Technical Papers by IBM Authors Published Recently in Other Journals

Achieving Subnanosecond Delays Using Feedback with the Current Switch, L. Weiss and T. S. Jen, *IEEE Journal of Solid-State Circuits* **SC-1,** No. 2, 86-94 (December, 1966).

Beginning with the basic current switch, the application of feedback is explored to achieve faster switching speeds with greater fanpower. This paper qualitatively describes the evolution of an integrated circuit that requires only one power supply and has, through the introduction of time-dependent negative feedback, achieved subnanosecond propagation delays with the ultimate speed limited primarily by the device used, the component tolerances, and the range of the operating environment. Higher input impedance, better stability and noise tolerance are also by-products of the circuit. From this analysis, a general logic family for high-speed computer applications may be derived.

Addendum to "Stronger than Uniform Convergence of Multistep Difference Methods," B. Dejon, *Numerische Mathematik* **9,** 268 (1966).

This paper fills a gap which remained in "Stronger than Uniform Convergence of Multistep Difference Methods," *Numerische Mathematik,* **8,** 29 (1966), namely to show that from the stability of the homogeneous difference operator on the particular basis chosen in the solution space, one can infer its stability on the whole solution space.

Application of the Ultrasonic Resonance Technique to Inspection of Miniature Soldered and Welded Junctions, R. G. Bayer and T. S. Burke, *Materials Evaluation* **25,** No. 1, 20-24 (January, 1967).

This article describes an exploratory study concerned with the application of the ultrasonic resonance technique of bond testing to miniature soldered and welded junctions. The study indicates that the technique can be applied to such cases.

Biased Resonance Circuits for Electro-Optic Digital Deflectors,† C. F. Haugh, *Applied Optics* **5,** No. 11, 1777 (November, 1966).

A number of circuits for electro-optic digital deflectors is presented. These circuits minimize power dissipation by utilizing the novel technique called biased resonance. This technique is based on the coincidence of zero points of a raised cosine and its derivative. Test results for one circuit that operated at 2200 volts, with a load capacitance of 200 pF, at greater than 100 k-baud width are reported. Dissipation for this breadboard model was 10 watts. Other circuits are shown; their advantages and disadvantages are discussed. Also discussed are some future switching device requirements.

† Work supported in part by the United States Army Electronics Command, Contract No. DA-28-043-AMC-01434 (E).

Bicyclo [2. 1. 1] Hexane Preparation and Photochlorination, R. Srinivasan and F. I. Sonntag, *Journal of the American Chemical Society* **89,** No. 2, 407-410 (January 18, 1967).

A simple method for the preparation of bicyclo[2.1.1]-hexane, which is based on the mercury of ($^3P_1$) sensitized isomerization of 1,5-hexadiene, is described. Photochlorination of bicyclo[2.1.1]-hexane in the gas phase, in solution in carbon tetrachloride or trifluortrichlorethane, or as pure liquid, led to more than 95 per cent of a single monochloride in good yield. Evidence to show that this compound is 2-chloro-bicyclo[2.1.1]-hexane is presented. Further chlorination gave 2.2-dichloro-bicyclo[2.1.1]-hexane and trans-2,3-dichloro-bicyclo[2.1.1]-hexane as the major products.

Computer-Aided Design for Integrated Circuits, J. S. Koford,* P. R. Strickland, G. A. Sporzynski and E. M. Hubacher, *Graphic Science* **9,** No. 1, 18 ff (January, 1967).

This paper describes a computer program that utilizes a graphic data processing system to aid in the design of mask artwork for hybrid integrated circuit modules of the type used in IBM System/360 Data Processing Systems. The system includes a small digital computer connected to a large-screen buffered display equipped with a light pen. A draftsman uses the light pen to assemble a circuit schematic on the display screen; simultaneously, a description of the schematic is entered into the computer memory. Thereafter, the draftsman can use the light pen to layout detailed artwork for fabrication on the circuit mask, subject to automatic checking against the stored schematic. When the layout on the display screen is complete, the corresponding mask artwork will be drawn by the computer via its digitally-controlled plotter. The graphical manipulations on the display screen, the automatic checking operations, and the control of the digital plotter are all part of a FORTRAN program that employs graphical subroutines to communicate with the light pen, display, and plotter.

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A Computer-Program System to Facilitate the Study of Technical Documents,† D. G. Bobrow,* R. Y. Kain,** B. Raphael, *** and J. C. R. Licklider, *American Documentation* **17,** No. 4, 186-189 (October, 1966).

The purpose of this paper is to describe a system, consisting of a digital computer and a computer program, intended for exploration of man-machine interaction and computer assistance to man in the study of technical documents. The computer and program system, which we call "Symbiont" because we hope to develop it into a truly symbiotic partner of the student, displays information to the student via the typewriter or the display screen.

Symbiont is an early stage of what we hope will be a continuing evolution. However, a sufficient set of functions has been implemented to lead us to take stock and gain experience in their use before modifying existing functions or adding new ones.

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The Contact Problem in Solid-Ink Printing, H. D. Conway* and R. R. Schaffer, *Experimental Mechanics* **7,** No. 1, 15-22 (January, 1967).

An analysis is made of the print-quality characteristics of multi-copy printing in which a rigid type font indents several layers of paper and carbon paper resting on a rigid platen. Particular attention is given to determining the contact-pressure distributions for two indenter shapes and for layers of various thicknesses. Stress distributions in the layers are computed and, using a stress-failure mechanism for solid ink, the stress distributions are found to agree well with optical-print density and reflectance measurements obtained from experiments.

* Cornell University and Consultant to IBM.

Contribution to the Computer Calculation of High Speed Plate Cams, W. Sakmann, *Konstruktion* **18,** No. 7, 278-283 (1966).

Some laws of motion are discussed. Graphs and simplified formulae are provided to determine cam parameters. A computer program is given to fabricate master cams on normal or numerical controlled milling machines. An analysis of dynamic and kinematic effects of cam motion, by varying the follower roller diameter on given cams, is also presented. The application of this method is illustrated by an example of a torque compensator.

Cost Estimating Becomes Less of an Art and More of a Science, J. F. Kelly, *Production* **58,** No. 6, 174-177 (December 1966).

Cost estimating is an important feature of the manufacturing process, and one in which consistency and accuracy can be critical features in business transactions. Increasing pressure on manufacturing facilities and a shortage of skilled estimators makes some form of automation necessary in this area. A computerized system of estimating which makes use of a "conversational" optical image terminal was developed to meet this need. Images are displayed on a screen, and the engineer can "talk" back and forth with the computer, entering information by means of a photosensitive light pen. There is real-time turnaround with documentation via an output typewriter. The manufacturing engineering task is accomplished in 20% of the time formerly required. The terminal is at present operating with a 1620 Mod II, but a link is planned with System/360 Mod 30 and up, on a multiple programming basis. The control or supervisor programs, developed by a scientific programming group, are written in a symbolic instruction language, while the processing programs which the engineer can develop to fit his own requirements employ FORTRAN. Estimating accuracy is predetermined and built into the computation logic of the program.

Crystal and Molecular Structure of a Chlorosulfonate of a Novel Cage Chlorocarbon, $C_{10}Cl_{11}SO_3Cl$, Determined by the Symbolic Addition Method,† Y. Okaya and A. Bednowitz,* *Acta Crystallographica* **22,** No. 1, 111-119 (January, 1967).

Hexachlorocyclopentadiene C_5Cl_6 dimerizes by action of $AlCl_3$ into an unusually stable chlorocarbon, $C_{15}Cl_{12}$. The configuration of the molecule has been studied by various physicochemical methods; thermal and dielectric studies on crystals, NMR, infrared and dipole moment measurements indicate that the molecule possesses a cage structure formed by two cyclopentane rings connected by four single bonds. Since $C_{10}Cl_{12}$ exhibits a disordered structure in the room temperature phase, a chlorosulfonate group was introduced onto one of the apex carbon atoms. The material crystallizes in the monoclinic system with $a = 16.75$, $b = 8.75_3$, $c = 14.45_9$, $\beta = 112.0°$; space group is $P2_1/a$. The crystal structure was determined by the symbolic addition method and refined by the least squares method. The basic cage structure is *trans* consisting of four cyclopentane and two cyclobutane rings, all of which are puckered. The correct chemical name of the chlorocarbon chlorosulfonate is undecachloro-10-pentacyclo [5.3.0.0^2, ^{6}.0^3, ^{9}.0^4, ^{8}] decane chlorosulfonate. The bond distances and angles in this fused ring system are discussed in detail.

† Research performed in part under the auspices of the U. S. Atomic Energy Commission.
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The Crystal Structure of Ammonium Acid o-Carboxybenzenesulfonate, $NH_4(C_6H_4COOH{\cdot}SO_3)$, Y. Okaya, *Acta Crystallographica* **22,** No. 1, 105-110 (January, 1967).

Crystals of ammonium acid *o*-carboxybenzenesulfonate crystallize in the orthorhombic system with $a=7.04_5\pm 0.003$, $b=10.53_5\pm 0.003$, $c=25.51_5\pm 0.005$ Å the space group is *Pcab*. The structure was determined by using three-dimensional intensity data collected on a computer-controlled diffractometer operated in a closed-loop manner by a stored data collection program in an IBM 1620 computer. The structure is ionic, consisting of ammonium ions and infinite chains of acid *o*-carboxybenzenesulfonate ions; the chains are formed by short O–H···O bonds of 2.64_0 Å from carboxyl groups to sulfonate groups through the *a*-glide planes perpendicular to the *b* axis. The locations of hydrogen atoms substantiate the chemical formula NH_4 $(C_6H_4 \cdot COOH \cdot SO_3)$ and the compound is named accordingly. The benzene ring is a slightly distorted hexagon with one relatively short C–C bond of 1.37_0 Å; the average of the remaining five C–C bond distances is 1.387 Å, and the average of the six angles is 120.0°. The carboxyl group makes an angle of 50.7° with the benzene ring. Other effects of steric hindrance include shifts of the sulfur atom and the carboxyl carbon from the benzene ring plane and also deviations of angles around the ring carbon atoms associated with the derivative groups from the normal value. Bond distances and angles in the carboxyl and sulfonate groups are normal.

Das paramagnetische Moment eines stromdurchflossenen Zylinders in einem longitudinalen Magnetfeld, (The paramagnetic moment of a current-carrying cylinder in a longitudinal magnetic field), H. Bross* and R. Jaggi, *Zeitschrift für Naturforschung* **21a,** No. 12, 2104-2105 (December, 1966).

The paramagnetic moment of a current-carrying cylinder in a longitudinal magnetic field is explained phenomenologically. Expressions in terms of the galvanomagnetic coefficients are given for three examples: cubic crystal, trigonal crystal, two-band model with spherical energy surfaces and energy-independent relaxation times.

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Development Trends of the Logic Devices of Electronic Computers, O. G. Folberth, *Elektronische Rechenanlagen* **8,** No. 4, 175-180 (1966).

The first part of the paper covers the present state-of-the-art of transistor technology and gives an estimate of the limits of this technology. Following this is a discussion of technologies where the transistor is not the basic element. Finally, some partially speculative ideas are presented concerning the future development particularly considering transistors at very low temperatures.

Diborane for Boron Diffusion into Silicon, M. C. Duffy, D. W. Foy and W. J. Armstrong, *Electrochemical Technology* **5,** No. 1-2, 29-33 (January-February, 1967).

A method for boron diffusion into silicon using B_2H_6 as the boron source is described. Surface concentration of 10^{17} to 10^{21} cm^{-3} were obtained by varying the B_2H_6 concentration in the gas stream. The effects of various diffusion parameters (time, temperature, concentration of reactants in the gas stream, and total gas flow rate) were investigated. Results include the effect of these parameters on surface concentration, borosilicate glass thickness, junction depth, and sheet resistance uniformity and reproducibility.

The Dynamic Response of Thin Membranes by the Moiré Method, W. E. Nickola, *Experimental Mechanics* **6,** No. 12, 593-601 (December, 1966).

This investigation considers the suitability of the moiré method as a technique for determining the dynamic response of thin membrances. Specimen preparation, test apparatus and test results are reported for a circular and a rectangular membrane. The applicability of the method for measuring transient as well as periodic behavior is discussed. Theoretical and experimental values are compared for the case of periodic response.

Effects of MTF Shapes on Preferences among Typewritten Reproductions, C. K. Clauer and R. L. Erdmann, *Photographic Science and Engineering* **10,** No. 6, 326-333 (November-December, 1966).

Comparative preferences of typewritten reproductions were determined for original and third carbon documents with the reproducing modulation transfer function (MTF) shape and spatial frequency scale factor as independent variables by using four different ranking tasks. Rank discrimination was excellent with each of the MTF shapes for scale factor steps of about 10 percent. Considerable variability resulted when all five MTF shapes were compared at equal scale factors. Comparisons between the two extreme MTF shapes reversed as scale factors were increased. The original document scale factor equivalents of the carbon document scale factors were also determined for each MTF shape.

Experimental Studies in Speaker Verification Using an Adaptive System, K. P. Li, J. E. Dammann and W. D. Chapman, *Journal of the Acoustical Society of America* **40,** No. 5, 966-978 (November, 1966).

This paper describes an investigation of the capability of a two-level adaptive linear threshold element (LTE) system to perform speaker discriminations. The study also includes an investigation of discriminating a speaker from an unknown population. The problem has been confined to the verification of an utterance as that of an expected informant. The environment of the experiments is discussed, and the experimental system is described. At the first level LTE, four different kinds of training have been developed for effective transformation and data reduction. At the second-level LTE, different training conditions and different decision processes are investigated and evaluated. Over 90% accuracy is obtained in separating a known speaker from impostors.

Factors to Consider in Selecting and Using Lenses in Optical Systems, A. D. Bates, *Proceedings of Seminar on Photographic Systems for Engineers, Society of Photographic Scientists and Engineers,* pp. 103-129 (May, 1966).

This tutorial discussion, directed to engineers with a general understanding of optical principles, emphasizes interactions among variables that affect lens performance in optical systems.

From Engineering Notebook to Technical Note, D. E. Olson, *Technical Communication* **14,** No. 1, 22-23 (First Quarter, 1967).

Making new technology available while it is still new is a problem that has plagued the technical community. Now comes an innovation that allows publication departments to make a more meaningful contribution to the rapid advances of their engineers. It is done through the "technical note." This note is prepared by the publications group and is one-page (printed on both sides) report about a new process, technique, or development. By-lines are not used but the engineer's name is listed as the person to contact for further information. The technical note gets the word out on new technology while it's still new.

Graphical Method for Obtaining the Natural Frequencies of a Three-Degree-of-Freedom System, H.-C. Wang, *Journal of the Acoustical Society of America* **40,** No. 5, 1081-1082 (November, 1966).

An analogy between an undamped three-degree-of-freedom vibration system and a three-dimensional elastic body is discussed. The approximate natural frequencies of the system are obtained graphically using the Mohr circle technique, which is applied for determining the principal stresses of an elastic body.

Integrated Computer Circuits—Past, Present, and Future, R. A. Henle and L. O. Hill, *Proceedings of the IEEE* **54,** No. 12, 1849-1860 (December, 1966).

Since 1960, computer circuits have evolved from discrete components to hybrid or integrated circuits, allowing an order of magnitude improvement in cost and reliability. Continuation of these trends points toward the availability of large-scale integration, with 100 or more circuits per chip, by 1970. Timely achievement of this potential improvement depends on increased interaction between system and device designers and reduction of costs associated with engineering changes and field stocking. The dominant role of the bipolar device is presently being challenged by the field effect device. Optical and bulk effect devices may have future application in the digital area.

Measurement of Picosecond Laser Pulse Widths, J. A. Armstrong, *Applied Physics Letters* **10,** No. 1, 16-18 (January 1, 1957).

The special symmetry properties of second-harmonic generation at the surface of a GaAs crystal are used in a technique which measures the shape of the fast pulses from a mode-locked Nd-glass laser. The pulses studied were found to have a full width at half power of between 4 and 6 picoseconds. The technique is capable of measuring pulse widths at least as short as 4×10^{-12} sec.

Measurement Techniques for Cathode-Ray Tubes, R. E. Hall, *Electronic Engineer* **26,** No. 1, 86-90 (January, 1967).

Cathode-ray tubes are widely used in industry and it is important that the engineer be familiar with some of the methods used in testing them. Methods for measuring the spot size, light output, spectral characteristics, phosphor aging, and phosphor noise are described.

The scanned double-slit is used to measure spot size. Light output power is obtained with a wideband thermopile. A grating monochromator with a photomultiplier (PMT) detector is used for spectral characteristic measurements. For phosphor aging, a small area on the screen is aged and compared to light output from the surrounding unaged area. Phosphor noise measurements are made by scanning a finely focused spot over a small length of the phosphor, displaying the output on an ocilloscope, and analyzing the trace to obtain the ratio of ac modulation of the light output to the average dc value.

Metastable Evaporated Thin Films of Cu-Ag and Co-Au Alloys, S. Mader, A. S. Nowick,* and H. Widmer,** *Acta Metallurgica* **15,** No. 2, 203-214 (February, 1967).

Metastable solid solutions of the Cu-Ag and Co-Au systems have been prepared by "vapor quenching," i.e. simultaneous vacuum evaporation of the two components onto a substrate held at liquid nitrogen temperature. The films so obtained are studied by resistivity measurements and by transmission electron microscopy and diffraction. The pure metals and dilute alloys are crystalline as deposited, while concentrated alloys (35-65% Ag for Cu-Ag and 25-65% Au for Co-Au) are amorphous when deposited on an amorphous substrate, but crystalline when deposited onto a pure metal. The resistivity in the as-deposited state is almost independent of composition, but the annealing behavior of the various compositions is quite different. In particular, the high resistivity of the amorphous alloys anneals out in two distinct steps. In the first step (near 370 °K for Cu-Ag and 410°K for Co-Au) a transformation from amorphous to a metastable single-phase crystalline solid solution occurs in a narrow temperature range. The second step, which is broader, involves the transformation to the equilibrium two-phase state. Structures at various stages of anneal are studied in detail by transmission microscopy and diffraction. A qualitative discussion is given of the reasons for the occurrence of the amorphous structure, for its relatively high metastability, and for its transformation first into a metastable single-phase crystalline structure.

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Metastable Evaporated Thin Films of Cu-Ag and Co-Au Alloys: II, Kinetics of the Transformations, S. Mader and A. S. Nowick, *Acta Metallurgia* **15,** No. 2, 214-222 (February, 1967).

The kinetics of the two stages in the transformation of an amorphous vapor-quenched alloy to the equilibrium two-phase state are studied in detail. The first stage, which involves the crystallization of the amorphous phase, is interpreted in terms of the classical theory of nucleation and growth. For Co-Au, the measured activation energy of 1.40 eV, is made up of a diffusion activation energy of 1.31 eV and a term $W^*/4 = 0.09$ eV, where W^* is the barrier height for nucleation at the transformation temperature (430°K). The corresponding numbers for Cu-Ag are 1.20, 1.12 and 0.08 eV (at 370°K). With the aid of thermodyamic data for the Cu-Ag system, a value of 115 ergs/cm^2 for the surface energy of the amorphous-crystalline interface is obtained. This agrees with values derived from the solidification of small droplets. The second stage can be interpreted as a spinodal decomposition process. It shows very nearly first order reaction kinetics, with activation energies of 1.65 eV for Co-Au and 1.43 eV for Cu-Ag, and a frequency factor $\nu_0 \sim 10^{12}$ sec^{-1}.

Molecular Properties Which Depend on the Square of the Electronic Coordinates; H_2 and NNO, A. D. McLean and M. Yoshimine, *Journal of Chemical Physics* **45,** No. 10, 3676-3681 (November 15, 1966).

Relationships between the diamagnetic susceptibility, diamagnetic anisotropy, rotational magnetic moment, molecular quadrupole moment, and computed expectation values of (r^2), (p^2), (z^2) for linear closed-shell molecules are given. A promising way of obtaining molecular quadrupole moments by combining theory and experiment is pointed out. Applications are made to H_2 and N_2O. New results are that the sign of the rotational g factor for N_2O is negative and the diamagnetic anisotropy of this molecule is -13×10^{-5} a.u.

A Note on the Quantum-Statistical Brillouin-Wigner Perturbation Theory, P. Erdös and K. P. Jain, *Physics Letters* **24A,** No. 2, 123-124 (January 16, 1967).

The Brillouin-Wigner form of quantum statistical perturbation theory is developed. This gives a better convergence to

expansions used to calculate the thermodynamic functions of many-particle systems. The method is demonstrated on the linked-cluster expansion for the free energy of a system of conduction electrons interacting with a magnetic ion.

On the Application of the Process of Equalization of Maxima to Obtain Rational Approximation to Certain Modified Bessel Functions,† I. Gargantini, *Communications of the ACM* **9,** No. 12, 859-863 (December, 1966).

The second Remes algorithm as originally established for polynomials, may converge or not when the approximating functions are rational. However, the few results known in this domain show how efficient the algorithm can be to obtain approximations with a small error, much more than in the polynomial case, in which the best approximation can be very nearly approached directly by a series development. The aim of this paper is to investigate the limitations of the applicability of certain extensions of the algorithm to the case where the approximations are rational as well as to present some numerical results.

† The work reported in this paper was started when the author was at Euratom, C. C. R., Ispra, Italy.

Packaging a Flyable Breadboard, R. W. Hinkley, *Electronic Packaging and Production* **7,** No. 1, 159-164 (January, 1967).

A flying breadboard packaging design is described. The flying breadboard is compact yet affords flexibility in wiring, and it was designed to operate in the environments of altitude, vibration, and humidity associated with airborne equipment. The packaging technique enables a mechanical designer to start final unit packaging layout by knowing only "ball park numbers" for the quantity and types of electrical components required.

Photoconductivity and Drift Mobilities in Single Crystal Realgar (As_4S_4), G. B. Street and W. D. Gill, *Physica Status Solidi* **18,** No. 2, 601-607 (1966).

The photoconductivity and carrier mobilities of synthetic crystals of realgar (As_4S_4) have been investigated. A sharp increase in the photoresponse at short wavelengths is attributed to an energy gap of (2.40 ± 0.05) eV. An additional weak peak in the photoresponse at 600 nm is due to free hole formation at defect or impurity sites. Electron and hole mobilities have been measured over the temperature range from 250 to 470°K. At 25°C the hole mobility was 12 cm^2/V-sec and the electron mobility 2×10^{-2} cm^2/V-sec. The hole transport can be described by band conduction controlled by lattice scattering. The electron changes are consistent with an intermolecular hopping process which at low temperatures transports to a trap-controlled mechanism.

Polycarbonate Flexure Holds Self-Aligning Typeface, F. C. Pexton, *Design News* **22,** No. 1, 110-111 (January 18, 1967).

A problem involving typeface alignment was solved through the design of a molded polycarbonate character support wheel with a thin rib support section. The ¼-in.-wide by 5/16-in.-thick characters are held by a 1/32-in.-thick by ¼-in.-thick wide rib. This thin section aligns type to the printing surface but withstands printing pressure.

Preparation and Properties of Pyrolytic Silicon Nitride, V. Y. Doo, D. R. Nichols and G. A. Silvey, *Journal of the Electrochemical Society* **113,** No. 12, 1279-1281 (December, 1966).

Silicon nitride has very attractive electrical, physical, and chemical properties which are of great interest for microelectronic devices. Until recently, most methods that have been reported in the literature produce silicon nitride in the form of powder, needles, ribbons, or flakes. Recently, Sterling and Swann reported that continuous films of silicon nitride have been obtained. A new pyrolytic method for preparing pinhole-free continuous silicon nitride film is described. Films have been successfully prepared in the temperature range of 750°-1100°C. Some physical and chemical properties of those films are summarized.

RF Sputtering of Insulators, P. D. Davidse and L. I. Maissel, *Transactions of the Third International Vacuum Congress* **2,** pp. 651-655 (1966).

The deposition of insulating thin films by reactive sputtering has been practiced for many years. The newly developed technique of radio frequency sputtering allows the direct sputtering of virtually any insulating material.

This paper discusses in detail the conditions and apparatus necessary to optimize both the deposition rate and film quality. For example, it has been found that a superimposed magnetic field enchances and stabilizes the glow to a considerably greater extent than under comparable DC conditions.

Insulators sputtered to date include quartz, alumina, mullite, boron nitride and a variety of glasses. Deposition rates up to 2000 Å/min have been obtained and a thickness uniformity of about 1 per cent over an area 4 in. diameter has been achieved.

Read Only Storage in Digital Computers, von H. Painke, *Elektronische Rechenanlagen* **8,** No. 1, 23-27 (February, 1966).

Read only storage is widely used in the control of modern computers. Since its access time is in the range of 100 to 200 nanoseconds, even complex jobs may be executed in a serial rather than a parallel mode of operation, which results in a simpler structure of the computer.

There are two types of read only storage used in modern computers. The basic principles of their operation as well as the technical realization of those principles are discussed in this article.

A simple data flow and micro-program model illustrates the principles of microprogramming and the reduction in structure that can be achieved by using read only storage.

Second Breakdown and Crystallographic Defects in Transistors, H. A. Schafft,* G. H. Schwuttke and R. L. Ruggles, Jr., *IEEE Transactions on Electron Devices* **ED-13,** No. 11, 738-742 (November, 1966).

A study was conducted to determine the effect on second breakdown in transistors of some of the crystallographic

defects that can develop during handling and fabricating procedures. X-ray diffraction microscopy was used to detect these defects. The susceptibility to second breakdown of about 1500 epitaxial planar silicon transistors diffused on two wafers was measured and the site of the current constriction of second breakdown was registered on most of these transistors. These data were then compared with the x-ray topographs. Any effect of the observed gross dislocations was masked by other factors, such as apparent surface induced effects, that were not discernible in the x-ray topographs. It is proposed that a faulted emitter structure, which has been correlated with the emitter diffusion step, may be of importance in affecting the susceptibility of the transistor to second breakdown. The heating in the transistor at the second breakdown current constriction site to temperatures above 600°C and recrystallized laser-induced melt regions smaller than about 30μm in diameter produced no crystallographic changes nor any frozen-in strain fields detectable in the x-ray topographs.

• National Bureau of Standards.

Sense Signal and Word Noise in a Thin Magnetic Film Memory with Easy Axis Bias Fields, W. Jutzi, *IEEE Transactions on Magnetics* **MAG-2,** No. 4, 710-714 (December, 1966).

In a thin magnetic film memory, an easy axis field due to the conducting surrounding of the cell is to be taken into account in order to evaluate the sense signal corresponding to a word pulse in the hard axis. For a simplified switching model, diagrams demonstrate the influence of the easy axis field on the sense pulse amplitude and width and the signal-to-word-noise ratios. Optimum word pulses yielding maximum signal-to-noise ratios are given. Finally, the calculated and measured sense pulse amplitudes are compared.

Simple Expression for Storage Time of Arbitrary Base Diode, L. A. Davidson, *Solid-State Electronics* **9,** Nos. 11-12, 1145-1147 (November-December, 1966).

A simple closed-form expression—approximately valid—for the storage time of an arbitrary base diode has been obtained, yielding excellent results for practical ranges of current drive ratios. This expression affords a convenient calculation of storage time in *p-n* junction diodes, and is useful for entire range of current-drive ratios and base width. Excellent accuracy is obtained, except for narrow-base diodes with small current-drive ratios. The latter cases are resolved by application of the Grove-Sah method.

Simulation Provides Real Time Representation of Missile Missions, P. A. Kilty, *Simulation* **7,** No. 5, 224-226 (November, 1966).

The man-in-the-loop simulator provides the operator with real-time representation of simulated missile missions. Simulation is provided for actual sensor operation against simulated targets, control and monitoring of the missile flight by an operator, and continuous evaluation of the accuracy and effectiveness of the system.

Spiraling Scanner Reads Handwritten Letters, M. D. King, *Machine Design* **38,** No. 30, 36 (December 22, 1966).

A detailed description of the IBM 1287 Optical Reader is presented as a "design in action." The 1287 uses optical scanning and character recognition circuitry to read any combination of hand-printed, machine printed, or pencil marked numbers directly into a System/360 computer.

This on-line input device reads, feeds, and stacks a wide range of documents. It is the first commercially available machine capable of reading handwritten numbers and certain alphabetic characters.

Stainless Steel Cuts Cost of Special Fastener, W. D. Kehr, *Materials in Design Engineering* **64,** No. 7, 27-29 (December 10, 1966).

A high-production brazed fastener, previously made from AISI 8620 steel, locally case hardened, and coated with an expensive proprietary dry film lubricant, was redesigned using different materials. The new fasteners consist of an AISI 416 stainless steel threaded shaft and a type 420F stainless steel washer which are simultaneously brazed together and hardened. The stainless steel fasteners require four fewer manufacturing operations and are thus less expensive to fabricate. Life tests showed that the stainless steel fasteners possessed adequate wear and corrosion resistance.

Studies of Perturbation Theory and Spin Temperature by Rotary Saturation of Spins,† J. R. Franz and C. P. Slichter,* *Physical Review* **148,** No. 1, 287-298 (August 5, 1966).

The relationship between the Bloembergen-Purcell-Pound theory of resonance saturation and the Redfield theory is discussed in terms of the effect of a weak perturbation acting for a long time on a spin system perfectly isolated from the lattice. A simple derivation of Provotorov's rate equations is given, based on Schumacher's concepts. The theoretical ideas are applied to the F^{19} resonance in CaF_2 to discuss the phenomenon of rotary saturation, in which one applies a radio-frequency field $\mathbf{H}_1$, and modulates the static field at a frequency ω_a such that $\gamma\mathbf{H}_1 \cong \omega_a$, where γ is the nuclear gyromagnetic ratio. When $\mathbf{H}_1$ is large compared to the local field, the rotary saturation is described by Redfields concepts; when $\mathbf{H}_1$ is comparable to the local field, the original Bloembergen-Purcell-Pound theory works.

† This research was partially supported by the U.S. Atomic Energy Commission under Contract AT(11-1)-1198 and was performed at the Department of Physics and Materials Research Laboratory, University of Illinois.

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A Systems Approach to N/C Machining, L. F. Knappe and J. J. Harvey, *Production* **58,** No. 6, 138-141 (December, 1966).

The practical application of computer-aided design systems to N/C machining is described using a cam case study and a model part study. Such design systems enhance the ability of the user to respond to changing and critical needs for parts during the development phase, pre-production phase, production phase, or at a later time for replacement of parts. The cost is usually less than for parts produced by conventional methods and the quality is consistently good.

The Theory and Computation of Knapsack Functions,† P. C. Gilmore and R. E. Gomory, *Operations Research* **14,** No. 6, 1045-1074 (November-December, 1966).

In earlier papers on the cutting stock problem we indicated the desirability of developing fast methods for computing knapsack functions. A one-dimensional knapsack function is defined by:

$$f(x) = \max \{\Pi_1 Z_1 + \cdots + \Pi_m Z_m;$$
$$l_1 Z_1 + \cdots + l_m Z_m \leqq x,\ Z_i \geqq 0,\ Z_i \text{ integer}\}$$

where Π_i and l_i are given constants, $i = 1, \ldots, m$. Two-dimensional knapsack functions can also be defined. In this paper we give a characterization of knapsack functions and then use the characterization to develop more efficient methods of computation. For one-dimensional knapsack functions we describe certain periodic properties and give computational results.

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Theory and Practice of RF Sputtering, P. D. Davidse, *Semiconductor Products and Solid State Technology* **9,** No. 12, 30-36, 55 (December, 1966).

The basic principles of rf sputtering of insulators and their properties are reviewed and an rf sputtering system is described. The effect of various process parameters on deposition rate and film properties is also given. RF sputtering of metals can be achieved by capacitively coupling the power supply to the metal electrode. With this technique, it is possible to deposit insulator films through rf reactive sputtering at rates significantly higher than those obtainable through dc methods.

Thermal Problems in a Space Environment by M. L. Rauhe, *Electronic Packaging and Production* **7,** No. 1, 60-64 (January, 1967).

The temperature of a semiconductor junction in an integrated circuit is a function of the circuit housing design and the environment. A widely used housing is the flatpack. To assist the circuit designer, the manufacturers of flatpacks have published *"k"* factors for their designs. The values represent the thermal resistance from the circuit chip to the case or to an ambient and are based on a convection cooled case. These *k* factors are not applicable to integrated circuits which must operate in a vacuum. Therefore, an investigation of selected flatpacks was performed to determine *k* factors which could be used for a vacuum environment. This paper presents the results of the investigation.

Thermal Stability and Glass Transition of Organotin Polyesters, S. D. Bruck, *Journal of Polymer Science* **4,** No. 12, 933-937 (December, 1966).

With the exception of polymetallosiloxanes, relatively little information is available on the physicochemical properties of other metal organic polymers, largely because of preparative difficulties. The object of this paper is to report the termal stability and glass transitions of poly(di-n-butyltin adipate), poly(di-n-butyltin fumarate) and poly(di-n-butyltin terephthalate).

3-D Imagery and Holograms of Objects Illuminated in White Light, R. V. Pole, *Applied Physics Letters* **10,** No. 1, 20-22 (January 1, 1967).

Described is a method of obtaining holograms of 3-D objects illuminated in white light. First, a 3-D scene, illuminated in white light, is photographed through a fly's eye lens. If this photograph is projected through the same lens it yields a real 3-D image of the object directly. However, by using coherent light for projection, this real image can be used to make a hologram, which in turn yields both a real and a virtual image of the object.

A Time Sharing System Using an Associative Memory, A. B. Lindquist, R. R. Seeber and L. W. Comeau, *IEEE Proceedings* **54,** No. 12, 1633-2034 (December, 1966).

The hardware scheme designed to implement an experimental IBM System/360, Model 40 time-sharing system will be discussed. The concept of a virtual system will be introduced which allows up to fifteen simultaneous users on the system, each user assuming he has a complete hardware-software system of his own. The problem of building and interfacing a 64-word associative memory mapping device into an existing hardware system will be reviewed.

A Tolerance Study of Printed Circuit Process Steps, F. E. Grace, *Electronic Packaging and Production* **7,** No. 1, 8-15 (January, 1967).

Close control and knowledge of processing tolerances is most important in many printed circuit applications. One such is use of printed circuitry for microwave applications. Based on these requirements, a study was undertaken at IBM on the tolerances obtained in the processing of printed circuitry for a microwave application. The details of this study, reported herein, should also be useful to processors of printed circuits for other applications.

Letters

Device for Converting Helium Dewar into Continuous Temperature Cryostat, B. Welber and E. E. Tynan, *Review of Scientific Instruments* **38,** No. 1, 137-138 (January, 1967).

The Existence of Slonczewski Modes in the Absence of Complete Orbital Degeneracy, K. A. Müller and W. Berlinger, *Helvetica Physica Acta* **39,** No. 7, 590 (November 15, 1966).

Isolated GaAs Transistors on High-Resistivity GaAs Substrate, W. von Munch, H. Statz and A. E. Blakeslee, *Solid-State Electronics* **9,** No. 8, 826-827 (August, 1966).

The Preparation of High Purity Gallium Arsenide by the Czochralski Method, W. K. Liebmann and G. Kampschulte, *Solid-State Electronics* **9,** No. 8, 828-830 (1966).