Technical Papers by IBM Authors Published Recently in Other Journals

a-c Exchange in the Garnets, G. Burns, E. A. Giess and K. W. Blazey, *Journal of Applied Physics* **37,** No. 3, 1301-1303 (March 1, 1966).

In the ferrimagnetic garnets the a-d (octahedral-tetrahedral) exchange is the dominant one and reasonable values of the other exchange values are difficult to obtain. Thus, direct measurement of some of the smaller exchange constants is of interest because of the ambiguity of the values obtained by molecular field analysis. In this paper an optical technique is used to measure the a-c exchange of Cr^{3+}-Gd^{3+} in the garnet $Gd_3Ga_2(GaO_4)_3$. The 16a site is octahedrally coordinated and the rare earth is on the 24c site. The structure on sharp redline fluorescence from the Cr^{3+} ions is measured. The fluorescence transitions are from the excited ^2E state to the ground $^4A_2$ state; thus the exchange constant in both states can, in principle, be determined. The analysis of the a-c interaction was done by assuming a Heisenberg Hamiltonian

$$\mathcal{H} = \sum_{i=1}^{6} JS_{Cr} \cdot S_{Gd_i},$$

where the sum is over the six nearest-neighbor Gd^{3+} ions each with a span 7/2. The most probable value of

$$\sum_{i=1}^{6} S_{Gd_i}$$

is 8. The Cr^{3+}-Gd^{3+} exchange splitting in the ^2E state of Cr^{3+} is just resolvable. A detailed fitting of the lines gives $J=0.32$ cm^{-1}(0.46°K). Cr^{3+}-Gd^{3+} exchange splitting of the Cr^{3+} ground state is not resolvable. However, the low-temperature linewidth is much too wide to be due to anything except an exchange splitting. Fitting the line, one obtains an exchange value in the ground state approximately half that of the excited state.

Annealing and Arsenic Overpressure Experiments on Defects in Gallium Arsenide, H. R. Potts and G. L. Pearson,* *Journal of Applied Physics* **37,** No. 5, 2098-2103 (April, 1966).

Previous experiments reported by the authors revealed a measurable expansion in the lattice constant of GaAs single crystals quenched from temperatures above 1000°C. These results led to the conclusion that a defect structure consisting of both Frenkel pairs and Schottky vacancies was produced in these crystals. In this paper we report experiments in which an arsenic overpressure, obtained by including metallic arsenic along with the GaAs crystal, depresses the defect concentration. These results are used to identify the primary defect species as arsenic monovacancies. Subsequent heat treatments at both room temperature and high temperature show that annealing proceeds in two stages. The first stage is quite rapid but does not have a well-defined activation energy. The second stage is slower and has an activation energy of 1.0 eV. These results are interpreted to include the presence of arsenic interstitial atoms. A physical model is proposed to describe the defect structure as well as the annealing behavior and the effect of excess arsenic pressure.

* Stanford University.

An Automatic System for Measuring Arm Blood Pressure, J. R. Vogt, *Conference Record of the Third Annual IEEE Rocky Mountain Bioengineering Symposium,* pp. 33-36 (May, 1966).

A system has been designed to measure arm blood pressure automatically by the Korotkoff method. Several tests of the system have been performed in the Mayo Clinic Hypertension Laboratory. Details of the system and results of the tests are presented.

The Korotkoff method normally used in clinical practice is used by the system. An armcuff with an attached microphone is placed over the brachial artery of the subject. The system rapidly inflates the armcuff and then monitors the microphone output as the cuff slowly deflates. Analog processing of the microphone output is combined with unique logical processing to determine when cuff pressure is equal to systolic or diastolic pressure. At the proper instant, cuff pressure is digitized and recorded.

In experimental procedures, the performance of the system was tested against the readings of trained technicians using the Korotkoff method. A three-way test compared simultaneous readings of the system and two trained technicians. Seventy-four cooperative hypertensive subjects participated in three separate tests.

Characterization and Analysis of a Polycrystalline Semiconducting ZnO Screened Capacitor Family, V. A. Vulcan, *Proceedings of the 1966 Electronic Components Conference,* pp. 296-312 (May, 1966).

Polycrystalline semiconducting ZnO capacitors, designed for decoupling in nanosecond computer circuits, have been fabricated on ceramic substrates by screening techniques. Theoretical treatments of the postulated physical and energy band models for three representative combinations yield results that satisfactorily account for both ac and dc behavior. Relaxation phenomena are analyzed by Cole-Cole plots of the complex dielectric constant. The addition of Bi_2O_3 raises the insulation resistance and the apparent static dielectric constant to values as high as 10^4, and introduces a second dispersion region at audio frequencies. The existence of an optimum concentration of Bi_2O_3 is predicted by the models. These Bi_2O_3 films act as sheets of electron traps between back-to-back ZnO depletion layers. Grain-boundary flux equations explain the observed Schottky exp $(V^{1/4})$ current dependence. At high biases, exponential trap distributions lead to power-law I-V relationships. Copper doping increases the Bi_2O_3 potential barrier and changes the dominant dc conductivity mechanism to a Schottky exp $(V^{1/2})$ law up to space-charge-limited biases.

Closed Circuit TV Reduces Maintenance Costs, A. N. Weiner, *Maintenance* **16,** No. 4, 24-25 (April, 1966).

A closed-circuit TV system designed for use in IBM's Endicott plant is described. The system enables one man to monitor the plant's power and air-conditioning operations from a single station. Two-way communication between maintenance men and the monitor has reduced maintenance costs while promoting safety for the maintenance workers.

The Composition and Some Physical Properties of Manganese Oxide Thin Films, R. M. Valletta, J. Makris and W. A. Pliskin, *Proceedings of the 1966 Electronic Components Conference,* pp. 31-37 (May, 1966).

A study of manganese oxide films prepared by spray deposition and of their effect on tantalum thin-film capacitors was performed. The purposes of the study were to determine the effect of deposition parameters on the composition and quality of the films and to see if their presence between the anodic tantalum film and the counter-electrode would increase the stability of tantalum thin-film capacitors having extremely thin (160-320 Å) anodic tantalum oxide films.

Infrared spectra of films prepared with various deposition parameters were obtained in the 4000-400 cm^{-1} range. These spectra were found to be very sensitive indicators of variations in the composition of the films. Heat treatment of the films in oxygen established that films prepared at low temperatures (175°C and 190°C) were in the highest oxidation state. The infrared spectra of films reduced by heating in forming gas were the same as those prepared at 230°C. Infrared spectra of an intermediate type were found for films prepared at temperatures between these two extremes.

Capacitors have been prepared with approximately 1 μ thick manganese oxide films between the anodic tantalum oxide and an aluminum counter-electrode. The capacitors were formed by anodization to 15-20 volts of a tantalum film deposited by sputtering onto an oxidized silicon wafer. These samples showed more high temperature thermal stability than capacitors prepared without the manganese oxide films. The capacitance was frequency dependent. This effect is discussed in some detail.

Computation of e^x with the Use of Large Tables, K. Spielberg, *IBM Systems Journal* **5,** No. 2, 102-114 (1966).

A procedure is given for computation of e^x using tables of coefficients of the economical approximating polynomial over a range of positive and negative x. A related procedure that uses continued fractions is also discussed. The exponential function was selected to test the effectiveness of table lookup methods in the computation of elementary functions. The number of multiplications or divisions required of standard methods is compared with the number required when table lookup is employed.

Computer Simulation of Photo-Optical Image-Forming Systems, D. P. Paris, *Journal of Photographic Science and Engineering* **10,** No. 2, 69-70 (March-April, 1966).

A computer program was developed to facilitate the simulation of one-dimensional images in an incoherent photo-optical image-forming system. The single or multiple stage image-forming system may consist of a sequence of linear and nonlinear components such as lenses, emulsions, and components that are described by their spread function or optical transfer function. Emphasis in developing the program was on: (1) simplicity of the statements in which the user specifies the system configuration to the program; (2) capability of requesting intermediate output at any point in the sequence of system components; and (3) capability of providing repeat runs with varied input or component parameters. These three goals were achieved by designing a simple, user-oriented special-purpose programming language called IMSIM/I.

A Computer System for Electrocardiographic Analysis, R. E. Smith* and C. M. Hyde, *Conference Record of the Third Annual IEEE Rocky Mountain Bioengineering Symposium,* pp. 20-24 (May, 1966).

A clinical system for the machine analysis of ECG's has been developed jointly by the Mayo Clinic and IBM. The data acquisition system is initiated at patient beds when multiple electrodes are placed on patients. With the system, 300 electrocardiograms can be recorded on one console each day. An operator at the control console selects the proper patient by a switching device, and monitors the multi-channel recording on an oscilloscope, the last human intervention into the system. Frank-lead system voltages are digitized and entered into the IBM 7040 Data Processing System. A recognition and measurement program determines heart rate, P and R duration, and PR and QT intervals. Magnitude and angles of the voltage vectors are determined. These measured values constitute a set of quantities upon which the analysis program is based. The program output consists of time interval measurements, narrative diagnostic statements, and graphic plots.

* Mayo Clinic, Rochester, Minnesota.

Correlation Energy in Atomic Systems. IV. Degeneracy Effects, E. Clementi and A. Veillard,* *The Journal of Chemical Physics* **44,** No. 8, 3050-3053 (April 15, 1966).

The degeneracy effects in the isoelectronic series of the first-row atoms are analyzed. The near-degenerate configurations $1s^22s^22p^2$ and $1s^22s^02p^{n+2}$ are computed within the framework of a two-configuration SCF technique. The newly obtained correlation energy diagram indicates a remarkable simplicity in its structure.

* Ecole Normale Superieure, Laboratoire de Chimie, Paris.

Creep Behavior of Polymer Films, A. H. Landzberg, *Materials Research & Standards* **6,** No. 5, 232-237 (May, 1966).

Creep-recovery tests were made on five polymer thin film materials used in computer equipment. The films were stressed in the 1000 to 3000 psi range at 26°C and 55 percent relative humidity. Poly(ethylene terephthalate) had the best dimensional stability under these conditions. An apparatus developed for these tests is described.

Cryoelectronics, H. L. Caswell, *Transactions of the Metallurgical Society of AIME* **236,** No. 3, 257-263 (March, 1966).

The present status of integrated circuits utilizing superconductive switching elements is reviewed with special attention given to fabrication techniques, methods for interconnecting completed circuits, and refrigeration requirements.

Data, Documentation and Decision Tables, D. L. Fisher, *Communications of the ACM* **9,** No. 1, 26-31 (January, 1966).

In business data processing systems, it is necessary to be able to define and document data, files, programs, and decision rules in a way that adequately represents both their changing information content and their continuous interaction. Tabular description makes this possible, since it is notably objective, thorough and economical in cost and time when systems must be analyzed and programs prepared or modified. To show how quickly tabular techniques make an unfamiliar system manageable, a detailed example and a self-test are provided.

Direct Optical Absorption Selection Rules for the Hexagonal Close-Packed Lattice, J. F. Cornwell,* *Physics of Condensed Materials* **4,** 327-329 (1966).

The direct electric dipole optical selection rules between Bloch electronic states at the symmetry points of the Brillouin zone of the hexagonal close-packed lattice are calculated. Bloch wave functions transforming according to the irreducible representations of both the single and double groups are considered.

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Distribution and Precipitation of Gold in Phosphorus-Diffused Silicon, S. Dash and M. L. Joshi, *Journal of Applied Physics* **37,** No. 6, 2453-2457 (May, 1966).

Distribution of gold and silicon wafers diffused with phosphorus was studied at different depths through electron transmission microscopy and radio tracer techniques. Phosphorus-gold precipitates were observed in the surface of the wafer in which gold was diffused from the other side. The distribution and precipitation of gold in the phosphorus-rich regions is shown to be consistent with the Reiss Theory of solubility of impurities in doped semiconductors.

Domain-Wall Structures in Magnetic Double Films, S. Middelhoek, *Journal of Applied Physics* **37,** No. 3, 1276-1282 (March 1, 1966).

Double films consisting of two Ni-Fe layers separated by a nonmagnetic SiO layer show many properties which differ from those known from single films. In the first part of this paper, the energy and the width of walls in double films are calculated. In the second part, the theory is compared with experimental Bitter observations of the walls. Further, domain structures and the reduction of the wall motion coercive force are discussed.

DSL/90—A Digital Simulation Program for Continuous System Modeling, W. M. Syn and R. N. Linebarger, *AFIPS Conference Proceedings, Spring Joint Computer Conference* **28,** 165-187 (April, 1966).

DSL/90 is an IBM 7090/94 FORTRAN IV program for the digital simulation of continuous system dynamics. Its nonprocedural problem-oriented input language accepts problems expressed either at the analog block diagram level or as systems of ordinary differential equations. DSL/90 permits the intermixing of DSL and FORTRAN IV statements and contains a library of subprograms which represent analog operational elements such as integrators, summers, limiters, etc. Programming consists of interconnecting these operational elements with simple connection statements. A translator converts the DSL/90 statements into a FORTRAN subprogram which is compiled and executed to accomplish the simulation. Principal features of DSL/90 are illustrated by three example applications: (1) a nonlinear CO_2 respiration control system simulation in Bio-medical Engineering, (2) the simulation of heat transfer dynamics of a recirculating furnace used in the glass industry, and (3) the simulation of the flight dynamics of a large aerospace booster rocket. A short discussion of the advantages and principal features of DSL/90 concludes the paper.

The Effect of the Concentration of Hypophosphite Ion on the Magnetic Properties of Chemically Deposited Co-P Films, J. S. Judge,* J. R. Morrison and D. E. Speliotis, *Journal of the Electrochemical Society* **113,** No. 6, 547-551 (June, 1966).

Samples of electroless cobalt-phosphorus films of various thicknesses in the region less than 3000Å were prepared from solutions containing different concentrations of hypophosphite ion. These samples were analyzed by x-ray fluorescence and their magnetic characteristics were studied. The percent phosphorus in the films was found to increase approximately logarithmically as the concentration of hypophosphite was increased. The plating rate increased concomitantly. The saturation magnetic moment and the coercivity were found to depend strongly on the phosphorus content of the films. The coercivities of these films also have a strong dependence on thickness. To a large extent the interaction of these two physical properties of the film determines the magnetic properties observed.

* On educational leave of absence.

Efficient Injection Electroluminescence in ZnTe by Avalanche Breakdown, B. L. Crowder, F. F. Morehead and P. R. Wagner, *Applied Physics Letters* **8,** No. 6, 148-149 (March 15, 1966).

A basic problem in obtaining efficient visible injection electroluminescence in the wide-band-gap II-VI compounds is the achievement of efficient minority-carrier injection. This goal has been attained at low temperatures (e. g., 77°K) by the use of *p-n* junctions produced by diffusion techniques in $Cd_xZn_{1-x}Te$ by Morehead and Mandel and $ZnSe_xTe_{1-x}$ by Aven. In the compound ZnTe, the use of alloy contacts of indium has led to low-efficiency electroluminescent diodes (less than 0.01% external quantum efficiency).

Electron Microprobe Study of Wear Involving Thin Sections, H. R. Potts, *Wear* **9,** No. 3, 228-235 (May-June, 1966).

A description is given of the operation of the electron microprobe analyzer. Specific emphasis is placed on its application to the analysis of thin sections of material particularly as they may appear in wear problems. Two types of problems are discussed as examples. In the first problem the material studied is in the form of a thin section whose wear properties are to be studied. In the second problem bulk samples are involved and the thin section represents the transfer of material from one sample to the other. The applications of the electron probe to the wear problems are emphasized rather than any particular problem.

Exact Matrix Elements of a Crystal Hamiltonian Between Harmonic-Oscillator Wave Functions, T. R. Koehler, *Physical Review* **144,** No. 2, 789-798 (April 15, 1966).

A method is given for the exact calculation, including all anharmonic effects, of the matrix elements of the true Hamiltonian H of a crystalline solid between the eigenfunctions of any arbitrary harmonic Hamiltonian appropriate to the crystal structure. By the introduction of a variational scaling parameter α, a set of harmonic eigenfunctions can be generated from the eigenfunctions of a single such harmonic Hamiltonian. The ground-state energy W_0 of the crystal and the optimum value α_0 of α are then determined by a variational calculation which minimizes the expectation value of H between the ground-state harmonic eigenfunctions. The other diagonal matrix elements of H, calculated using the states determined by α_0 then give first-order values for the energy of one-phonon and multiphonon states. In addition, the off-diagonal matrix elements can be obtained and used in a perturbation calculation to improve the energies. It is shown that the value of W_0 will always be lower than energy obtained from a closely related variational calculation using a wave function constructed out of a product of Gaussian orbitals centered on the lattice sites. The decrease in energy is about 12% of the original kinetic energy, and is divided approximately equally between the kinetic- and potential-energy contributions. Numerical results are given for W_0 and for a few phonon energies of a model bcc crystal in which each atom interacts with its first two shells of nearest neighbors through a realistic atomic potential. Possible applications of this theory to rare-gas solids are discussed.

Frequency Equations for Wave Propagation in an Initially Stressed Circular Cylinder, W. T. Chen and T. W. Wright,* *Journal of the Acoustical Society of America* **39,** No. 5, 847-848 (May, 1966).

This paper describes the derivation of frequency equations for the propagation of small sinusoidal waves in an infinitely long isotropic elastic cylinder that has been initially stressed.

* The Johns Hopkins University.

General Purpose 30-Nanosecond Logic Circuit Family for IBM System/360, E. F. Hahn and J. J. Tomczak, *Electro-mechanical Design* **10,** No. 4, 38-40, 42-43 (April, 1966).

The SLT 30-nsec logic circuit family is described and the design concepts are outlined. Design features include high fan-in capability, good isolation between circuits driven by the same block and uniform switching speeds. The three classes of circuit modules discussed are logic (AND-Inverter (AI), AND-OR-Inverter (AOI) and AND-Power Inverter (API)), logic support (Isolating Inverter, Exclusive-OR and Exclusive-OR Latch) and transistor-diode (four basic logic transistors and four pairs of common-anode logic diodes).

High Performance Parallel-Serial Analog-to-Digital Convertor With Error Correction, G. G. Gorbatenko, *IEEE International Convention Record* **14,** Part 3, pp. 39-43 (1966).

The ability to make revokable comparator decisions using a novel error correction feature provides (1) a practical means of performing parallel conversion, and (2) the A/D converter decision logic to act on the various analog signals while they are still in a transient state, thereby reducing decision time. As a result, this converter has a five-fold dynamic improvement over a conventional successive-approximation-by-bit converter using the same hardware. An example is presented using presently available components to achieve a 15-bit conversion rate of approximately 200kc/sec.

High-Speed Saw for Dicing Silicon Wafers, H. Wing and D. K. Seto, *Proceedings of the Annual ASTME Engineering Conference and Tool Exposition,* pp. 174-1 to 174-8 (April, 1966).

The design features and cutting action principles of a gang-type slurry saw are described. The saw is used for the dicing of silicon wafers and makes 40 parallel full plunge cuts. The blades are 4 inches in diameter, 2 mils thick, and yield a kerf of 4 mils. Cutting is achieved by feeding an abrasive slurry to the high-speed rotating blades.

It is believed that material removal occurs by an abrading and/or fracturing mechanism. The dominant mechanism depends on the abrasive, its concentration in the slurry, and its feed rate. Characteristics of the cut for various operating conditions are discussed. This saw has been designed for the specific application of dicing single-crystal silicon material; however, its principles should be applicable to similar cutting operations.

How IBM Presets N/C Tooling, G. R. Nelson, *American Machinist* **110,** No. 9, 97-100 (April 25, 1966).

A well-planned combination of numerical controlled programming and precision tool presetting reduces operator error, increases output as much as 75%, and cuts tooling costs 45 to 90% at the IBM plant in Rochester, Minnesota. By switching over to more and more N/C machines and preset/quick-change tooling, the responsibility for production rates and product quality has shifted from machine operators to the programmers in the numerical control engineering department, and to the tool presetters who work from programmed instruction sketches.

How to Measure Switching Delay Times with Picosecond Resolution, E. J. Rymaszewski, *EEE, The Magazine of Circuit Design Engineering* **66,** No. 14, 48, 51-52, 54-55 (April, 1966).

The basic problem in characterizing and testing high speed logic circuits lies in creating realistic operating conditions. The method described here does this well. The method also gives high resolution of delay times, while requiring only relatively modestly priced instrumentation for the digital readout.

IBM 2321 Data Cell Drive, A. F. Shugart and Y. H. Tong, *AFIPS Conference Proceedings, Spring Joint Computer Conference* **28,** 335-345 (April, 1966).

The IBM 2321 Data Cell Drive economically extends on-line random access capability to a volume of data beyond that of previous storage units. With open-ended storage capacity made possible by the removability feature of the data cells, plus multiple 2321 usage, data processing requirements for billions of characters have been met.

From a circular array of 10 data cells with 20 subcells each, a cell drive positions a selected subcell of 10 strips beneath an access station. At this station a selected strip is first withdrawn from the subcell, then rotated past a magnetic head for data transfer, and finally returned to its original location in the subcell.

In developing the means for transporting the strip and transferring the data, some challenging problems were faced in such areas as anticlastic curvature, squeeze film, hydrodynamic lubrication film, etc. Recording reliability was achieved through the implementation of a variable-frequency-oscillator detection scheme in conjunction with dual-frequency encoding.

The IBM 2560 Multi-Function Card Machine, C. E. Spurrier, *AFIPS Conference Proceedings, Spring Joint Computer Conference* **28,** 315-321 (April, 1966).

The IBM Multi-Function Card Machine (MFCM) was developed to combine into one unit the functions of reading, printing, punching, collating, and selecting cards. This machine feeds cards from two hoppers, performs any or all of the functions of reading, punching, and printing of cards from either hopper, and stacks cards from either hopper into any of five stackers. This paper is concerned with the engineering and technological aspects of developing this multi-function equipment.

Development of the new wire matrix printer is discussed, including such aspects as character selection, hold-magnet requirements, noise reduction, and ink shielding and lubrication. Read station development and selecting, punching, and stacking design are considered. Also reviewed are the design of card transport mechanisms and miscellaneous electronic circuit design considerations.

Interpretive Technical Reporting, D. E. Olson and R. A. Lee, *Proceedings of the Society for Technical Writers and Publishers Convention,* pp. 69-1 to 69-6 (May, 1966).

Most large industrial firms employing technical writers also have some type of industrial publication or employee communication. By teaming up with the company publication editor, a new dimension can be added to the role of a technical writer through interpretive technical reporting. This paper discusses how the technical writer can discover a new satisfaction in creative expression by observing and writing about the human side of engineers, scientists, and their projects.

Linear and Circular Acoustic Birefringence in Ferroacoustic Resonance, B. Lüthi, *Journal of Applied Physics* **37,** No. 3, 990-991 (March 1, 1966).

Experimental results of the linear and circular magnetoacoustical birefringence effects are presented for gadolinium iron garnet and yttrium gallium iron garnet. Some special features of these effects, such as directional dependence on the magnetic field and internal field variation are discussed. Magnetoelastic coupling constants and anisotropy constants deduced from these experiments are presented.

Lubricating Separable Electric Contacts and Tarnish Prevention, R. V. Chiarenzelli and B. C. Henry, *Lubrication Engineering* **22,** No. 5, 174-180 (May, 1966).

Electrical contacts are being lubricated more frequently today than in the past. The requirements for a good contact lubricant are discussed, as well as the advantages and disadvantages of using a lubricant. The results of studies on lubricated gold and silver are reported. Several different lubricants are evaluated using laboratory and field aging procedures and friction and wear testing. It has been found that paraffin mixed with polyphenyl ether is a particularly effective boundary lubricant which possesses significant tarnish-preventing properties. Tarnish prevention is a valuable characteristic of contact lubricants because most contact failures are the result of metal degradation. Possible applications of the tarnish-preventing lubricants are discussed, and precautions concerning the use of lubricants on contact materials are pointed out.

Macro Language Design for SYSTEM/360, D. N. Freeman, *IBM Systems Journal* **5,** No. 2, 62-77 (1966).

The macro language design discussed in this paper provides a systematic means by which the SYSTEM/360 assembler-language programmer can develop macro-instructions, thereby expanding the set of machine-oriented instructions that serve as the basis of the assembler language. Also treated is the format of macro definitions, the design of a macro generator, and the principal considerations that governed the design of the system as a whole.

A Magnetic Film Memory Element for Fully Unipolar Operation, J. Hohl, S. Middelhoek and Th. Mohr, *Journal of Applied Physics* **37,** No. 3, 1382-1383 (March 1, 1966).

The most generally known mode of operation of a thin-film memory uses unipolar field pulses in the hard direction and positive and negative field pulses in the easy direction for writing. For reading, unipolar field pulses are applied in the hard direction, and according to the stored information, a positive pulse followed by a negative one or vice versa are induced in a sense line. The circumferential electronic circuitry is rather complex, as bipolar bit drivers and sense detectors are required. Savings in driving and detecting circuitry are possible with an element which requires bit drive pulses of only one polarity, and produces a sense signal for a binary "1," but no sense signal for a binary "0." An element satisfying the above requirements will be described. It consists of two magnetic Ni-Fe layers evaporated on top of each other, which are separated by a thick SiO layer. The easy axes of both magnetic layers form a small angle with each other. Preliminary experience with this new memory element, with respect to its preparation, physical behavior, and pulse operation, is discussed.

Das Magnetische Moment Eines Stromfuehrenden Wismut-Zylinders (The magnetic moment of a current-carrying bismuth cylinder), R. Jaggi, *Naturwissenschaften* **53,** No. 4, 104-105 (1966). Also, *Verhandlungen der Deutschen Physicalischen Gesellschaft* **2,** 137, (1966).

It has been observed that a cylindrical bismuth single crystal carrying a dc current I parallel to the axis located in a longitudinal homogeneous dc magnetic field shows a longitudinal magnetic moment $M(H) \propto I^2$. This has been explained by solving the system of equations of motion for electrons and holes.

Materials and Processes for Passive Thin-Film Components, R. Glang, *Journal of Vacuum Science and Technology* **3,** No. 2, 37-48 (March-April, 1966).

Vacuum evaporation and sputtering processes of materials in use or under investigation for passive thin-film components in integrated circuits are reviewed. Molybdenum, silver, gold and the platinum metals have been considered to replace aluminum contacts and interconnections. However, silicide formation at low temperatures and lack of the required contact properties limit their usefulness. Dielectric materials amenable to controlled deposition are silicon monoxide and dioxide. Both oxides have low dielectric constants and are more suitable for insulation layers than for capacitors. To produce stress-free, nonhygroscopic SiO films, control of deposition conditions is most important. The integration of SiO_2 films depends on the availability of a process yielding good properties at low deposition temperatures. Radio frequency sputtering seems to meet these requirements. Nichrome and Cr-SiO cermet are possibilities for integrated thin-film resistors. Their fabrication techniques and the resulting properties are reviewed. Tighter process control than presently possible is needed for integration into monolithic circuits.

Mechanism Behind Emitter Dip Effect, R. Gereth* and G. H. Schwuttke,** *Applied Physics Letters* **8,** No. 3, 55-57 (February 1, 1966). Published under the incorrect title, "Localized Enhanced Diffusion in npn Silicon Transistors."

Localized indentations in the base collector junction underneath the entire emitter regions have been frequently observed in high frequency *npn* silicon transistors. This phenomenon is referred to as Emitter Dip Effect (EDE). The cross section of an *npn* structure exhibiting the EDE is illustrated, and it can be seen that the magnitude of the dip in the base collector junction is equal to $X_3 - X_2 = \Delta X = 0.3\mu$.

The knowledge of the mechanism governing the EDE is of greatest importance both for the basic understanding of diffusion anomalies in heavily doped surface layers and for the fabrication of subnanosecond devices. Several attempts have been made in the literature to interpret EDE. None of these hypotheses, however, is consistent with the experimental results. This letter presents new experimental evidence for the EDE and, based on this evidence, a vacancy model is developed which fully accounts for the effect.

* The diffusion experiments were carried out when the author R. Gereth was with the Shockley Research Laboratories, Palo Alto, California.

** Work partly supported by Air Force Contract AF 19(628)-5059.

Metallurgy in Computer Development, H. D. Ross, *Metal Progress* **89,** No. 5, 75-79 (May, 1966).

The complexity of computers in design and operation imposes many diverse problems in their construction. In this article, the author describes materials and methods used in making actuator rods, detent racks, springs, data drums, card transporting mechanisms and other computer parts.

A Method for Measurement of "Creep" in Thin Magnetic Films, W. R. Beam and F. L. Thiel,* *IEEE Transactions on Magnetics* **MAG-2,** No. 1, 31-35 (March, 1966).

The "creep" phenomenon in thin magnetic films is measured using a field consisting of a static field parallel to the film's easy axis, and a high frequency sinusodial field along the transverse axis. A special field-gradient coil is used to establish a two-domain magnetization configuration in the film plane, and the Kerr magneto-optic effect is employed to measure the position of the disturbed domain wall. Measurements on Ni-Fe-Co and Ni-Fe alloy films show the typically sharp threshold field below which there is no wall creep; nonuniform creep gives evidence for wall "pinning" phenomena. With the method described for field calibration and the simple form of fields employed, this procedure should be valuable in establishing comparative creep sensitivity data for films formed from different alloys or by different technologies.

* Rensselaer Polytechnic Institute.

Morphologies of Acicular γ-Fe_2O_3 Particles, J. Hurt, A. Amendola and R. E. Smith, *Journal of Applied Physics* **37,** No. 3, 1170-1171 (March 1, 1966).

Commercial iron-oxide magnetic recording tapes have long been made using acicular particles of γ-Fe_2O_3 dispersed in an organic matrix. X-ray diffraction of coatings of this type showed little or no preferred crystallographic orientation even though these coatings had been oriented by the presence of a strong magnetic field during coating. Low-viscosity binders were used in some experimental coatings while the oxide was subjected to a strong magnetic field, and similar x-ray results were obtained. Electron microscopy revealed aligned particles at or near the surfaces of oriented coatings, and the particle morphology was examined by electron diffraction. The majority of particles examined were found to be polycrystalline, and single-crystal particles were seen to possess a [110] needle axis. X-ray evidence of some preferred orientation in a coating could be seen only when the particles were oriented by stretching the coating. The x-ray results obtained using both magnetically oriented and unoriented coatings are explained by a combination of the polycrystalline nature of the particles and the inefficiency of the magnetic orienting process.

NDT Looks at Hidden Surfaces, G. C. Pendley, *Iron Age* **197,** No. 14, 78-79 (April 7, 1966).

Occasionally there arises a need for non-destructive examination of precision machined surfaces in bores or holes which are not accessible to surface roughness measuring devices or visual inspection. Recently, IBM was confronted with such a problem, involving examination of wear (on a before-and-after basis) of a bore surface in a large casting.

Conventional instrumentation such as Talysurf, Proficorder, etc., could not be employed. However, a technique of surface replication and then the microscopic examination of the replica proved to be a very workable solution. This process in conjunction with contact interferometry permitted measurements of surface scratches and imperfections to within ± 0.5 microinch.

Negative Field-Effect Mobility on (100) Si Surfaces, F. F. Fang and W. E. Howard, *Physical Review Letters* **16,** No. 18, 797-799 (May 2, 1966).

The surface mobility of carriers in an *n*-type inversion layer has been studied by field-effect experiments with metal-oxide-semiconductor structures. It was shown that at moderate fields the carriers suffer from surface scattering and the surface mobility, as measured from both field-effect mobility and the surface Hall effect, is reduced with increasing field. In this letter, we report an anomalous effect of high field ($>10^6$ V/cm) on the field-effect mobility, which is defined as $\mu_{F.E.} = \partial\sigma_s/\partial Q_s$.

A New Algorithm for a Class of Quadratic Programming Problems with Application to Control, M. D. Canon* and J. H. Eaton, *SIAM Journal on Control* **4,** No. 1, 34-45 (1966).

The control problem considered is that of determining an input which will take a linear sampled system from a specified initial state to a desired terminal state in minimum time, subject to amplitude constraints on the input. The problem is reduced to solving a sequence of simple quadratic programming problems; a new algorithm is presented for solving this class of problems. Preliminary computational results for a fourth-order system are favorable.

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Nonlinear Terminations for Memory Drives, A. R. Berding, *EEE, The Magazine of Circuit Design Engineering* **14,** No. 5, 79-81 (May, 1966).

The use of nonlinear terminations in a core memory drive line offers a practical system that overcomes many of the problems experienced with conventional systems. Among the advantages are a fast rise time to a given current from a limited supply voltage, and the use of lower voltage devices and less power. In turn, this means greater reliability at less cost, without sacrificing performance.

Numerical Control—The First Fifteen Years, M. Morgan, *Proceedings of the Annual ASTME Engineering Conference and Tool Exposition,* pp. 190-1 to 190-17 (April, 1966).

Born at M.I.T. as a new way to operate milling machines, numerical control has expanded into fields beyond machine tools. As a means of communication between man and machines, it is the basis of manufacturing enterprises that are operated through data processing techniques.

What has been done in the past fifteen years—by whom, when, and how—to make possible such an evolution? Did the machine tool companies lead the way? Did the large data processing companies participate in the marketing of numerical control hardware? How did those companies contribute with software developments? What was the effect on the engineering profession? What was the role of the electrical manufacturing companies? What other applications has numerical control generated? Which applications are blossoming, which faltering?

This paper reviews the aforementioned topics, analyzing the technical, business, and management aspects of numerical control as it has progressed through the years.

On a Family of Cubature Formulae, B. Meister, *The Computer Journal* **8,** No. 4, 368-371 (January, 1966).

The paper is concerned with the construction of symmetric cubature formulae, each of which is exact for polynomials up to a certain joint degree in two variables. Some examples of new cubature formulae of this kind are given.

One-Bit Comparator Uses FET's to Achieve a Low Component Count and Simple Circuitry, J. R. Dailey, *Electronic Design* **14,** No. 13, 58-60 (May 24, 1966).

Metal-oxide-semiconductor field-effect transistors (FET's) were used in the construction of a one-bit digital comparator. An existing comparator implementation, using RTL NOR circuitry, contains a total of 26 active and passive components; the circuit with FET's contains 8 discrete devices, or, if fabricated monolithically (all FET's diffused on a single chip), the equivalent of 4 MOS devices.

One application for this comparator is in a digital servo system where a binary command signal and a binary position signal, corresponding to a shaft position, are compared and a correcting signal issued. The comparator can also be used in logic circuits, with minor modifications, as a dual exclusive-OR circuit; in power supply systems as a high-input-impedance comparator; and in other applications where two inputs are sensed and a proportional error voltage is produced.

Optical Study of the $GeCl_4$/Ge System,† K. E. Haq and W. von Muench, *Journal of the Electrochemical Society* **113,** No. 3, 260-262 (March, 1966).

The optical absorption characteristics of $GeCl_4$, both with and without free germanium present in the system, have been studied for the wavelength region between 2300 Å and 2 μ. Pure $GeCl_4$ was found to have a dissociation continuum with the long wavelength edge beginning at 2700 Å at a temperature of 150°C. When free germanium was added to the system, $GeCl_4$ was found to react with it to give rise to one or more species, depending on whether or not the molar quantity of free germanium was greater than that of $GeCl_4$. It has also been observed that $GeCl_4$ has a strong absorption band with a peak at 3150 Å.

† This work was supported in part by A. F. C. R. L. Contract No. AF 19(628)-2468.

Phase Shift Corrections for Infrared Interference Measurement of Epitaxial Layer Thickness, P. A. Schumann, Jr., R. P. Phillips and P. J. Olshefski, *Journal of the Electrochemical Society* **113,** No. 4, 368-371 (April, 1966).

Under certain conditions of wavelength and substrate impurity level, correction factors were found to be necessary for the infrared interference method of measuring epitaxial layer thickness. A general theory has been developed which relates the index of refraction and extinction coefficient to physical properties of the semiconductor and the wavelength. From these constants, a phase change at the epitaxial layer-substrate interface is calculated. This phase shift is shown to influence the measurement and a correction factor is derived.

Phase Transformations Induced by the Jahn-Teller Effect, J. C. Slonczewski, Colloque 1965 de L'Association Française de Cristallographie, *Bulletin de la Société Scientifique de Bretagne* **39,** special issue, 53-58 (1966).

Since Jahn and Teller (1937, 1938) first proved their famous theorem concerning the stability of molecular configurations, it has been applied to a wide variety of phenomena in solids. Of interest to us is the fact that destabilizing forces of the Jahn-Teller type produce cooperative phase transitions. Rather than try to cover the whole subject, this paper discusses one general kind of phase transition in detail, and indicates the extent of other work in the field.

Photoelectric Counting Distributions for a Noise-Modulated System, P. J. Magill and R. P. Soni, *Physical Review Letters* **16,** No. 20, 911-913 (May 16, 1966).

This article describes the statistical properties of a laser operating above threshold in single mode configuration. The results are given in terms of the probability distribution of photoelectrons as determined by a single-channel counting experiment. It shows that $P(n, T)$ based on a signal-plus-noise system describes the measurable departures from Poisson statistics.

Predict Common Emitter Performance, F. Hilsenrath, *Electronic Design* **14,** No. 10, 52-55 (April 26, 1966).

Step response of a linear common emitter T-equivalent circuit, driving a complex load, leads in the simplest case to the solution of cubic equations. The use of Giacoletto's model simplifies this to quadratic equations but neglects one pole of the network. It also divides the circuit into separate input and output loops from which input and output time constants can easily be determined.

This article describes a graphic method which enables the designer to determine the circuit performance by visual inspection. The normalized output equation consists of the sum of two exponentials of opposite polarity. One exponential represents the input loop—the other, the output loop. Two families of such exponentials can be plotted to represent all possible transistor and R-C load combinations. The graphical addition of the two appropriate exponentials (corresponding to the input and output loop time constants) yields the output response. Delay and rise time can then be visually determined. Furthermore, an approximate correction term restores the neglected third pole and the well-known in-phase overshoot without having to revert to a T-equivalent model.

Producing Ultra-Pure Water, J. D. Peruffo, *Industrial Water Engineering* **3,** No. 4, 12-17 (April, 1966).

This paper describes the operation of two large treatment plants used to provide a semiconductor facility with ultra-high purity, "ultimate," water having an 18 + megohm-cm specific resistance, a very low organic content, and a 0.45 micron maximum particle size. Details are given of the equipment and results obtained to date. In addition, the evolution of the present system is traced and predictions are made of future system design requirements.

Properties of Indium Oxide Glaze Resistors, M. L. Block and A. H. Mones, *Proceedings of the 1966 Electronic Components Conference,* pp. 191-196 (May, 1966).

This paper describes the structure, important details of the fabrication process, and reliability data for an indium oxide-glass resistor system that has application in hybrid integrated circuit modules. The system is relatively simple in constitution and processing; it is composed of comparatively inexpensive raw materials.

Properties of Thin Films of High Permeability Alloys, B. L. Flur and A. J. Griest, *Journal of Applied Physics* **37,** No. 3, 1478-1480 (March 1, 1966).

A number of commercially available high-permeability nickel-iron base alloys with low values of coercive force, magnetostriction and crystalline anisotropy are of potential interest as materials for thin film memory elements. Because of their compositional complexity, however, films of these alloys are not easily prepared by vacuum deposition. By use of bias sputtering, thin films of Mumetal (4.5% Cu-1.5% Cr), Conetic AA (2% Cu-5.4% Cr), Supermalloy (5% Mo) and 4-79 Permalloy have been successfully prepared. The effects of substrate temperature (100–400 °C) and film thickness (500–1000 A) on the properties of wall motion threshold H_0, anisotropy field H_{k_0}, dispersion α_{90}, skew β, magnetostriction and sheet resistivity have been experimentally determined.

In general, for the same thickness and substrate temperature, the high permeability alloys show lower H_0 and H_{k_0} than the binary 81% Ni–19% Fe alloy. The data show that the reduction is most pronounced in the molybdenum-containing alloys, less so in Conetic AA, and least in Mumetal. Molybdenum additions appear to be the most effective in inhibiting the rate of increase of dispersion with increasing H_0/H_{k_0} ratio; e.g., a supermalloy film was deposited with $H_0/H_{k_0} = 0.9$ Oe/0.4 Oe and $\alpha_{90} = 4.5°$.

A Queuing Model for a Simple Case of Time Sharing, W. Chang, *IBM Systems Journal* **5,** No. 2, 115-125 (1966).

This paper discusses a queuing model for a non-priority time-sharing environment in which all active tasks fit in a homogeneous main storage. Design parameters such as queue length and response time, as well as their distributions, can be estimated with the aid of the model. The model provides a basic frame of reference for the development of more complicated models.

Queuing with Nonpreemptive and Preemptive-Resume Properties, W. Chang, *Operations Research* **13,** No. 6, 1020-1022 (November-December, 1965).

This paper considers a special queue situation, one in which a single facility serves two major priority classes of customers. Within each class, there are several levels of priorities. The first class has the higher priority. On arrival, a customer of the first class immediately replaces any customer of lower priority being served. The second class has the lower priority, as compared to the first class. On its arrival, a customer of the second class cannot interrupt the current service of a lower priority customer in the system; it must wait until the service is completed. The first class is the preemptive priority, and the second class is the nonpreemptive priority. This paper formulates a theoretical solution for this queuing system, which has a wide range of application in the computer industry. The real-time control program under the multi-programming environment is an analog of this priority queuing model.

Relation Between Latent Electrostatic Image and Developed Image for Dielectric Coated Paper, Y. Moradzadeh and D. Woodward, *Journal of Photographic Science and Engineering* **10,** No. 2, 96-103 (March-April, 1966).

Experimental data are presented to show that dielectric coated paper charged to the same surface potential by three different charging methods (corona charging, charge transfer from a photoconductor, and an electrographic method) yield different developed reflection densities. An explanation of this effect is proposed in the theory presented. Supporting experimental evidence presented indicates that spatial charge distributions exist inside the dielectric coated paper and that variations in the internal charge distribution account for differences in the developed density.

The Relation of $f'_+(a)$ to $f'(a^+)$, W. E. Langlois and L. I. Holder,* *Mathematics Magazine* **39,** No. 2, 112-120 (March, 1966).

There are functions for which $f'_+(a)$ and $f'(a^+)$ have different finite values. However, the derivative of every such function fails to exist on a set of points which have a as a left-hand limit point. If f is differentiable throughout some interval (a,b), the behavior of each of these quantities strongly influences the behavior of the other. Without further hypotheses, it can be shown: If both exist, they are equal, if $f(a^+)$ and $f'(a^+)$ both exist, so does $f'_+(a)$, which then equals $f'(a^+)$; $f'_+(a)$ exists whilst $f'(a^+)$ does not if and only if $f'(a)$ converges to $f'_+(a)$ as $x \to a^+$, not as a limit but in the Hölder sense.

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The Relationship Between Coercivity and the Structure and Composition of Electroless Cobalt-Phosphorus Films, M. G. Miksic,* R. Travieso, A. Arcus and R. H. Wright, *Journal of the Electrochemical Society* **113,** No. 4, 360-362 (April, 1966).

Electroless cobalt-phosphorus films were prepared under varying conditions of temperature, hypophosphite concentration, total concentration, time, and pH to determine the relationship between coercivity, structure and chemical composition of the films. It was found that coercivity increases with increasing percentage of phosphorus content. The thickness effect on coercivity is complex and dependent upon the phosphorus concentration. The preferred orientation of the films is related to phorphorus concentration. Films with phosphorus weight percent smaller than 2 exhibit, on the average, a normal orientation of the c-axis to the substrate; those with higher percent phosphorus generally have the c-axis parallel to the substrate.

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Remark on Rational Interpolation of Function and Derivatives, D. A. Jacobs, *Zeitschrift für angewandte Mathematische und Physik* **17,** No. 1, 195-197 (1966).

The inverse difference scheme is extended to furnish estimates of a function and its first few derivatives that correspond to a rational interpolation between given nodal values.

RF Sputtering of Insulator Films Offers Many Advantages, P. D. Davidse and L. I. Maissel, *Insulation* **12,** No. 4, 41-43 (April, 1966).

This article describes RF sputtering of insulator films and compares this approach with other vacuum deposition techniques such as evaporation and dc reactive sputtering. The applicability of this RF sputtering to thin film and semiconductor technology is also presented.

Saturn V Guidance System Protective Finish, L. P. Cabrinety and R. A. Hagstrom, *Plating, Journal of the American Electroplaters' Society* **53,** No. 3, 331-332, 336 (March, 1966).

LA141 magnesium alloy is used extensively in the Saturn V guidance computer and data adapter. Because of the reactivity of this alloy under accelerated corrosion test conditions, modified surface finishing techniques are required. A modified fluoride anodizing process followed by resin sealing and paint for a protective finish is used. This system results in excellent corrosion protection; and, unlike other anodic coating does not cause any loss in fatigue strength.

Size Effect and Electron-Phonon Interaction in the Lattice Conduction of Cu-Ge Alloys,† P. Lindenfeld,* E. A. Lynton,* D. S. McLachlan, and R. Soulen,* *Physical Review* **143,** No. 2, 434 (March 11, 1966).

We have measured the lattice thermal conductivity between 0.3°K and 4°K of annealed, polycrystalline specimens of Cu-Ge alloys with residual resistivities between 10 and 22 micro-ohm/cm. This is an extension of earlier work to lower temperatures and higher resistivities. Over most of the measurement range the phonons are primarily scattered by electrons and the main features continue to be well described by Pippard's relations for the phonon-electron interaction. There is a marked size effect, showing that scattering by the external boundaries is effective up to 4°K. There is some evidence for additional scattering but the uncertainties of the analysis do not allow a definite conclusion on this point.

† Work supported by the National Science Foundation and the Rutgers University Research Council, and performed at Rutgers—The State University, New Brunswick, N. J.

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Some Comments on the Influence of Stearates on Wear Between Sintered Bronze and 416 Stainless Steel, R. G. Bayer and J. L. Sirico, *Wear* **9,** No. 3, 236-238 (May-June, 1966).

It has been observed that in machine applications where 416 stainless steel (416SS) was used in conjunction with sintered bronze, the stainless steel experienced more wear than would normally be anticipated. Detailed examinations indicated that the mechanical factors alone could not explain the phenomenon. After some consideration, it was conjectured that residual stearates, used as mold releasing agents in the sintered bronze, might adversely affect the wear of the 416SS. A series of wear experiments was therefore performed to investigate this.

Some Effects of Clipping in Array Processing, W. R. Remley, *Journal of the Acoustical Society of America* **39,** No. 4, 702-707 (April, 1966).

The process of amplitude clipping in array processing is examined to determine (1) the fidelity of the system, (2) the improvement in system performance resulting from a post-beamforming filter, and (3) the effects of nongaussian noise. It is found that under suitable conditions, the system fidelity is quite good. The overall process is statistically equivalent to passing the signal waveform through a soft amplitude limiter with characteristics determined by the noise statistics and the signal-to-noise ratio. It is shown that a post-beamforming filter can improve the output signal-to-noise ratio by nearly 1.0 dB for narrow-band signals. For nongaussian noise, the clipping loss can be relatively large. For sinusoidal interference, the clipping loss is between 6 and 7 dB.

Some Properties of Cycle-Free Directed Graphs and the Identification of the Longest Path, Y. C. Chen and O. Wing, *Journal of The Franklin Institute* **281,** No. 4, 293-301 (April, 1966).

A number of interesting properties of a cycle-free directed graph are presented. By making use of these properties an efficient algorithm is deduced which identifies the longest path, or the Hamiltonian path if any, between every pair of vertices. The properties are expressed in terms of the "terminal connection matrix" which compactly describes the connectedness of the graph. Examples of practical applications of the results are given.

Stronger than Uniform Convergence of Multistep Difference Methods,* B. Dejon, *Numerische Mathematik* **8,** No. 1, 29-41 (March, 1966).

This paper is concerned with the numerical integration of ordinary differential equations of the order κ. Sufficient conditions and also necessary ones are given for the s-th difference quotient of the approximate solution to approach the s-th derivative of the exact solution for $s \geqq 0$. This requires a more subtle examination of the multiplicities of the characteristic roots of modulus 1.

* The work reported in this paper was started when the author was a member of the Institut für Parktische Mathematik (Prof. Dr. h. c. A. Walther), Technische Hochschule, Darmstadt, Germany.

A Study of Replacement Algorithms for a Virtual-Storage Computer, L. A. Belady, *IBM Systems Journal* **5,** No. 2, 78-101 (1966).

This study is based on a virtual-storage concept that provides for automatic memory allocation. Several algorithms for the replacement of current information in memory are evaluated. Discussed is the simulation of a number of typical program runs using differing replacement algorithms with varying memory size and block size. The results are compared with each other and with a theoretical optimum.

Synthetische Edelsteine in der Modernen Physik (Synthetic precious stones in modern physics), K. A. Mueller, *Naturwissenschaftliche Rundschau* **19,** No. 4, 147-152 (April, 1966).

Some aspects of precious stones related to solid-state physics and physical chemistry are treated. The growing interest in the synthesis of hard insulator single crystals in this century, starting with the successful process invented by Verneuil, is reviewed. Modern physical methods of investigation are discussed with special emphasis on magnetic resonance methods. Application examples of synthetic stones in modern industry are mentioned.

Tracing Printed Circuit Patterns by N/C Optical Techniques, G. F. Rollo, *Automation* **13,** No. 4, 77-79 (April, 1966).

This article describes the operation of a numerically controlled system, currently used in manufacturing Solid Logic Technology circuit boards, to optically expose circuit paths on the boards. A four-head, five beam, printed-circuit generator can trace approximately 4000 inches of circuit path in 20 minutes. Because this system is under computer program control, the generator can efficiently produce a wide variety of circuit designs; its adaptability to engineering changes is also a strong point.

Traffic Data Acquisition from Aerial Photographs by Photographic Image Processing, T. A. Baggot, *Highway Research Record for Photogrammetry and Aerial Surveys,* No. 109, 1-7 (1966).

The approach to traffic data acquisition known as image processing employs electro-optical scanning and conventional electronic data processing techniques to extract useful data from imagery. Basically, image processing involves three steps: (1) digitizing; (2) transforming; and (3) processing.

Letters

Dotierte SiO_2-Schichten als Quelle für die Sn- und Zn-Diffusion in GaAs (Doped SiO_2 layers as source for tin and zinc diffusion into GaAs), W. von Muench, *Verhandlungen der Deutschen Physikalischen Gesellschaft* **2,** 81 (1966).

Influence of Small Signal Modulation on Photoelectron Counting of He-Ne Laser Intensity Fluctuations, P. J. Magill, *Journal of Applied Physics* **37,** No. 5, 2198-2199 (April, 1966).

Isolierte GaAs Transistoren auf Hochohmigen GaAs Substrat (Insulated GaAs transistors on high-resistivity GaAs substrates), W. von Muench and H. Statz, *Verhandlungen der Deutschen Physikalischen Gesellschaft* **2,** 105 (1966).

Magneto-Acoustic Birefringence in Magnetite and Nickel, B. Luethi, *Applied Physics Letters* **8,** No. 5, 107-109 (March 1, 1966).

On Moiré Fringes as Fourier Test Objects, A. W. Lohmann, *Applied Optics* **5,** No. 4, 669-670 (April, 1966).

Phase Changes in Bismuth under High Pressure, R. Jaggi, Colloque 1965 de L'Association Française de Cristallographie, *Bulletin de la Société Scientifique de Bretagne* **39,** special issue, 120 (1966).

A Study of Superconducting Composite Sn and Au Films, C. Chiou and E. Klokholm, *Acta Metallurgica* **14,** No. 4, 565-567 (April, 1966).