetic energy maximum for slow ions indicate that the electrons are released in an Auger type process for which the energy is supplied by the potential and not the kinetic energy of the ion (potential ejection). Electrons of kinetic energy greater than the upper limit predicted by present theory are observed for faster ions and are accounted for by the shift of the energy levels of the bombarding particle when it is near the metal surface. Some conclusions con-

<sup>1</sup> Bell Telephone Laboratories, Inc.

<sup>6</sup> Westrex Corporation.

<sup>7</sup> Columbia Pictures Corporation.

cerning reflection processes at a metal surface and the nature of electron ejection by the alpha-particle ( $\text{He}^{++}$ ) and the molecular helium ion ( $\text{He}_2^+$ ) come out of this work.

HEIDENREICH, R. D.<sup>1</sup>

**Methods in Electron Microscopy of Solids**, Rev. Sci. Instr., **23**, pp. 583-594, Nov., 1952 (Monograph 2047).

Methods of replicating solid surfaces for electron microscopy are reviewed and compared. Preparation of metal surfaces for electron microscopy is discussed, and the advantages of employing electron diffraction techniques in evaluating prepared surfaces are pointed out. Examples of the application of replicas include steel, precipitation in alloys, such as Alnico 5, and studies of slip in aluminum. Growth spirals on the surfaces of crystals of *n*-paraffins are demonstrated. The use of thin metal sections and of emission electron microscopy in studying metallic structures is discussed, and examples are given.

HUTCHINSON, A. R.<sup>3</sup>

**How to Conceal Telephone Wires, Keep Desks Neat, Standardization**, **23**, p. 407, Dec., 1952.

JAKES, W. C., JR.<sup>1</sup>

**Theoretical Study of an Antenna-Reflector Problem**, I.R.E., Proc., **41**, pp. 272-274, Feb., 1953.

This paper gives the results of a theoretical investigation of an antenna used with a plane reflector. This finds application in microwave relay stations, where the antenna is placed at ground level facing up and the reflector is located some distance above it. The results given show that there are certain values of  $\lambda$ , separation distance, reflector and antenna size for which the received power is greater than for the same antenna alone at the elevated location.

KAPLAN, E. L.<sup>1</sup>

**Tensor Notation and the Sampling Cumulants of *k*-Statistics**, Biometrika, **39**, pp. 319-323, Dec., 1952.

Now and then in the literature one finds results relating to multivariate distributions which are derived virtually independently of, or with considerable effort from, the corresponding univariate relations, whereas they are in fact only very mild generalizations of the latter, as will be shown. Only the familiar concepts of moments, characteristic functions, cumulants, and *k*-statistics and their sampling cumulants will be discussed here. It should be emphasized that these concepts are identical with those ordinarily used in multivariate situations; the only novelty lies in the concise manner of representing and handling them.

<sup>1</sup> Bell Telephone Laboratories, Inc.

<sup>3</sup> Western Electric Company, Inc.

KELLER, A. C.<sup>1</sup>

**Economics of High-Speed Photography**, S.M.P.T.E., Jl., **59**, pp. 365-368, Nov., 1952 (Monograph 2052).

The economics of the use of high-speed photography in research and development work are discussed. High-speed photography is a relatively new tool for engineers which can be used to measure mechanical or electrical effects or both at the same time. Examples are given which illustrate the savings in engineering manpower as well as in materials, devices and systems.

KERN, H. E., see J. J. Lander.

KOCK, W. E.,<sup>1</sup> AND R. L. MILLER.<sup>1</sup>

**Dynamic Spectrograms of Speech**, Letter to the Editor, J. Acoust. Soc. Am., **24**, pp. 783-784, Nov., 1952.

KOCK, W. E.<sup>1</sup>

**Problem of Selective Voice Control**, J. Acoust. Soc. Am., **24**, pp. 625-628, Nov., 1952 (Monograph 2048).

The development of devices which can be operated automatically from the phonetic content of speech may be viewed in terms of the more general problem of the reduction of channel capacity in communications systems. Significance has been observed in formant positions and movements as regard the identification of speech sound. The basic problems in the derivation of phonemes from the formant patterns are reviewed.

LANDER, J. J.,<sup>1</sup> H. E. KERN<sup>1</sup> AND A. L. BEACH<sup>1</sup>

**Solubility and Diffusion Coefficient of Carbon in Nickel: Reaction Rates of Nickel-Carbon Alloys with Barium Oxide**, J. Appl. Phys., **23**, pp. 1305-1309, Dec., 1952.

Experimental values for the solubility of carbon in nickel in the range 700°C to 1300°C yield the equation  $\ln S = 2.480 - 4,880/T$ , where  $S$  is the solubility in grams of carbon per 100 grams of nickel. Values obtained for the diffusion coefficient in the same range fit the equation  $\ln D = 0.909 - 20,200/T$ , where  $D$  is in  $\text{cm}^2$  per second. These results are of some interest in the problem of the activation of thermionic oxide coated cathodes, and the experimental method used to measure the diffusion coefficients is related to phenomena occurring in vacuum tubes. To extend the usefulness of the results in this direction, rates of reaction between diffused carbon and barium oxide coatings on nickel have been measured. It was found that the rates are diffusion limited over a wide range of conditions of interest.

LEWIS, H. W.<sup>1</sup>

**Multiple Meson Production in Nucleon-Nucleon Collisions**. Revs. Modern Phys. **24**, pp. 241-248, Oct. 1952 (Monograph 2049).

LIVADARY, J. P., see J. G. Frayne

<sup>1</sup> Bell Telephone Laboratories, Inc.

LUKE, C. L.<sup>1</sup>

**Photometric Determination of Silicon in Ferrous, Ferromagnetic, Nickel, and Copper Alloys — A Molybdenum Blue Method**, Anal. Chem., **25**, pp. 148–151, Jan., 1952.

A simple, rapid photometric method for the determination of silicon in ferrous, ferromagnetic, nickel, and copper alloys has been developed. Wide applicability is its most unique and important feature. Interfering elements are removed by a carbamate-chloroform extraction and silicon is then determined by the photometric molybdenum blue method. Confirmatory data on a wide variety of samples of known silicon content are presented.

LUMSDEN, G. Q.<sup>1</sup>

**A Quarter Century of Evaluating Pole Preservatives**. Amer. Wood Preservers' Assoc., Proc., **48**, pp. 27–47, 1952 (Monograph 1999).

MACWILLIAMS, W. H., JR.<sup>1</sup>

**Computers — Past, Present, and Future**, Elec. Eng., **72**, pp. 116–121, Feb., 1953.

This article deals with the historical development of computers. It also discusses current problems and indicates future structural and functional computer trends which will help to free man from burdensome calculations and increase his material wealth while permitting him more time for pursuits not directly concerned with earning a living.

MILLER, R. L., see W. E. Koch.

MUMFORD, W. W.<sup>1</sup>

**Optimum Piston Position for Wide-Band Coaxial-to-Waveguide Transducers**<sup>2</sup> I.R.E., Proc., **41**, pp. 256–261, Feb., 1953.

A coaxial line can be matched to a waveguide by means of a probe antenna located ahead of a short-circuiting plunger. An impedance match can usually be achieved by varying any two of the following three dimensions: (a) the off-center position of the probe, (b) the probe length, (c) the piston position. This paper points out that there is, theoretically, an optimum piston position for greatest bandwidth, and presents some evidence corroborating this theory. Bandwidths greater than  $\pm 10$  per cent to the 1 db swr points have been realized by fixing the piston at its optimum position and varying (a) and (b) above to obtain a match.

NELSON, R. A.,<sup>1</sup> AND W. BAND<sup>4</sup>

**Vapor Pressure of  $\text{He}^3 = \text{He}^4$  Mixtures**, Letter to the Editor, Phys. Rev., **88**, p. 1431, Dec. 15, 1952.

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<sup>2</sup> American Telephone and Telegraph Company.

<sup>4</sup> State College of Washington.

OSBORNE, H. S.<sup>2</sup>

**A Rose by Any Other Name**, Report on Work of the Anglo-American Committee on Technical Terminology, Standardization, **24**, pp. 19-20, Jan., 1953.

PECK, D. S.<sup>1</sup>

**Ten-Stage Cold-Cathode Stepping Tube**, Elec. Eng., **71**, pp. 1136-1139, Dec., 1952 (Monograph 2054).

Developments in the art of transferring a gas discharge from one point to another in a multi-electrode tube have led to the design of a 10-stage counting tube operating up to about 2,000 pulses per second. Such a tube can be used for pulse counting, frequency division, time measurements, and similar functions.

PETERSON, G. E.<sup>1</sup>

**Information-Bearing Elements of Speech**, J. Acoust. Soc. Am., **24**, pp. 629-637, Nov., 1952.

This study deals with those aspects of speech which are phonetically significant. A technique has been developed with which phonetically equivalent speech samples may be obtained in different phonetic contexts and from different speakers. Data on two front vowels by different types of speakers are presented. The technique has also been applied to the evaluation of words containing these two vowels.

PIERCE, J. R.<sup>1</sup>

**New Method of Calculating Microwave Noise in Electron Streams**, I.R.E., Proc., **40**, pp. 1675-1680, Dec., 1952.

The noise in a temperature-limited electron beam in a drift space is calculated by a new means. Noise maxima and minima are found. The results agree with calculations made by the Rack-Llewellyn-Peterson method.

RICE, S. O.<sup>1</sup>

**Statistical Fluctuations of Radio Field Strength Far Beyond the Horizon**, I.R.E., Proc., **41**, pp. 274-281, Feb., 1953.

When a sinusoidal radio wave of extremely high frequency is sent out by a transmitter, the wave received far beyond the horizon is often observed to fluctuate. Here some of the statistical properties of this fluctuation are derived on the Booker-Gordon assumption; namely, that the received wave is the sum of many little waves produced when the transmitter beam strikes "scatterers" distributed in the troposphere. Expressions are obtained for the periods of the fluctuations in time, in space, and in frequency. These expressions extend closely related results obtained by Booker, Ratcliffe and others.

SCHIMPF, L. G., see R. L. Wallace, Jr.

<sup>1</sup> Bell Telephone Laboratories, Inc.

<sup>2</sup> American Telephone and Telegraph Company.

SMITH, K. D.<sup>1</sup>

**Properties of Junction Transistors**, Tele-Tech, **12**, pp. 76-78, Jan., 1953.

TOWNSEND, J. R.<sup>5</sup>

**What We Have Learned in 1952**, Standardization, **24**, pp. 16-18, Jan., 1953.

TOWNSEND, J. R.<sup>5</sup>

**What We Have Learned in 1952**, A Report to the Joint Meeting of Standards Council and Board of Directors of ASA, A.S.T.M. Bull., No. 187, pp. 22-23, Jan., 1953.

VAN ROOSBROECK, W.<sup>1</sup>

**Large Current Amplifications in Filamentary Transistors**, Letter to the Editor, J. Appl. Phys., **23**, pp. 1411-1412, Dec., 1952.

WALLACE, R. L., JR.,<sup>1</sup> L. G. SCHIMPF<sup>1</sup> AND E. DICKTEN<sup>1</sup>

**High-Frequency Transistor Tetrode**, Electronics, **26**, pp. 112-113, Jan., 1953.

Sine-wave oscillators at frequencies up to 130 mc and tuned amplifiers with substantial gain at frequencies of 50 mc or higher are obtained by using junction transistors with an added connection to the base electrode biased negative at six volts.

<sup>1</sup> Bell Telephone Laboratories, Inc.

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