Abstracts of Bell System Technical Papers* Not Published in this Journal

ANDERSON, J. R.[1]

Electrical Delay Lines for Digital Computer Applications, I.R.E., Trans. P.G.E.C., **2,** pp. 5–13, June, 1953.

A survey of existing lumped parameter and distributed parameter delay lines has shown that their maximum storage capacity is about 23 pulses and 15 pulses respectively regardless of total delay time. An analysis of pulse transmission through distributed delay lines indicates that dissipation in the inductive elements is the chief factor limiting storage capacity. A method is proposed for decreasing this dissipation through the use of high Q nickel zinc ferrites around straight conductors for inductive elements.

ARMSTRONG, C. A.[2]

Communications for Civil Defense, A.I.E.E., Trans., Commun. & Electronics, **7,** pp. 315–326, July, 1953.

BAROTTA, P. J., see S. P. GENTILE.

BIRDSALL, H. A., see D. A. MCLEAN.

BOGERT, B. P.[1]

On the Band Width of Vowel Formants, Letter to the Editor, J. Acoust. Soc. Am., **25,** pp. 791–792, July, 1953.

Measurements were made on a sample of vowel utterances, by male talkers, of the band widths of the first three formants. It was found that the band

* Certain of these papers are available as Bell System Monographs and may be obtained on request to the Publication Department, Bell Telephone Laboratories, Inc., 463 West Street, New York 14, N. Y. For papers available in this form, the monograph number is given in parentheses following the date of publication, and this number should be given in all requests.

[1] Bell Telephone Laboratories.

[2] American Telephone and Telegraph Company.

width was essentially constant and independent of the particular vowel. The mean values for bars 1, 2, and 3 were 130, 100, and 185 cps, respectively. Ten per cent of the 300 band widths measured were less than 90 cps and ten per cent greater than 260 cps.

BRANGACCIO, D. J., see C. C. CUTLER.

BRATTAIN, W. H., see A. M. PORTIS.

BULLINGTON, K.[1]

Frequency Economy in Mobile Radio Bands, I.R.E., Trans., P.G.V.C., **3,** pp. 4–27, June, 1953 (Monograph 2109).

CALBICK, C. J., see D. A. MCLEAN.

CAMPBELL, R. D.[2]

Path Testing for Microwave Radio Routes, Elec. Eng., **72,** pp. 571–577, July, 1953.

CAMPBELL, W. E.[1]

Solid Lubricants, Lubrication Eng., **9,** pp. 195–200, Aug., 1953.

CICCOLELLA, D. F.[1] AND L. J. LABRIE[1]

High Frequency Crystal Units for Use in Selective Networks and Their Proposed Application in Filters Suitable for Mobile Radio Channel Selection, I.R.E., Trans, P.G.V.C. **3,** pp. 118–128, June, 1953.

CONWELL, E. M.[6]

High Field Mobility in Germanium With Impurity Scattering Dominant, Phys. Rev., **90,** pp. 769–772, June 1, 1953.

Experimental measurements show a variation of mobility with electric field intensity of electrons in n type germanium which differs at 20 degrees K from that observed in the same specimen at 77 degrees K and higher temperatures. This difference can be accounted for by scattering by ionized impurities. A crude quantitative treatment is carried out along the lines of Shockley's treatment for the case of lattice scattering. As in that case, the resulting theory fits the data well if the rate of energy loss is taken several times higher than that given by the theory assuming that the surfaces of constant energy are spherical.

[1] Bell Telephone Laboratories, Inc.
[2] American Telephone and Telegraph Company.
[6] Formerly Bell Telephone Laboratories.

CUTLER, C. C.[1] AND D. J. BRANGACCIO[1]

Factors Affecting Traveling Wave Tube Power Capacity, I.R.E., Trans., P.G.E.D., **3,** pp. 9–23, June, 1953.

DACEY, G. C.[1]

Space-Charge Limited Hole Current in Germanium, Phys. Rev., **90,** pp. 759–763, June 1, 1953.

A situation can arise in semi-conductors similar to the space-charge limited emission of electrons in vacuum. The theory of Shockley and Prim for this phenomenon has been extended to the high field case using the approximation that the drift velocity of the carriers is $v = \mu(EE_0)^{1/2}$, where μ is the low field mobility, E the electric field, and E_0 the "critical field." For this approximation the current density analogous to Child's law for a plane parallel diode is

$$J = (2/3)(5/3)^{3/2} K \mu E_0^{1/2} V_a^{3/2} / w^{5/2},$$

where V_a is the potential across a diode of thickness w and K is the dielectric constant in mks units. Good agreement between theory and experiment for hole flow in germanium at liquid air temperature has been obtained, using values of μ and E_0 obtained independently by Ryder.

ESHELBY, J. D.[8], READ, W. T.[1] AND W. SHOCKLEY[1]

Anisotropic Elasticity with Applications to Dislocation Theory, Acta Metallurgica, **1,** pp. 251–259, May, 1953.

The general solution of the elastic equations for an arbitrary homogeneous anisotropic solid is found for the case where the elastic state is independent of one (say x_3) of the three Cartesian coordinates x_1, x_2, x_3. Three complex variables $z(\ell) = x_1 + p(\ell)x_2(\ell = 1, 2, 3)$ are introduced, the $p(\ell)$ being complex parameters determined by the elastic constants. The components of the displacement (u_1, u_2, u_3) can be expressed as linear combinations of three analytic functions, one of $z_{(1)}$, and of $z_{(2)}$, and one of $z_{(3)}$. The particular form of solution which gives a dislocation along the x_3-axis with arbitrary Burgers vector (a_1, a_2, a_3) is found. (The solution for a uniform distribution of body force along the x_3-axis appears as a by-product.) As is well known, for isotropy we have $u_3 = 0$ for an edge dislocation and $u_1 = 0$, $U_2 = 0$ for a screw dislocation. This is not true in the anisotropic case unless the x_1x_2 plane is a plane of symmetry. Two cases are discussed in detail, a screw dislocation running perpendicular to a symmetry plane of an otherwise arbitrary crystal, and an edge dislocation running parallel to a fourfold axis of a cubic crystal.

FULLER, C. S.[1] AND J. A. DITZENBERGER[1]

Diffusion of Lithium Into Germanium and Silicon, Letter to the Editor, Phys. Rev., **91,** p. 193, July 1, 1953.

[1] Bell Telephone Laboratories, Inc.
[8] University of Illinois.

GENTILE, S. P.[1] AND P. J. BAROTTA[4]

Transistor Physics Simplified, Radio and Telev. News, **50,** pp. 44–46, 100–102, July, 1953.

HINES, M. E.[1]

Traveling-Wave Tube, Radio and Telev. News, **49,** pp. 12–14, 26, June, 1953.

KOLB, E. D., see W. P. SLICHTER.

LABRIE, L. J., see D. F. CICCOLELLA.

LINVILL, J. G.[1]

Transistor Negative-Impedance Converters, I.R.E., Proc., **41,** pp. 725–729, June, 1953.

MAY, A. S.[1]

Microwave System Test Equipment, Commun. Eng., **13,** pp. 24–25, 44–45, May–June, 1953.

McKAY, K. G.[1]

Bombardment Conductivity, Ind. Diamond Rev., **13,** pp. 127–130, June, 1953.

McLEAN, D. A.,[1] BIRDSALL, H. A.[1] AND C. J. CALBICK[1]

Microstructure of Capacitor Paper, Ind. and Eng. Chem., **45,** pp. 1509–1515, July, 1953 (Monograph 2142).

McMILLAN, B.[1]

Basic Theorems of Information Theory, Ann. Math. Stat., **24,** pp. 196–219, June, 1953 (Monograph 2124).

This paper describes briefly the current mathematical models upon which communication theory is based, and presents in some detail an exposition and partial critique of C. E. Shannon's treatment of one such model. It then presents a general limit theorem in the theory of discrete stochastic processes, suggested by a result of Shannon's.

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[1] Bell Telephone Laboratories, Inc.
[4] Hudson Technical Institute.

MERTZ, P.[1]

Influence of Echoes on Television Transmission, J.S.M.P.T.E., **60,** pp. 572–596, May, 1953 (Monograph 2144).

PETERSON, G. E.[1]

Basic Physical Systems for Communication Between Two Individuals, J. Speech and Hearing Disorders, **18,** pp. 116–120, June, 1953 (Monograph 2135).

PIERCE, J. R.[1]

Transistors, Radio-Electronics, **24,** pp. 42–44, June, 1953.

PORTIS, A. M.,[7] A. F. KIP,[7] C. KITTEL,[7] AND W. H. BRATTAIN[1]

Electron Spin Resonance in a Silicon Semi-Conductor, Letter to the Editor, Phys. Rev., **90,** pp. 988–989, June 1, 1953.

PRIM, R. C., see W. SHOCKLEY.

QUARLES, D. A.[5]

Progress and Problems, Elec. Eng., **72,** pp. 667–669, August, 1953.

QUARLES, D. A.[5]

Report to the Membership, Elec. Eng., **72,** pp. 477–479, June, 1953.

READ, W. T., see J. D. ESHELBY.

RYDER, E. J.[1]

Mobility of Holes and Electrons in High Electric Fields, Phys. Rev., 90, pp. 766–769, June 1, 1953.

The field dependence of mobility has been determined for electrons and holes in both germanium and silicon. The observed critical field at 298 degrees K beyond which μ varies as $E^{-1/2}$ is 900 volts/cm for n-type germanium, 1400 volts/cm for p-type germanium, 2500 volts/cm for n-type silicon, and 7500 volts/cm for p-type silicon. These values of critical field are between two to four times those calculated on the basis of spherical constant energy surfaces in the Brillouin zone. A saturation drift velocity of $6(10)^6$ cm/sec is observed in germanium which is in good agreement with predictions based on scattering

[1] Bell Telephone Laboratories, Inc.
[5] Sandia Corporation.
[7] University of California, Berkeley.

by the optical modes. Data on n-type germanium at 20 degrees K show a range over which impurity scattering decreases and the mobility increases with field until lattice scattering dominates as at the higher temperatures.

SHOCKLEY, W., see J. D. ESHELBY.

SHOCKLEY, W.[1] AND R. C. PRIM[1]

Space-Charge Limited Emission in Semi-Conductors, Phys. Rev., **90,** pp. 753–758, June 1, 1953.

A situation analogous to thermionic emission into vacuum can occur in semi-conductors. A semi-conductor analog for a plane parallel vacuum diode may consist of two layers of n type semi-conductor bounding a plane parallel slab of pure semi-conductor. The current density analogous to Child's law is $J = 9\kappa\epsilon_0\mu V^2/8W^3$, where κ = dielectric constant, ϵ_0 = mks permittivity, μ = mobility, V = applied voltage, and W = thickness of pure region. The condition prevailing at the space-charge maximum is analyzed taking into account diffusion due to random thermal motion. Brief discussions are given of the effect of fixed space charge, the dependence of mobility upon electric field strength and the role of space-charge limited emission in a new class of unipolar transistors.

SLICHTER, W. P.[1] AND E. D. KOLB[1]

Solute Distribution in Germanium Crystals, Letter to the Editor, Phys. Rev., **90,** pp. 987–988, June 1, 1953.

TOWNSEND, J. R.[1]

A Dynamic Program for Conversion, Metal Progress, **63,** pp. 79–81, June, 1953.

TURNER, E. H.[1]

New Non-Reciprocal Waveguide Medium Using Ferrites, Letter to the Editor, I.R.E., Proc., **41,** p. 937, July, 1953.

WANNIER, G. H.[1]

Threshold Law for Single Ionization of Atoms or Ions by Electrons, Phys. Rev., **90,** pp. 817–825, June 1, 1953.

When an electron hits an atom or ion, it may knock off an electron. This process is fundamental in almost all types of gas discharge. The reaction is endothermic; hence there is a threshold value in the electron energy below

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which it does not occur. In this paper, the dependence of the yield on the energy just above this threshold is derived. The derivation is not rigorous because it circumvents some of the difficulties of the three-body problem by applying ergodicity, albeit in a weakened form. The result is that, for atoms, the yield rises as the 1.127th power of the energy excess. For ions the exponent lies between this number and unity.

WILLARD, G. W.[1]

Ultrasonically Induced Cavitation in Water: A Step-by-Step Process, J. Acoust. Soc. Am., **25,** pp. 669–686, July, 1953.

A 2.5-mc, barium-titanate, spherically focusing radiator was used to produce cavitation in both degassed and aerated water entirely within the restricted, high intensity focal region, remote from the water boundaries. The sonic intensity rises to 1.8 kw/cm^2 and the pressure amplitude to ± 70 atmospheres at the focus. High-intensity illumination and an unusual high speed photographic technique permit observation and timing of the step-by-step process of cavitation development.

Feather-shaped cavitation bursts are sporadically produced, being initiated in the insignificant quill portion nearest the radiator, then abruptly expanding to form the catastrophic plume portion. The plume is believed to be formed by myriads of microcavities, too small and close for individual observation. These two fundamental steps are identically produced, and with equal ease, both in degassed and aerated water. The whole action is over in several milliseconds, except that in the case of aerated water a third bubble step is produced. In aerated water, non-collapsing gas bubbles are generated by and concurrently with, the catastrophic step. These bubbles remain after collapse of the burst, to be blown off down stream by the sonically induced liquid streaming.

The bubble step is not generated without the presence of the catastrophic step. The latter is generated only if the initiation step reaches a definite degree of development (not always attained). This requires sonic activation for increasing lengths of time for decreasingly smaller sonic intensities. Origination of the initiation step, and hence of the whole cavitation phenomena, is believed to occur whenever a stray nucleus (weak spot) streams into the high intensity sonic field.

YOUNG, W. R.[1]

Comparison of Mobile Radio Transmission at 150, 450, 900 and 3700 Mc, I.R.E., Trans., P.G.V.C. **3,** pp. 71–83, June, 1953.

[1] Bell Telephone Laboratories, Inc.