July through September 1960

IBM Technical Papers Published in Other Journals

An Alternative to Set Theory, P. C. Gilmore, *The American Mathematical Monthly,* **67,** 621-632 (August-September, 1960).

In this paper an alternative to set theory is discussed which provides not only a conceptual basis for analysis free from the difficulties that trouble set theory, but also a language for mathematics with some technical advantages over set theory.

Anisotropy of the Intrinsic Domain Magnetization of a Ferromagnet, S. H. Charap, *The Physical Review,* **119,** No. 5, 1538-1542 (September 1, 1960).

The effect of pseudodipolar coupling on the intrinsic domain magnetization of a cubic ferromagnet at low temperatures is investigated. Besides the anisotropy in the magnetization resulting from the dependence of the thermal excitation of spin waves on magnetization direction in the crystal, the pseudodipolar coupling is capable of making an anisotropic contribution to the magnetization, even at $T=0°K$, in the same approximation as its contribution to the first-order anisotropy constant K_1. Both effects are calculated and found to be in opposition to one another, tending to cancel in nickel at about 7.5°K.

A Class of Differential-Functional Systems. I, Robert B. Kelman, *Transactions of the American Mathematical Society,* **96,** 54-66 (July, 1960).

An investigation is made of the asymptotic behavior of a class of differential-functional systems. These systems were suggested by the system of differential equations arising when a Prüfer-type transformation is applied to the second-order linear differential equation. The simplest system studied here is $y'(x)=g(x)\cos(ux+vy(px+q)+w)$ where u, v, w, p and q are certain constants and $g(x)$ is a function of bounded variation tending to zero as x tends to infinity. The asymptotic behavior of the solution $y(x)$ depends on the algebro-number theoretic properties of p.

Coding the Transportation Problem,* S. Glicksman,** L. Johnson and L. Eselson, *Naval Research Logistics Quarterly,* **7,** 169-183 (June, 1960).***

This article describes two ways to simplify computer programming and reduce computational effort for the transportation problem. The amount of data processing at each iteration is held to a linear function of the smaller dimension of the problem, and the definition of a nucleus problem opens the way for effective computation of large problems in which the number of destinations is much larger than the number of sources. Performance data are given for a number of computations.

* Work done at Sperry Rand Corporation.
** Sperry Rand Corporation.
*** For period April 1 through June 30, 1960.

Critical Fields of Thin Superconducting Films, W. B. Ittner, III, *The Physical Review,* **119,** No. 5, 1591-1596 (September 1, 1960).

The critical fields of thin superconducting films have been calculated on the basis of the Bardeen-Cooper-Schrieffer (BCS) theory of superconductivity following a method outlined by Schrieffer. It is shown that it is convenient to use the critical field formula postulated by London where the London penetration depth is replaced by an effective penetration depth which can be specified through the use of the BCS theory. The effective penetration depth, unlike the London penetration depth which, for a given material, varies only with the temperature, is found to vary, in the BCS theory, with both the film thickness and the electronic mean free path of the normal material. This paper attempts to show that the measured critical fields of thin tin films are in general qualitative agreement with the predictions of the BCS theory.

Crystal Structure of 9:10-Dimethyl-1:2-benzanthracene,* D. Sayre and P. H. Friedlander,** *Nature,* **187,** No. 4732, 139-140 (July 9, 1960).

As part of an investigation into Daudel and Pullman's theory of the connexion between the carcinogenic activity of benzanthracene derivatives and their structure, we have made an accurate determination of the crystal structure of 9:10-dimethyl-1:2-benzanthracene. It is a potent carcinogen, unlike its parent, 1:2-benzanthracene, the structure of which we have reported previously.

* E. R. Johnson Foundation for Medical Physics, University of Pennsylvania.
** The Thompson-Ramo-Wooldridge Products Co., Beverly Hills, California.

Dependence of the Optical Bleaching Rate of X-Irradiated KCl Crystals on Light Intensity, W. E. Bron and W. R. Heller, *The Physical Review,* **119,** 1864-1868 (September 15, 1960).

Measurements have been made on the changes in the bleaching rate of the F band as the result of varying the intensity of F light. Bleaching was done on KCl crystals which had been irradiated at room temperature with hard X-rays into either the first or second stage of coloration. In the first stage irradiated crystals, the total bleaching of the F centers during the first ten seconds of illumination varies approximately linearly with light intensity at low intensities, but becomes saturated at intensities greater than 5×10^{14} photon/sec/cm^2. The bleaching process is thought to occur primarily through the capture of photoelectrons at pre-existing electron traps. Based on this model it is possible to set up the kinetic

equations for the bleaching process. Using reasonable values for photoelectron capture coefficients forces one to conclude that the number of photoelectrons is always very small throughout the bleaching process. The resulting simplification in the analysis of the kinetic equations leads to a prediction of the experimentally observed variation of the initial bleaching rate with light intensity. The analysis shows that the ratio of the capture coefficient for photoelectrons of the electron trapping centers to that of negative-ion vacancies is about unity, which strongly suggests that the trapping centers are either traps with net positive charge or are neutral traps located close to the original F centers.

The rate of bleaching during the second stage of bleaching saturated at the lowest intensity used which was about 1×10^{14} photons/sec/cm^2. This result is discussed in terms of the analysis given for the first stage of bleaching.

Domaenenwaende in Duennen Ferromagnetischen Ni-Fe Schichten (Domain Walls in Thin Ferromagnetic Ni-Fe Films), S. Middelhoek, *Berichte der Arbeitsgemeinschaft Ferromagnetismus 1959,* Verlag Stahleisen M.B.H. Düsseldorf, pp. 119-123 (August, 1960).

According to Néel a transition from the normal Bloch wall type (i.e., rotation of the magnetization vector in the plane of the Bloch wall) to the Néel type (i.e., rotation of the magnetization vector in the plane of the film) occurs at decreasing film thickness, due to the changing stray field relations. It is assumed that the barbed-wire (crossties) structure observed in thin Ni-Fe films with uniaxial anisotropy corresponds to such a transition, where this structure leads to a decrease of the magnetostatic energy. According to this explanation such a structure should occur in a certain thickness range. Experimental observations on Ni-Fe wedge films show the occurrence of barbed-wire structure in the thickness range 400-800 A, which is the range predicted by theory. Measurements of the thickness dependence of the coercive force show an anomaly in the same thickness range. Confirmation of the model was possible by the observation of the Bitter figures of scratches in the easy direction in negative magnetostrictive material. In the neighborhood of the scratch the magnetization in the plane of the film is rotated out of the easy direction. A barbed-wire structure again appears which leads to a decrease in the magnetostatic energy.

Duality in Quadratic Programming, W. S. Dorn, *Quarterly of Applied Mathematics,* **18,** 155-162 (July, 1960).

A proof, based on the duality theorem of linear programming, is given for a duality theorem for a class of quadratic programs. An illustrative application is made in the theory of elastic structures.

Dynamic Factors in Force Judgment, E. T. Klemmer, *Perceptual and Motor Skills,* **11,** 39-42 (August, 1960).

It has long been known that human judgments of lifted weights are influenced by the speed with which the weight is moved. The present study provides an objective measurement of this phenomenon utilizing an apparatus which provides maximum control over the kinematic factors involved. The influences of force build-up time, initial acceleration, peak velocity, average velocity and previous judgments are considered.

Effect of High Pressure on Some Hot Electron Phenomena in n-Type Germanium, S. H. Koenig, M. I. Nathan, W. Paul, and A. C. Smith,* *The Physical Review,* **118,** No. 5, 1217-1221 (June 1, 1960).**

The pressure dependence of the current density vs electric field characteristic for n-type germanium at 297°K has been measured to a maximum pressure of 30,000 kg/cm^2, and to a maximum field of 10,000 v/cm. It is concluded that the electrons are "heated" by the field sufficiently to cause the conduction band valleys along the <100> directions in reduced momentum space to be appreciably populated with electrons at atmospheric pressure. The pressure dependence of the angle ϵ between current and field at 77°K has been measured to a maximum field of 3000 v/cm and a maximum pressure of 5000 kg/cm^2; ϵ is independent of pressure except for a small increase for applied fields of ~3000 v/cm. Suggested interpretations for the data are given.

* Gordon McKay Laboratory, Harvard University. Present address: Massachusetts Institute of Technology, Department of Electrical Engineering.

** For period March 1 through June 30, 1960.

Error Detecting and Correcting Codes for Arithmetic Operations, D. T. Brown, *IRE Transactions on Electronic Computers,* **EC-9,** No. 3, 333-337 (September, 1960).

The most important property of the codes derived in this paper is that two coded numbers, $C(i)$ and $C(j)$, can be added in a conventional binary adder and the sum $C(i)+C(j)$ differs from $C(i+j)$, the code for the sum, by (at most) an additive constant. This makes possible the detection and/or correction of errors committed by the arithmetic element of a computer. In addition, messages can be coded and decoded and errors can be detected and corrected by arithmetic procedures, making it possible to eliminate some or all of the special-purpose equipment usually associated with error-detecting or correcting codes. This property may make these codes useful for data transmission as well as for computation.

An Evaporation Source with Controlled Characteristics, E. M. DaSilva, *The Review of Scientific Instruments,* **31,** No. 9, 959-960 (September, 1960).

Reproducible and constant evaporation rates can be realized when the evaporant is heated by radiation. This article describes a basic source structure with the controlled characteristics necessary for reproducible thin film techniques. Particular attention to the simplicity of design and application has provided an easily constructed, practical source.

Finding Focal Length of a Thick Lens, D. H. Cronquist, *Product Engineering,* **31,** No. 27, 49-51 (July 4, 1960).

A simple method of finding principal points of a thick lens by determining the focal length is described. The method consists of locating focal points, measuring distances from an object and its image to a reference edge, then using the derived equation.

The Formation of 1,4-Bisdiphenylene-2,3-diphenylbutadiene, an Abnormal Grignard Reaction, S. L. Solar and R. M. Lindquist, *Journal of the American Chemical Society,* **82,** No. 16, 4285-86 (August 20, 1960).

The Grignard reaction between α-phenyl-β-diphenylenevinylmagnesium bromide (I) and 9-fluorenone has been reported by C. F. Koelsch to give in good yield, α,γ-bisdiphenylene-β-phenylallyl alcohol (II). In many of our attempts to synthesize this compound, as an intermediate in the preparation of the stable free radical, α,γ-bisdiphenylene-β-phenylallyl, we have found as the major product, a high-melting hydrocarbon, $C_{40}H_{26}$. None of the expected tertiary alcohol was recovered. This hydrocarbon, previously unreported, is now believed to be 1,4-bisdiphenylene-2,3-diphenylbutadiene (VI), arising from the coupling of the radical derived from the dissociation of α-phenyl-β-diphenylenevinylmagnesium bromide (I).

The Grammar of English Nominalizations, R. B. Lees, Indiana University Research Center for Anthropology, Folklore, and Linguistics, Publication #12; *Suppl. to International Journal of American Linguistics,* **26,** No. 3, xxvi + 205 (July, 1960).

Detailed description of a sentence-generating grammar of English with special emphasis on nominalizing grammatical transformations and the generation of nominal compounds.

Group Codes for Prescribed Error Patterns, R. T. Chien, *1960 IRE International Convention Record, Part 4,* **8,** 125-134 (July, 1960).

This paper studies the problem of constructing group codes for correcting error patterns. An equivalence relation is defined and error patterns are divided into equivalent classes. If a group code can be constructed for any pattern, a transformation technique will give group codes for all error patterns in the same class. For any error pattern, a necessary and sufficient condition for the existence of a correcting group code is given. Procedure for constructing group codes is illustrated for patterns which fulfill the condition. The case of $r=3$ is worked out completely by hand. Out of more than 10^7 matrices, only 20 equivalent classes were found.

Insulating Liquids and Their Applications, T. D. Callinan, *Digest of Literature on Dielectrics—National Research Council,* **23,** 45-56 (August 4, 1960).

The engineering approach to insulating liquids continues to dominate the literary efforts of specialists in this field. Mineral oil remains the chief subject of their studies, and the deterioration of this liquid in service continues to be a puzzle whether considered from the viewpoint of oxidation, metal-ion or free radical kinetics.

Integer Programming and Pricing, R. E. Gomory and W. J. Baumol, *Econometrica,* **28,** No. 3, 521-550 (July, 1960).

In this article a method of solution of integer linear programming problems is described briefly (with an example of the method of solution). The bulk of the paper is devoted to a discussion of the dual prices and their relationship to the marginal yields of scarce indivisible resources and their efficient allocation.

Loss and Recovery of Information by Course Observation of a Stochastic Chain, M. S. Watanabe and C. T. Abraham, *Information and Control,* **III,** No. 3, 248-278 (September, 1960).

In a stationary stochastic chain, the states are grouped into classes or coarsely defined macro-states, engendering another chain defined in terms of macro-states. Comparison of information content of these two chains is made in detail. Loss of information caused by the coarseness of the definition of macro-states can be recovered, partially or totally depending on the case, when there is correlation in the chain. The range of correlation is increased by the coarse definition of states, thus creating a longer "after-effect." If the correlation is weak, this after-effect tapers off exponentially with time.

Magnetische Eigenschaften Duenner Ferromagnetischer Schichten (Magnetic Properties of Thin Ferromagnetic Films), H. Thomas, *Berichte der Arbeitsgemeinschaft Ferromagnetismus 1959,* Verlag Stahleisen M.B.H. Düsseldorf, pp. 86-103 (August, 1960).

Thin films present the possibility of investigating the changes in magnetic behavior occurring at certain characteristic values of the thickness, in order to use them as criteria for the underlying elementary processes. Furthermore, processes can be studied which can be observed in bulk material only indirectly or imperfectly, or which take place more simply or more clearly, or even become really possible in thin films only, because of the reduced influence of disturbing parameters. In addition, investigations on deviations from the normal structure in thin films and their influence on the magnetic properties are especially significant. A survey is given on the state of the art in the following fields: 1) Change of saturation magnetization and Curie temperature with thickness. 2) Magnetic anisotropy in thin films; in addition to the mechanisms known for bulk material, new reasons for an anisotropy are found in thin films. 3) Domains and Bloch walls: Direct observation by Kerr and Faraday effect and Bitter-technique, measurement of wall velocity, new wall structures caused by the change of magnetostatic energy with film thickness. 4) M-H loop: Change of hysteresis loop of the isotropic material by an induced uniaxial anisotropy, coercive force for the different modes of magnetization reversal, rotational hysteresis. 5) Magnetodynamics in thin films: Ferromagnetic resonance, spin wave resonance, switching processes in thin films, and spin damping.

Mechanical Model for Uniaxial Magnetic Anisotropy, H. J. Oguey, *The Review of Scientific Instruments,* **31,** No. 7, 710-711 (July, 1960).

A mechanical model has been constructed as a means of understanding certain properties of anisotropic thin films. The model renders possible direction finding of the magnetization for a given amplitude and direction of the magnetic field vector lying in the plane of the film, provided rotational processes only are considered. The magnetic field is represented by the position of a small knob, and can be set in its amplitude and direction. A pointer then indicates

the orientation of the magnetization vector. Jump phenomena can be easily observed, the loci of which form the critical curve for the uniaxial anisotropy.

A Method for Determining the Effect of Annealing on Residual Molding Stresses of Plastics, L. B. Allen, *SPE Journal,* **16,** No. 17, 713-716 (July, 1960).

It is seldom possible to eliminate residual stresses in thermoset moldings by design or in-mold cure. Where the part is subject to thermal or mechanical shock, annealing is usually necessary to prevent cracking. The annealing schedule is usually determined by statistical methods.

In this method, the residual surface stresses are determined by means of brittle lacquers. With suitable care, semi-quantitative strain values may be obtained for two or three annealing times and the curve extrapolated to minimum strain. This method represents a significant development in plastics technology, obviates the need for large scale testing, and may result in the optimum annealing schedule for each part. Determining residual stress by this method is an extension of a technique sometimes used on metals for design purposes.

A Model of an Elementary Industrial Processing System, Burton Grad, *Proceedings—11th Annual National AIIE Conference,* pp. 81-87 (August 1, 1960).

The paper develops a schematic and symbolic representation plan for a simple information and physical processing system. Certain properties of such a system are explored, including major restraints imposed by inventories, time lags and event sequence within a particular time interval. Consideration is given to these systems change factors: shipments, arrivals, orders placed, orders received and quantity scheduled. A few systems status variables are defined: inventories, unfilled orders and open requests.

Molecular and Ionic Interactions in Dielectrics, Ann M. Parks, John Hart and M. O. Poirier, *Digest of Literature on Dielectrics,* **23,** 1959, Chapter III, 69-99 (August 4, 1960).

This chapter is a review of the literature published in 1959 on the subject of molecular and ionic interactions in dielectrics.

A Multiple Ambiguous Adjectival Construction in English, R. B. Lees, *Language,* **36,** 207-221 (April-June, 1960).*

Traditional doctrines on syntactic analysis of natural-language sentences are discussed and criticized, including the so-called "phonemic approach," substitution in diagnostic environments, and "tagmemic analysis." An analysis is then given for each of eight different English adjectival constructions, all of the form *(too) Adj to Verb.* The multiple grammatical ambiguity among three of these of the form "It is too hot to eat" and four others of the form "It is easy to call" then shows the inadequacy of generally accepted analytic canons.

* For period April 1 through June 30, 1960.

A New Core Switch for Magetic Matrix Stores and Other Purposes, I. P. V. Carter, *IRE Transactions on Electronic Computers,* **EC-9,** No. 2, 176-191 (June, 1960).*

This paper analyzes the conventional uses of magnetic switch cores to drive matrix stores in both current-driven and voltage-driven modes. A new method of using switch cores is proposed and analyzed which offers, at the cost of replacing in every selection line the usual switch-core and terminating resistor by two smaller cores, intrinsic pulse shaping and amplitude regulation, and much reduced power dissipation, particularly in the driving stages. Constructional details of an application of the new method to drive a store $100\times80\times10$ are given, and waveforms for this store are shown. All address decoding and driving are performed by 34 transistors. A model of a multiple coincidence store 101×101 with a cycle time of $1\mu s$ has also been constructed; details are given.

* For period April 1 through June 30, 1960.

A New Look at Electrical Grounding, W. E. Mesh, *National Safety News,* **82,** No. 2, 20-21, 101-102 (August, 1960).

This paper provides a fresh look at grounding rules applicable to electrical equipment, such as portable hand tools and electronic laboratory set-ups, and suggests an approach to providing the greatest number of safety factors for personnel.

A Note on the Application of Graph Theory to Digital Computer Programming, Richard M. Karp, *Information and Control,* **3,** 179-190 (August, 1960).

A graph-theoretic model for the description of flowcharts and programs is defined. It is shown that properties of directed graphs and the associated connection matrices can be used to detect errors and eliminate redundancies in programs. These properties are also used in the synthesis of composite programs. Finally, the model is expanded to take into account frequencies of execution of portions of a program, and a problem concerning optimum arrangement of a program in storage is solved.

On Some Aspects of Electron Beam Evaporation, R. E. Thun, *Proceedings of Second Symposium on Electron Beam Processes,* March 24-25, 1960, pp. 71-85 (July, 1960).

A two-grid electron gun and a Pierce-type gun focussing the electron beam by a spherical accelerating field are compared with regard to their performance as electron beam evaporation sources. Whereas the grid gun operated satisfactorily only at low power levels, such a restriction was not found for the Pierce gun. The practical performance of the latter agrees closely with the theoretical data on power, current, current density and focussing conditions which are presented in a number of graphs. As an example for the possibilities of electron beam evaporation, a method is described for the rapid determination of multi-component phase diagrams. In this method, the system components are vacuum-deposited as stacked wedge-shaped films and subsequently brought to diffusion. The resulting sample contains all possible concentrations of the components and the cor-

responding compounds in a predictable geometry. By means of an electron diffraction scan across the sample surface, the phase diagram is obtained directly.

The Optical Coupling of a Scintillation Chamber to an Image Intensifying Tube, R. J. Potter and R. E. Hopkins, *IRE Transactions on Nuclear Science, Proceedings of the Seventh Scintillation Counter Symposium,* **NS-7,** No. 2-3, 150-158 (June-September, 1960).

Several methods for coupling a fiber scintillation chamber to an image-intensifying tube are considered. A high-speed lens has been designed to image the ends of a curved fiber bundle on the curved cathode of an image-intensifying tube. The lens covers a five-inch field at one-to-one magnification, and at a speed of f/1.5. The details of this lens design and its expected performance are discussed.

The results of a series of experiments on plastic scintillating fibers have been used to determine that the internal reflectivity is 0.993 and absorption constant is 0.015 cm^{-1} in the fiber. The data have then been used to compute the optical properties of fibers appropriate to a scintillation chamber system. Certain other optical properties of the components were estimated so that three possible optical coupling schemes could be compared in detail. They are: 1) the lens alone, 2) a glass fiber bundle alone, and 3) a combination of the lens and a glass fiber bundle. The lens alone is about half as efficient as either of the other two methods. The numerical aperture and probable transmission properties of each system are outlined.

Parametric Standing Wave Amplifiers, R. Landauer, *Proceedings of the IRE,* **48,** No. 7, 1328-1329 (July, 1960).

This paper treats development of subharmonic standing wave oscillations on non-linear transmission line sections which are pumped by a signal which is a function of time only, but has the same phase all along the line.

Phase Equilibria in the System La_2O_3-Iron Oxide in Air, V. L. Moruzzi and M. W. Shafer, *Journal of the American Ceramic Society,* **43,** No. 7, 367-372 (July, 1960).

Phase equilibria data are presented for compositions in the system La_2O_3-iron oxide in air. Liquidus and solidus curves were obtained by the quenching method in the iron-rich portion of the system. The remainder of the diagram was determined using a strip-furnace technique. Two compounds have been found, the orthorhombic perovskite $LaFeO_3$ and a compound with the magnetoplumbite structure corresponding to a composition $LaFe_{12}O_{19}$. $LaFeO_3$ was determined to melt congruently at about 1890°C whereas $LaFe_{12}O_{19}$ has both a stability minimum and maximum at 1380° and 1421°C, respectively. The iron-rich portion of the system is essentially ternary, whereas the remainder can be considered to be a simple binary. Liquid compositions have been determined and are plotted in terms of the ternary system La_2O_3-Fe_2O_3-FeO.

Polygonization of 31% Alpha-Brass, V. Y. Doo,* *Acta Metallurgica,* **8,** No. 2, 106-111 (February, 1960).**

31% alpha-brass crystals grown by melting high purity copper and zinc together were used in this investigation. Single crystals bent within, as well as slightly beyond, the single slip region were polygonized to form dislocation walls perpendicular to the major set of slip planes after a final anneal of ½ hr at 700°C or 750°C. Bent polycrystalline specimens having very high dislocation densities in all sets of active slip planes were polygonized to form subgrain boundaries after a similar anneal.

Even though the stacking fault energy of alpha-brass is likely to be lower than that of the copper, the former polygonized at a relatively lower temperature. It is believed that the high self-diffusivity of alpha-brass is one of the important factors which facilitated the climbing of its dislocations. The present results substantiated Barnes' prediction that the dissociated dislocations can climb.

* Mining and Metallurgy Department, University of Illinois. Present address: The IBM Product Development Laboratory, Data Systems Division, Poughkeepsie.

** For period January 1 through March 31, 1960.

A Possible Explanation of Immiscibility in Silicate Melts, E. Christiaan De Wys, *Journal of Mineralogical Society* —London, pp. 471-479 (June, 1960).*

The problem of silicate immiscibility, of petrological and technological interest, is discussed in terms of the structures of silicate crystals and certain phase diagrams. Physical chemical principles are employed to indicate the author's basis for suspecting that certain structures in the crystalline solid are carried over into the melt and are a major contributory cause of silicate immiscibility. These structures appear to be limited to the neso $(SiO_4)^{4-}$, soro $(Si_2O_7)^{6-}$, cyclo $(Si_3O_9)^{6-}$, and ino $(SiO_3)^{2-}$ types of silicate polymers and do not include the more complex phyllo- and tectosilicate polymers.

* For period April 1 through June 30, 1960.

Relation Between X-Ray Coloration and Optical Bleaching of KCl Crystals, W. E. Bron, *The Physical Review,* **119,** 1853-1863 (September 15, 1960).

Changes in the absorption of KCl crystals in the spectral region of 200 $m\mu$ to 1000 $m\mu$ have been observed during room temperature X-ray irradiation and subsequent bleaching with F light. It is observed that both coloration and bleaching of the F band occurs in two stages. Secondary centers such as M, R, and V_3 centers grow primarily during the second stage of coloration, and the rate of growth of these centers during the second stage is enhanced by plastic deformation in a manner similar to that of the F band. It is found that the absorption change of the F band during the first stage of bleaching approximately equals that during the first stage of coloration. Furthermore, the initial rate of bleaching of the F band is proportional to the initial F band absorption in samples irradiated only into the first stage of coloration, but is essentially independent of the initial F band absorption in samples irradiated into the second stage of coloration. It is concluded from this and other evidence that the center responsible for the first stages of coloration and bleaching differs from the center responsible for the second stages of coloration and bleaching. A major point of difference is that the first stage centers are considered to be located in the bulk of the crystal, whereas the second stage centers are located in the vicinity of dislocations.

It is also observed that M centers which are formed from F centers during the first stage of bleaching can be bleached with F light. To explain the observations concerning this M band bleaching, it is proposed that M as well as F centers

are bleached when they are joined by mobile defects, possibly vacancy pairs. Some of the second stage centers located in the vicinity of dislocations are thought to compete with the centers located in the bulk of the crystal for the mobile defects.

Reversible und Irreversible Magnetisierungs-Aenderungen in Duennen Magnetischen Schichten (Millimicrosecond Magnetization Reversal in Thin Magnetic Films), W. Dietrich, *Berichte der Arbeitsgemeinschaft Ferromagnetismus 1959*, Verlag Stahleisen M.B.H. Düsseldorf, pp. 115-118 (August, 1960).

Three different processes of magnetization reversal in thin permalloy type films with uniaxial anisotropy are described in detail: wall motion, coherent and incoherent rotation. All three processes are demonstrated on characteristic examples. The coherent rotation of the magnetization vector is described more in detail. The special experimental equipment for the measurement of fast rotation processes is described and illustrated by sketches and photos of the measurement setup and the resulting switching signals displayed on a sampling oscilloscope.

A Review of the Thin Film Cryotron,* W. B. Ittner III, *The Solid State Journal*, **1,** 44-47 (July/August, 1960).

In 1935 Casimer-Jonker and de Haas described a circuit in which a superconducting coil could be used to switch resistance into a superconducting alloy. This basic method of building a superconductive switching element was re-emphasized in 1956 by Dudley Buck, who published a paper describing a method of using such switching elements in a variety of computing circuits.

The cryotron, Buck's name for this switching element, attracted at the time only a limited amount of interest because of a number of potential disadvantages, such as the necessity of continuous low-temperature refrigeration. Shortly thereafter, however, it became apparent that the cryotron and the cryogenic computer offered a number of potential advantages that would be difficult to realize through any other existing, or even contemplated, technology. Subsequently, the fields of cryogenics and superconductivity have attracted considerable industrial interest, and a rather substantial amount of effort has been expended in investigations of the feasibility of using thin-film superconductors to build large, high-speed computing assemblies. This paper reviews the basic features of the thin-film cryotron, delineates both a number of its advantages and its limitations, and discusses briefly some of the technological problems which must be solved if the cryogenic computer is to become a commercial reality.

* This review is based on research which has been supported in part by the Department of Defense.

Sensitive Flux Measurement of Thin Magnetic Films, H. J. Oguey, *The Review of Scientific Instruments*, **31,** No. 7, 701-709 (July, 1960).

The two main difficulties encountered in the design of a sensitive hysteresis loop tracer for thin magnetic films are the flux calibration and the reduction of noise. The aim of this paper is to examine their nature and to show the possible solution for the design of very sensitive hysteresis loop tracers. The study of the flux distribution around a thin magnetic film specimen permits determination of the merits of various pickup coil configurations, as well as the form which optimizes the signal-to-noise ratio. The various disturbing voltages and the ways to eliminate them are examined. Optimization of the amplifier noise figure, proper choice of the integration network, dc restoration, and hum synchronization are described for the reduction of the output noise after integration and amplification. Two instruments built according to these principles are outlined. The first has a single wire pickup and is well suited for measurement of the flux distribution around a thin magnetic film and for experiments in vacuum at elevated temperatures; the second is more flexible and sensitive. With different pickup coils covering a frequency range from 50 cps to 10 kc, its sensitivity is sufficient to measure flux values of 2×10^{-12} v-sec at a frequency of 500 cps.

A Short Study of Notation Efficiency, H. J. Smith, Jr., *Communications of the ACM*, **3,** No. 8, 468-473 (August, 1960).

A discussion of the techniques involved in comparing the efficiency of use of storage when different byte sizes is possible. The logical characteristics of the problem are discussed. The mathematics of the solution are derived and tabular and graphical presentations of results are shown. Comparison of a 6-bit and an 8-bit byte is used as one illustration of these techniques.

Some Effects of Pulse Irradiation on Semiconductor Devices, W. A. Bohan, J. D. Maxey, and R. Pecoraro, *Proceedings of Institution of Electrical Engineers, 1959*, **106,** Part B, Supplement No. 15, London, 361-367 (January, 1960).*

The effects of pulse irradiation upon majority and minority carrier properties of semiconductor devices are presented, with emphasis on those effects peculiar to radiation rates of the order of 10^{16} neutrons/cm^2 per second and 10^7 röntgens (gamma)/sec.

* For period January 1 through March 31, 1960.

Some Moral and Technical Consequences of Automation—A Refutation, A. L. Samuel, *Science*, **132,** 741-742 (September 16, 1960).

The machine is not a threat to mankind, as some people think. The machine does not possess a will, and its so-called "conclusions" are only the logical consequences of its input, as revealed by the mechanistic functioning of an inanimate assemblage of mechanical and electrical parts.

Some Studies of Getter-ion Pumped Vacuum Systems, I. Ames and R. L. Christensen, *1959 Sixth National Symposium on Vacuum Technology Transactions*, **6,** 311-316 (1960).

Vacuum phenomena in several small, bakeable glass-metal systems, evacuated by getter-ion pumps, have been investigated. The systems were evacuated by various combinations of water-aspiration, cryogenic pumping, and getter-ion

pumping. Various degrees of baking were employed. These ranged from heating of localized portions, through mild baking of the entire system while at the "fore" pressure of the liquid helium pump, to hard baking at high vacuum. The composition and behavior of the residual gases were examined by means of an omegatron.

Some Studies of the Superconducting Transition in Purified Tantalum,* J. I. Budnick, *The Physical Review*, **119,** No. 5, 1578-1586 (September 1, 1960).

Extremely sharp magnetic transitions from the superconducting to the normal state are found for highly purified tantalum specimens with residual resistivities approaching 1×10^{-3} μohm-cm. Negligible flux trappings and pronounced supercooling is found to occur in these samples near the transition temperature T_c.

Values of T_c as high as 4.483°K±.002°K and of the critical field at 0°K, H_o, as low as 830±8 gauss were found for these specimens. The critical field curve is found to have a maximum deviation from a parabolic temperature dependence of about 3%. For tantalum the transition temperature decreases with increasing residual resistivity in much the same way as that observed by Serin and co-workers in dilute substitutional alloys.

Some investigation is made of the current dependence of the resistance transition in a magnetic field.

* Supported in part by Department of Defense.

Spreading Resistance in Cylindrical Semiconductor Devices, D. P. Kennedy, *Journal of Applied Physics,* **31,** No. 8, 1490-1497 (August, 1960).

For cylindrical semiconductor components, computation of spreading resistance is considered a boundary value problem of the solid circular cylinder. Solutions of this problem may be used, for example, to characterize the thermal spreading resistance within the package of a semiconductor device, the electrical spreading resistance in a mesa-type parametric diode, and the extrinsic collector resistance of a mesa transistor. Equations describing the thermal (or electrical) spreading resistance are presented in graphical form for a range of geometrical parameters applicable to many practical situations. Further, examples are given for the potential distribution within each cylindrical structure considered in this analysis.

Stability of a Turbine-Generator Rotor Including the Effects of Certain Types of Steam and Bearing Excitations, A. H. Landzberg, *Journal of Applied Mechanics,* **27,** 410-416 (September, 1960).

The effects of certain steam forces and bearing oil-film forces on vibration stability of a turbine-generator rotor are considered. A matrix method for systematically calculating the characteristic equation of a real rotor is developed with the aid of complex notation. The matrices are 4×4 in size. Pedestal effects are not included. A simple example is worked out and the results are compared to those obtained by another author. Complete agreement is obtained in the determination of the characteristic equation.

Submicrosecond Core Memories Using Multiple Coincidence, I. P. V. Carter and H. P. Schlaeppi, *IRE Transactions on Electronic Computers,* **EC-9,** No. 2, 192-198 (June, 1960).*

Memories using toroidal ferrite cores with cycle times less than a microsecond are described; the selection ratio is increased by the use of biassing and the multiple coincidence principles of Minnick and Ashenhurst. It is shown that this mode of operation leads to important changes in the structure of the store; in particular, the classical core switch does not fulfill the new requirements. The "two-core" switch is then briefly described; it permits an elegant and economic solution of the problems arising at high selection ratios. Details of the design and operation of memories embodying these ideas are given; it is shown, for example, that standard core memory matrices can be used very efficiently at a selection ratio of 3:1 to achieve a cycle time of 2 microseconds. Further illustrations are given from a model of a 100×100 store operated at 4:1 and 7:1 selection ratios, and it is shown that a store of 10,000 8-bit characters with a cycle time of 0.25 microsecond is feasible.

* For period April 1 through June 30, 1960.

Temperature Dependence of Optical Bleaching of KCl Crystals Near 0°C, W. E. Bron and A. S. Nowick, *The Physical Review,* **119,** 114-121 (July 1, 1960).

It has been observed in KCl crystals colored with hard X-rays that the initial bleaching of the F band during illumination with F-light is temperature dependent in the range of −30°C to +10°C. The bleaching process can be described as the superposition of a temperature independent process and a temperature dependent process, the temperature dependence being determined by an activation energy which is calculated to have a value of roughly 0.3 to 0.4 ev. Data on the M band growth during similar bleaching of additively colored crystals by Petroff have also been analyzed, and indicate a single temperature-dependent process with an activation energy of 0.36 ev. These results indicate that the temperature dependent bleaching processes in X-irradiated and additively colored KCl crystals may be the same. It is concluded that the origin of the temperature independent process in X-irradiated crystals results from the trapping of photoelectrons at electron traps existing in the crystal prior to bleaching, while the temperature dependent process in both X-irradiated and additively colored crystals results from the trapping of photoelectrons at vacancy clusters which are formed during bleaching through the motion of relatively mobile defects, possibly vacancy pairs.

Theory of Nuclear Quadrupole Interaction in Beryllium Metal,* M. Pomerantz and T. P. Das,** *The Physical Review,* **119,** No. 1, 70-78 (July 1, 1960).†

The theory of the origin of the field gradient at nuclei in metals has been analyzed. The contributions of the ion cores and conduction electrons have been separately considered. In the case of beryllium metal, using orthogonalized plane wave functions, the conduction electrons are shown to enhance, by about eight percent, the field gradient due to the ion cores. Combining the results of our calculations with Knight's experimental value of 48 kc/sec for the Be^9 coupling constant e^2qQ/h, a value of $Q=0.032\times10^{-24}$ cm^2 is obtained. The dependence of the potential for the conduction electrons on the model chosen is analyzed in some detail. The

various uncertainties in our field-gradient calculation and the theoretical value of the Knight shift in beryllium metal are discussed.

* This work was included in a thesis submitted by M. Pomerantz to the faculty of the University of California, Berkeley, in partial fulfillment of the requirements for the Ph.D. degree.

** On leave of absence from Saha Institute of Nuclear Physics, Calcutta. Present address: Department of Chemistry, Columbia University.

† This research was supported in part by the Office of Naval Research and in part by the U. S. Air Force Office of Scientific Research.

Trends in Dielectric Research During 1959, T. D. Callinan, *Digest of Literature on Dielectrics—National Research Council,* Washington, D. C., **23,** 1-6 (August 4, 1960).

Students of dielectrics showed an increased interest during 1959 in complex insulating systems. Instead of disclosures of new insulants, analytical studies of combinations of known materials constitute most of the literature. This will lead to a more critical examination of the present theories.

Trigonal Magnetocrystalline Anisotropy in Hexagonal Oxides, L. R. Bickford, Jr., *The Physical Review,* **119,** No. 3, 1000-1009 (August 1, 1960).

Torque measurements of the magnetocrystalline anisotropy between 77°K and 300°K are reported for single crystals of two different ferrimagnetic oxides having structures related to that of the mineral magnetoplumbite. The compounds, with chemical compositions $Co_2Ba_2Fe_{12}O_{22}$ and $Co_2Ba_3Fe_{24}O_{41}$, are known as Co_2Y and Co_2Z, respectively. Both compounds, after suitable magnetic field cooling treatment, display trigonal anisotropy in the basal plane at 77°K. The field cooling is shown to have the effect of placing the magnetization into one of two energetically equivalent orientations, each of which leads to a trigonal term of different sign. Examination of the crystal structures shows that in the case of Co_2Y an additional term $K'_2 \sin^3 \theta \times \cos \theta \cos 3\psi$ (where θ and ψ are the polar coordinates of the magnetization) should be added to the generally accepted phenomenological hexagonal anisotropy expression. The anisotropy constant K'_2 is evaluated as 6×10^5 erg/cm^3 at 117°K. In the case of Co_2Z this trigonal anisotropy term is not consistent with the crystal symmetry, although it is appropriate for structural subgroups of the unit cell. Its trigonal anisotropy is explained in terms of a "puckered" magnetization pattern whereby the sign of the *c*-axis component of magnetization is different from adjacent subgroups. The existence of this puckered pattern implies that the exchange coupling across the boundaries between subgroups is relatively weak. A new rotational hysteresis effect in Co_2Y is described and explained phenomenologically. An atomic theory assigning the origin of the trigonal anisotropy of both compounds to the cobalt ions is presented.