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

AHEARN, A. J.,[1] AND H. B. HANNAY[1]

Formative of Negative Ions of Sulfur Hexafluoride, J. Chem. Phys., 21, pp. 119–124, Jan., 1953.

Negative ion production in SF_6 has been studied in a mass spectrometer; SF_6^-, SF_5^-, SF_2^-, F- were identified. The SF_6^- and SF_5^- are produced in very large quantities by a resonance capture process at an electron energy of about 2 ev, and are formed in approximately equal amounts. At higher electron energies, the same capture occurs by a secondary process, in which low energy electrons released by other excitation and ionization processes suffer the resonance capture. Partial dissociation after electron capture accounts for the appearance of F- and F_2^- ions below 16 ev. Above this energy, other processes will also produce these ions. Possible explanations of the primary resonance capture mechanism are discussed.

ANDERSON, F. B.[1]

Gain and Phase Angle Measuring Set, Elec. Eng., **72,** pp. 245, Mar., 1953.

Digest of paper "A 10-Cycle to 10-Megacycle Gain and Phase Angle Measuring set."

ARMSTRONG, C. A.[2]

Communications for Civil Defense, Elec. Eng., **72,** pp. 218–222, Mar., 1953.

BECK, A. C., see S. E. MILLER.

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* 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, Inc.

[2] American Telephone and Telegraph Company.

BECKER, J. A.,[1] AND C. D. HARTMAN[1]

Field Emission Microscope and Flash Filament Techniques for the Study of Structure and Adsorption on Metal Surfaces, J. Phys. Chem., **57,** pp. 153–159, Feb., 1953 (Monograph 2073).

With field emission electron microscopes one can see the structure of the surface of a single crystal at the tip of a metal "point." The magnification is about 10^6 and the resolution about 20×10^{-8} cm. At 2800°K, the surface of W point is hemispherical. Only the 110, 111 and 100 regions consist of small flat planes. In fields of 50 million volts/cm. and 1200°K. these planes enlarge. The edges of the planes are seen to be in violent agitation. Hence surface atoms are mobile at temperatures above one-third of the melting point. Ba atoms show surface mobility at 400°K. on the 110 and at 800°K. on the 100 planes. With the flash filament technique one can measure the rate at which N_2 is adsorbed on a W ribbon at low pressures. After N_2 has been absorbed for minutes at a low temperature, the ribbon is flashed at 2300°K. The sudden rise of pressure is recorded with an ion gage and measures θ, the layers adsorbed. From a family of θ versus time curves one calculates s, the sticking probability. For $T = 300$°K., $s = 0.55$ from $\theta = 0$ to 1.0. Then s decreases from 0.55 to about 4×10^{-4} for $\theta = 2.0$. These data yield an activation energy for the conversion of a molecule to two adatoms of about 100 cal./g. mole for $\theta = 0$ to 1.0 and 5000 cal./g. mole at $\theta = 2.0$. Other experiments yield 100,000 cal./g. mole for the heat of adsorption of 2 adatoms. The heat of adsorption of molecules is much smaller.

BOZORTH, R. M.,[1] AND R. W. HAMMING[1]

Measurement of Magnetostriction in Single Crystals, Phys. Rev., **89,** pp. 865–869, Feb. 15, 1953 (Monograph 2074).

A simplified procedure is given for determing the five magnetostriction constants of a single crystal of a ferromagnetic cubic crystal. The crystal is cut as a disk parallel to a (110) plane, and strain gauges are cemented to the surfaces to measure strains in (001) and (111) directions. A magnetic field sufficient for saturation is oriented in 10° steps at various angles to the (001) direction, and magnetostriction is measured over a 90° range for each gauge. Each of the 18 data is then multiplied by suitable numbers, obtained by inversion of the strain matrix, to give the constants $h_1 \ldots h_5$. The method is applied to a crystal of a 78 per cent nickel-iron alloy to determine the magnetostriction associated with spontaneous magnetization in the (111) direction: $\lambda 111 = 2h_2/3 + 2h_5/9$, a quantity important in the "Permalloy problem." The constants are also determined for a single crystal of nickel.

BOZORTH, R. M.,[1] AND J. G. WALKER[1]

Magnetic Crystal Anisotropy and Magnetostriction of Iron-Nickel Alloys, Phys. Rev., **89,** pp. 624–628, Feb. 1, 1953 (Monograph 2076).

[1] Bell Telephone Laboratories, Inc.

Single crystals of a number of iron-nickel alloys were prepared, and measurements made of the magnetic crystal anisotropy, and of the magnetostriction at saturation in different crystallographic directions, as dependent on the rate of cooling of the specimens after annealing. There is a large effect of the cooling rate on the anisotropy, for compositions near $FeNi_3$, where atomic ordering occurs. There is a definite but smaller effect of cooling rate on the magnetostriction. The composition for highest initial and maximum permeabilities is nearly that for which $\lambda 111$, the magnetostriction in the direction of easy magnetization, is equal to zero.

DALTON, A. G.[3]

Practice of Quality Control, Sci. Am., **188,** pp. 29–33, Mar., 1953.

Statistical analysis of manufacturing processes has become a powerful tool of technology. An account of how its principles are now applied in the factory.

DRVOSTEP, J. J.,[1] AND A. W. LEBERT[1]

Standardization of Rigid Coaxial Transmission Lines, Tele-Tech, **12,** pp. 78–79, Feb., 1953 (Monograph 2077).

DEHN, J. W., see R. W. Burns.

FELKER, J. H.[1]

Arithmetic Processes for Digital Computers, Electronics, **26,** pp. 150–155, Mar., 1953 (Monograph 2078).

Special codes and arithmetical processes enable digital computers to perform rapidly many heretofore laborious mathematical tasks. Review of these processes serves as introduction to newcomers to field and review for veteran computer engineers.

GOUCHER, F. S.,[1] AND M. B. PRINCE[1]

Interpretation of α-values in p-n Junction Transistors, Phys. Rev., **89,** pp. 651–653, Feb. 1, 1953 (Monograph 2068).

By the measurement of five parameters in several p-n junction transistors, viz., the conductivities and diffusion lengths of minority carriers in the emitter and base regions and the widths of the base regions, the current amplification factor α of the transistors has been computed from theory. Previous to this investigation two of the parameters associated with the thin p-layer had not been measured. The quantity α also was obtained independently by two alternate methods: (1) by measuring the collector-emitter current characteristic, and (2) by measuring the apparent quantum efficiency of the transistor as a two-electrode photocell with a floating base. The three determined values of α for each sample agree within the experimental error.

[1] Bell Telephone Laboratories, Inc.
[3] Western Electric Company.

HAMMING, R. W., see R. M. Bozorth.

HANNAY, N. B., see A. J. Ahearn.

HARTMAN, C. D., see J. A. Becker.

HEWITT, W. P., see W. P. Mason.

HULM, J. K., see B. T. Matthias.

JONES, H. L.[4]

Approximating the Mode From Weighted Sample Values, Am. Stat. Assoc., J., **48,** pp. 113–127, Mar., 1953.

The weighted mean of ordered sample observations can be used to approximate the mode under favorable conditions, where the weights are determined from the first two terms in a Taylor expansion of the maximum likelihood estimate. Such weights are shown in Table 1 for the case where the sample is selected from a *t*-distribution with known kurtosis.

LEBERT, A. W., see J. J. Drvostep.

LEWIS, H. W.[1]

Calibration of the Rolling Ball Viscometer, Anal. Chem., **25,** pp. 507–508, Mar., 1953.

MASON, W. P.,[1] W. H. HEWITT[1] AND R. F. WICK[1]

Hall Effect Modulators and "Gyrators" Employing Magnetic Field Independent Orientations in Germanium, J. Appl. Phys., **24,** pp. 166–175, Feb., 1953 (Monograph 2079).

Three uses for the Hall effect in germanium crystals are described. These are (1) use of Hall effect probes in measuring magnetic flux, (2) use of Hall effect in crystals to produce a pure product modulator, and (3) use of Hall effect in germanium crystals to produce a nonreciprocal transmission. If the resistances are shunted around such gyrators, the transmission can be made zero in one direction and finite in the other. In all these applications, use is made of a crystal orientation for which the cross magneto-resistance effects are zero and the Hall effect constant does not vary with field by more than 2 per cent out to a flux density of 20,000 gausses. This orientation was located by making a phenomenological study of the magneto-resistance and Hall effect corrections for a cubic crystal and evaluating constants experimentally. Correction terms to fourth and fifth powers of the magnetic field have been obtained.

[1] Bell Telephone Laboratories, Inc.
[4] Illinois Bell Telephone Company.

MATTHIAS, B. T.,[1] AND J. K. HULM[1]

Superconducting Properties of Cobalt Disilicide, Phys. Rev., **89,** pp. 439–441, Jan. 15, 1953.

A solid rod of cobalt disilicide was found to have a superconducting transition temperature close to 1.4°K, a critical field gradient of 146 gauss per degree at the transition point, an ice-point resistivity of 16.5 micro-ohm cm and a residual resistivity of about 16 per cent of the ice-point value.

MILLER, R. L.[1]

Auditory Tests with Synthetic Vowels, J. Acoust. Soc. Am., **25,** pp. 114–121, Jan., 1953.

The results are given for a series of phonetic evaluation tests which were made by means of synthetically produced vowel sounds. By employing synthetically produced sounds, a number of the significant parameters could be varied in an independent and systematic manner without encountering the uncertainties and limitations of the human speech mechanism. The types of parameter changes which were investigated by this means were those of fundamental frequency or pitch, formant frequency and amplitude, and, finally, the number of formants important to a sound. The results of the tests indicate that all of these parameters are important in the evaluation of the sound. In particular, there is a shift in the phonetic evaluation which can be attributed to pitch alone.

MILLER, S. E.,[1] AND A. C. BECK[1]

Low-Loss Waveguide Transmission, I.R.E., Proc., **41,** pp. 348–358 Mar., 1953 (Monograph 2080).

The circular electric mode in round metallic tubing becomes increasingly more attractive than the dominant mode from the standpoint of minimizing the waveguide size at frequencies above about 10,000 mc for the loss criterion of 0.25 db/100 feet. The circular electric (TE_{01}) mode also makes available a theoretical heat loss of 2 db/mile in waveguides less than 6 inches in diameter at frequencies higher than about 5500 mc. Increased transmission bandwidth, reduced delay distortion, and reduced waveguide size are factors favoring use of the highest practical frequency of operation. An increased number of freely propagating modes and smaller mechanical tolerances are the associated penalties. Experimental work has been carried out in the 9000-mc region using the TE_{01} mode in a pipe about 5 inches in diameter. Transmission of 0.1-μ sec pulses had been observed over a distance of 40 miles. Mode conversion and surface roughness of the tubing walls result in observed losses which average about 50 per cent higher than the theoretical values for geometrically perfect, smooth-walled tubing. There is included a brief discussion of several problems unique to transmission in a multimode medium, including pure mode generation, mode filtering, the bend problem, and the effects of mode conversion on transmission loss and signal fidelity.

[1] Bell Telephone Laboratories, Inc.

NYE, J. F. [1]

Some Geometrical Relations in Dislocated Crystals, Acta Metallurgica, **1,** pp. 153–162, Mar., 1953.

When a single crystal deforms by glide which is unevenly distributed over the glide surfaces the lattice becomes curved. The constant feature of distortion by glide on a single set of planes is that the orthogonal trajectories of the deformed glide planes (the *c*-axes in hexagonal metals) are straight lines. This leads to the conclusion that in polygonisation experiments on single hexagonal metal crystals the polygon walls are planes, while the glide planes are deformed into cylinders whose sections are the involutes of a single curve. The analysis explains West's observation that *c*-axes in bent crystals of corundum are straight lines. For double glide on two orthogonal sets of planes there is a complete analogy between the geometrical properties of the distorted glide planes and those of the "slip-lines" in the mathematical theory of plasticity. More general cases are discussed and formulae are derived connecting the density of dislocations with the lattice curvatures. For a three-dimensional network of dislocations the "state of dislocation" of a region is shown to be specified by a second-rank tensor, which has properties like those of a stress tensor except that it is not symmetrical.

O'CONNOR, S. F.[3]

Plating Room Waste Water Disposal, Metal Finishing, **51,** pp. 56–58, Feb., 1953.

OLSEN, K. M., see W. G. Pfann.

OWENS, C. D.[1]

Analysis of Measurements on Magnetic Ferrites, I.R.E., Proc., **41,** pp. 359–365, Mar., 1953 (Monograph 2075).

The unconventional behavior of permeability and core loss in the magnetic ferrites as compared to metals has led to a study of core-loss measurements. The relationships between the magnetic quality factor μQ and the characteristics of coils and transformers are developed, and the advantages of μQ as a parameter for the study and application of ferrites are discussed. A selected bibliography is given.

PFANN, W. G.,[1] AND K. M. OLSEN[1]

Purification and Prevention of Segregation in Single Crystals of Germanium, Letter to the Editor, Phys. Rev., **89,** pp. 322–323, Jan. 1, 1953.

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[1] Bell Telephone Laboratories, Inc.
[3] Western Electric Company.

PRINCE, M. B., see F. S. Goucher.

QUARLES, D. A.[5]

A.I.E.E. Progress, Elec. Eng., **72,** pp. 189–191, Mar., 1953.

In his address before the A.I.E.E. Winter General Meeting, President Quarles reviews some matters of current interest to the engineering profession, and to members of the Institute in particular.

RAE J. R.[2]

Microwaves from Coast-to-Coast, Gen. Elec. Rev., **56,** pp. 17–21, Mar., 1953.

STANSEL, F. R.[1]

Transistor Equations, Electronics, **26,** pp. 156–158, Mar., 1953 (Monograph 2066).

Circuit gain and impedance characteristics are given in terms of transistor parameters for grounded base, grounded emitter and grounded collector configurations. Simplifying approximations are given where appropriate.

VARNEY, R. N.[6]

Drift Velocity of Ions in Oxygen, Nitrogen, and Carbon Monoxide, Phys. Rev., **89,** pp. 708–711, Feb. 15, 1953 (Monograph 2081).

The drift velocities of ions of the parent gas in oxygen, nitrogen, and carbon monoxide have been measured as a function of field strength to pressure ratio by techniques previously reported. Oxygen gave results similar to those in the rare gases reported previously. A log-log plot of drift velocity against E/p_0 in volts/(cm/mm Hg) starts with a slope near unity which gradually decreases to one-half at high values of E/p_0. The mobility, extrapolated to zero field and atmospheric pressure is 2.25 cm²/volt-sec. Nitrogen and carbon monoxide both show a novel characteristic; the drift velocity first rises with E/p_0 but reaches a maximum and actually decreases, then finally resumes a more normal rise with E/p_0 as described for oxygen. It is believed that a high E/p_0 the drift velocity is characteristic of N_2 + ions and CO + ions, respectively. At low fields the ion in nitrogen is believed to be N_4^+. In CO the ion at low fields is believed to be CO^+, with $(CO)_2^+$ being formed at intermediate fields. The results are complicated by an additional ion which appears in the range of E/p_0 from 95 to 250 and which has a higher speed than the other ion. It is suspected of being C^+.

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[1] Bell Telephone Laboratories, Inc.
[2] American Telephone and Telegraph Company.
[5] Sandia Corporation.
[6] Washington University, formerly with Bell Telephone Laboratories.

WANNIER, G. H.[1]

Connection Formulas Between the Solutions of Mathieu's Equation, Appl. Math. Quart, **11,** pp. 33–59, Apr., 1953 (Monograph 2082).

The problem of connecting the various types of solutions of Mathieu's equation is solved by the introduction of a new parameter ϕ which is a function of the two equation parameters a and q. This quantity ϕ is introduced and enclosed between two very close analytic limits in section 2. In sections 3, 4, 5 precise definitions are given and information is collected for the three main types of functions which are to be connected. Section 6 contains the connection formulas. Section 7 reviews the status of knowledge achieved. Section 8 is an appendix on integral equations which are more general than those developed earlier in the text, but which appear to be of no use for the main purpose of this paper.

WALKER, J. G., see R. M. Bozorth.

WICK, R. F., see W. P. Mason.

[1] Bell Telephone Laboratories, Inc.