

Technical Papers by IBM Authors Published Recently in Other Journals

The Anomalous Codeposition of Iron-Nickel Alloys, H. Dahms and I. M. Croll, *Journal of the Electrochemical Society* **112**, No. 8, 771-775 (August, 1965).

The dependence of the anomalous codeposition of iron-nickel alloys on the pH at the cathode surface is investigated. An equation is derived to evaluate the surface pH as a function of bulk pH, rate of hydrogen evolution, buffer concentration, and diffusion conditions. The results obtained on rotating disk electrodes show that anomalous codeposition is due to a suppression of nickel discharge and that suppression occurs only when the surface pH is high enough to cause hydroxide formation. A type of mechanism is proposed by which the adsorption of ferrous hydroxide suppresses the deposition of nickel but permits a high rate of iron discharge. Experimental results which support this mechanism are discussed. This type of mechanism could be of general importance for other systems exhibiting anomalous codeposition.

The Anomalous Magnetic Moment of the Muon, G. Charpak,* F. J. M. Farley,** R. L. Garwin, T. Muller,*** J. C. Sens,** and A. Zichichi,** *Il Nuovo Cimento, Series X* **37**, No. 4, 1241-1363 (June 16, 1965).

The anomalous part of the gyromagnetic ratio, $a \equiv \frac{1}{2}(g - 2)$ of the muon has been measured by determining the precession $\theta = a\omega_0 \bar{B}t$ for 100 MeV/c muons as a function of storage time t in a known static magnetic field of the form $B = B_0(1 + ay + by^2 + cy^3 + dy^4)$. The result is $a_{\text{exp}} = (1162 \pm 5) \times 10^{-6}$ compared with the theoretical value $a_{\text{th}} = \alpha/2\pi + 0.76\alpha^2/\pi^2 = 1165 \times 10^{-6}$. This agreement shows that the muon obeys standard quantum electrodynamics down to distances ~ 0.1 fermi. Details are given of the methods used to store muons for $\sim 10^8$ turns in the field, and of measuring techniques and precautions necessary to achieve the final accuracy. Some of the methods of orbit analysis, magnet construction shimming and measurement, polarization analysis, and digital timing electronics may be of more general interest.

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Anticlastic Action of Flat Sheets in Bending, H. D. Conway* and W. E. Nickola, *Experimental Mechanics* **5**, No. 4, 115-119 (April, 1965).

A theoretical analysis is made of the stresses induced in thin elastic strips which are bent (by uniform bending moments) into arcs with substantially constant radii of curvatures. Stresses determined experimentally on aluminum and steel strips agree very well with the theory.

* IBM Consultant and Professor of Mechanics, Cornell University.

Better Quality, Lower Costs, Through Designer-Fabricator Communication, L. V. Mason, *Transactions of the American Society for Quality Control Technical Conference*, pp. 639-649 (May, 1965).

Product release groups constantly strive to shorten lead time, prove designs more rapidly, and control waste. To accomplish these objectives, the quality drawing system adds production-oriented quality information to the development laboratory designs. The system provides a preliminary classification of characteristics, workmanship definitions, and destructive test instructions. This information effectively reduces lead time through fewer rejections, offers a more scientific inspection technique for proving designs, and reduces costs through less inspection and fewer rejects.

Computer Automates X-Ray Stress Analysis, G. Koves, *The Tool and Manufacturing Engineer* **55**, No. 1, 43-44 (July, 1965).

This paper describes an x-ray diffraction test method in which both the measurement and evaluation steps are highly automated, making this high-precision technique available as a practical quality control tool. The evaluation procedure is completely computer automated using a FORTRAN program and an IBM 7090 Data Processing System. The test method combines the depth and accuracy of the x-ray technique with the high speed and simplicity essential for a quality control procedure.

Critical Points and Moments of Some Binary Rare Earth Alloys, R. M. Bozorth and R. J. Gambino, *Proceedings of the International Conference on Magnetism*, Nottingham, England, pp. 263-265 (July, 1965).

Observed values of the Néel points T_N and Curie points T_C of a number of alloys of the heavy rare earths (1) confirm the previous view that T_N is nearly a universal decreasing function of the number of electrons in the 4f shell, and (2) show that T_C , on the contrary, is specifically dependent on the elements alloyed. A particularly important concentration of 4f electrons is 10.5, between Ho and Er, where the Curie points of alloys of these elements rise to 35°K, almost twice that of the elements. At the same average electron concentration a Dy-Tm alloy shows a Curie point below that of either element. Gadolinium alloys with Dy and with Er show that the spiral structure that occurs in the latter elements between T_N and T_C ceases to exist at 4f electron concentrations of 7.9 and 8.8, respectively.

A Design for a Versatile Communication Facilities Testing System, A. W. Maholick, *Conference Record of the First IEEE Annual Communications Convention*, Boulder, Colorado, pp. 461-463 (June, 1965).

Special-purpose test equipment has been designed to obtain statistical information on digital-data-transmission facilities. This test equipment employs a digital computer with remote testing stations. Digital data is transmitted from remote testing stations at speeds up to 5,000 bits per second under the control of the centrally located digital computer. Incoming data is compared with reference data and a failure-to-match results in the recording of the erroneous information on magnetic tape along with pertinent status and real-time information. The information is then processed in a form tailored to the use of system engineers of communication-based data-processing systems.

Dielectric and Anelastic Relaxation of Crystals Containing Point Defects,† A. S. Nowick and W. R. Heller, *Journal of Advances in Physics* **14**, 101 (April, 1965).

A theory is developed which describes the linear, reversible, time-dependent response of a crystal containing point defects to stress or electric fields, respectively known as anelastic and dielectric relaxation. Such relaxation occurs because of the redistribution of the defects among sites which are initially equivalent, but which become inequivalent in the presence of the external field. The macroscopic behavior of such a crystal is found to be describable in terms of the symmetry which can be assigned to the defect. This defect symmetry determines whether or not the crystal will undergo dielectric or anelastic relaxation and, if relaxation can occur, which specific coefficients of elastic compliance or electric susceptibility show the relaxation effect. The latter information, called the "selection rules" tells, in effect, which combination of stress or electric field components is capable of redistributing the defects. Tables are given for these selection rules for all possible defect symmetries in each of the 32 crystal classes. It is also shown that a hitherto unobserved phenomenon of piezoelectric relaxation may occur; the selection rules for this effect are also given.

Aside from its symmetry, the defect can be described as an "electric dipole" in terms of a suitable dipole moment vector μ , and as an "elastic dipole" in terms of a tensor λ . It is shown that the defect symmetry determines the number of independent components of μ and λ . Finally, a thermodynamic theory is developed which permits calculation of the relaxation strengths for those compliance, susceptibility, and piezoelectric coefficients which undergo relaxation, in terms of the independent components of μ and λ . Applications of the theory to specific cases are then reviewed.

† Work partially supported by U. S. Atomic Energy Commission.

Diskussion eines Experiments zur Erhöhung des Auflösungsvermögens (Theory of a New Superresolution Experiment), A. W. Lohmann and D. P. Paris, *Optik* **22**, 226-234 (1965).

According to E. Lau (1937) it is possible to increase resolution by inserting an absorbing edge in front of the image plane. We investigated this problem theoretically, using a model which is different from Lau's experiment. Lau's results were obtained visually. In both models, the operations

are performed behind the aperture of the image-forming system. Our calculations demonstrate that an increase of resolution can be expected for a double slit if visual observation is used. However, if an *objective* method of observation is used, the resolution will be decreased by the operation.

Energy Transmission by Stress Waves in Prismatical Bars, J. H. Meier, *Experimental Mechanics* **5**, No. 5, 135-141 (May, 1965).

This paper deals with energy transmission by stress waves in prismatical bars and its possible application in high-speed printers. Theory is reviewed briefly for straight bars, and energy losses caused by cross-sectional impedance mismatch and length mismatch are calculated. In order to check the theory, experiments were conducted on straight bars with theoretically perfect impedance match. In the absence of a theory for curved bars, some experiments were conducted which indicate the possibility of energy transfer with acceptable efficiency.

Epitaxial Growth of GaAs Through Cracks in SiO₂ Masks, M. Michelitsch, *Journal of the Electrochemical Society* **112**, No. 7, 747-748 (July, 1965).

SiO₂ covered GaAs substrates, (111)-oriented, often show cracks in the SiO₂ layer, if the oxide layer is thicker than 500 Å, due to differential thermal expansion of the SiO₂ and GaAs. They are only formed during heat-up prior to the epitaxial growth. They are parallel to the (211) directions of the substrate, 0.5 to 1 μ wide and several millimeters long. The bottoms of the cracks serve as nucleation sites for epitaxial growth. Once the cracks are filled up with epitaxial material, the growth spills over the SiO₂ layer (overgrowth).

The Etching and Polishing Behavior of Ge and Si with HI,† A. Reisman and M. Berkenblit, *Journal of Electrochemical Society* **112**, No. 8, 812-816 (August, 1965).

Studies of the etching and vapor polishing behavior of Ge with HI as a function of temperature, linear gas stream velocity, etch rate and etchant concentration, indicate that temperature is the most significant parameter affecting the smoothness of the etched surfaces. A less pronounced effect is the occurrence of microscopic pitting above a critical etchant concentration. The other parameters did not appear to affect surface characteristics. Less detailed studies of the HI etching of Si have been used to define practical conditions for the vapor polishing of Si. A qualitative analysis of the requirements for a useable vapor polish and the experimental conditions necessary to quantitatively define the kinetics of solid-gas etching reactions are presented.

† This work was supported in part by AFCL Contract AF19 (628)-2468.

Evaluation of Parameters in Semiempirical Molecular Quantum-Mechanical Calculations,† Thomas H. Brown and Robert L. Taylor,* *Journal of Chemical Physics* **42**, No. 11, 3979-3983 (June 1, 1965).

General analytic expressions are given for the partial derivatives of both eigenvalues and eigenvectors with respect to the various molecular integrals, or parameters, which appear in the secular equation in molecular quantum-mechani-

cal problems. Since most physical properties of interest depend upon the various eigenvalues and eigenvectors in a straightforward manner, it is then possible to evaluate analytically the derivatives of the calculated values of these properties with respect to the various parameters associated with the problem. With the aid of nonlinear estimation procedures, it is therefore possible to readily find that set of parameters which gives the "best fit" to a particular set of experimental data. Thus a systematic procedure for evaluating these parameters is available.

† This research was initiated when both authors were employed by the Union Carbide Corporation.

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An Explanation of High Cation Vacancy Concentration And p-Type Conductivity in Semiconductors Containing a Multivalent Metal in Its Lowest Valence State, M. R. Lorenz and D. W. Jepsen, *Journal of the Physics and Chemistry of Solids* 26, No. 7, 1177-1180 (July, 1965).

A model is presented which features an explanation for the large deviation from stoichiometry and correspondingly high hole concentration in semiconductors containing a multivalent metal in its lowest valence state. The model is based on the assumption that cation vacancy acceptor states are associated with a band which lies below the highest filled band. The energy of vacancy formation is thereby reduced by a compensating energy, E_c , which is gained as the acceptor states are filled. Using SnTe as an example, its value of E_c is estimated.

Flexible-Mold Casting of Small Experimental and Surgical Parts,† C. D. Ray* and T. M. Richards, *The American Journal of Medical Electronics* 4, No. 2, 100-103 (April-June, 1965).

Techniques for the small volume reproduction of experimental plastic parts are described. The method involves the preparation of a flexible silicone rubber mold from an original pattern and the subsequent casting of a liquid epoxy resin in the mold.

† Supported in part by U.S.P.H.S. Grant NB-04457.

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Gaussian-Transform Method for Molecular Integrals. I. Formulation for Energy Integrals, I. Shavitt* and M. Karplus, *Journal of Chemical Physics* 43, No. 2, 398-414 (July 15, 1965).

The Gaussian-transform method for the evaluation of multi-center nuclear-attraction and electron-repulsion integrals over one-electron exponential orbitals is described. The basic formulas for $1s$ orbitals are developed, and machine methods for their extension to higher orbitals are outlined. Computational techniques for the implementation of the Gaussian-transform method are given with emphasis on the requirements for accuracy and speed in the calculations. Possible improvements and extensions of the method are discussed.

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Gaussian-Transform Method for Molecular Integrals. II. Evaluation of Molecular Properties, C. W. Kern* and M. Karplus, *Journal of Chemical Physics* 43, No. 2, 415-429 (July 15, 1965).

The Gaussian-transform approach to the evaluation of multi-center molecular integrals is developed for one- and two-electron coordinate operators averaged over a wavefunction which is constructed from one-electron orbitals composed of exponential basis sets. The general method is outlined and applied to a number of electric- and magnetic-interaction operators. Formulas for these operators are given not only for exponential orbitals but also for Gaussian orbitals, which enter at an intermediate stage in the treatment of the exponential case. The complete analysis, supported by numerical data gathered from test programs, serves to demonstrate that the Gaussian-transform method represents a possible approach to the determination of polyatomic wavefunctions and their properties.

* Department of Chemistry, State University of New York at Stony Brook.

Heats of Mixing of Electrolytes Having Common Ions, Y. C. Wu, M. B. Smith,* and T. F. Young,* *The Journal of Physical Chemistry* 69, No. 6, 1868-1872 (June, 1965).

Heats of mixing of 24 pairs of 1 m aqueous solutions of 1-1 electrolytes having an ion common to the pair have been measured at 25°. Heats of mixing of NaCl and Na₂SO₄, each in an aqueous solution of unit ionic strength, have also been determined. The effect of the substitution of one common ion for another has been investigated for five homionic pairs. The maximum effect observed is about 3 cal/mole of electrolyte. The heats of mixing of HCl with the alkali metal chlorides differ from the heats of mixing of LiCl with the same respective electrolytes by approximately a constant amount, ~ 13 cal/mole of solute.

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Heats of Mixing of Electrolytes of the 1-1 Charge Type, Y. C. Wu, M. B. Smith,* and T. F. Young,* *The Journal of Physical Chemistry* 69, No. 6, 1873-1876 (June, 1965).

Heats of mixing of eight pairs of 1 m aqueous solutions of 1-1 electrolytes not having an ion common to the pair have been measured at 25°. The average of the absolute values of the molal heats of mixing is somewhat larger than the average of the absolute values of the heats of mixing of pairs of the same electrolytes so grouped that there is a common ion within each pair. The thermochemical relation between the heats of cross mixing and the heats of common-ion mixing (the cross-square rule) has been tested by application to four systems. The rule fits the data remarkably well. The purely thermodynamic, and hence exact, relation between heats of dilution and heats of cross mixing has been pointed out and its application illustrated. Work with relatively dilute solutions is not in accord with the Brønsted principle of specific ionic interaction.

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An Investigation of Separation Losses in High-Speed, High-Density Recording Tapes, D. E. Speliotis, G. Bate, J. R. Morrison, and R. E. Braun, *IEEE Transactions on Magnetics* **1**, No. 2, 101-104 (July, 1965).

The trend in digital tape recording is toward larger storage capacity and faster accessing, which necessitate packing information at greater densities on tapes moving at higher speeds. The losses that inevitably arise from the finite separation between the head and the moving tape become much more serious as the length of the magnetized regions in the tape is reduced and as the relative velocity of head and tape is increased.

The purpose of this paper was to investigate experimentally the dependence of separation losses on bit density and head-gap length, and to distinguish from the reading losses those losses introduced during the writing process. Briefly, results showed that, for the heads and tapes used in the experiment, virtually all the losses could be attributed to the reading process. Furthermore, writing with a wide-gap head and reading back with the four heads established that the percentage reading losses as a function of separation were apparently the same whatever reading head was used.

Neon Tube Circuit Forms One-Shot Pulse Generator, A. M. Patlach, *Electronic Design* **13**, No. 12, 38-39 (June 7, 1965).

A novel monostable multivibrator is described which utilizes the switching action of a neon tube to produce a single pulse of less than one microsecond duration. The recycle time of the device is controllable.

1965 Survey of Commercial Semiconductor Photosensitive Devices, R. D. Kaus, *Electronic Industries* **24**, No. 7, 73-83 (July, 1965).

The relative merits of photoconductors, photovoltaic diodes, phototransistors, and PNP light-activated devices are discussed. Comparative data on the properties of the most common photosensing materials are presented. Terminology and figures of merit used in evaluating the various devices and materials are defined. (Part 1 of a 3-part series.)

Note on Differential Operators with a Purely Continuous Spectrum, F. Odeh, *Proceedings of the American Mathematical Society* **16**, No. 3, 363-366 (June, 1965).

Under mild assumptions on the asymptotic behavior of the potential of a Schrodinger-like equation a theorem is given which asserts the nonexistence of eigenfunctions in any number of dimensions.

On a Cracked Dislocation in an Anisotropic Elastic Medium, W. T. Chen, *Philosophical Magazine* **11**, No. 114, 1207-1215 (June, 1965).

The solution of a cracked dislocation under uniform stress in a homogeneous anisotropic elastic medium is given. The analysis is exact within the realm of classical linear elasticity. The solution is used to deduce criteria for cleavage fracture according to some dislocation models. The results are compared with the corresponding criteria for isotropic elastic materials.

A One-Dimensional Real-Time Iterative Multiplier, A. J. Atrubin, *IEEE Transactions on Electronic Computers* **EC-14**, No. 3, 394-399 (June, 1965).

The class of one-dimensional, real-time, iterative, discrete-state automata is described. By example, it is shown that serial multiplication can be carried out by such a sequential switching network. Each of two arbitrarily large integers is represented in binary notation by a time sequence of digits 0 or 1, the lowest order digits first. A design is given for a discrete-state machine that has as input the two time sequences of binary digits and as output a single sequence of binary digits, which is the product of the two input integers, lowest-order digit first. The multiplier is constrained to be a linear array of identical cells. The cells each have a finite number of states and each cell communicates directly only with the adjacent cells, such communications occurring in a synchronous manner. The multiplication is performed in real time; that is, the delay between the receipt of the n^{th} digits of the input and the generation of the n^{th} digit of the output is a fixed number of periods of the synchronizing clock. A design with no time delay is described.

Optimizing Magnetostrictive Delay Lines, V. Ramakrishna, *Electro-Technology* **76**, No. 2, 45-47 (August, 1965).

One way to store information for later use is to slow down the signal which contains it. The magnetostrictive delay line, in effect, slows down an electrical signal travelling at the speed of light to the speed of sound. Milliseconds later, the input is available for further processing or for comparison. But the accuracy and strength of the output depend on the dimensions and materials of the delay line. This paper describes an analytical technique for optimizing these parameters.

The Organization of Structured Files, B. J. Dzubak and C. R. Warburton, *Communications of the ACM* **8**, No. 7, 446-452 (July, 1965).

A data file is an integral part of a data processing system. In many systems, the selection of an organization for the data within the file can be critical to the system's operating efficiency. This paper provides the systems designer with an information source which describes ten techniques that may be employed for organizing structured data. The characteristics of the organizations described are application independent, thus providing the designer with a reference which allows him to limit the number of file organizations he must consider for his system.

Physical and Chemical Studies on Ceruloplasmin III. A Stabilizing Copper-Copper Interaction in Ceruloplasmin, Philip Aisen and Anatol G. Morell,* *Journal of Biological Chemistry* **240**, No. 5, 1974-1978 (May, 1965).

Ceruloplasmin is a deep blue protein isolated from blood serum which tightly binds 8 atoms of copper per molecule.

These may be reversibly removed by the chelating agent sodium diethyldithiocarbonate. Stable intermediate species of ceruloplasmin, containing more than 0 and less than 8 atoms of copper per molecule, could not be observed either during removal of copper from ceruloplasmin or reconstitution of ceruloplasmin from its apoprotein and copper. The mechanism of the stabilizing interactions producing this "all-or-none" effect is unknown.

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Polarization of Photoelectrons from Magnetized Nickel,† R. L. Long, Jr.,* V. W. Hughes,* and J. S. Greenberg,* I. Ames and R. L. Christensen, *The Physical Review* **138**, A1630-A1635 (June 14, 1965).

An experiment is described in which the polarization of photoelectrons from a magnetized nickel crystal was measured. After acceleration of the photoelectrons to 120 keV by an electrostatic accelerator, the polarization was measured by the Mott scattering technique and was found to be zero within the experimental accuracy of 2%. Possible explanations of this result, including the nature of the electron band structure and depolarizing mechanisms, are discussed. Hence, photoemission from ferromagnets does not appear to be a useful source of polarized electrons for other experiments.

† This research was supported in part by the National Aeronautics and Space Administration and in part by the Office of Naval Research in contracts with Yale University.

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Preliminary Comparisons of Positive and Negative Images in a Learning Task, R. L. Erdmann, C. K. Clauer, A. S. Neal, *Proceedings of the American Psychological Association Convention*, pp. 45-46 (September, 1965).

This is a preliminary report of a pilot study of viewing conditions associated with a learning task presented on a rear projection device. For the experimental conditions, the results indicate: (1) Subjects showed a significant preference for positive images under low ambient illumination and for negative images under high ambient illumination. (2) Significantly fewer errors occurred under these preferred conditions. (3) In addition, significantly fewer errors were observed under low ambient than under high ambient illumination. (4) Time scores were independent of polarity, but significantly higher with high ambient illuminations. (5) Subjects selected relatively high contrast under all viewing conditions but preferred slightly higher contrast with negative images. (6) When permitted to choose, subjects generally selected a low ambient illumination. However, subjects did not alter or experiment with the viewing conditions.

Product Planning, W. Brodbeck, *Elektronische Rechenanlagen* **7**, No. 3, 119-122 (1965).

The Product Plan provides an excellent tool for planning and program supervision of new products as well as for changing existing ones. Once developed, such a product plan tells, in a common language, all divisions within a company that are concerned with a given development what their respective responsibilities are. These methods and aids of practical product planning are applicable to all products.

Proton Magnetometer and Stable Oscillator for Remote Measurement of Strong Magnetic Fields, R. L. Garwin and A. M. Patlach, *Review of Scientific Instruments* **36**, No. 6, 741-742 (June, 1965).

A simple apparatus for measuring magnetic fields by a proton resonance technique is described. The device has many advantages over existing magnetometers and is particularly useful for high field measurements. Part of the apparatus is a stable variable-frequency transistor r-f oscillator which can be made to operate from 10-300 Mc/sec. It, too, is described in detail.

Quantum Theory of Lattice-Wave Amplification in Semiconductors, J. B. Gunn, *The Physical Review* **138**, A1721-A1726 (June 14, 1965).

The amplification of lattice waves (acoustical or optical) in semiconductors is considered from the viewpoint of the absorption and stimulated emission of phonons by conduction electrons. An adaption of the Weisskopf-Wigner theory is used to calculate the effect of scattering in permitting transitions for which wave vector is conserved between initial and final states, but energy is not. No restriction on the frequency or wave vector of the phonon is made. A finite probability of emission and absorption of a given phonon is found for every initial electronic state; emission exceeds absorption when the group velocity of the state exceeds the phase velocity of the phonon. An expression is given for the net rate of emission into a particular mode by a distribution of electrons, uniform in real space but arbitrary in wave-vector space, and rates of lattice-wave amplification are calculated for some simple cases. These rates are compared with previously known macroscopic calculations based on transport theory, and the reasons for the differences found are discussed. It is concluded that the present results describe the contribution to the amplification by the spatially uniform part of an electron distribution, whereas the macroscopic ones are associated with bunching phenomena.

Rare Earth Ions in the Alkali Halides, II. Pseudo-Localized Vibrational Frequencies, Max Wagner* and W. E. Bron, *The Physical Review* **139**, A233-A240 (July 5, 1965).

Vibronic structure, observed in the emission and absorption spectra of alkali halides containing either Sm^{2+} , Eu^{2+} , or Yb^{2+} is reported and shown to result from pseudo-localized vibrations occurring in the rare-earth defect. A model for the defect is defined, and an analysis of its vibrational frequencies is given for the sample case of a RbCl host lattice. A Green's function formalism is used in the analysis. The calculation, in which a number of approximations are made, yields the qualitative features of the experimental results.

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Rare Earth Ions in the Alkali Halides III. Electron-Lattice Coupling and the Details of the Vibronic Spectra, W. E. Bron and Max Wagner,* *The Physical Review* **139**, A223-A232 (July 5, 1965).

Electron-lattice interaction is discussed for the case of rare-earth ions in the alkali halides. A selection rule is derived to show that for the present defect electronic transitions can be coupled only to vibrational modes of A_1 symmetry.

Under the assumption of electrostatic coupling between the electron and the lattice vibrations, a coupling function is derived which is proportional to the projection of the field of the electron undergoing a transition onto the eigenvectors of the vibrations. It is further shown that this coupling function can be determined from the details of the structural form of the vibronic spectra. A number of other features of the vibronic spectra are accounted for through the properties of Frank-Condon integrals.

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The Reflection Characteristics of Hemodynamic Systems at 632.8 mμ, G. E. Edgington and N. R. Cholvin,* *Proceedings of the Second Annual Rocky Mountain Bioengineering Symposium*, pp. 62-65 (May, 1965).

The results of a series of experiments, performed to determine the effects of blood flow, pressure, and oxygen saturation on the intensity of reflected light at 632.8 mμ, are described. *In vivo* and *in vitro* experiments showed a velocity dependence below a critical velocity and an independence of pressure. It was shown that for a constant hematocrit and oxygen saturations between 40 and 100%, the relationship between blood oxygen saturation and reflected light intensity can be approximated by a straight line. Filtering the electrical signal was found to be an effective means of removing the *in vivo* pulsatile artifact.

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Refractive Index of SiO₂ Films Grown on Silicon, W. A. Pliskin and R. P. Esch, *Journal of Applied Physics* 36, No. 6, 2011-2012 (June, 1965).

By more precise variable-angle, monochromatic-fringe observation (VAMFO), it has been found possible to improve the precision of thickness determinations of transparent thin films (800 Å to several microns) on reflective substrates to better than 0.1%, and to extend the determination of the refractive index to films as thin as 900 Å. The measured refractive indices (at 5459 Å) of silicon dioxide films grown in steam and/or dry oxygen (atmosphere pressure) at 980 to 1200°C varied from 1.461₀ to 1.462₀ for 3500- to 6800-Å films. These compare with the refractive indices (at 5461 Å) of 1.461₀ for a thick (2.148 μ) steam-grown film (at 980°C) and 1.461₀ for a thick (2.135 μ) oxygen-grown film (at 1200°C). The technique has also been used to measure the refractive indices of thin films (> 900 Å) other than thermal SiO₂.

Relation of the Koster Effect to Low-Temperature Internal Friction Peaks in Deformed Copper, B. M. Mees and A. S. Nowick, *Acta Metallurgica* 13, No. 7, 771-778 (July, 1965).

A study is made to determine the relationship between the Koster effect, i.e., the modulus defect due to dislocations, which is present in a freshly deformed sample and which subsequently anneals out, and the various low temperature relaxation peaks which have been observed. It is shown that

the Koster modulus defect at room temperature is made up of several parts. The largest fraction corresponds to dislocation motion which contributes to the high-temperature side of the Bordoni peak and also to the subsidiary Niblett-Wilks peak. About 40% of the Koster modulus defect is still present at 5°K. The significance of the present results to the interpretation of the Bordoni relaxation is discussed. In particular, it is shown that these results are consistent with a mechanism for which the relaxation time depends on a power of the dislocation loop length.

Scribing and Breaking Semiconductor Material, E. J. Creighton, *SCP and Solid State Technology* 8, No. 7, 11-14 (July, 1965).

Improvements in scribing and breaking techniques are discussed. A low-inertia head scribe scores the surface of the semiconductor material providing clean edge definition and no loss of material upon breaking. The breaking mechanism is adjustable, enabling the producer to vary the dice geometry. Tests indicate that when scribing germanium or silicon wafers, the most favorable results were achieved using lapped material in oriented planes.

Some Design Considerations for Low Voltage Contacts, R. G. Bayer and D. D. Roshon, *Microelectronics and Reliability* 4, No. 2, 131-144 (June, 1965).

The relationship between wear and contact resistance on low voltage contacts is discussed in terms of design parameters such as load, geometry, materials and lubricants. A summary of practical design criteria for assuring that resistance requirements will be satisfied is presented, as well as some data on low voltage contacts operating under "dirty" conditions. In addition, an engineering model for wear, in which wear is related to stress, is applied in discussing the wear problem associated with a low voltage contact.

Some Problems of Finite Representability, Edward Altman and Ranan Banerji,* *Information and Control* 8, No. 3, 251-263 (June, 1965).

A subclass of the context-free class of grammars is developed which is based solely upon the structural property which bounds the number of nonterminal symbols which may appear at any step of a derivation dominated by the initial symbol of the grammar. This subclass is then utilized, along with the class of finite state grammars, as the bases in the construction of a partial hierarchy of the entire class of context-free grammars. In turn, this hierarchy makes possible the extension of certain information theoretic measures, namely informational capacities, beyond their finite state limitations. Various restrictions upon the method of generating sentences, the restrictions being of such a nature as to pre-designate the symbol to be transformed, are introduced and the consequences of these restrictions are studied, in a general way, using mainly the introduced notion of production indexing sets.

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Specific Heat Singularity in MnF_2 , D. T. Teaney, *Physical Review Letters* **14**, No. 22, 898-899 (May, 1965).

The specific heat of MnF_2 was measured in the range $\pm(10^{-1}$ to $10^{-4}) T_K$ (67°K) by special high resolution techniques. A logarithmic form of a divergence is found. Quantitative comparison is made with theory and with experiments on argon. The results show that an antiferromagnet is a good approximation of the rigid lattice gas.

Stresses in a Transversely Isotropic Elastic Cone Under an Asymmetric Force at its Vertex, W. T. Chen, *Zeitschrift für angewandte Mathematik und Physik* **16**, No. 3, 337-344 (May, 1965).

The problem of a transversely isotropic elastic solid bounded by two concentric conical surfaces under asymmetrical force at its vertex is studied. Simple closed form solutions are obtained. A special case of interest is the Cerruti problem of a tangential concentrated force acting on the surface of an elastic half space. The analysis is exact within the realm of classical linear elasticity.

Superconducting Lanthanum Chalcogenides, R. M. Bozorth, F. Holtzberg, and S. Methfessel, *Physical Review Letters* **14**, No. 23, 952-953 (June 7, 1965).

The compounds La_3Se_4 and La_3S_4 have been found to be superconducting below 8.6 and 6.5°K, respectively. These materials crystallize with the bcc Th_3P_4 -type structure which extends in a solid-solution system to the 2:3 compound. The superconductivity was detected by the observation of magnetic moments measured with a pendulum magnetometer in fields of 0.1 to 25 kOe in 1.25°K and above. The critical temperatures were derived from the temperature dependence of frozen-in magnetic flux after the field $H = +20$ kOe had been applied. The results open the way to further studies of the influence of the conduction-electron concentration, lattice spacing, and defects on superconductivity and its relation to ferromagnetism.

Synthesis of the Impedance Matrix of Star Port Resistor Networks, T. J. Harrison, *Journal of The Franklin Institute* **279**, No. 6, 445-456 (June, 1965).

A new synthesis method is presented for the realization of the impedance matrix of an n -port resistor network in which all n ports have a common node. The necessary and sufficient conditions for the realization of a given matrix are stated. Several examples using the method are calculated.

System/360 Influence on the Design of SLT, R. M. Meade and H. Geller, *Solid State Design* **6**, No. 7, 21-27 (July, 1965).

Solid Logic Technology (SLT) and the IBM System/360 were planned jointly. This paper describes areas of interaction and the ways in which SLT was defined. It suggests parallels that will occur in the development of any major integrated component line. The translation of system requirements and constraints into program objectives is demonstrated. The process of designing the logic circuit for that application is discussed. The paper emphasizes packaging and the system's consideration therein. Procedural constraints such as design and field operations are explored.

Temperature Dependence of Microwave Phonon Attenuation, M. Pomerantz, *The Physical Review* **139**, A501-A506 (July 19, 1965).

Measurements of the temperature dependence of the attenuation of 9-Gc/sec phonons are presented. They include measurements on crystals of quartz, CdS, GaAs, Ge, Si, CaF_2 , Al_2O_3 , and MgO in several directions and modes of polarization. The attenuation in most of the materials is proportional to T^n , where the average value of $n = 4.1 \pm 1.2$ for the fast transverse waves, 4.0 ± 1.7 for the slow transverse waves, and 4.8 ± 1.4 for the longitudinal waves. For MgO and Al_2O_3 the attenuation is proportional to the frequency of the sound between 3 and 9 Gc/sec. An empirical correlation of the data is that the attenuation of 9-Gc/sec phonons is 3 dB/cm when $(T/\theta) \approx 0.1$, where θ is the Debye temperature of the crystal. Values of the third-order elastic constants are used to make absolute comparisons of the theory of attenuation by three-phonon processes with the data. The agreement is good in some cases but not in others.

Thickness Measurements of Thin Permalloy Films: Comparison of X-Ray Emission Spectroscopy, Interferometry, and Stylus Methods, M. D. Silver and E. T-K. Chow, *The Journal of Vacuum Science and Technology* **2**, No. 4, 203-207 (July/August, 1965).

Magnetic properties of vacuum-evaporated thin Permalloy films for memory applications are affected greatly by the thickness of the film as well as by the composition and various evaporation parameters. X-ray emission spectroscopy is generally used for thickness measurements and composition studies. In this paper, the thicknesses of nickel-iron films (81 to 82% nickel and 400- to 3500-Å thickness range) are compared by a stylus method (Talysurf), a high resolution multiple beam interferometer (Tolansky-type), and x-ray fluorescence analysis with calibrated standards. Data are presented showing that the x-ray method is the most reproducible and allows rapid calibration and computation by computers.

Transpiration in an Open Tube GaAs/HI/ H_2 System, G. Hellbardt, *Journal of the Electrochemical Society* **112**, No. 4, 443-446 (April, 1965).

Etching and deposition rates have been measured in an open tube GaAs/HI/ H_2 system for various iodine concentrations, flow rates, and temperatures between 500 and 850°C. Etching as well as deposition reactions are close to equilibrium at the surface of the solid GaAs. However, the amount of material of the vapor phase coming into contact with the solid is different in the two cases. At low flow rates the total flux through the tube takes part in the etching reaction, whereas only a certain fraction takes part in the deposition reaction. It is suggested that different diffusion processes in the vapor phase cause this difference.

The Use of Nonlinear Estimation Techniques in Simple Molecular Orbital Calculations,† Thomas H. Brown and Robert L. Taylor,* *Journal of Physical Chemistry* **69**, No. 7, 2316-2318 (July, 1965).

Nonlinear estimation techniques have been applied to simple π -electron molecular orbital calculations which seek to have self-consistent Coulomb integrals and charge densities. Hav-

ing analytic expressions for the various derivatives involved allows one to use the Newton-Raphson-Gauss estimation procedure, rather than integration by substitution, as is customarily done. The present procedure converges very rapidly to the self-consistent solution, in contrast with the slow convergence or even divergence of the previous method.

† This research was initiated when both authors were employed by the Union Carbide Corporation.

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Vacuum Annealing of Soft Ferromagnetic Alloys, G. Koves, *Transactions of the Vacuum Metallurgy Conference 1964*, pp. 189-201 (April, 1965).

The magnetic, physical, and structural properties of commercially pure iron and 2.5% silicon iron are compared in various heat-treated conditions. Annealing environments studied include numerous reducing atmospheres as well as vacuum in three stages of pressure. It is shown that a vacuum of 2×10^{-4} Torr as an annealing environment is equivalent to purified hydrogen atmosphere, other factors being equal. Magnetic properties are equal within experimental error, residual stresses are lowest in vacuum, and the imperfection density is comparable. Less pure commercial reducing atmospheres yield considerably inferior results. Reducing the pressure further in the vacuum anneal did not achieve apparent improvement of properties.

What Does Commander Need Is A Still Unanswered Question in R&D, N. P. Edwards, *Armed Forces Management* **11**, No. 10, 79-85 (July, 1965).

The paper discusses how R&D in the area of automated information support can be applied to help military commanders do their job better. The problems discouraging the application of R&D are described. The capabilities and limitations of automatic data processing are reviewed. Finally, the paper observes key areas where R&D might be useful: Data gathering, communications, data analysis, and decision making.

Letters to the Editor

Refractive Index of InP, G. D. Pettit and W. J. Turner, *Journal of Applied Physics* **36**, No. 6, 2081 (June, 1965).

Transpiration Studies of the Gallium-Hydrogen Iodide-Hydrogen System, V. J. Silvestri, *Journal of the Electrochemical Society* **112**, No. 7, 752 (July, 1965).