

IBM Technical Papers Published Recently in Other Journals

An Analysis of the Effect of Component Tolerances on the Amplification of the Balanced-Pair Tunnel-Diode Circuit, R. Brayton and R. Willoughby, *IEEE Transactions on Electronic Computers* EC-12, No. 3, 269-274 (June, 1963).

The purpose of the present study is to determine for the balanced-pair tunnel-diode circuit the minimum amount of control required when specified parameter imbalances are present in the system. The problem is formulated, and the minimum control is determined numerically. These results are compared with an analytic formula for the minimum control, which is presented here but is derived in another paper. The results obtained may be used to determine allowable tolerances on the circuit components for a given requirement on the maximum amplification or the total number of input and output connections.

Angular Alignment Mechanism, J. P. Goldsborough, *The Review of Scientific Instruments* 34, 806 (July, 1963).

A device for precisely varying the angular alignment of a mirror or other object is described. This device is free of backlash and hysteresis; furthermore, it is rugged enough to withstand the atmospheric forces on a vacuum chamber and is simple to construct. The device is particularly suitable for adjustment of laser mirrors because a hysteresis-free manual tuning is possible.

The Behavior of a Silicone-Lubricated Electrostatic Clutch, P. J. Magill, R. E. Mc Curry, and R. R. Schaffer, *ASLE Transactions* 6, 218-226 (1963).

The performance of a silicone-lubricated electrostatic clutch, as originally reported by Fitch (*IBM Journal* 1, 49 (1957)), differs considerably from that of one using dry surfaces or boundary lubricants. The study reported here, of constriction resistance, and the dependence of the coefficient of friction on the bearing modulus ($\mu v/p$), provides a qualitative and quantitative explanation of this behavior. The existence of an air film was experimentally observed for the first time. This film, occurring under proper speed and loading conditions, explains the low residual torque. Effects due to voltage, rotor surface speed, fluid viscosity, band width, and surface roughness are shown to exist and are discussed. The lubricating film thickness, determined by a radioactive tracer technique, is shown to depend on rotor surface speed and voltage.

The Carry-Dependent Sum Adder, M. Y. Hsiao and F. F. Sellers, Jr., *IEEE Transactions on Electronic Computers* EC-12, No. 3, 265-268 (June, 1963).

In this paper, the authors exhibit a checking scheme called "carry-dependent sum add" which is based on the parity

prediction method. This scheme assures single-fault detection without duplication of the carry circuit. An example of a binary adder and a decimal adder using the scheme are included.

Cascaded Binary Counters with Feedback, M. P. Marcus, *IEEE Transactions on Electronic Computers* EC-12, No. 4, 361-364 (August, 1963).

A simple general method for analyzing any given cascaded binary counter feedback configuration is presented. The count can be determined directly from the diagram without the need of writing equations of any form. The synthesis of cascaded binary counter feedback configurations is also discussed, and a table of feedback configurations with the minimum number of feedback connections is presented.

A Catalog of Three-Variable Or-Invert and And-Invert Logical Circuits, Leo Hellerman, *IEEE Transactions on Electronic Computers* EC-12, No. 3, 198-223 (June, 1963).

This report gives a complete catalog of minimal NOR circuits and minimal NAND circuits, assuming complements not available, for all logic functions of three variables. Minimal circuits for a function are those that satisfy the following conditions: 1) The number of logic blocks of the circuit is least possible for performing the function; 2) The number of connections in the circuit (total number of inputs) is least possible, subject to the condition that the circuit satisfies the first condition. In addition, the circuits satisfy certain reasonable restrictions on fan-in and fan-out.

A Comparison of Resistivity Measurement Techniques on Epitaxial Silicon, E. E. Gardner, J. F. Hallenback, Jr., and P. A. Schumann, Jr., *Solid State Electronics* 6, 311-313 (June, 1963).

A brief description of two new nondestructive methods of measuring epitaxial layer resistivity is given. These two methods are then compared with an existing method and with each other. The precision obtained with these techniques when measuring N on N^+ epitaxial silicon is given.

Computer-Controlled Diffractometer, H. Cole, Y. Okaya, and F. W. Chambers, *The Review of Scientific Instruments* 34, No. 8, 872 (August, 1963).

The general features of a computer-controlled x-ray diffractometer system are described. A standard four-axis Geiger counter single-crystal diffraction configuration is made automatic by attaching encoders to all shafts, with provision made for electronic input of all settings and readout of all

data. A small solid-state computer is made an integral part of the system, which permits the system to be used in a decision-making closed-loop manner. The mode of operation can be changed by changing the program in the computer.

Computer Programs for Electronic Wave Function Calculations, R. K. Nesbet, *Reviews of Modern Physics* **35**, 552-557 (July, 1963).

Several computer programs which carry out important stages of atomic and molecular wave-function calculations are described. Despite their relatively simple structure these programs are completely general for their particular purposes, and have been used in a great variety of different research projects in atomic and molecular physics. The programs described here evaluate one-center integrals, carry out matrix Hartree-Fock calculations by either the unrestricted or truncated methods (equivalent to the traditional method in many important cases), and transform two-electron integrals from one orbital basis to another.

The Correlation Between Closed Loop Frequency Response and Time Domain Response in Linear Feedback Control Systems, J. R. Carthew, *Control* **7**, No. 61, 24-29 (July, 1963).

The design of control systems would be considerably simplified if it were possible to state with confidence the parameters of a unit step response produced at the output of any system which has a known frequency response function. The object of this paper is to investigate and clarify the relationship between well known parameters in the time domain (e.g., the peak overshoot, rise time, and peak time of the unit step voltage response) and their equivalent closed loop frequency parameters (e.g., the peak of the curve of frequency response magnitude M and the various parameters describing the shape of this curve). The M curve is a log-log plot of $F(j\omega) = M(j\omega)$, when $F(s)$ is the frequency response function in the s plane.

A set of curves is generated in this paper to describe these and other relationships, all having stable, linear, minimum phase control systems with a single resonant peak in the M curve. The conversion curves are generated by an IBM 650, programmed to solve a conversion equation described by E. Rushton.

A detailed explanation is given of the mathematical methods used to obtain the results from which the conversion curves are drawn. The equations which were programmed are derived from basic control system theory. The unit step response of a control system example is obtained using the type D conversion charts, and the ease and accuracy of the method are demonstrated.

Correlation Energy for Atomic Systems, II: Isoelectronic Series with 11 to 18 Electrons, E. Clementi, *Journal of Chemical Physics* **39**, 175-179 (July 1, 1963).

The correlation energy for the ground-state isoelectronic series of the second-row atoms of the Periodic Table is estimated. In this estimate the relativistic energies for the closed and the open shells, and the Hartree-Fock energies are taken from calculations recently performed. As expected, the second-row correlation energy parallels, in general, the characteristics of the first-row correlation energy. The principal contribution to the correlation energy is due to pairing of electrons in a given orbital. The intershell correlation is smaller than the intrashell correlation (but not negligible) and the $3s$ - $3s$ electron correlation is linear in Z .

Correlation Energy in the CH_4 Molecule, E. Clementi, *Journal of Chemical Physics* **39**, 487-488 (July 15, 1963).

Evidence is accumulating that the correlation energy in both diatomic and polyatomic molecules can be obtained with sufficient accuracy without the need of computing correlated wavefunctions.

The Cubic Field Splitting of the Eu^{++} EPR Spectrum in the Alkaline Earth Fluorides, Reuben S. Title, *Physics Letters* **6**, 13 (August 15, 1963).

The EPR spectra of Eu^{++} in CaF_2 , SrF_2 , and BaF_2 have been measured. The variation in the fine structure splitting is found to depend linearly on the crystalline field potential as had been predicted by Lacroix. The sub-linear dependence on the crystalline field potential found for the fine structure of Gd^{3+} in these lattices is attributed to a distortion of the lattice caused by incorporating trivalent Gd at the divalent cation site.

Delay Times for Switching Superconducting Thin Film In-Line Cryotrons, A. E. Brennemann, J. J. McNichol and D. P. Seraphim, *Proceedings of the IEEE* **51**, 1009-1014 (July, 1963).

The delay time involved in switching indium cryotrons is investigated as a function of the applied magnetic control fields. For overdrive fields greater than the isothermal critical magnetic field, but smaller than the constant-entropy critical magnetic field, the rate of transition appears to be controlled by the rate of supply of latent heat from the environment. In this range of overdrive, delay times (for build-up of full resistance) experimentally determined and calculated with overdrive and temperature as controlled variables are in the range of 0.1 to 1 μsec in good quantitative agreement.

For overdrive fields 40 per cent above the critical magnetic field, the delay times (10 to 40 nanoseconds) for build-up of full resistance are unexpectedly long compared to the phase propagation time through the film (less than 1 nanosecond) computed from Pippard's equations for eddy-current delay. Indeed, the normal phase appears to nucleate first in isolated regions from which it propagates laterally, i.e., in the plane of the film, to provide for a rather continuous increase in resistance from the time the pulse is started until the transition is complete. Thus, the major delay in the completion of the transition is probably associated with the time taken to propagate the phase between the various nucleation sites. The propagation distance, i.e., the distance between nucleation centers, is then calculated to be several microns. Methods of decreasing the delay time are discussed.

Design of a Pulse-Narrowing Network, H. M. Sierra, *Electro-Technology* **72**, 38-42 (September, 1963).

The practical possibilities of network synthesis methods are demonstrated in this article. Magnetic-tape recording density is doubled by the use of a passive network designed by synthesis methods. The author develops a suitable transfer function, indicates how a solution may be obtained by use of a digital computer and shows experimental test results.

Determining a Satellite's Attitude, A. Robin Mowlem, *Space/Aeronautics* 40, 99-105 (September, 1963).

A system of IBM 7090 programs was developed to help predict and determine, from data from IR sensors, the spin-axis orientation of the TIROS satellite. This program system can be applied equally well to other satellites that use IR scanners, that spin on an axis that is essentially fixed in inertial space during orbit, and that can be controlled by torques induced from magnetic coils around the base of the satellite.

Ein Diagram für Stabilität, Verstärkung, und Bandbreite des einstufigen Tunnelioden-Verstärkers (A Diagram for Stability, Gain, and Bandwidth of the One-Stage Tunnel Diode Amplifier), Dieter Seitzer, *Archiv der Elektrischen Uebertragung* 17, 403-412 (1963).

Starting from the linear equivalent circuit of the tunnel diode the complex voltage gain of a single-stage amplifier is derived. The shape of the stable gain locus is found by construction and the stability conditions are formulated. The two parameters determining the stability are the coordinates of a stability diagram where the stable range represents an isosceles right-angled triangle. Within the triangle, the curves of constant magnitude of the gain are for each frequency a family of concentric ellipses which link in an illustrative manner the parameters of the circuit, of the tunnel diode, the gain, and the frequency. Also entered in the stability triangle are the curves of constant maximum gain, the associated frequency values, and the curves of constant bandwidth. Apart from the associated exact formulas, approximations are given for rough calculations. Oscilloscopic records of a pulse amplifier with a tunnel diode conclude the paper.

Discrete Tracks for Saturation Magnetic Recording, L. F. Shew, *IEEE Transactions on Electronic Computers*, EC-12, 383-387 (August, 1963).

Discrete-track recording is a magnetic recording method which employs a single-gap head and a discrete-track medium to increase the head-repositioning tolerance in saturation digital recording. A head with a conventional ring structure may be used. The recording medium consists of discrete magnetic tracks separated by nonmagnetic lands. Width of the magnetic tracks depends on the desired track density and maximum tolerable head-repositioning error. Test results indicate excellent track performance; consequently, satisfactory and reliable operation can be expected under actual machine conditions. Major advantages of discrete-track recording are economy, reliability, and increased head-repositioning tolerances.

Disk File Sorting, Thomas Schick, *Communications of the ACM* 6, No. 6, 330-331 and 339 (June, 1963).

Sorting techniques are evaluated using an IBM 1401 with a random access storage device.

Drawing Fine Glass Fibers for Mounting X-Ray Diffraction Powder Samples, Frank A. Toman, *Norelco Reporter X*, No. 3, 93 (September, 1963).

Construction details are shown and instructions given for use of an electrically heated fixture to draw by gravity pull the straight, tapered, fine-tipped glass fibers used in micro, x-ray diffraction analysis.

The Effect of Adsorbed Films on the Attractive and Frictional Forces Developed in an Electrostatic Clutch, W. C. Clinton and R. L. Lyon, *ASLE Transactions* 6, 209-217 (1963).

An investigation has been made of the effect of adsorbed organic films at the solid/air interface of a rotor in an electrostatic clutch. The solid was a cured composition of butadiene-acrylonitrile novalak phenolic resin. The film substances included mono- and multilayers of a homologous series of fatty acids. These films were prepared by both the Langmuir-Blodgett technique and the static vapor-condensation method. A dynamic vapor-condensation oven for continuously adsorbing condensed films of polar compounds on rotor surfaces under specified clutch operating conditions is described. It is shown that the tension developed in the band can be calculated theoretically to within $\pm 15\%$ of that measured experimentally. It is shown that an adsorbed film, the thickness of which is less than the order of roughness of the rotor surface (20×10^{-8} inches), has no effect upon the measured values of the tension developed in the band. The ratio of the dielectric coefficient and the equivalent interface gap thickness is shown to be constant for all calculated values. Finally, it is concluded that the life expectancy of an electrostatic clutch can be infinite when the solid material is prevented from transferring to the band by maintaining one or more monolayers of polar-nonpolar compounds at the solid/air interface.

The Effect of Cutoff Configuration on Pure Tones Generated by Small Centrifugal Blowers, L. A. Lyons and S. Platter, *Journal of the Acoustical Society of America* 35, No. 9, 1455 (September, 1963).

Two methods of reducing the blade-passage tone of a centrifugal blower are presented. The effectiveness of these two methods is described.

The Effects of Air Pollution On Electric Contacts, M. Antler* and G. Gilbert, *Journal of the Air Pollution Control Association* 13, No. 9, 405-415, 450 (September, 1963).

Air pollution is a major cause of the degradation of electric contacts. Certain materials and connector design types can often minimize the effects of pollutants, but not without considerable added cost. A knowledge of environment and its effects is essential to the development of connector technology. The systematic investigation of air pollution, has, however, been largely neglected in the connector field.

In the program of this paper, closely related field and laboratory studies are carried out concurrently with the objective of determining the behavior of environment-exposed materials for low energy circuits. Air pollution is measured at field sites in which contact materials and connector hardware are exposed. Laboratory accelerated aging tests involving polluted environments are developed on the basis of field experience. Contact degradation mechanisms are studied by measuring contact resistance with surface probes, as well as other film-related materials.

By combining knowledge of environment, of the basic physics and chemistry of interfaces, and an understanding of the phenomenological response of materials to environment from an electric contact point of view, cause-effect relationships are established which aid in materials selection and the development of connector designs. The end result of this work is a product of higher reliability.

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The Effect of Fabrication Variables on Chromium Thin Film Resistors, R. M. Chapman, *Vacuum* 213-221 (June, 1963).

The process of vapor deposition has long been appreciated and employed for a wide range of applications. However, today's needs of microminiaturization require a more stringent evaluation of the process. This paper describes the effect of various process variables on the electrical properties of chromium thin films. The effects of deposition rate, stabilization heat treatment, substrate composition, topography and cleanliness are among the parameters discussed. Also considered is the reproducibility of fabricated films.

Electron Spin Resonance of Some Arylsulfonyl Radicals, P. J. Zandstra and J. D. Michaelsen, *Journal of Chemical Physics* 39, 933-938 (August, 1963).

Radicals formed by vapor pyrolysis of β , β' dinaphthyl- and diphenyldisulfide have been studied by electron spin resonance. In each case one of the radicals, identified as the arylsulfonyl radical, shows a large g -value anisotropy in the spectrum. The observed anisotropies are interpreted in terms of the spin-orbit coupling which mixes two states of different orbital angular momentum. The spin densities in one of the states are calculated using a perturbation treatment, according to McLachlan, to allow for the difference in orbitals occupied by different sets of electrons in a nonclosed shell system. The energy differences of the two states are estimated using a molecular orbital approximation. The results indicate that in the ground state of the radical the unpaired electron is localized in a nonbonding orbital of the sulfur.

The Entropy of Skew Product Transformations, R. L. Adler, *Proceedings of the American Mathematical Society* 14, No. 4, 665-669 (August, 1963).

There are many ways of combining measure preserving transformations on a Lebesgue space to form new ones. One of these combinations is the so-called skew product transformation. The purpose of this note is to compute the entropy of skew product transformations in terms of their constituent parts.

EPR Detection of Lattice Distortions in Mn^{++} Doped II-VI Compounds, Reuben S. Title, *The Physical Review* 131, 2503 (September 15, 1963).

Kikuchi and Azarbajani explained the differences in the crystalline field parameter α and the hyperfine parameter A for Mn^{++} doped ZnTe and CdTe on the basis of a model which assumed lattice distortions caused by the different ionic radii of Zn^{++} , Mn^{++} and Cd^{++} . Measurements are reported for Mn doped ZnSe and CdSe which are in agreement with the model. A comparison of the paramagnetic data for Mn^{++} in the zinc and cadmium compounds of tellurium, selenium and sulfur gives additional confirmation of the model.

EPR Spectra of Cr^{+} , Mn^{++} and Fe^{+++} in Cubic ZnS, Reuben S. Title, *The Physical Review* 131, 623 (July 15, 1963).

The paramagnetic spectra of the three $S_{5/2}$ ions Cr^{+} , Mn^{++} and Fe^{+++} have been measured in cubic ZnS. The paramagnetic resonance parameters g , α and A are compared to the theories for these parameters for the $S_{5/2}$ state. It is

found that the covalent character of the lattice must be taken into account. For the parameter A , a linear relation is found to exist for all three ions between the value of A and the ionicity of the lattice. The extrapolated value of A at 100% ionicity is found to be in agreement with the calculations of Watson and Freeman. The values of g and α are found to be in qualitative agreement with the theories of Watanabe and Gabriel, and Johnston and Powell. Exact calculations of the parameters g and α require a detailed knowledge of the environment of the ion.

Equations and Tables for Analyzing Solid-State Reaction Kinetics, E. A. Giess, *Journal of The American Ceramic Society* 46, 374-376 (August, 1963).

The Jander, Dünwald-Wagner, and Ginstling-Brounshtein equations for isothermal reaction kinetics are discussed and compared directly. A table of α (fraction of total material reacted) versus Kt (product of isothermal reaction constant and time) is given for each of the three equations. In order of decreasing relative speed of reaction predicted up to $\alpha = 0.94$, the equations are: Ginstling-Brounshtein, Dünwald-Wagner, and Jander. The equations are further compared with the aid of the Arrhenius expression assuming the Ginstling-Brounshtein to be correct for a rate process having an E (activation energy) of 2 eV per molecule. It is demonstrated that analyzing data at constant α , rather than at constant t , is a general method which will give the same E for any equation wherein α is a function of Kt .

Europium Orthosilicate, A New Transparent Ferromagnet, M. W. Shafer, T. R. McGuire, and J. C. Suits, *Physical Review Letters* 11, 251-253 (September, 1963).

Ferromagnetism has been discovered in europium orthosilicate, Eu_2SiO_4 . This is an ionic compound which is optically transparent in the bulk. Its crystal structure is orthorhombic with $a = 9.71$, $b = 49.5$, $c = 5.65$. Its magnetization is 184 emu/gm at 0°K and it has a Curie temperature of 7°K. Magneto-optical measurements on single crystal samples gave a Verdet constant (at 20°C) of -2.5 min/oe/cm, almost an order of magnitude higher than that reported for any other material. A rotation of 76,000 deg/cm would be expected at 4.2°K if the rotation remains proportional to the magnetization.

The Evaporation Rate of Filament Material from Alternating Current Heated Filaments, A. D. Wilson, *Applied Optics* 2, No. 10, 1055 (October, 1963).

The operation of an incandescent filament on alternating current of the form $i = i_0 \sin \omega t$ is reviewed. A model for the ac evaporation rate, in a vacuum of a uniformly heated straight wire, is presented in terms of (1) the known temperature fluctuations, and (2) the evaporation rate evaluated at the dc and the ac mean filament temperatures. It is shown that the ac evaporation rate can be significantly greater than the dc evaporation rate. A method of evaluating the ac evaporation rate in terms of the spectral modulation is developed.

Extended Initial-Value Problems and Their Numerical Solution, H. J. Greenberg, *Progress in Applied Mechanics*, The Prager Anniversary Volume, pp. 25-40, The Macmillan Company, 1963.

For problems such as heat conduction and wave motion it is shown how data taken at successive times at fixed locations may be incorporated into the formulation of what

are here called *extended initial-value problems*. Associated *extended difference operators* are obtained which form the basis of integration procedures for the numerical solution of such problems. Increased accuracy is obtained by taking more data in time as a basis for prediction, rather than more data in space at a single instant of time as is usually required. Since in many practical prediction problems it may be difficult or impossible to do the latter, the approach developed here may offer real advantages.

Ferroakustische Resonanz (Ferroacoustic Resonance), B. Lüthi, *Physik der Kondensierten Materie* **1**, 197-207 (August, 1963).

A quantum theory of the resonant interaction between spinwaves and phonons (magnetoacoustic resonance) is presented. The interaction Hamiltonian is diagonalized and its new eigenstates, the magnetoelastic waves, are discussed. The phenomena of anomalous dispersion, such as damping and the rotation of the phonon polarization vector, are calculated. Finally the connection between a classical description and this theory is given.

Fluid Logic Devices and Circuits, A. E. Mitchell, H. H. Glaettli, and H. R. Müller, *Fluid Power International*, Part I, **28**, No. 326, 168-174 (May, 1963); Part II, **28**, No. 328, 243-247 (July, 1963).

A review of fluid logic devices is given. The devices are classified into two main groups depending on whether or not they utilize movable or deformable mechanical parts. Some general comparisons and a discussion of the governing and limiting parameters are made in the text. Several examples of circuits are given to illustrate the techniques used in their design and fabrication. Fabrication methods and applications are discussed in the concluding sections of the paper.

A Frequency Modulator with Gain for a Space Array, E. M. Rutz-Philipp and E. Kramer, *IEEE Transactions PTGMITT* **11**, No. 5, 149-155 (September, 1963).

An active microwave FM modulator which has been devised for a retrodirective space array is described. In this modulator one tunnel diode simultaneously functions as amplifier, frequency translator, and FM modulator. The modulator is an image frequency converter with a local oscillator signal injected into the modulator circuit. The frequency of the image signal is modulated by varying the frequency of the local oscillator. The image frequency is the difference between the second harmonic of the local oscillator and the signal frequency. The frequency deviation of the image frequency signal is twice the frequency deviation of the local oscillator signal.

Since the image frequency signal is the lower modulation sideband, its phase is inverted in reference to the phase of the incoming signal. The retrodirective characteristic of the modulated space antenna is realized by the phase inversion property of the modulator. Each array element is terminated with one modulator, and the local oscillator signals that are directed to the modulators must be of equal phase. No nonreciprocal device is required to separate incoming and reradiated signals in the antenna array. To determine the optimum operating conditions the analysis of the image frequency converter was derived, and an experimental model was tested at 2 Gc. Amplification of the image fre-

quency signal over the incoming signal of 27 db was obtained. The local oscillator power required by one modulator is 10 μ w; the dc bias power is less than 100 μ w.

Gaseous Equilibria in the Germanium Iodine System, R. F. Lever, *Journal of The Electrochemical Society* **110**, 775-779 (July, 1963).

Measurements on the thermal dissociation of gaseous GeI₄ and the reaction of gaseous GeI₄ with excess germanium have been made by observing the dependence of the total pressure on temperature for the corresponding closed systems at constant volume. The dependence of equilibrium constant on temperature is given for the reactions $\text{Ge}_{(s)} + \text{GeI}_{4(g)} = 2 \text{GeI}_{2(g)}$ and $\text{GeI}_{4(g)} = \text{GeI}_{2(g)} + \text{I}_{2(g)}$. Average heats of reaction and entropy changes are deduced for the temperature range 600°-1200°K.

Harmonic Generation in GaAs Injection Lasers, J. A. Armstrong, Marshall I. Nathan, and Archibald W. Smith, *Applied Physics Letters* **3**, 68 (August, 1963).

Second harmonic generation has been observed to accompany the fundamental 8350 Å radiation from the GaAs laser. This is the first time harmonic generation has been seen from a laser itself. The harmonic power was observed to vary as the square of fundamental power, as expected theoretically. The nonlinear susceptibility in GaAs was found to be at least 100 times larger than in a corresponding constant for KDP.

Influence of Image Motion on the Resolution of a Photographic System: II,* Dieter P. Paris, *Photographic Science and Engineering* **7**, 233-236 (July-August, 1963).

Using a previously described method, the decrease in resolution due to linear image motion is derived from the transfer function for various values of the camera shutter efficiency. It is shown that for practical cases an efficiency of 0.6 only decreases the resolution by about one step on the standard U. S. Air Force resolution target. Simultaneous sinusoidal vibration and linear motion is then treated. Curves are given representing the decrease in resolution as a function of linear motion, sinusoidal vibration, angle between directions of motion and vibration, and angle of observation.

* Work performed at The Boeing Company, Seattle, Washington.

The Interaction and Non-Interaction of Ions and with a Natural Polysaccharide,* J. A. Barry and G. D. Halsey, Jr.,† *Journal of Physical Chemistry* **67**, 1698-1701 (August, 1963).

The interaction of a neutral polysaccharide with various ions in aqueous solution has been investigated. No observable binding took place between the polymer and H⁺, Na⁺, K⁺, Ag⁺, Ba²⁺, C₂H₃O₂⁻, Cl⁻, NO₃⁻, SO₄²⁻, or HSO₄²⁻. The polysaccharide displayed an affinity only for OH⁻, and this affinity has been treated as an adsorption phenomenon. Adsorption isotherms, isosteric heats of adsorption, and integral heats of adsorption were determined for the binding of OH⁻ to locust-bean gum and are discussed herein.

* Work performed at University of Washington, Seattle, Washington.
† University of Washington, Seattle, Washington.

Ion Radicals of Methyl-Substituted Benzenes: Temperature Dependence of Spin and Charge Densities, T. H. Thomas* and M. Karplus, *Journal of Chemical Physics* **39**, No. 4, 1115-1122 (August 15, 1963).

The spin and charge densities for the monomethyl and dimethyl benzene negative ions are calculated with the valence-bond perturbation procedure developed previously. Because the difference in energy (ΔE) between the two lowest eigenvalues of these systems is found to be small, thermal averaging is included in the determination of the theoretical spin densities. Meta-xylene negative-ion data are used to evaluate the required valence-bond parameters. Comparison of the measured and calculated hyperfine constant values, including the available temperature-dependence data, shows good agreement in most cases. However, a number of discrepancies appear to exist and further investigation is required. The experimental and theoretical difficulties in obtaining good ΔE values are also discussed.

The formulation is used to predict spin densities for some unknown methyl-substituted benzene negative ions and for the methyl-substituted benzene positive ions. Also, values are obtained for the perturbation parameter (ΔC_{π^-}) for the other alkyl-substituted benzene negative ions which have been studied experimentally. Some discussion is given concerning the extension of the treatment to systems other than substituted benzene ion-radicals. The reliability of the method is considered, and comparisons are made with available molecule-orbital calculation.

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Ion-Water Interaction "Salting Out" in Nitromethane and the Free Energy of Transfer of Some Electrolytes to Pure Nitromethane from Nitromethane Saturated with Water,* G. R. Haugen,† and H. L. Friedman, *The Journal of Physical Chemistry* **67**, 1757-1761 (September, 1963).

The solubilities of the perrhenates of Na, K, Rb and Cs and the perchlorates of K and Rb in nitromethane at 25° have been measured as functions of the concentration of added water. The data have been employed to calculate the free energy of transfer of each of the electrolytes to pure nitromethane from nitromethane saturated with water (1.30 molal water). The dependence of solubility on water concentration is analogous to the nonelectrolyte-electrolyte interaction in water commonly described as "salting out," but which is of the opposite sign and is also much larger in magnitude. The electrolyte-water interaction in nitromethane calculated on the basis of a simple ion-dipole model with reasonable parameters is much smaller than observed. This is derived as an application of a general cluster theory expression for the interaction.

* Experimental part of work performed at University of Southern California, Los Angeles.

† Stanford Research Institute, Menlo Park, California.

The Lubrication of Gold, Morton Antler,* *Wear* **6**, 44-65 (1963).

The friction, wear, and contact resistance of lubricated sliding gold contacts at low-energy circuit conditions have been studied with representatives of the major fluid chemical types. An understanding of the basic phenomena of lubricated sliding has been developed and compared with details of unlubricated sliding.

Boundary properties of the fluid as well as its viscosity determine performance. Fluids high in halogen content are

generally better than other types, while silicon-containing fluids are poorer. Liquids are preferred to greases and solids in multiple-pass sliding since they can self-heal. Alteration of contact surface by wear profoundly affects subsequent performance if repeated traverses are made. Good lubricants allow sliding with low friction, and little or no wear debris is generated. Surfaces, however, may show extensive cold flow, which increases the possibility of hydrodynamic lift and contact resistance noise associated with such lift. Electrical noise caused by sliding-generated adherent insulating solids has also been identified. Thin films of fluids having good boundary properties and low volatility may have practical applications as electric contact lubricants.

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Magnetocrystalline Anisotropy of Magnetite at Low Temperature, W. Palmer, *The Physical Review* **131**, 1057-1062 (August, 1963).

The magnetocrystalline anisotropy of magnetite has been measured by the torque method between 4.2 and 110°K. The anisotropy energy of the orthorhombic phase, which exists below 114.5°K, is represented by the formula

$$E_a = K_a \alpha_a^2 + K_b \alpha_b^2 + K_{aa} \alpha_a^4 + K_{ab} \alpha_a^2 \alpha_b^2 + K_{bb} \alpha_b^4,$$

where α_a and α_b are the direction cosines of the magnetization with respect to the hard and intermediate axes, respectively. The five anisotropy coefficients were determined from torque values measured in the cubic (001) and (011) planes in fields as large as 25,000 G. The values of K_a and K_b confirm the conclusion of Slonczewski that the anisotropy of the orthorhombic phase cannot be accounted for simply by a consideration of magnetic dipole, spin-orbit, and intra-atomic spin-spin interactions. With the exception of K_b , the anisotropy coefficients show little temperature dependence. An increase of K_b by more than 40% between 4.2 and 110°K is attributed to local disorder which is generated with an activation energy of 0.016 eV.

Matching Communications Facilities to Data Processors, M. A. Berk and C. F. Haugh, *IEEE Transactions on Communications and Electronics* **67**, 429-435 (July, 1963).

A number of problems arise when data processing equipment is to be connected to communications lines in real-time systems. This paper discusses four different solutions utilizing essentially three basic approaches consisting of (a) a system modification (b) an addition, and (c) an independent stored-program device. Each approach has certain advantages and disadvantages; the choice depends on system complexity and size, information flow rates, and the central processor requirements.

Minimum-Weight Design of Beams Subjected to Fixed and Moving Loads,* M. Save,† and W. Prager, *Journal of the Mechanics and Physics of Solids* **11**, 255-267 (1963).

This paper is concerned with minimum-weight design of statically indeterminate beams that are subjected to a system of fixed loads and a single moving load.

* Work performed at Brown University.

† Brown University.

Multiphase Sorting, H. H. Manker, *Communications of the ACM* **6**, No. 5, 214-217 (May, 1963).

With a limited number of tape drives available for sorting, the polyphase technique of merging provides faster sorting than the conventional balanced method of merging. This paper describes the polyphase method used in the IBM 1401 Sort 2 program for a computer system with four tape drives available.

A Network-Topological Formulation of Structural Analysis, Steven J. Fenves,* and Franklin H. Branin, Jr., *Journal of the Structural Division, Proceedings of the American Society of Civil Engineers* **89**, No. ST-4, 483-514 (August, 1963).

Structural analysis is formulated using topological and algebraic laws which are counterparts of those used in treating electric network problems. The structural problem has three aspects: topological interconnections, geometric relationship, and mechanical properties of members. Formulation as a network problem follows directly once these aspects have been identified and characterized by matrix equations. Thus, a unified and generalized approach to structural analysis is obtained. Geometric manipulations and load-deflection relationships of structural members are reviewed, and abstract topological and algebraic properties of the network problem are described. Equilibrium, continuity, and load-deflection relationships are then shown to correspond to basic network properties. Force and displacement methods of analyzing linear, framed structures are developed as counterparts of mesh and node methods of network analysis. This formulation, adaptable to a digital computer, paves the way for applying to structural problems many existing and future developments in network analysis, design, and synthesis. Specifically, it permits the use of Kron's method of piecewise analysis.

* Associate Professor of Civil Engineering, University of Illinois.

The Neutral Axis in Creep of Beams,* A. Phillips† and E. Donath, *International Journal of Mechanical Sciences* (Great Britain) **5**, 309-320 (1963).

A study of the movement of the neutral axis in nonsymmetrical pure bending of beams in creep when the moment vector changes direction is presented. The stress-rate of strain law of a power law type is assumed. The influence of changes in the value of the exponent of the power law on the position of the neutral axis is determined; thus, the influence of a change in the temperature on the direction of the deflection can be assessed.

The first part of the paper develops the general theory. Neutral axes form a family of straight lines that remain constant when the bending moment increases. A method is developed for determining the envelope of the family of neutral axes. The relationship between direction of moment vector and direction of neutral axis is determined. The second part of the paper applies theory to a channel cross section. Computations are made with the help of an IBM 7090 computer. It is shown that for the selected channel cross section the direction of the deflection in some cases is influenced considerably by a change in the value of the exponent n .

* This work was sponsored in part by the National Science Foundation.

† Department of Engineering and Applied Science, Yale University.

New Ternary Semiconducting Compounds, $Cd_3(P,As)_2(Cl,Br,I)_3$, Lawrence Suchow and Norman R. Stemple, *Journal of the Electrochemical Society* **110**, 766-769 (July, 1963).

Five new ternary semiconducting compounds have been synthesized: $Cd_3P_2Cl_3$, $Cd_3P_2Br_3$, $Cd_3P_2I_3$, $Cd_3As_2Br_3$, and $Cd_3As_2I_3$. These compounds are all cubic (space group $Pa\bar{3}$) and isomorphous with each other. Their lattice constants vary with sizes of the component atoms. The structure appears to be based on a nearly face-centered cubic arrangement of cadmium atoms in a pseudocell having half the edge of the true primitive cell. All the new compounds are deeply colored. Estimates of their energy band gaps have been made from optical and electrical measurements.

Now a "Talking" Computer Answers Inventory Inquiries, L. H. Lee and R. B. Mulvany, *Electronics* **36**, No. 33, 30-32 (August 16, 1963).

Many business applications, e.g., production control and information services, would welcome voice input from a computer in response to a telephone inquiry. An indication of the direction future computer-controlled voice-response equipment may take is DIVOT (Digital-to-Voice Translator), an experimental system developed in the IBM Advanced Systems Development Laboratory. In this system, an inquirer in effect dials the address in computer storage that contains the latest "program" to compose the answer to his request. The program thus dialed is read into DIVOT where it controls the selection, in proper sequence, of audio signals from a prerecorded vocabulary and transfers them at high speed to one of many channels of a playback buffer. The whole process from dialing to reply occurs in a matter of seconds.

Observation of an Optical Difference Frequency,* Archibald W. Smith and Norman Braslau, *Journal of Applied Physics* **34**, 2105 (July, 1963).

The mixing of a ruby optical maser with spectral lines from a high pressure mercury lamp is discussed. The mixing is performed in crystals of KDP, which has a first-order nonlinear polarizability. A difference frequency signal at 5650 Å arising from the lamp output at 3115 Å has been observed. The output intensity was compared to that of a sum frequency signal at 3056 Å produced by mixing the ruby maser with the mercury line at 5461 Å in the same crystal. The same nonlinear coefficient describes both experiments. With suitable simplifying assumptions it was therefore possible to calculate the intensity ratio of these signals in terms of known quantities. This ratio was found to be in satisfactory agreement with the experimentally determined ratio.

* This research has been supported in part by the Army Research Office, Durham, North Carolina.

On the Computation of Euler's Constant, Dura W. Sweeney, *Mathematics of Computation* **XVII**, No. 82, 170-178 (April, 1963).

The computation of Euler's constant, γ , to 3566 decimal places by a procedure not previously used is described. As a part of this computation, the natural logarithm of 2 has been evaluated to 3683 decimal places. A different procedure was used in computations of γ performed by J. C.

Adams in 1878, by J. W. Wrench, Jr. in 1952, and more recently by D. E. Knuth. This latter procedure is critically compared with that used in the present calculation. The new approximations to γ and $\ln 2$ are reproduced *in extenso* at the end of this paper.

On the Convergence of an Integer-Programming Process, R. E. Gomory and A. J. Hoffman, *Naval Research Logistics Quarterly* **10**, No. 2, 121-123 (June, 1963).

The convergence of an integer programming process proposed by G. B. Dantzig is analyzed and two necessary conditions for convergence are given.

On the Duals of Symmetric Partially-Balanced Incomplete Block Designs, A. J. Hoffman, *The Annals of Mathematical Statistics* **34**, No. 2, 528-531 (June, 1963).

This paper investigates conditions under which the dual of a symmetric partially-balanced incomplete block design with m associate classes is a design with all parameters the same. This condition is significant in the problem of enumerating all designs and in applications to miscellaneous combinatorial investigations. Sufficient conditions are given for the dual to have the desired property, together with an example that demonstrates that, if no conditions are postulated, the dual need not have this property.

An Optical System for Manned Vehicle Terminal Guidance, Harold P. Van Cott, *Human Factors* **5**, No. 3, 137-141 (June, 1963).

An optical system for implementing manned vehicle terminal guidance for a soft lunar landing is described. The method utilizes an on-board tracking telescope to establish azimuth and elevation angles. With altitude, this system provides sufficient information for computing lateral vehicle velocity which can be controlled within less than 2 ft/sec, a value not to be exceeded for a safe landing.

Output Distribution of a Single-Channel Queue, Wei Chang, *Operations Research* **11**, No. 4, 620-623 (July-August, 1963).

The interdeparture-time distribution of a single-channel queueing system with general arrival and service time distribution is derived by applying the complex-variable theory. It is important in studying the queues in series, since the output from one channel comprises the input into the subsequent channel. An example is given on the exponential channel. This shows that the output from such a system with a Poisson input is itself a Poisson. The interdeparture times fail to be statistically independent if the interarrival times and the service times are other than exponentially distributed.

Photochemical Formation of Phenanthrene from Cis-Stilbene in the Vapor Phase, R. Srinivasan and J. C. Powers, Jr., *Journal of Chemical Physics* **39**, 580 (1963).

Photolysis of cis-stilbene in the vapor phase at 170° leads to the formation of trans-stilbene, phenanthrene, and hydrogen. The formation of phenanthrene is not eliminated by the addition of oxygen (35 mm) or nitric oxide (6 mm),

nor is the rate affected by large excesses of ether or cyclohexane. It is believed that phenanthrene and hydrogen are formed from cis-stilbene by an intramolecular process which probably proceeds in a single step—the elimination of hydrogen occurring at the same time as the closure of the third ring. The reaction is also observed to occur in the pyrolysis of cis-stilbene at 550°. Qualitative results on the photolysis and pyrolysis of 1,4-diphenyl-1,3-butadiene in the vapor phase are reported.

Photo-induced Recombination Radiation in InP, W. J. Turner and G. D. Pettit, *Applied Physics Letters* **3**, 102-104 (September, 1963).

This letter reports the results of photoluminescence measurements on InP at 6° and 77°K. At 6°K, five sharp lines and two broad bands are observed. The first line is at 1.416 eV at 6°K and appears to be an exciton line. Lines 2, 3, 4, and 5 correspond to recombination at an impurity with the emission of 0, 1, 2, and 3 optical phonons. Line 2 (the zero phonon line) is the strongest line at 6°K and has a peak energy of 1.374 eV. This is very near the laser energy reported by K. Weiser and R. S. Levitt (*Applied Physics Letters* **2**, 178, 1963). The broad band emissions have peak energies of 1.04 and 0.72 eV and are due to recombination at some unknown deep levels similar to those observed in GaAs.

Polymerization of Butadiene Gas on Surfaces Under Low Energy Electron Bombardment, I. Haller and P. White,* *Journal of Physical Chemistry* **67**, 1784 (September, 1963).

The kinetics of the formation of butadiene polymer film have been investigated on a surface exposed to 250-eV electrons. In the presence of butadiene vapors at pressures between 3×10^{-4} Torr and 10^{-6} Torr, the rate of growth of the transparent film, insoluble in benzene, acetone, CCl_4 or CS_2 , was found to be proportional to the square root of the current density. The rate increased with increasing pressure, becoming independent at higher values of pressure. The kinetics have been interpreted to indicate that after the first layer of polymer has formed, subsequent layers grow by interaction of adsorbed monomer gas with active species, probably positive ions, in the polymer. The measured lifetime of the active species is about one minute. The apparent activation energy is -6 ± 2 Kcal/mole.

* Standard Telecommunication Laboratories, Ltd., Harlow, Essex, England.

Radiative Transition Probabilities with $4f^n$ Configurations,* John D. Axe, Jr., *Journal of Chemical Physics* **39**, 1154-1160 (September, 1962).

The relative intensities of the transitions occurring in the fluorescence spectrum of $\text{Eu}(\text{C}_2\text{H}_5\text{SO}_4)_3 \cdot 9\text{H}_2\text{O}$ have been measured at 77°K and 4°K. The strengths of both the "forbidden" electric dipole transitions and magnetic dipole transitions which were observed are compared to theoretical expressions and the results are discussed. The results are in reasonable agreement with recent phenomenological treatments of crystal field induced dipole radiation, and suggest that g -orbital configurational mixing contributes significantly to the process.

* This research has been supported in part by the Army Research Office, Durham, North Carolina.

Rejecting Common Mode Noise in Process Data Systems, James Jursik, *Control Engineering* **10**, 61-66 (August, 1963).

In the past several years, the digital computer has been used extensively in the control of complex multivariable industrial processes. To implement the computer control of such processes has required the development of high performance data input systems. Of particular importance has been the necessity of processing low level analog information and converting it to digital form while maintaining the high degree of accuracy necessary to obtain required system performance.

For low level analog signals, common mode noise can be a major source of input error. This article presents some design techniques to surmount this problem. Other factors which can influence system performance are also evaluated.

Role of Computers in Industrial Process Control, Gary K. L. Chien, *Automation* **10**, 52-59 (August, 1963).

Regardless of the forms and mechanics of the various computer control systems, their most important role in the over-all industrial control complex is to provide an effective means of communication and transformation between the physical and economic aspects of industrial process control problems.

Also included within the scope of this paper are the following topics: a close examination of a typical problem of production process control; the role of computers in providing efficient evaluation and optimization; limitations of conventional process control techniques; differences between serial and parallel types of control problems; a brief history of process control technology; and possibilities for future broadening of systems technology.

Self-Consistent-Field Wavefunctions for the Na^- and NO_2^+ Molecules, E. Clementi and A. D. McLean, *Journal of Chemical Physics* **39**, 323-325 (July 15, 1963).

The self-consistent field (SCF) wavefunctions for the Na^- and NO_2^+ molecules, are reported. The basis set of Slater-type orbitals (STO's) includes $3d\pi$ and $3d\sigma$ STO's, to account for polarization in the bonds. A gain over a previous computation of about 5 eV was obtained in the total energy despite the limited number of functions in the basis set.

Sensory Feedback Analysis of Visual Behavior: A New Theoretical-Experimental Foundation of Physiological Optics,* Karl U. Smith,† John D. Gould, and Lynn Wargo, *American Journal of Optometry* **40**, 365-417 (July, 1963).

This paper presents a new evaluation of the organization of visual behavior, utilizing new concepts and methods based on studies of space and time displacement of the visual feedback of common motions, and applies a new viewpoint about integration of visual motion to the understanding of research problems in physiological optics. The main purpose of the paper is to discuss the scientific basis of learning theory as applied to visual perception and behavior and to bring new data to bear upon this general problem.

* Work performed at the University of Wisconsin.

† Principal author, Professor of Psychology, University of Wisconsin.

Sequentielle asynchrone Logik (Sequential Asynchronous Logic) H. Zemanek *Elektronische Rechenanlagen* **4**, No. 6, 248-253 (1962).

Asynchronous logic as proposed by D. E. Muller is presented in a new, more precise form, applying the switching time diagram by E. Winkel. Principle, requirements, basic and some special elements are given. Nothing, however, is said on the final design of circuits and systems.

Signal Processing for Increased Bit Densities in Digital Magnetic Recording, C. E. Schlaepfer, *IEEE 1963 Convention Record* **11**, Part 4, pp. 2-10.

This paper presents a practical approach to the design of linear waveform filters which serve to increase electronically the lineal bit density capability of digital magnetic recording systems. Bit densities are limited by the degeneration of read-back signals caused by the interference of adjacent pulses. It is shown that suitable time-domain filters can be derived which effectively narrow the individual read pulses and thereby allow an increase in the packing density. Beginning with a review of some pertinent characteristics of the magnetic recording channel and a brief descriptive discussion on the concept of time-domain filtering, the realization of practical pulse slimming filters is detailed. Simple filters show a nominal doubling of bit packing, resulting in densities as high as 10,000 bits per inch in experimental systems.

Spectral Characteristics of GaAs Lasers Operating in Fabry Perot Modes, P. P. Sorokin, J. D. Axe, Jr., and J. R. Lankard, *Journal of Applied Physics* **34**, 2553-2559 (September, 1963).

High resolution spectral measurements of cw GaAs lasers were made. The results were interpreted on the basis of a simple narrowing theory.

Statistical Theory of Atoms, L. H. Thomas, *Reviews of Modern Physics* **35**, 508-510 (July, 1963).

The history of the statistical theory of atoms is summarized and its present state is discussed.

A Survey of Analog Memory Devices,* George Nagy, *IEEE Transactions on Electronic Computers* **EC-12**, 388-393 (August, 1963).

Widespread and persistent interest in the implementation of multi-level logic, conditional probability computers, learning machines, and brain models has created a need for an inexpensive analogue or quasi-digital storage element. A number of possible approaches to this problem, ranging from the slow and reliable electro-mechanical systems to the many forms of charge and flux intergration, are reviewed, and the suitability of each device for various fields of application is briefly discussed.

* Work performed at Cornell University.

A Theoretical Treatment of Self-Demagnetization in Magnetic Recording, R. G. Bayer, *IEEE Transactions on Audio* **AU-11**, No. 3, 81-88 (May-June, 1963).

A model for self-demagnetization is proposed which states that the value of the field and magnetization at every point in the material represents a point on a particular hysteresis

loop of the material. This loop can either be a major or a minor loop of the material. The particular loop ascribed to a point is determined by the magnetization which existed at that point initially. This model has been applied to an ideal case of longitudinal recording. The results are compared with the Kostyshyn model for self-demagnetization and with experimental data.

Thin Films Analysis by X-ray Fluorescence, K. T. Potts and R. R. Stone, *Norelco Reporter* **10**, No. 3, 94-97 (July-September, 1963).

This article describes a nondestructive, quantitative analytical procedure for determining composition and thickness of nickel-iron thin films. The nondestructive X-ray fluorescence analysis and the calibration by both spectrophotometry and interferometry are described in detail.

Toward A Study Of Bidding Processes, Part II: Games With Capacity Limitations,* James H. Griesmer and Martin Shubik, *Naval Research Logistics Quarterly* **10**, 151-173 (June, 1963).

This paper is the second of a series on bidding. A previous paper considered bidding situations formulated as two-person constant-sum games; this article is devoted to the important case of non-constant-sum bidding models involving two participants.

Following an introduction on solution concepts, the single-shot bid is analyzed, both for the case of no penalty in the case of a tie, and for the case of a penalty. The majority of the paper is devoted to a study of bidding on a sequence of jobs, using three different assumptions about the amount of information revealed after the award of each job. These three assumptions are, respectively, the *super-silent* bid, where no information is given; the *silent* bid, where only the name of the winner is announced; and the *noisy* bid, where complete information is given. The analysis is primarily a study of equilibrium solutions under each assumption. It is shown that in passing from one type of bid to a second in which more information is given, new families of equilibrium solutions are added, and existing families become more extensive.

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Ein Transistorverfahren zur Regeneration von Nachrichtentimpulsen in digitalen Systemen (A Transistor Technique for the Regeneration of Signal Pulses in Digital Systems) K. Walk, *Elektronische Rechenanlagen* **5**, No. 4, 155-165 (1963).

Recent developments of transistor techniques for the regeneration of signal pulses primarily aim at the construction of very fast digital systems. In addition, development of small, low-cost systems with medium speed satisfies current needs. A switching technique is given which allows good utilization of transistor properties, making possible the use of slower and less expensive transistors. Contrary to most well-known switching techniques, no feedback of the regenerating circuits is used. Accordingly, no transistor lead is occupied by the feedback circuit and circuits are simplified. The new synchronizing technique makes circuits highly insensitive to delay effects due to the saturation region of the transistors. The generation of small turn-on times partially is taken over by the clock pulses.

Vacuum Evaporation of Cadmium Telluride, Reinhard Glang, John G. Kren, and William J. Patrick, *Journal of Electrochemical Society* **110**, No. 5, 407-412 (May, 1963).

Structural and electrical properties of CdTe films prepared by vacuum evaporation of the compound were studied. Films 0.1-1 μ thick were deposited on glass substrates between 25° and 250°C at ambient pressures below 10⁻⁶ Torr. The deposition rate was controlled by an ionization rate monitor. Film thickness, uniformity, adhesion, and infrared absorption were determined. X-ray diffraction techniques were used to analyze the structure, grain size, and orientation of the films. These properties were found to be related to the deposition temperature. Film resistivities were greater than 10⁷ ohm-cm at all deposition temperatures, even if impurities were added during evaporation. Possible causes for this behavior are discussed.

Velocity Modulation of Propagating Waves, Rolf Landauer, *Journal of Applied Physics* **34**, 1893-1896 (July, 1963).

Waves moving through a medium in which the wave velocity is a function of time and space suffer frequency changes. If the velocity modulation is small and adiabatic, very elementary kinematic considerations define these frequency changes. For a uniformly moving velocity pattern the frequency change suffered by a portion of the wave is shown to depend only on the wave velocity at the input and output end of the modulating system, and not on the intermediate velocities experienced by the wave. Electro-optic modulation and deflection experiments are treated in this framework. The paper is intended to present a particularly simple viewpoint, and does not arrive at really new results.

Letters to the Editor

Continuous Stimulated Emission from GaAs Diodes at 77°K, M. Pilkuhn, H. Rupprecht, and J. Woodall, *Proceedings of the IEEE* **51**, 1243 (1963).

A Diagram for Stability, Gain, and Bandwidth of a Linear One-Stage Tunnel Diode Amplifier, D. Seitzer, *Proceedings of the IEEE* **51**, No. 8, 1157 (August, 1963).

Donor-Diffused Gallium Arsenide Injection Lasers, C. E. Kelly, *Proceedings of the IEEE* **51**, 1239-1240 (September, 1963).

Double Photon Excitation of Organic Molecules in Dilute Solution, W. L. Peticolas and K. E. Rieckhoff, *Journal of Chemical Physics* **39**, 1347-1348 (September, 1963).

Effects of Gamma Radiation on Reverse-Biased Silicon Junctions, D. R. Kerr, *Proceedings of the IEEE* **51**, 1142 (August, 1963).

Fabrication of Thin Film Diodes Using Reactive Sputtering, P. J. Magill, *Proceedings of the IEEE* **51**, No. 7, 1040 (July, 1963).

Generalization of the Note "An Error Analysis in the Digital Computation of the Autocorrelation Function," H. L. Crowson, *AIAA Journal* **1**, No. 8, 1968-1969 (August, 1963).

A Gyrator Realization, Thomas J. Harrison, *IEEE Transactions on Circuit Theory*, **CT-10**, 303 (June, 1963).

Optimum Stability Criterion for Tunnel Diodes Shunted by Resistance and Capacitance, L. A. Davidson, *Proceedings of the IEEE* **51**, No. 9, 1233 (September, 1963).

A Relation Between the Current Density at Threshold and the Length of Fabry-Perot Type GaAs Lasers,

M. Pilkuhn and H. Rupprecht, *Proceedings of the IEEE* **51**, 1243-1244 (1963).

Relay Essential Hazards, M. P. Marcus, *IEEE Transactions on Electronic Computers* **EC-12**, No. 4, 405-407 (August, 1963).

Some Properties of InP Lasers, G. Burns, R. S. Levitt, M. I. Nathan, and K. Weiser,* *Proceedings of the IEEE* **51**, No. 8, 1148-1149 (August, 1963).

*The work of K. Weiser is supported by U. S. Army Electronics Research and Development Laboratory, Fort Monmouth, N. J., under Contract No. DA 36-039-SC-90711.

Use of a Π -Complex of an Olefin as a Photochemical Catalyst, R. Srinivasan, *Journal of the American Chemical Society* **85**, 3048 (1963).

Vicinal Proton Coupling in Nuclear Magnetic Resonance, M. Karplus, *Journal of the American Chemical Society* **85**, No. 18, 2870-2871 (September, 1963).