Technical Papers by IBM Authors Published Recently in Other Journals

Across Machine Lines in COBOL, D. S. Fredericks and C. R. Warburton, *Communications of the ACM* **8,** No. 12, 731-735 (December, 1965).

The production of a large file-maintenance-and-retrieval program system written in COBOL is described. The COBOL language was used specifically to enable the system to operate on three IBM computers.

Aluminum Oxide Films from the Reaction of Aluminum and Water Vapor, L. Kaplan, *Electrochemical Technology* **3,** No. 11-12, 335-337 (November-December, 1965).

Aluminum oxide films have been prepared by the deposition of Al in the presence of water vapor. The films ranged in appearance from metallic through brownish to colorless and transparent. From measurements of the molar ratio of water to aluminum it was concluded that their composition approached closely the composition Al_2O_3. Their dielectric constant at 1 Kc/sec was 3.41 while their dissipation factor at that frequency was 0.20. The latter was high, in accord with high dissipation factors ordinarily observed for vacuum deposited insulating films. However, the former ranged from about 2.2 to 4.5, which is close to reported values of from 4.5 to 8.4 for bulk Al_2O_3.

Anisotropy in Nickel-Iron Films: The Pair-Strain Model,† W. T. Siegle and W. R. Beam, *Journal of Applied Physics* **36,** No. 5, 1721-1727 (May, 1965).

A sytematic investigation has been made of magnetically induced uniaxial planar anisotropy in a series of 27 Ni-Fe normal incidence, vapor-deposited films spanning the composition range 65% Ni to 100% Ni. The small experimental data scatter permits an unambiguous presentation of the compositional dependence. A series of magnetic annealing treatments was applied under various temperature and field conditions; each produced changes in the compositional dependence of anisotropy. The data can be closely fitted to a theoretical model (for the compositional dependence) based on mechanisms of magnetostrictively induced anisotropic strain and short-range iron-pair order. The component of anisotropy associated with strain is in good agreement with theoretical predictions for its magnitude, and is found to be characterized by the deposition substrate temperature, or (after long anneal) the anneal temperature. An activation energy of around 0.9 eV (for the films in this study) fits the annealing behavior of the strain component. The remaining anisotropy, although well represented in its compositional form by the $c^2(1 - c)^2$ form expected for pair order, does not respond to annealing treatment with a discrete relaxation time. Two possible explanations are considered.

† Supported in part by National Science Foundation.

The Application of a New System for Monitoring the Surgical Patient, J. D. Michenfelder,* H. R. Terry, Jr.,* F. R. Anderholm, and D. G. Shaw, *Proceedings of the Eighteenth Annual Conference on Engineering in Medicine and Biology,* p. 233 (November, 1965).

An IBM-Mayo Clinic surgical monitoring system was designed to provide two major functions: first, as a monitor of vital physiologic variables to improve care of the anesthetized patient, and second, as an investigational tool with which to accept, collect, and store data from diverse inputs. This information is displayed in the operating room as well as in adjacent areas for responsible physicians or interested observers. In addition to real-time display of these data, a permanent record is also made.

* Mayo Clinic, Rochester, Minnesota.

The Application of Variational Techniques to Real-Time Command and Control of an Entry Vehicle, Martin Rush and Alice Schmidt, *Record of the Twelfth Annual East Coast Conference on Aerospace and Navigational Electronics,* pp. 3.4.6-1 to 3.4.6-16 (1965).

Variational techniques are applied to command and control of a maneuvering entry vehicle. The application of these techniques can provide a ground processor with the capability of impact control and real-time monitoring of the vehicle's maneuver capability. The paper presents the analytic approach and simulation results of applying such techniques in the Gemini reentry phase, but these same techniques are generally applicable to other vehicles and mission phases.

Automated Experiment Systems—A Practical Guide, H. Cole and Y. Okaya, *Laboratory Management* **3,** No. 11, 32 (November, 1965).

The computer-controlled x-ray diffractometer (CCXD) which has been operating for two years at the IBM Thomas J. Watson Research Center has to date produced significant new structural information on more than two dozen crystalline materials. Beyond the technical value of the immediate results to crystallographers, however, operation of the CXD demonstrates the major concepts and benefits of automated experiment systems.

A review of the CCXD system may be particularly useful to laboratory management because many other x-ray diffractometers are now being operated both manually and in open-loop automated experiment systems. Therefore, together with the diffractometer under full computer control at the Research Center, all degrees of automation—from zero to complete— are represented in running a single common experiment.

Backward Superconducting Switching, Hirsh Cohen and Farouk Odeh, *Journal of Mathematical Physics* **6,** No. 9, 1411-1424 (September, 1965).

A discussion is given of the initial speeds at which superconducting material changes state according to the London electro-dynamics. These transitions are taken to occur in the form of phase boundary motions. Phase changes from the normal to the superconducting state and vice versa are considered for the cases in which the external magnetic field is radiated to the boundary of the superconducting material. A distinct difference is found in transition rates depending on whether the transition is from the superconducting or from the normal state. In another case considered, the transition from normal to super is studied when the superconducting material is bounded by a good conductor. In all cases, constant critical field is taken as the switching criterion. The mathematical treatment involves the approximate solution of free boundary problems and mixed hyperbolic-parabolic boundary value problems.

The Behavior of Nonamplifying Photographic Detectors, H. J. Zweig, *Photographic Sciences and Engineering* **9,** No. 6, 371-377 (November/December, 1965).

The behavior of one-quantum, nonamplifying photographic detectors is examined from a statistical point of view. H and D curves are derived for two separate models. In one model, there is an immediate photo effect during exposure (i.e., bleaching) which simulates the behavior of diazo materials, while in the other model the light absorbing properties remain unchanged during exposure (which more closely corresponds to organic photoconductors). It is shown that the statistical behavior due to photon fluctuations in exposure and absorption account for the behavior observed in these types of photodetectors.

Computer Controlled Data Reduction, R. E. Blue, *Proceedings of the 20th Annual ISA Conference,* Part III, pp. 7.4-11 to 7.4-17 (October, 1965).

This paper develops a framework for discussing four papers to be presented at the 20th Annual International Conference and Exhibit Workshop on "Computer Controlled Data Reduction." Developments in the fields of data acquisition and computing are analyzed in terms of the future use of computer control techniques.

Computers for Information Retrieval, A. D. Pratt, *Ideas for Management: the Proceedings of the Eighteenth International Systems Meeting,* pp. 52-61 (November, 1965).

Information retrieval is a computer application which differs in some very significant respects from applications most familiar in the current day. One of the most significant differences is the need to organize extremely large files for inquiry and response on a near real-time basis. Development of new searching strategies, synthesized from older methods, combined with improving technological capability for large-capacity, direct-access devices, is permitting the IR systems designer to approach this goal. It is possible to envision realistic systems, not hypothetical ones, which will connect the office console of a user to a large IR file located elsewhere, so that he can inquire at will, and get responses in a manner of seconds or minutes.

Concerning the Euclidean Algorithm, R. P. Kelisky, *The Fibonacci Quarterly* **3,** No. 3, 219-223 (October, 1965).

It is well known that the Euclidean algorithm will always yield a solution to $ax + by = 1$, where a and b are integers and $(a, b) = 1$. In this note it is shown that if $a > b > 1$, the solution obtained by the Euclidean algorithm is the point with integer coordinates on the line $ax + by = 1$ which is nearest the origin.

Convergent Beam Digital Light Deflector,* W. Kulcke, K. Kosanke, E. Max, H. Fleisher, T. J. Harris, *Optical and Electro-Optical Information* (Proceedings of the Symposium on Optical and Electro-Optical Information) pp. 371-418 (November, 1965).

In this paper we discuss the physical principles of digital light deflection and their embodiment in a convergent beam digital deflector. The deflector under development is a digital positioning device with the capability of placing a beam focussed to 50 μ into any one of 256 $\times$ 256 spots in a 1.3 cm $\times$ 1.3 cm square.

Light beam positioning by the digital deflector is jitter-free so that fluctuations of control voltage are translated only into fluctuations of background. This property of the deflector will enhance its usefulness to applications such as display, hard copy production and optically accessed memories.

Our discussion of the digital light deflector covers the following topics: (a) optical design criteria: orientation of the birefringent crystals, "isotropic" splitting angle determination, relation between deflector aperture and spot diameter; (b) performance criteria: sources of background light, and its distribution, optical path length compensation, influence of fabrication tolerances, switching control and its relation to beam position logic; (c) high-speed, high-voltage switching circuits: the need for minimum dissipating high-speed switching circuits, alternative circuits as reasonable solutions.

In conclusion we discuss applications of the digital light deflector displays, hard copy production, optically accessed memories, and optical logic.

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Data Acquisition For Computer Analysis and Display of the Radioisotope Scan, D. W. Chaapel, W. N. Tauxe,* and A. C. Sprau, *Proceedings of the Eighteenth Annual Conference on Engineering in Medicine and Biology,* p. 162 (November, 1965).

This paper compares current techniques for data acquisition and display of radioisotope scanner information, describes a method of acquisition of such data preparatory to computer analysis and display, and discusses computer analysis techniques, their contribution to scan improvement, and the increased flexibility possible using computer displays.

* Mayo Clinic, Rochester, Minnesota.

Data Extraction from a Video Display, J. J. Sanders, *IEEE Transactions on Bio-Medical Engineering* **BME-12,** Nos. 3 and 4, 147-154 (July/October, 1965).

Describes the technique of using a video densitometer for detecting and measuring the change of brightness vs. time of an incremental area of a video display. A clinical experience using a video tape recording of a densicardiogram as an example is explained. Methods of recording, reproducing, digitizing, and analyzing cardiovascular characteristics are described from the standpoint of development experience.

Designing Transmission Lines into Multilayer Circuit Boards, W. K. Springfield, *Electronics* **38,** No. 22, 90-96 (November 1, 1965).

Transmission lines made by multilayer printed-circuit techniques are a reliable means of transmitting high-frequency signals and distributing high-current power among the active circuits of high-performance microelectronic computers. Electrical characteristics vary with the thicknesses of the dielectric and the width of the conductor lines. The circuit designer must temper his requirements to accommodate manufacturing limitations on tolerances. These aspects of transmission lines are discussed as they pertain to SLT packaging.

Detailed Planar Magnetic Anisotropy Evaluation from Flux Sensing Measurements, W. R. Beam and W. T. Siegle, *The Review of Scientific Instruments* **36,** No. 5, 641-643 (May, 1965).

A method is described for accurate measurement of the variations of magnetic anisotropy energy with magnetization orientation in the plane of a magnetic thin film. The result, when properly chosen bias fields are applied, is shown to be identical in form to the torque curves obtained by mechanical means. The method is suitable for study of non-uniaxial as well as uniaxial anisotropies. For uniaxial films, values of H_k can be obtained with far greater sensitivity than is possible in conventional switching-type measurements. A major advantage of the technique is that it can be applied to small areas of large films, for local anisotropy variation studies.

Determination of Magnetic Properties by Residual Stress Analysis in Soft Ferromagnetic Alloys, G. Koves, *Materials Research and Standards* **5,** No. 11, 573-578 (November, 1965).

A test method has been developed for evaluating magnetic properties of soft ferromagnetic alloys by measuring residual stress. Macroscopic and microscopic internal stresses are measured by x-ray diffraction techniques and are integrated into a single stress indicator. The structure-sensitive magnetic properties are combined into a single magnetic parameter. The procedure has proved a practical method of routine testing for production components.

Diffraction of Radiation by Matter, G. Koves, *Research/Development* **16,** No. 11, 8-13 (November, 1965).

Once a specialized research tool of the crystallographer, diffraction techniques are now solidly established as a versatile material-testing method of basic importance to the metallurgist, chemist, and physicist. Apart from the verification of modern quantum theory, diffraction of particles has opened up new avenues for this unique tool of 20th century science.

Digital Simulation for Bio-Medical System Studies, R. N. Linebarger and R. D. Brennan, *Proceedings of the Eighteenth Annual Conference on Engineering in Medicine and Biology,* p. 129 (November, 1965).

Within the past few years, digital computers have been increasingly applied to solving system analysis problems. Now, digital computer techniques are being successfully applied to the simulation of complex dynamic systems, long the exclusive domain of the analog computer. Over 28 separate computer languages have been successfully used to simulate continuous system dynamics on a digital computer. DSL/90 provides an easily-learned tool for digitally simulating complex bio-medical systems by personnel relatively untrained in digital computer programming. These techniques combine the best features of analog block programming and digital solution methods—the result is a significant new tool for bio-medical system analysis.

Digital Simulation for Control System Design, R. N. Linebarger and R. D. Brennan, *Instruments and Control Systems* **38,** No. 10, 147-152 (October, 1965).

Digital computer languages for simulating control-system responses are new and powerful tools for the design engineer, and extend considerably his ability to develop automated equipment for specific control applications. This paper discusses how the computer simulation field is being expanded rapidly by the introduction of many new program languages. A forecast of future trends in languages, applications, numerical methods, and graphic input/output devices is also made.

A Distributed Model of the Junction Transistor and its Application in the Prediction of the Emitter-Base Diode Characteristic, Base Impedance, and Pulse Response of the Device, H. N. Ghosh, *IEEE Transactions on Electron Devices* **12,** No. 10, 513-531 (October, 1965).

A distributed model for a junction transistor has been analyzed to include both dc and ac biasing effects in the active base region, with particular emphasis on a small-geometry diffused base planar transistor. For such devices with extremely narrow base width, dc biasing effects cannot be neglected. At high frequencies, the response of these devices is greatly modified by ac biasing effects which are accentuated by the significant dc biasing at large emitter current levels. Two-dimensional current flow under these biasing conditions was studied with a distributed model of the active base region. From such a model, the expressions for emitter-base diode characteristic, small-signal and large-signal base resistance, and complex base impedance valid for high frequencies have been deduced in terms of physical

parameters of the devices like the geometry, base resistivity, etc. This equivalent base impedance and an ideal diode with its diffusion and emitter-base transition capacitance constitute the lumped model of the emitter-base region. For any particular frequency, the base impedance can be represented exactly by a parallel *RC* network. The distributed model can also predict the pulse responses of the device more accurately than a lumped model and show the sensitivity of the transient response to the physical parameters mentioned above. Experimental verifications of the theoretical expressions are found to be satisfactory, and limitations of the earlier works are pointed out in regard to present devices.

Das elektrodynamische Schaltverhalten dünner Magnetschichten in leitender Umgebung (The Electrodynamic Switching Behavior of Thin Magnetic Films in Conducting Surroundings), Wilhelm Jutzi, *Archiv der Elektrischen Uebertragung* **19,** No. 4, 178-188 (1965).

The influence of eddy current fields on the rotation of the magnetization in thin magnetic films is investigated numerically for different conductor configurations. It is shown that nondestructive readout is feasible with two thin magnetic films coupled electrodynamically and magnetostatically, if the maximum angle of rotation in one of the thin films does not exceed a certain value. This maximum angle is reached with different critical drive pulses of certain amplitudes and widths. The measured and computed critical drive pulses are in good agreement.

Electron-Beam-Controlled Scanlaser, R. V. Pole and R. A. Myers, *Northeastern Region Electronics Meeting Record* **7,** p. 244 (November, 1965).

This paper proposes an extension of the concept of the scanning of laser light by electrically lifting the degeneracy of multimode cavities, in which the easily deflectable electron beam is employed as a basic element in the mode selection process. We describe a device in which an angularly degenerate and optically conjugate resonator (i.e., a resonator in which one reflecting surface is imaged upon the other) is coupled to a cathode ray tube (CRT) via an "electro-optic transducer." This transducer, actually an electro-optic crystal with additional coatings, serves simultaneously as one end of the optical resonator and as the target for the electron beam. The charges deposited on the crystal by the electron beam introduce a local birefringence in the material in the manner of an electro-optic display tube. In the present device, however, the charges serve merely to lift the degeneracy of the resonator so that a single mode, corresponding to a particular direction through the resonator, is made to oscillate. Thus, the easily deflected electron beam is used to steer a light beam which is orders of magnitude brighter than that in the usual flying spot scanners.

Electron Beam Exposure of Photoresists, R. F. M. Thornley and T. Sun, *Journal of the Electrochemical Society* **112,** No. 11, 1151-1153 (November, 1965).

The exposure and stripping characteristics of several commercial photoresists have been investigated for electron exposure. Of the materials tested, Kodak Thin Film Resist was the most satisfactory, showing excellent resist formation and stripping characteristics with 10^{-5} coulombs/cm^2 at 20 kV.

Electron-Spinwave Scattering in Gadolinium, B. Lüthi and H. Rohrer, *Solid State Communications* **3,** No. 9, 257-261 (September, 1965).

The electrical resistivity due to magnetic scattering in polycrystalline gadolinium has been determined in the temperature range between 4.2°K and 30°K. The part of the resistivity due to scattering by domains and magnetic impurities is practically independent of temperature, whereas that due to spinwave scattering follows above 10°K a $T^{3.1\pm0.2}$ law and is considerably smaller than the resistivity due to phonon scattering. The temperature dependence of the latter varies between $T^{3.5}$ and $T^{3.8}$.

Emulation of Large Systems, S. G. Tucker, *Communications of the ACM* **8,** No. 12, 753-761 (December, 1965).

The conversion problem and a new technique called emulation are discussed. The technique of emulation is developed and includes sections on both the Central Processing Unit and the Input/Output. This general treatment is followed by three sections that describe in greater detail the implementation of compatibility features using the emulation techniques for the IBM 7074, 7080 and 7090 systems on IBM System/360.

Evidence for Avalanche Injection Laser in p-Type GaAs, K. Weiser* and J. F. Woods, *Applied Physics Letters* **7,** No. 8, 225 (October 15, 1965).

Lasing has been observed in *p*-type GaAs in which the necessary population inversion is brought about by avalanche breakdown of a high-resistivity region which is formed when zinc is diffused into manganese-doped, *p*-type GaAs. The region is less than 5 microns thick and is located at the boundary of the zinc-diffused layer. Threshold current density for lasing is about 10^4 A/cm^2 at 77°K and 2.5×10^3 A/cm^2 at 4.2°K.

* The work of this author was in part supported by the US Army Electronics Laboratories under Contract DA-36-039-AMC-02349(E).

Exchange Anisotropy and Strain Interactions in the Ni-NiO System, A. E. Berkowitz and J. H. Greiner, *Journal of Applied Physics* **36,** No. 10, 3330-3341 (October, 1965).

The interactions between Ni and NiO were investigated by examining the magnetic properties of Ni films on single-crystal NiO substrates. The orientations of the NiO substrates were (001) (compensated spin planes), and (111) (parallel spin planes). With (001) NiO the Ni films were strained an amount corresponding approximately to the rhombohedral deformation of NiO below its Néel temperature. The amplitude and symmetry of magnetic torque data were consistent with the magnitude of this strain and the symmetry of the antiferromagnetic domain structure, respectively. Ni films on (111) NiO substrates had a complex field dependence of rotational hysteresis. This behavior was analyzed in terms of exchange anisotropy coupling and the interaction of the field with both the Ni and NiO spin systems. The analysis provided good agreement with the data for an exchange anisotropy energy of 1.75 erg/cm^2 of interface, a crystalline anisotropy of NiO in its parallel spin plane of 1.1×10^3 erg/cc NiO, and a "flop field" for NiO

in its parallel spin plane of 5 to 10 kOe. The analysis showed that two new regions of rotational hysteresis loss are present in fields $\geq$ the "flop field" of the antiferromagnetic spin system. Some more general features of exchange anisotropy coupling are also discussed.

Eye-Movement Patterns During Visual Information Processing, J. D. Gould and Amy Schaffer, *Psychonomic Science* **3,** No. 8, 317-318 (October 15, 1965).

Eye-movement patterns were recorded while Ss visually scanned 5-cell patterns to compare the sum of the 3 digits in each of 4 peripheral cells with the sum of the 3 digits in the central "target" cell. Both larger target sums and greater target-nontarget similarity caused significantly longer fixations; number and pattern of fixations were independent of experimental variables. Results supported predictions based upon previous studies correlating eye-movement patterns and visual stimuli.

Ferromagnetic and Paramagnetic Resonance in EuS, S. von Molnar and A. W. Lawson, *The Physical Review* **139,** No. 5A, A1598-A1602 (August 30, 1965).

Ferromagnetic and paramagnetic resonance has been observed in single crystals of EuS. A standard microwave spectrometer, operating near 22 Gc/sec, was used to measure the power absorption at 1.4 and 300°K. The resonance line width, 75 Oe at 1.4°K, was found to be approximately 1200 Oe at room temperature. An upper limit of 30 Oe has been established for the magnitude of the magneto-crystalline anisotropy field, in contrast to the value of —190 Oe found for EuO. The paramagnetic line width is explained solely on the basis of spin-spin interactions. The anisotropy results are understood in terms of crystal-field perturbations of the magnetic Eu^{2+} ion.

1401 Compatibility Feature on the IBM System/360 Model 30, M. A. McCormack, T. T. Schansman and K. K. Womack, *Communications of the ACM* **8,** No. 12, 773-776 (December, 1965).

The IBM System/360 has been designed with the problem of program conversion specifically in mind. One of the conversion aids available on the Model 30 is the 1401 compatibility feature. This feature, in conjunction with other aids, permits a smooth and inexpensive transition to optimum use of the new system.

Further Analysis of an Integrated Switching and Multiplexing (ISAM) System, P. M. Thrasher, *Proceedings of the Eleventh Annual NATCOM Symposium,* pp. 311-321 (October, 1965).

The paper extends earlier analysis work relating to a new method of achieving frequency division multiplexing and time division switching in one operation. Associated with this method is the concept of generalized resonant transfer, which refers to an ideally lossless mode of transmission between band pass filters, which do not necessarily cover the same band, via a sampling gate. This paper is specifically concerned with analyzing this generalized resonant transfer mode of operation. The prime purpose is to establish firmer criteria than have currently been developed on which to base the design of the filters and also to gain insight into the fundamental operation of this unique modulation-demodulation scheme utilizing generalized resonant transfer. It is shown that the circuit will function in an ideal fashion provided certain fundamental assumptions are adhered to. These assumptions, which are reasonable from the viewpoint of reduction to practice, become the criteria on which to base the design.

Future of Magnetic Memories, G. Kohn, *Proceedings of the IFIP Congress, Vol. 1,* pp. 131-136 (1965).

Although magnetic memory devices have played a predominant role in the computer technology of the last ten years, they still have great potentialities which will lead to larger and faster computer memories for the future. Some characteristic directions in the future technology of electronically addressed computer memories are discussed here. In large capacity storage systems with more than 10^7 bits, the problems of batch fabrication and redundancy against element failures are to be considered. In read only memories and in "changeable memories" a very fast access is required. In competition to the classic electronic access, optical systems might become of more interest together with transparent ferrimagnetic garnets. For very fast memories magnetic films are, due to their nanosecond switching time, the most promising elements. Present film memories are speed limited to about 100 nsec cycle time by the drive and sensing circuits. New approaches which employ non-destructive read operation of the films, evaporated stripline arrays, and high-speed circuits are reviewed. Read cycle times of less than 20 nsec have already been achieved experimentally.

A General Method of Variation of Parameters for Numerical Integration, William H. Goodyear, *Astronomical Journal* **70,** No. 8, 524-526 (October, 1965).

The method of variation of parameters is applied to perturbed motion by defining the parameters as the initial coordinates of an osculating two-body trajectory. A completely general closed-form solution of the two-body problem is used to determine coordinates and partial derivatives of the osculating trajectory. This frees the method from singularities associated with different types of two-body motion. The numerical integration of the differential equations for the parameters provides a relatively simple and completely general technique for the computation of perturbed trajectories.

Graphic Data Processing, F. V. Windes, *Graphic Science* **7,** No. 12, 22 (December, 1965).

Designers and draftsmen can use graphic data processing effectively to control, manipulate, analyze, update and distribute design information without having to be expert computer programmers. Systems such as those now being built by IBM for Graphic Data Processing become valuable tools for designer/draftsmen.

The IBM 7770 and 7772 Audio Response Unit, a New Type of Output Unit for Data Processing Systems, W. G. Spruth, *Elektronische Rechenanlagen* **7,** No. 5, 268-271 (October, 1965).

A general description of both the IBM 7770 and the 7772 Audio Response Units is given. The vocabulary needed for the audio output function is stored in the 7770 in analog form on a rotating drum, while the 7772 Audio Response Unit uses the system random access file for digital storage of the audio information. A brief description of Audio Response Unit applications is given.

The IBM 9020: A Modular Multi-Processing System for NAS, J. R. Wood. *Proceedings of Third International Aviation Research and Development Symposium,* pp. 1-14 (November, 1965).

The Central Computer Complex (CCC) of the National Airspace System (NAS) is an IBM 9020, a large-scale data processing system. The 9020 was designed to perform in the exact type of environment specified for the CCC: a large, fast-response, real-time control system with particularly stringent requirements for around-the-clock operation.

Infrared Heat-Transfer Engineering—A State-of-the-Art Evaluation, G. W. Carter, *Electronic Packaging and Production* **5,** No. 9, 34-45 (September, 1965).

This article is a state-of-the-art evaluation of infrared measurement techniques as used to determine temperatures of microelectronics. The applications and limitations of two basic types of infrared systems are examined with emphasis on limiting parameters. The advantages and disadvantages of infrared as a nondestructive test technique are discussed. Particular emphasis is given to the pitfalls one may experience in making infrared temperature measurements and what can be done to avoid them. Examples are given of how IBM's Electronics Systems Center has utilized infrared techniques for the past two and one-half years in thermal analysis of electronic equipment.

An Investigation of Self-Acting Foil Bearings, J. T. Ma, *ASME Journal of Basic Engineering* **87,** No. 4, 837-846 (December, 1965).

This report describes experiments on the measurements of foil bearing film thicknesses by means of capacitance probes, intended to provide confirmation for theoretical results previously available. Experimental results on the interior and the exit region film-thickness measurements of self-acting foil bearings are presented and discussed. The measured and predicted values agree very well within the range of certain given nondimensional parameters. Empirical expressions for predicting the constant and minimum film thickness applicable beyond these ranges are also presented. Growing sinusoidal film thickness in the exit region was also observed, measured, and checked with theoretical predictions.

An Investigation of a Control System with a Multiplicative Inertia Nonlinearity, P. M. Will,* *Proceedings of the 21st National Electronics Conference,* pp. 564-568 (October, 1965).

This paper examines the response of a control system in which the armature and field currents of the d.c. servomotor are varied simultaneously. The resulting differential equation has a multiplicative nonlinearity in the inertia term and showed responses which are good in the transient domain while giving the jump phenomenon for sinusoidal perturbations. The practical usefulness of the system is discussed.

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Kinetic Models for Consecutive Heterogeneous Reactions, M. J. Shah and B. Davidson, *Industrial and Engineering Chemistry* **57,** No. 10, 18-23 (October, 1965).

The assumption that there is only one controlling step in a reaction series is an oversimplification, and is often dangerous. Yet consideration of more than one step leads to extremely complicated expressions. This article presents an interpolation technique which assists in curve-fitting and which may bring this kind of kinetic analysis into more widespread use for applied problems.

Laser Deflection and Scanning, R. V. Pole, R. A. Myers, H. Wieder and E. S. Barrekette, *Optical and Electro-Optical Information Processing* (Proceedings of the Symposium on Optical and Electro-optical Information Processing Technology), pp. 351-364 (November, 1965).

A concept of light deflection which is unique to the laser and its special properties is described, wherein a resonator which is initially capable of emitting light in a multiplicity of directions, i.e., which is directionally, or angularly degenerate, is combined with a mode selector by means of which the degeneracy is lifted and one direction is favored over all others.

Several degenerate resonators and a number of mode-selection schemes are described and results of theoretical and experimental work on deflection and scanning are presented.

Management Games and Programmed Instructions A. Schulz, *Grundlagenstudien aus Kybernetik* **6,** No. 3, 85-96 (September, 1965).

The first part of this paper reports about experience with management games at universities. A proposal on how to measure the effectiveness of management games is made. In the second part a comparison between management games and programmed instructions is presented. It is based on the fact that in both cases a computer is used as a teaching machine. Common characteristics are:

(1) Learning by experiment and error.
(2) Dividing the material into elementary units (frames). Many management games of the present do not have this feature which is necessary for use in universities.
(3) Feedback from the learning system to the teaching system.

Teaching in European universities, in many cases, lacks the interaction between lecturer and students. The paper shows how management games might be improved to fulfill this requirement.

A New Multicontact, Multipurpose, Brain Depth Probe: Details of Construction,† C. D. Ray,‡ R. G. Bickford,* L. C. Clark, Jr.,** R. E. Johnston, T. M. Richards, D. Rogers* and W. E. Russert,* *Mayo Clinic Proceedings* **40,** No. 10, 771-780 (October, 1965).

This paper presents a new multicontact brain depth probe for multiple utility. Many contacts may be placed along the probe structure while maintaining a small external diameter. With the associated simple attachment devices, the probe is easily placed on either a short-term or a long-term basis. It is a definite improvement over previous probes in the ability to measure low-frequency activity of alternating and direct current. In addition, it has given excellent results in recording changes in alternating-current impedance in tissue and for polarographic and potentiometric measurements. Various animals and clinical studies have indicated the validity of this probe for the determination of brain activity in the presence of pathologic changes.

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A Note on the Evaluation of a New Answer Form, Irwin Miller, *Journal of Applied Psychology* **49,** No. 3, 199-201 (June, 1965).

An answer form with a new item format proved comparable to a standard IBM form in an answer-marking task. A new red answer form with similar new item format was then used with actual tests. Subjects were 4th graders, 8th graders, and 12th graders in 4 cities; each took a test form appropriate for his grade level with a new and old answer form. The new answer form was considered acceptable for use in the 8th grade and higher grades. Color change represented by the new red answer form had no significant effect on test performance of persons in the 8th grade or higher. Statistical analyses of the 4th-grade data proved inconclusive.

An Operational Amplifier for Monitoring Multiple Body Function Transducers, J. W. McCullough, *Proceedings of the Eighteenth Annual Conference on Engineering in Medicine and Biology,* p. 217 (November, 1965).

This paper discusses the amplifier considerations in a physiological monitoring application. The following areas are expanded: operational amplifier requirements, transducer circuit design objectives with methods of realizing the gain and frequency response performance for each transducer, multiplexer design with considerations for component requirements and switching transients, special techniques in transducer and operational amplifier design, and design example—photoelectric pulse detection.

The Optical Absorption Bands and their Anisotropy in the Various Modifications of Silicon Carbide, E. Biedermann, *Solid State Communications* **3,** No. 10, 343-346 (October, 1965).

The optical absorption of 4*H*, 6*H*, 8*H*, and 15*R* SiC crystals has been measured in the wavelength range from 0.35 to 2.5 μ with polarization of light parallel and perpendicular to the *c*-axis of the crystals. The observed absorption bands are assumed to be due to electron excitation from the conduction band minimum to other sites of increased density of states in the higher, empty bands. In all modification a strong anisotropy of free carrier absorption is found.

An Optically Accessed Memory using the Lippmann Process for Information Storage,† H. Fleisher, P. Pengelly, J. Reynolds, R. Schools, G. Sincerbox, *Optical and Electro-Optical Information Processing* (Proceedings of the Symposium on Optical and Electro-Optical Information Processing Technology) pp. 1-30 (November, 1965).

In this paper we discuss the application of the Lippmann Standing Wave process to information storage in suitable high resolution silver-halide emulsion in order to achieve extremely high-density, high-capacity memories.

With the use of narrow band radiation at different optical frequencies, this technique enables us to store information in depth as well as on the surface of the emulsion. High density volume storage is effectively achieved by this approach. A volume density of 3×10^{10} bits per cubic inch appears feasible.

Specific topics for presentation include: (a) the Lippmann Standing Wave process and the characteristics of the photographic emulsion; (b) the relation between the time coherence (bandwidth of the writing radiation) and emulsion thickness for optimum information storage and resolution; (c) writing and readout techniques involving narrow band sources and detectors, "spectrographic" readout, and Bragg angle readout; (d) error detection and compensation.

In conclusion we present experimental results on achieved density of storage, and suggested read-only memory configurations.

† Work performed under Government Contract No. AF 33-657-11589, Wright-Patterson Air Force Base.

An Optical Pencil-Mark Reading System, J. F. Bene, *Design News* **20,** No. 23, 122-127 (November 10, 1965).

This mark-read head uses a significantly new approach in reading ordinary pencil marks from an 8-½ × 11-in. sheet. Silicon solar cells are used as transducers to optically scan a sheet. Banks of miniature incandescent lamps provide major advantages over a single illumination source. These advantages and the functional operation of the mark reading process are discussed along with the double threshold amplifier circuit used to reduce document error rate.

PbS Thin Film Transistors, W. B. Pennebaker, *Solid-State Electronics* **8,** 509-515 (1965).

Thin film transistors were prepared using evaporated PbS films. It is shown that films containing oxidized barriers to the conductivity have very little sensitivity to electric fields. However, nearly intrinsic films show a much larger field effect, and can be switched from *n*-type to *p*-type conduction by the field. Effective electron mobilities as high as 260 cm^2/V-sec were obtained. Interesting effects due to non-uniform fields applied by the gate are illustrated and discussed.

While data can be qualitatively explained in terms of a simple model, the strong frequency dependence is not yet understood. The sensitivity to water vapor indicates, however, that surface states may play a strong role. Mobility variation and capacitive relaxation may also occur.

Photoeffects in Lead Telluride p-n Junctions, Robert A. Laff, *Journal of Applied Physics* **36,** No. 10, 3324-3329 (October, 1965).

The direct energy gap in PbTe has been deduced over the range $3.5 \leq T \leq 300°K$, from the spectral dependence of short circuit photocurrent in grown *p-n* junctions. At temperatures above $\sim 30°K$, the deduced absorption in the depletion region is found to be exponential, with the steepness of the edge dominated by thermal broadening. At lower temperatures, the effects of broadening due to the electric field within the junction depletion region have been observed. A third broadening mechanism is observed at low temperatures. At 5.8°K, this mechanism is of approximately equal strength to the thermal broadening. The energy gap, taken from the photon energy at which the photocurrent has fallen to one-half its maximum value, at which point the absorption coefficient $\alpha = 14$ cm^{-1}, is given by $E_g = 0.173 + 0.485 \times 10^{-3} T$ eV for temperatures $30 < T < 250°K$. Below $\sim 10°K$, the energy gap has a constant value of 0.185 ± 0.002 eV.

Photoisomerization of 1, 6-Heptadiene Sensitized by Mercury (6^3P_1) Atoms, R. Srinivasan and K. A. Hill, *Journal of the American Chemical Society* **87,** No. 22, 4988-4992 (November 20, 1965).

The decomposition of 1, 6-heptadiene photosensitized by mercury (6^3P_1) atoms has been studied in the pressure range from 3 to 65 mm. In addition to free radical products and a polymer which accounted for 95% of the decomposition, six isomers were observed. Four of these were identified as 4-cyclopropylbutene-1, bicyclo [3.2.0] heptane, bicyclo [3.1.1] heptane, and 1-methyl-2-vinylcyclobutane. It is proposed that unconjugated diolefins isomerize on mercury photosensitization by two mechanisms. Type I leads to hydrogen migration of the kind observed in monoölefins. Type II proceeds through a "hot" bicyclic intermediate and gives either the thermalized bicyclic compound or a cyclopropyl (linear) olefin.

Properties of Ni-Fe Double Films, Simon Middelhoek, *Zeitschrift für angewandte Physik* **18,** No. 5/6, 524-528 (1965).

Domain walls and wall creeping were investigated in double films, consisting of two Ni-Fe films separated from each other by a thin non-magnetic film of SiO, Ag or Au. It is shown that a Néel wall in one of the films is capable of inducing a so-called quasi-Néel wall in the other film, and that this pair of Néel walls possesses a lower energy than one single cross-tie or Bloch wall. Like very thin films, where also only Néel walls appear, the double films do not show any creeping if unipolar sinusoidal magnetic fields of 50 c/sec in the hard direction are applied. In addition, it is established that a large reduction of H_c occurs in the double film, compared with the single films of which the double film is composed.

Saturn Guidance Computer Checkout, R. F. Jergel and R. E. Long, *Ground Support Equipment* **7,** No. 3, 16-17 (Third Quarter, 1965).

This test equipment complex, Aerospace System Test and Evaluation Complex (ASTEC), checks out the Saturn IB/V guidance computer and the computer's companion data adapter. ASTEC provides both manual and programmable automatic modes of operation for testing the computer and adapter as separate entities or in combination as a subsystem of the Saturn instrument unit.

Series Solution of the Ginzburg-Landau Equations for the Abrikosov Mixed State, G. Lasher, *The Physical Review* **140,** No. 2A, A523-A528 (October 18, 1965).

Periodic solutions of the Ginzburg-Landau (GL) equations in the form of a power series in the quantity $(H_{c_2} - B)/B$ are found. The lowest order term of the series satisfies the linearized GL equation. The order parameter, the free energy, and the magnetic moment are explicitly evaluated to the next higher order for the regular triangular lattice and the square lattice. These results evaluate the error in using the solutions of the linearized equation and extend the range of magnetic field for which the mixed-state configuration is known. An orthonormal set of functions in which the order parameter may be expanded is generated. The mixed-state solutions of the linearized equation with fluoid quantum numbers greater than unity are determined and shown to have higher free energy than the unit-fluxoid solutions of the same symmetry.

Shock Tests Analyzed by Computer Methods, J. L. Kracke and R. E. Tomek, *Electro-Technology* **76,** No. 4, 50-51 (October, 1965).

A major difficulty encountered in experimental shock vibration analysis is that the input shock profile can, in general, not be made identical to the contractual shock specification. This is due to inherent limitations in shock testing equipment. This article defines an analytical procedure for defining the *g*-level seen by a subassembly within a shocked package for any input shock profile. The analytical technique is particularly applicable to experimental input shock data which in general shows a jagged spectrum and is therefore not solvable in closed form solution. Equivalence between the specification and experimental input shock levels is shown to be approximately attainable.

Space Data Handling (with Emphasis on Data Compaction), M. A. Hyman, *Record of the Twelfth Annual East Coast Conference on Aerospace and Navigational Electronics,* pp. 3.3.3-1 to 3.3.3-6 (1965).

Space data processing requirements for the decade 1965-1975 are surveyed. Some recently developed techniques for data compaction are discussed, including "weighted information theory," K-L expansions, and ART (for 2D patterns).

Spectral Theory for Operators Generated by Elliptic Boundary Problems with Eigenvalue Parameter in the Boundary Conditions, II, Joseph Ercolano and Martin Schechter,* *Communications on Pure and Applied Mathematics* **28,** No. 3, 397-414 (August, 1965).

In this paper we propose to study some spectral problems in the theory of general boundary problems for symmetric partial differential operators. Our method consists of putting these problems in a Hilbert space framework in order to use the known results from that theory. The principal tool in our development is an a priori estimate with which we are able to prove a regularity theorem for a class of functions corresponding to a variety of general self-adjoint eigenvalue problems, where the eigenvalue parameter may appear either in the domain or boundary conditions. (The kinds of problems with which we are able to deal are characterized.) The regularity theorem, when interpreted in a more general setting than Hilbert space, leads to a topological vector space which has been termed "nuclear." In this space, we are able to supplement the classical spectral theory by proving the existence of a spectral function for each problem under consideration, and a Green's function for appropriately related problems.

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Spectrophotometer: New Instrument for Ultrarapid Cell Analysis, Louis A. Kamentsky, Myron R. Melamed* and Herbert Derman,** *Science* **150,** No. 3696, 630-631 (October 29, 1965).

A new device has been developed for measuring and displaying multiple spectrophotometric properties of biological cells at rates exceeding 500 cells per second. Preliminary observations of human cells from different sites in the body were made at wavelengths of 2537 and 4100 angstroms to estimate cellular nucleic acid per unit volume of individual cells of large populations of cells. Display patterns were obtained which were consistent, and characteristically different for certain of the cell populations studied.

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Spill-back From an Exit Ramp of an Expressway, D. C. Gazis, *Highway Research Record,* No. 89, 39-46 (1965).

A discussion is given of the problem of control of an oversaturated system comprising an expressway, a highway, and an exit ramp leading from the expressway to the highway. A traffic light is assumed to control the intersection of the exit ramp and the exit highway. The operation of this traffic light is determined which minimizes the delay of vehicles served by the entire system.

Statistical Approach to Growth of Single Crystals of GaSb by Horizontal Growing Techniques, J. R. Peloke, R. R. Stone and L. R. Yetter, *Solid-State Electronics* **8,** No. 11, 861-867 (November, 1965).

Several variables, considered to be of importance in the process of crystal growing, were tested statistically using a four-factor, two-level (2^4) factorial design. The experimental and analytical techniques employed to investigate the crystal growing process are described. Then, the mathematical model and the actual conditions required to grow single crystal GaSb are presented.

Structural Evaluation of Silicon Oxide Films, W. A. Pliskin and H. S. Lehman, *Journal of the Electrochemical Society* **112,** No. 10, 1013-1019 (October, 1965).

Techniques for physical and chemical evaluation of silicon oxide films formed by a wide variety of techniques have been developed. It has been established that by the use of infrared absorption spectroscopy, preferential etching procedures, precise optical measurements of thickness, density, and refractive indices, and carefully chosen environmental tests, differences in the oxide films can be determined. Techniques of oxidation studied were: thermal (oxygen and steam), evaporated, pyrolytic, lead catalyzed, sputtered and anodic. In many cases, improvement of oxide film properties can be achieved by simple thermal treatment of the original films.

The Superconducting and Normal State Properties of Dilute Indium-Tin Alloys: Bulk and Thin Film, A. M. Toxen, M. J. Burns and D. J. Quinn.* *The Physical Review* **138,** A1145-A1154 (May 17, 1965).

Measurements are reported of normal state and superconducting state properties of bulk and thin film indium-tin alloys. For the bulk samples, whose compositions were in the range 0-5.8 at. % tin, the residual resistivities, critical magnetic fields, and critical temperatures were measured. It is shown that both similarity conditions are well obeyed for the critical fields of samples containing 0-1.8 at. % Sn, for which detailed data were taken. High purity films were produced containing up to 5 at. % tin. From resistance measurements, the critical temperatures, critical fields, thicknesses, and residual resistivities of the films were obtained. The formula for boundary scattering by Fuchs has been recast into a more convenient form from which one may calculate the intrinsic mean free path and intrinsic resistivity directly from the measured resistivity and thickness. From the resistivity measurements, one may infer a value for the product of intrinsic resistivity and mean path, p_i, of 1.6×10^{-11} Ω-cm². The critical temperature measurements indicate that bulk and film specimens having the same composition do not have the same critical temperature.

On the basis of a model which attributes the shift in critical temperature to stress effects, formulae are derived from which one may calculate the stress in a film as well as the equivalent (i.e., stress-shifted) bulk critical field for any film. However, the stress-shifted bulk critical field curves obtained in this way for the indium alloy films are nearly the same as one would have obtained under the assumption of similarity. Analysis of the critical temperature results indicates that while stresses in the most dilute films are prob-

ably relieved by ordinary dislocation flow, some other mechanism, perhaps twinning, dominates in the more concentrated alloys. The largest uniaxial stress calculated for the films studied was 2.6×10^9 dynes/cm^2, which was obtained for a film of indium containing 2.6 at. % tin.

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Surface Defects in Silicon Epitaxial Wafers, C. E. Hallas and E. J. Patzner, *SCP and Solid State Technology* **8,** No. 11, 20-24 (November, 1965).

Many of the defects seen on epitaxial silicon layers grown on (111) silicon substrates by the vapor decomposition of $SiCl_4$ are described. The most common defects are Pyramids, Stacking Faults, Mounds and Cloudy surfaces. An attempt is made to classify these defects with respect to their causes such as: orientation effects, gas ambient contamination effects, residual surface contamination effects and substrate crystal imperfection effects. The topography of the defects is presented using photographs. The techniques used for characterization of the surface, i.e. defect dimensions and geometry, are presented.

SYNTRAN, L. L. Briner, *Proceedings of GUIDE International 20th Meeting,* pp. 24-40 (May, 1965).

An experimental system using a computer for information retrieval was developed by the Applications Development Group in the Data Processing Division, Federal Region, Washington, D. C. The programming system is known as SYNTRAN, from SYNtax TRANslation. It is capable of providing completely automatic abstracting of texts, and retrieval of both abstracts and texts. SYNTRAN has been designed for the abstracting and retrieval of prose, non-fiction texts. It is more thorough than manual systems, is competitive in cost, and, of course, is much faster.

A 375-Nanosecond Main Memory System Utilizing 7-Mil Cores, G. E. Werner and R. M. Whalen, *AFIPS Conference Proceedings, Fall Joint Computer Conference* **27,** pp. 985-993 (1965).

The availability of ferrite cores with a 7.5-mil inside diameter and a 12-mil outside diameter offers the opportunity to package large memory arrays which are uniquely suited to high-speed operation. A fast array geometry, coupled with the ability to design higher coercivity, faster switching cores with reasonable drive currents, provides the essential ingredients for making ferrite cores a contending technology for very high-speed memory systems.

The memory described in this paper has an array capacity of 590,000 bits. The 12-mil cores are assembled on 15-mil centers and mounted into planar configurations of 295,000 bits each on either side of a single contiguous ground plane. The ground plane is multipurpose in that it serves as a return path for all array currents, it acts as a heat sink for dissipating array power and is used to establish a constant array temperature by circulating a temperature controlled liquid through it. This geometry provides a bit density of 4000 bits/in.^{2}, with the longest array wire only 21 in.

The memory unit which is logically organized as 8192 words of 72 bits each can execute instructions at a 2.66-Mc/sec receptition rate and has an access time including address decoding of 200 nsec. While this performance does not represent the ultimate speed capabilities of toroidal ferrite technology, a geometry is demonstrated which can predictably go much faster.

Three-Phase Sequence Test Circuit, K. Kraut, *Electro-Technology* **76,** No. 4, 118 (October, 1965).

This article describes a safety device consisting of a three-phase checking circuit that prevents a computer drum motor from rotating in the wrong direction if the three-phase input connections are reversed.

Theory of Ferromagnetic Resonance Line Shape outside the Spin-Wave Manifold, K. Motizuki* and M. Sparks* and P. E. Seiden, *The Physical Review* **140,** No. 3A, A972-A985 (November 1, 1965).

In the usual ferromagnetic resonance experiment the uniform precession lies within the magnon manifold; that is, there are long-wavelength magnons degenerate with the uniform precession. Several recent experiments have been performed with the uniform precession driven outside the magnon manifold. In this paper we calculate the line shape (χ'' as a function of applied field) for these experiments. Specifically, the relaxation frequency η of the uniform precession and the line shift δH (deviation of the uniform precession frequency from the Kittel frequency) are calculated. For relatively large η ($\eta \ll \gamma 4 \pi M$ not satisfied) the line shift δH is at least as important as η in determining the line shape. Explanations are given for the three interesting observations of Liu and Shaw that: (1) The relaxation frequency has the large value of the order of 150 Oe when the uniform precession is driven below the bottom of the spin-wave manifold; (2) The relaxation frequency drops sharply as the uniform precession passes below the bottom of the spin-wave manifold; and (3) The relaxation frequency within the spin-wave manifold is relatively independent of applied field. Examination of several possible sources of the 150-Oe relaxation frequency (1) indicates that the 150 Oe arises from the magnon manifold being modified by nonmagnetic voids in the sample in such a way as to allow two-magnon scattering below the magnon manifold of a perfectly dense sample. The field independence of relaxation frequency within the manifold (2) is in apparent agreement with the two-magnon scattering theory of Sparks, Loudon, and Kittel; Seiden; and Seiden and Sparks.

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Ultrasonic Gain and Loss Mechanisms in Semiconductors, M. Pomerantz, *IEEE Proceedings* **53,** No. 10, 1438-1451 (October, 1965).

Several kinds of interactions of ultrasound in semiconductors are reviewed. The subjects discussed are the effects of interaction with (1) thermal phonons, which produces temperature dependent attenuation, (2) free carriers, which may give attenuation or amplification, (3) electrons bound to shallow donors, giving rise to attenuation at low temperatures, and (4) other ultrasonic waves, which may give attenuation or amplification. An introduction to relaxation effects is included.

Vapor Phase Equilibria in the Gallium-Chlorine and Gallium Arsenide-Chlorine Systems, M. A. Zuegel, *Journal of the Electrochemical Society* **112,** No. 11, 1153-1157, (November, 1965).

An experimental investigation of the equilibrium composition in the gallium arsenide-chlorine system and in the gallium-chlorine system was made. From these data the temperature dependence of the equilibrium constant for the gallium-chlorine system was determined in the temperature range 420 to 630°C and the equilibrium constant for the gallium arsenide-chlorine system was determined in the temperature range 640 to 980°C.

Vapor Transport and Thermodynamic Equilibria in the Germanium-Gallium-Iodine System,† R. F. Lever, *Journal of the Physics and Chemistry of Solids* **26,** No. 11, 1629-1641 (November, 1965).

Thermodynamic information is used to correlate the composition of germanium-gallium solid solutions with the temperature, pressure and composition of a gas mixture with which the solid is in equilibrium. At temperatures below 1000°K, and gallium concentrations in excess of 10^{16} atoms/cm^3 of solid, the dominant gas phase species are GaI, GeI_2 and GaI_3 with the mole fraction of GeI_2 in the gas mixture becoming very small at gallium concentrations greater than 10^{18} atoms cm^{-3} and temperatures below 900°K. Epitaxial gallium-doped germanium layers were grown and their composition found to be close to the calculated equilibrium composition. The growth rate agreed quantitatively with that predicted on the assumption that gaseous diffusion was the rate-limiting process. The very low mole fraction of GeI_2 prevents rapid quasi-equilibrium single-crystal growth of heavily doped material at low temperatures.

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A Versatile Technique for Synchronous Remote-Controlled Photography, H. E. Van Luvanee, *Journal of the Society of Motion Picture and Television Engineers* **74,** No. 11, 999-1001 (November, 1965).

Remote-controlled photography, under certain conditions and for certain purposes, is more accurate than that possible for a cameraman. The system described here, presently used chiefly in photoinstrumentation work, depends on such relationships between the subject and the camera as time, event, position and repetition rate. Minor variations will adapt the system to most cameras. Methods of operation and variations required for individual problems are discussed.

Wear of Thin Ferric Oxide Coatings Bonded to Mylar Tape, W. C. Clinton, J. L. Sirico and W. T. Pimbley, *Wear* **8,** No. 5, 337-348 (September/October, 1965).

An investigation has been made of the wear which occurs in depth to thin films of various magnetic oxide-filled polymeric resins bonded to 1.2 mm thick polyester films (Mylar) when the resin surfaces are in sliding contact with an iron-nickel base alloy and a sintered metallic oxide. It is shown that the experimentally determined number of passes required to wear through each resin, correlated well with the theoretical number calculated in terms of the engineering model for wear. A similar correlation was found between the experimental and the theoretical when the surfaces were lubricated with mono- and multi-layers of lauric acid which were adsorbed on the surfaces from a dynamic vapor phase. The relationship between the static coefficient of friction and adsorption curves of the film thickness vs the resin surface temperature is briefly discussed for two samples.

X-Ray Method for the Determination of the Polarity of SiC Crystals, K. Brack, *Journal of Applied Physics* **36,** No. 11, 3560-3562 (November, 1965).

The SiC polarity in {001} wafers is determined by an x-ray dispersion method, measuring the intensities on two opposite {001} surfaces. The results are correlated to the surface structure obtained after etching the wafers. It is established that the smooth surface is the silicon face and the rough surface the carbon face.

Letters

GaAs Optically Coupled Transistor with a Lasing Emitter, R. F. Rutz, M. I. Nathan, A. E. Michel and J. C. Marinace, *Proceedings of the IEEE* **53,** No. 10, 1664 (October, 1965).

A Novel Photochemical Cycloaddition Reaction of Benzene, R. Srinivasan and K. A. Hill, *Journal of the American Chemical Society* **87,** No. 20, 4653 (October 20, 1965).

Statistical Properties of Computer Acceptance Schemes, V. D. Barnett, H. F. Ross, P. A. W. Lewis, *Journal of the Royal Statistical Society* **128,** Series A, No. 3, 391-392 (1965).