

April through June, 1959

IBM Technical Papers Published in Other Journals

Anisotropy, Other Than in Thin Films (Effect of Orbital Degeneracy on Magnetoelastic Energy), J. C. Slonczewski, *Journal of Applied Physics*, Supplement to Vol. 30, No. 4, 310S-311S (April, 1959).

Because of the configurational instability of an orbitally degenerate system, ferrimagnetic crystals containing orbitally degenerate cations should exhibit large magnetostriction. The effect of orbital degeneracy of Co^{2+} on magnetostriction in cobalt-iron ferrite is calculated by means of perturbation theory. A value of $1.4 \times 10^3 \text{ cm}^{-1}$ for trigonal crystal field splitting of Co^{2+} is inferred by comparing calculated results with experimental data.

An Application of Algebraic Topology: Kron's Method of Tearing, J. Paul Roth, *Quarterly of Applied Mathematics*, XVII, No. 1, 1-24 (April, 1959).

An algebraic topological interpretation of the electrical network problem and a method for solving it due to Kron is discussed. A theoretical justification is given for Kron's method, and several examples are worked out in some detail to exhibit the efficiency of the method.

Aufnahme der Hystereseschleife von dünnen magnetischen Schichten (Thin Magnetic Films Hysteresis Loop Display), K. E. Drangeid, *Zeitschrift für angewandte Mathematik und Physik*, (ZAMP) 10, 96-100 (January, 1959).*

The publication describes an instrument which permits direct display of the hysteresis loops of thin magnetic films. No integrating amplifier is used, to avoid the necessity of calibrating the instrument before use. A combination of an LR and an RC integrating network is utilized.

*For the period January through March, 1959.

Barkhausen Effect in Nickel-Iron Films, N. C. Ford, Jr., and E. W. Pugh, *Journal of Applied Physics*, Supplement to Vol. 30, No. 4, 270S-271S (April, 1959).

A statistical study of Barkhausen discontinuities in nickel-iron films has been made by observing independent hysteresis loops obtained from different areas of each film. The magnetization changes were detected by photomultiplier sensing of the light output from a standard Kerr magneto-optical apparatus. Observations could thus be restricted to any desired region of the film by suitably varying the light-spot size and location. The sequence of Barkhausen discontinuities in a given reversal is generally random and cannot be predicted by the sequence in a previous reversal. The statistical distribution of discontinuity sizes obtained from many reversals is shown to be well described by a simple model of wall motion in which the probability of a wall stopping in an interval of distance dx is proportional to dx . The applicability of this model to bulk materials is discussed.

Civilization and Science — Man and Machine, Satoshi Watanabe, *Annals of the Japan Association for Philosophy of Science*, 1, No. 4, 12-30 (March 1959).*

The problem of the modern age is visualized as one of conflict between civilization as a pure value and civilization as a tool. The functions and limitations of various modern machines, especially of information-processing machines, are critically analyzed. The author concludes, "A machine can aim at something, it can have a goal, but it cannot determine values; it does not have freedom to choose values."

*For the period January through March, 1959.

Diagnostic Program Techniques for SAGE Computer Maintenance, D. F. Benkart and W. Thomson, *Third National Convention on Military Electronics*, 359-362 (June 29 to July 1, 1959).

In a system as large as the Air Force's Sage Computer, the large number of tubes, circuits, and even logic sections involved, prohibits the use of normal maintenance practices. To overcome this problem new techniques had to be developed. The unique features utilized are the program control of the marginal checking system, the use of equipment under test, the diagnosis of this information using all functional parts of the computer system, and the presentation of reduced data to maintenance personnel. This paper describes the successful use of this type of program in the maintenance of the Sage Computer System.

Electromechanical Behavior of Single Crystals of Barium Titanate from 25° to 160°C, E. J. Huibregtse, W. H. Bessey,* and M. E. Drougard, *Journal of Applied Physics*, 30, No. 6, 899-905 (June, 1959).

Dynamic piezoelectric resonance measurements have been made on single crystals of barium titanate in the range from room temperature to 160°C. In the ferroelectric region (room temperature to 120°C) the material is spontaneously polarized and hence naturally piezoelectric. For this range of temperature, results are presented for the elastic compliance coefficients s_{11}^E and s_{11}^P , the combination $(2s_{12} + s_{66})$ at constant field and constant polarization, and the piezoelectric coefficient d_{31} as functions of temperature. Above the Curie temperature (120°C) the piezoelectric resonances can be observed only by polarizing the crystal with an external field. From measurements of the resonant frequencies in crystals having their longitudinal axes along the (100) and the (110) direction, and the assumption of the validity of the Cauchy relation ($c_{12} = c_{44}$), the elastic coefficients at constant polarization have been determined as functions of temperature and polarization from the Curie point to 160°C. The strains induced by the polarization in a stress-free crystal are shown to be proportional to the square of the polarization, for values of polarization up to one-third of the spontaneous polarization at room temperature.

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Electron Paramagnetic Resonance in Single Crystals of BaTiO₃, A. W. Hornig, R. C. Rempel,* and H. E. Weaver,* *Journal of Physics and Chemistry of Solids*, **10**, No. 1, 1-11 (April, 1959).

The paramagnetic resonance of an impurity in single crystals of BaTiO₃ has been studied. The impurity ion has been identified as Fe³⁺ and is believed to be located at the titanium position in the unit cell. The zero field splittings for the Fe³⁺ ion in the tetragonal ferroelectric phase have been measured at room temperature and as a function of temperature through the Curie point. The values at room temperature are 11.7 and 4.9 kmc/s, respectively. The corresponding zero field splitting in the cubic phase is about 0.90 kmc. The effects of temperature variation on the resonant magnetic fields are discussed with special reference to the observation of a zero magnetic field transition at 9.5 kmc/s and at a temperature of 75°C.

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Evaluating Intelligence for Programming Systems, R. W. Bemer, *Automatic Control*, **10**, 22-24DC (April, 1959).

A remarkable variation exists in the degree of sophistication of various programming systems. A particular manifestation is the jungle of assorted devices for reproducing limited human-decision procedures. An attempt is made here to begin a systematic classification of the various devices for educating the computer to take over the various decision-making functions of one or many human operators.

Estimation of Duplex Computer Dependability from Simplex Data, J. Gold, *Third National Convention on Military Electronics*, 385-389 (June 29 to July 1, 1959).

The concept of duplexing equipment in order to obtain greater dependability is receiving considerable attention in the field of military electronics today. A prediction model has been derived for use in preparing quantitative estimates of the dependability gains afforded by duplexing. The development of the prediction model revealed that a simple approach was not adequate. Numerous operational and equipment parameters were incorporated into the final prediction model.

Evaluation of New High-Speed Magnetic Ferrite System for Use in Computer Components, B. R. Eichbaum, *Journal of Applied Physics*, Supplement to Vol. **30**, No. 4, 49S-52S (April, 1959).

Present-day computer speeds are limited by the magnetic components utilized in their construction. Such components have been fabricated from square-loop ferrites of the MgO·MnO·Fe₂O₃ system. Since such materials limit the speed at which the computers can operate, a new ferrite system, namely the CdO·MnO·Fe₂O₃ system, was studied and has been proven feasible for many new high-speed applications. Some of the compositions of this new system exhibiting square hysteresis loops have switching constants as low as 0.200 oe-μsec. Such materials, in comparison with those of the MgO·MnO·Fe₂O₃ system, have a much lower coercive force, require lower driving currents, and have a flux reversal or switching time which is five times as fast. These materials have been used in fast-switching multipath elements and matrix switch cores. The operation of such elements is described.

Functional Components, R. J. Cypser, *Proceedings of IRE Conference on Electronic Components*, 1-4 (May 6-8, 1959).

Industry in general, and the military in particular, are currently greatly handicapped in their ability to implement or mechanize complex data-handling operations both by relatively low dependability and by high cost of complex systems. At the same time, data-handling capability and, hence efficiency, are limited by slow switching speeds and large transmission delays found in equipments of normal size. The bulk components employed in present-day solid state production items appear to present large barriers to the reduction of transmission delays, automation of fabrication, and progress in system dependability. Some examples of functional components, and the processes involved in their production, are discussed.

Handling Identifiers as Internal Symbols in Language Processors, F. A. Williams, *Communications of the Association for Computing Machinery*, **2**, No. 6, 21-24 (June, 1959).

To reduce the lengthy symbol table manipulations which are connected with the translation of programming languages to machine languages, the few symbols chosen by a programmer from the sets of possible symbols are mapped into a smaller, more easily handled set. This smaller set is machine-oriented to facilitate processing. Communication with the programmer is by the programmer-oriented symbols.

He³-He⁴ Thermal Rectifiers, R. L. Garwin and H. A. Reich, *Supplemental Bulletin of the International Institute of Refrigeration, Commission 1*, 83-89 (Annex 1958-1).*

Devices for the unidirectional passage of heat have been constructed in a simple fashion using the heat-flush in He³-He⁴ solutions. By careful attention to the Kapitza film resistance we have produced heat rectifiers with a forward impedance of 1°K/watt at ~1.5°K and a back-impedance 10⁴ as large. These devices depend at high temperatures on a difference in geometry at the two ends. At one end of the tube an extra volume is provided so that the He³ may hide out of the path of the heat flow, while at the other no such space exists. At the lower temperature they depend on the gravitational convection effect proposed by Fairbank¹ et al. The performance of these rectifiers has not been investigated below 1°K, but they are very useful for the high-temperature end of a continuously cycling adiabatic demagnetization refrigerator.

*For period April through June, 1958.

¹W. M. Fairbank, *Proc. He³ Symposium*, Ohio State University, August 1957.

Human Factors Engineering at IBM, A. H. Schroeder, *American Medical Association Archives of Industrial Health*, **19**, No. 3, 283-287 (March, 1959).*

The paper discusses how the human factors engineering program is organized and implemented at IBM, and why it is considered an important program. Details are given of the techniques used to gather and evaluate data. Starting with the over-all task analysis, the tools of operator opinion, job sampling, motion pictures, and the critical incident technique are described, and examples of their application are given.

*For the period January through March, 1959.

Increasing Reliability by the Use of Redundant Machines, D. E. Rosenheim and R. B. Ash, *IRE Transactions of the Professional Group on Electronic Computers, EC-8*, No. 2, 125-130 (June, 1959).

The improvement of reliability and availability through redundancy of entire machines, rather than of components, is investigated. An attempt is made to break down the cost of operating a digital computer, and to determine the relationship between cost and system failure. Three specific cases are discussed:

Case 1: Where n machines are operated independently, processing the same input data. The output is taken from a single one of them; if this machine fails, the output is promptly switched to a machine which is operating properly. As soon as repairs can be completed, the machine which had failed is returned to operation. System failure occurs only when all n machines are in the failed condition at the same time. A penalty cost is assessed for system failure, this cost being proportional to the system down-time.

Case 2: Where n machines are operated as in Case 1, except that any machines which fail are not returned to operation until the beginning of the next operating period. Penalty cost for system failure is assessed in the same way as in Case 1.

Case 3: Where n machines are operated as in Case 2, but where the penalty cost for system failure is a fixed amount and is independent of the resulting down-time.

Influence of Substrate Processing on the Magnetic Properties and Reproducibility of Evaporated Nickel-Iron Films, K. H. Behrndt and F. S. Maddocks, *Journal of Applied Physics*, Supplement to Vol. 30, No. 4, 276S-277S (April, 1959).

The properties of evaporated nickel-iron films, deposited on substrates cleaned with detergent only, were observed to vary widely from one evaporation run to another and even within a run. This erratic variation is believed to be due partially to inhomogeneities in the surface structure of the substrates. Several other substrate cleaning techniques were evaluated for their effectiveness in reducing this variation in film properties. As a result, both wall motion and rotational threshold have been lowered, and the average percentage variations of the magnetic properties have been considerably reduced. Because of the resulting improvement in film reproducibility, it has been possible to verify the predicted dependence of domain-wall coercive force on film thickness, even for films which had been deposited in separate evaporations.

On the Magnetic Anisotropy in Manganese-Iron Spinel, R. F. Penoyer and M. W. Shafer, *Journal of Applied Physics*, Supplement to Vol. 30, No. 4, 315S-316S (April, 1959).

The magnetic anisotropy energy is measured as a function of temperature in eleven single-crystal compositions corresponding to $Mn_xFe_{3-x}O_4$, where x is varied from 0.00 to 1.90. The interesting features observed are as follows.

(1) Small manganese concentrations in magnetite ($x=0$) are shown to decrease the temperature of the "isotropy point" known to exist in magnetite at low temperatures.

(2) An unexpected variation is shown in the temperature dependence and magnitude of the anisotropy energy in the $x = 0.4$ to 1.0 composition region.

(3) The anisotropy energy in the composition region between $x = 1.0$ and 1.8 is semiquantitatively shown to be related to cubic crystalline field splitting of the energy levels of ferric ions.

(4) A large planar anisotropy is measured in a crystal composition given by $x = 1.90$ and is discussed in terms of the expected tetragonal nature of trivalent manganese.

Magnetic Annealing of Yttrium Iron Garnet, B. A. Calhoun, *Journal of Applied Physics*, Supplement to Vol. 30, No. 4, 293S-294S (April, 1959).

At -195°C the hysteresis loops of certain yttrium iron garnet cores are strongly affected by a large magnetic field applied as the cores are cooled from room temperature. In order for this magnetic annealing effect to occur, the dc resistivity at room temperature must be less than 10^9 ohm-cm. The hysteresis loops, permeability and pulse response of these cores have been measured at -195°C . The magnetic behavior of the annealed cores at this temperature can be explained qualitatively by assuming that the domain walls do not move under the influence of magnetic fields less than a critical value.

Millimicrosecond Switching Properties of Ferrite Computer Elements, W. Lee Shevel, Jr., *Journal of Applied Physics*, Supplement to Vol. 30, No. 4, 47S-48S (April, 1959).

An examination of the switching properties of square-loop ferrites is presented. Switching times have been studied over the range 5 μsec to 10 $\text{m}\mu\text{sec}$. The switching parameters, threshold field and switching constant, have been studied as a function of temperature and of ceramic processing. The plot of inverse of switching time versus applied fields displays three nearly linear portions, for which the slopes vary by a factor of from two to ten. The inverse slope, known as the switching constant of the material, has therefore three values; this is interpreted as indicating three mechanisms to be responsible for the process of flux reversal, each mechanism being dominant over a certain region of the switching curve. These mechanisms are proposed as being wall motion, incoherent rotation, and coherent rotation. A model allowing a coherent rotation process is proposed. Data are presented for several ferrites which have widely varying properties.

Miniaturized Digital Computing Systems, F. A. Foss and R. E. Lyons, *Astronautics*, 4, No. 5, 42-43, 54-60 (May, 1959).

This article describes the problems in miniaturizing a large-capacity, high-speed digital computer to allow precise control of advanced aircraft and space vehicles. The major design areas of DINABOC (Digital Navigational Bombing Computer), which IBM developed to determine the feasibility of placing a digital computer into an aircraft, are discussed and the computer characteristics described. The following problem areas and their solutions are discussed:

- Computer memory
- Floated read-write heads
- Weight and volume
- Conversion equipment
- Human operator in the loop
- Reliability.

How the DINABOC basic technology has contributed toward a more advanced computer is reviewed. Future computers, using cryotons and ferromagnetic devices are discussed, along with means for improving reliability using "triple modular redundancy."

A New High-Speed Core Memory, E. C. Schuenzel, *The Ferroxcube Engineer*, 1, No. 1, 6-7 (Spring, 1959).

The need for higher speed, random-access memories for data-processing equipment has stimulated the development of

ferrite materials and devices, resulting in ferrite core memories up to five times faster than those previously available. As an example, the core storage unit used in the IBM 7090 Data Processing System is described. This memory has a cycle time of 2.4 μ sec, primarily because of improved ferrite toroids, 0.030"ID $\times$ 0.050"OD in size, and with switching speeds $\leq$ 0.43 μ sec.

A Note on Syntactic Symmetry and the Manipulation of Formal Systems by Machine, H. Gelernter, *Information & Control*, 2, No. 1, 80-89 (April, 1959).

In the past few years, digital computer programs that depart from the traditional numerical computation and data processing for which these machines were conceived have become increasingly commonplace. In many of these programs, the computer is called upon to manipulate a complex, formal logistic system as a tool to implement the solution of a problem. This paper is concerned with the problem of efficient machine manipulation of formal systems in which the predicates display a high degree of symmetry. The solution to the problem, embodied in a theorem and a rule of syntactic symmetry, is specified in Section I. The theorem is in fact a metatheorem concerning formal systems and is used in the synthesis of proofs. On the other hand, the rule is an invaluable aid in the search for a proof by the so-called analytic method. In Section II, the set of all syntactic symmetries for a given set of formulas is construed and displayed in a form conducive to minimum programming effort for a computer.

Off-Campus Resident Graduate Programs at Company Centers, J. R. Lakin, *IRE Transactions on Education*, E-2, No. 2, 51-52 (April, 1959).

The objectives of the jointly-sponsored IBM-Syracuse University graduate program are reviewed, and the program is described. The program was begun in 1952. Its history is outlined and the future of such a program is discussed.

Parametrische Resonanz und parametrische Verstärker (Parametric Resonance and Parametric Amplifiers), A. P. Speiser, *Scientia Electronica*, Band V, Heft 2, 61-75 (June, 1959).

Parametric resonance has become increasingly important in electrical engineering. Electronic computers based on this phenomenon have successfully been put into operation, and interest in microwave amplification has greatly increased.

Precision Molded Plastics Parts, R. M. Bell, *Plastics World*, 17, No. 6, 10-12 (June, 1959).

The use of plastics to mold precision parts is becoming an important technique, both economically and technically. Particularly with the very complex shapes required by business machines, plastics can produce results virtually impossible with other materials. This article cites several examples of the successful use of precision molding to form intricate parts within close tolerances.

A Procedure for the Diagonalization of Normal Matrices, H. H. Goldstine and L. P. Horwitz, *Journal of the Association for Computing Machinery*, 6, No. 2, 176-195 (April, 1959).

The so-called Jacobi Procedure is extended to the case of normal matrices. A stable iterative procedure is described utilizing plane unitary transformations for such matrices which yield both the characteristic values and their associated vectors. Generally, the technique consists of minimizing at

each stage the sum of the squares of the off-diagonal elements of the given matrix. There is one case, however, in which this leads to no improvement, i.e., the lowest value for the change is non-negative. In this case, it is shown that a convergent procedure is still possible.

Ring Gives Even Vacuum Deposition, K. H. Behrndt, R. A. Jones, and D. M. Hart, *Electronics*, 32, No. 24, 84-87 (June 12, 1959).

This article consists of portions of two papers by Kingston Engineering people. The papers are entitled: "A Comparison between the Evaporation Characteristics of a Crucible and Ring Source," by K. H. Behrndt and R. A. Jones; "A Demountable Glass Vacuum System Using Electron Bombardment in the Vacuum Deposition of Ferromagnetic Films," by D. M. Hart.

Rotational Hysteresis in Thin Films, J. R. Mayfield, *Journal of Applied Physics*, Supplement to Vol. 30, No. 4, 256S-257S (April, 1959).

Rotational losses in films of nickel-iron have been studied over a wide range of frequencies and applied fields by measuring the torque exerted on the films by a rotating magnetic field. Rotational frequencies from 10 cps to 1 mc and field intensities from 0 to 100 oe were used with films ranging in nickel content from 70% to 90% and in thickness from 400 Å to 12,000 Å.

For applied fields less than 2K/M, the observed losses agree well with the theory of rotational hysteresis in materials with uniaxial anisotropy. When combined with standard torque or hysteresis loop data, these losses yield information regarding the uniformity of the effective anisotropy within the sample. In fields considerably greater than 2K/M the loss per cycle for any given sample is found to be independent of the rotational frequency. According to the analysis of Gilbert and Kelly, in which the high-field losses are proportional to the intrinsic damping parameter, these experimental results imply an inverse frequency dependence of the damping parameter. However, correlations between the high-field and the low-field losses, as well as the results of certain auxiliary experiments, indicate that the high-field losses are of essentially the same origin as the low-field losses and are not a measure of the intrinsic rotational damping.

RTA Computer, T. E. Digan, *Third National Convention of Military Electronics*, 215-218 (June 29 to July 1, 1959).

The Reliability Test Assembly (RTA) was developed and constructed to establish advanced concepts in solid-state computer design. Major emphasis was given to the areas of circuits, logic, power supplies, packaging, and error detection. The machine, which utilizes 20,000 transistors, has a cycle time of 1.6 μ sec. This is indicative of the computational speed and capacity of the machine. It is intended to perform approximately 400,000 instructions per second, with a 540 m μ sec add-time. The machine incorporates extensive air-detection logic intended to provide close to 100% air-detection capability.

Secondary Effect of Diode Leakage in Selection Matrices, M. Collins and I. N. Saxe, *Electronic Design*, 7, No. 12, 46-49 (June 10, 1959).

In large, single-level selection matrices there is leakage current through the many "cut-off" diodes. In matrices using germanium diodes the total leakage current is often more than can be supplied by an economical driving circuit. With

silicon diodes the leakage currents are negligible and single-level circuits can sometimes be used. However, the diode and line capacitance may cause the voltage rise and/or fall time to be excessive. Even with multiple-level switching, the circuit will continue to be too slow in some special cases. A simple modification to multiple switching circuits which will guarantee consistent operation in both germanium and silicon matrices is described.

The Share 709 System: Programming and Modification, Irwin D. Greenwald,* and Maureen Kane, *Journal of the Association for Computing Machinery*, **6**, No. 2, 126-133 (April, 1959).

The SHARE 709 System permits the programmer to communicate with the machine and with itself entirely in a symbolic language. The compiler specifications including instruction format, pseudo-operations, program library, and system and programmer-macro operation generators are described. The methods for handling symbolic input/output, symbolic debugging, and symbolic modification of a compiled program are discussed.

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Standards and Shop Practice at IBM, H. G. Atwater, *Proceedings of the Standards Engineers' Society*, **1958**, 50 (May, 1959).

The necessity of standardized drafting and drawing practices are discussed for IBM's decentralized manufacturing engineering operations. The relationship and similarity of IBM Standards and other adopted standards, such as ASA and ASMA Standards, is reviewed. The implementation of standards and shop practices at IBM is described. Basic drawing rules are listed, and the main points of the Vendor Guide are outlined.

Structural and Magnetic Properties of Permalloy Films, J. C. Lloyd and R. S. Smith, *Journal of Applied Physics*, Supplement to **Vol. 30**, No. 4, 274S-275S (April, 1959).

The wall-motion coercive force H_c and the rotational coercive force H_r of thin electroplated nickel-iron films are studied as a function of film roughness. Three types of roughness are considered: the first, periodic with a wavelength large compared to a domain wall width and an amplitude small compared with the film thickness; the second, of the order of size of a domain wall; and the third, a substrate roughness that is large compared to the film thickness.

H_c was found to be related to film thickness according to $H_c = CsD^n$. This observation was predicted by Néel, except that his assumption of a form of roughness only of the first kind led to a single value for n of $-4/3$. Electron micrographs showed that roughness of the second kind increased with film thickness, indicating that n depends on this factor. Roughness of the third kind, as introduced by unidirectional polishing, results in an increase of Cs , while n and H_r are not affected. This third type of roughness was observed to orient the easy magnetic axis parallel to the polishing grooves.

Study of Ferroelectric Transitions of Solid-Solution Single Crystals of KNbO_3 - KTaO_3 , S. Treibwasser, *The Physical Review*, **114**, No. 1, 63-70 (April 1, 1959).

Methods of preparation and results of measurements of the dielectric constant of solid-solution single crystals of KNbO_3 and KTaO_3 are presented. Data are given for the composition range 0-80 mole percent KTaO_3 in the interval -180° to 450°C . It is found that all of the crystals studied show Curie-

law behavior of the dielectric constant in the paraelectric state. The data indicate that the paraelectric-to-ferroelectric transition, which is first order for pure KNbO_3 , becomes second order at a concentration of approximately 55 mole percent KTaO_3 . Analysis of the results in terms of Slater's model of ferroelectricity in a perovskite lattice leads to the conclusion that the dependence of the Lorentz correction on volume plays a major role in determining the ferroelectric behavior. Ionic polarizabilities and their dependence on volume are also discussed.

A Symbol Coder for Automatic Documenting, M. D. Grems and Malcolm Post,* *Computing News*, **7**, Nos. 8 and 9, 147-9 to 18 and 148-15 to 19 (April 15, 1959 and May 1, 1959).

A Symbol Coder simultaneously documents a scientific problem and machine codes the problem as input to a digital computer. Documenting a scientific problem consumes a considerable portion of the total elapsed computing time. Part of this elapsed time is spent on transcribing from man's language. This time can be shortened by introducing an input-output device called a Symbol Coder. A Symbol Coder accepts, recognizes, and returns approximately 350 coded symbols and keyboard controls such as: the Arabic alphabet, the Greek alphabet, punctuation marks, brackets, Boolean operators, signs, digits, vertical or horizontal full-spacing and half-spacing, vertical paper control, upper case or lower case shift, and tab keys.

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Thin Magnetic Films, W. E. Proebster, S. Methfessel, and C. O. Kinberg, *UNESCO/NS/ICIP*, **K-2** (June 20, 1959).

A survey is made of the state of the art in thin magnetic films, particularly on magnetic films of the Permalloy type. Special emphasis is placed on switching behavior, and some new results of the Zurich magnetic film research are given. Reference is made to known and potential applications.

Zener Diode Curve Tracer, C. C. Packard and V. A. Cordi, *Electronics*, **32**, No. 19, 76-79 (May 8, 1959).

This article describes a Zener diode curve tracer and presents a brief discussion on suggested applications. The Zener diode tracer provides an accurate and rapid method of determining Zener diode characteristics. Suggested applications include determination of Zener dynamic impedance, detection of avalanche noise, definition of temperature coefficient, and application to the large-scale inspection testing of Zener diodes.

Ueber die Leistungsfähigkeit einiger statischer magnetischer Speicherverfahren (The Performance of Some Static Magnetic Storage and Driving Methods), H. P. Schlaeppli, *Nachrichtentechnische Fachberichte*, **NTF 14**, 12-20 (May, 1959).

The fundamental speed limitations of the classical coincident current storage scheme are outlined in terms of the switching behavior of ferrite cores. Measurements of voltage induced or of current drawn by cores switching at constant voltage or at constant current, respectively, are described and analyzed. It is shown that the model of Van der Heide et al does not fit the results.

A review is made of a number of published schemes by which speed is gained by not relying on a selection ratio limited as usual to 2:1. One of them, the multiple-coincidence principle due to Minnick and Ashenhurst, is treated in some

detail; the switching problems at the periphery of the storage array, which are peculiar to this scheme, are mentioned and practical solutions are proposed. In particular, a novel magnetic-core switch is described which permits inhibition of transmission of a write-pulse following a read-pulse, which is essential in multiple-coincidence stores. This core switch has a number of other advantages that render its use advantageous in conventional core stores as well.

A Unified Approach to the Theory of Sampling Systems, R. E. Kalman* and J. E. Bertram, *Journal of the Franklin Institute*, **267**, No. 5, 405-436 (May, 1959).

A new method is shown for the analysis of sampling (or sampled data) systems. Unlike methods currently in use, it is not necessary to assume that the sampling operations are synchronous, performed at constant rate, and representable by means of an impulse modulator. Several different types of sampling operations are considered in detail, with the analysis proceeding similarly in each case. The paper concludes with a brief study of the stability of sampling systems and a generalization of Floquet's theorem.

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X-Ray Measurement of Microstrains in Germanium Single Crystals, L. P. Hunter, *Journal of Applied Physics*, **30**, No. 6, 874-884 (June, 1959).

The high intensity of the anomalously transmitted x-ray beam depends upon the coincidence of the nodal planes of the x-ray wave field with one set of atomic planes within the crystal when the crystal is set for Laue diffraction. If there is any structural defect within the crystal which causes some of the atoms of the crystal to deviate from their normal location in perfect planes, these atoms will no longer be at the nodes of the x-ray wave field, and by their absorption they will reduce the transmitted intensity.

The present paper shows how this effect may be employed to measure the amount of microstrain present in nearly perfect germanium crystals. It is found that some apparently dislocation-free crystals show a greater degree of crystalline imperfection than crystals with a finite dislocation count.

Zahlen, Verschieben und Verknüpfen mit Magnetkernen (Counting, Shifting and Local Operations with Magnetic Cores), C. O. Kinberg, *Nachrichtentechnische Fachberichte*, NTF **14**, 5-11 (May, 1959).

The use of magnetic cores with square-loop characteristics for performing logical operations is discussed. It is demonstrated how various effects displayed in the hysteresis loop can be utilized to realize control operations. Three principles of operation are demonstrated with examples: the coincident-current principle, use of the current-limiting properties, and operation with quantized fluxes. The paper discusses advantages and limitations of the circuits described.