

IBM Technical Papers Published in Other Journals

Antiferromagnetic Resonance in MnF_2 , Fred M. Johnson* and Arthur H. Nethercot, Jr., *Physical Review*, **114**, 705 (May 1, 1959).**

Measurements of the antiferromagnetic resonance frequency, $\nu(T)$, were made on single-crystal slabs of MnF_2 in the frequency range 96 to 247.2 kMc/sec and at temperatures T ranging from 4.2°K to 64°K ($T_N = 67.7^\circ\text{K}$). The results are in general agreement with the resonance relations derived for antiferromagnetic materials by Nagamiya, Keffer, and Kittel, and others. At low temperatures, values of $\nu(T)/\nu(0)$ and $\nu(0)$ are consistent with spin-wave method calculations of the sublattice magnetization and of the value and temperature dependence of the anisotropy energy. This agreement indicates almost complete correlation of adjacent electron spins in the low-temperature range as predicted from spin-wave theory.

From the antiferromagnetic resonance measurement of $\nu(0) = 261.4 \pm 1.5$ kMc/sec and Oguchi's calculation of H_A , $z|J|$ is 3.94×10^{-15} erg, in agreement with other determinations. Antiferromagnetic resonance line widths were measured from 4.2°K to 64°K. The observed asymmetric line shapes are satisfactorily accounted for as arising from a mixing of absorption and dispersion and from reflections. A simplified line-width theory is given which satisfactorily accounts for the observed line widths except at the lowest temperatures, where a residual width is found. Finally, antiferromagnetic resonance measurements on two crystals, which were grown under different conditions, indicate no difference in resonance frequency or line width.

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Automatic Failure Recovery in a Digital Data Processing System, R. H. Doyle, R. A. Meyer, and R. P. Pedowitz, *Proceedings of the Western Joint Computer Conference*, March 3-5, 1959, pp. 159-168 (September 9, 1959).

This paper describes a program which will enable a complex digital data processing system to give "first aid" to itself. Ordinarily, when an error occurs during system operations, the computer must be stopped for corrective maintenance. The FIX program, however, automatically compensates for computer malfunctions so that recovery from errors may be effected with a negligible loss of operational time. Some equipment features used by the FIX program are briefly outlined prior to a detailed discussion of the structure and function of the program itself. In its initial application in the SAGE system, FIX provided automatic recovery from more than 90% of all failures occurring during the period studied.

Automatic Torque Balance for Magnetic Anisotropy Measurements, R. F. Penoyer, *The Review of Scientific Instruments*, **30**, No. 8, 711-714 (August, 1959).

An automatic torque balance for the determination of magnetic anisotropy in ferromagnetic single crystals is described. The balance consists of a mechanical coupling between a solenoid suspended in a static magnetic field and a single-crystal specimen. The torque produced by the specimen causes a minute motion of the solenoid, which is detected by means of a light beam—mirror—phototube network. An automatically controlled current is fed back to the solenoid, establishing a torque equal and opposite to that produced. A voltage proportional to the feedback current, and thus the applied torque, is recorded on one axis of an X-Y recorder. The other axis is driven by a voltage governed by the direction of magnetic field in which the crystal is suspended. A method that automatically compensates for the deviation of magnetization from applied-field direction in highly anisotropic crystals is described, and further advantages of the automatic balance over other systems are discussed.

An Automatic Transistor Test Set, R. A. Planck, *Electronics*, **32**, 80-82 (August 14, 1959).

The transistor test set is a self-contained unit capable of measuring up to 18 dc parameters on germanium or silicon transistors with maximum rating of 20 watts. The test set will measure 30 transistors at 18 parameters each in 15 minutes. To automate these measurements, a read record system with adequate programming is required. For our use, a Delaware Products digital voltmeter and an IBM 526 card punch make up the read record system.

Diffusion and Relaxation in He^3 to 0.5°K, H. A. Reich and R. L. Garwin, *Proceedings of the 10th International Congress of Refrigeration*, Copenhagen (August 19, 1959).

By use of a He^3 refrigerator¹ we have extended our measurements² of diffusion constant D , and spin relaxation time T_1 to 0.5°K, in pure He^3 and in dilute solutions of He^3 in He^4 . We have also measured the susceptibility of a 2% solution to 0.5°K. In pure He^3 , D is independent of temperature at the lowest temperature reached, while in this same region the viscosity varies as $T^{-1/2}$ or faster.³ The freezing out of rotons and the subsequent He^3 - He^3 scattering is observed in dilute solutions. D fits an equation of the form $D^{-1} = 714T + 2.4 \times 10^7 \exp(-13.7/T)$. The low temperature behavior of D , varying as T^{-1} , is in contradiction to the expected⁴ $T^{1/2}$.

¹H. A. Reich and R. L. Garwin, *Rev. Sci. Instr.*, **30**, 7 (1959).

²R. L. Garwin and H. A. Reich, *Bull. Am. Phys. Soc.*, **II**, **3**, 133 (1958).

³K. N. Zinovieva, *Soviet Physics JETP*, **34**(7), 421 (1958).

⁴A. Akhiezer and V. Aleksin, *Dokl. Akad. Nauk. SSSR*, **92**, 259 (1953).

Electron Spin Resonance of Nitrogen Donors in Diamond, W. V. Smith, P. P. Sorokin, I. L. Gelles and G. J. Lasher, *Physical Review*, **115** (September 15, 1959).

Electron spin resonance of bound substitutional nitrogen donors in diamond is observed and discussed. The g factor is isotropic at 2.0024 ± 0.0005 . For a given donor, one of the C-N bond directions is a hyperfine axis with constants $A=40.8$ oersted, $B=29.2$ oersted. There are thus four types of donors, equally abundant. A model for the donor wave function is proposed which puts the donor electron principally into an anti-bonding orbital located on a nitrogen atom and on one of its nearest-neighbor carbon atoms. A C-N bond distortion results which can be regarded as a manifestation of the Jahn-Teller effect. A careful search reveals the presence of an additional weak spectrum due to donors on $N^{14}-C^{13}$ pairs. (The isotope C^{13} which has a nuclear spin of $1/2$ has a natural abundance of 1.1%.) The hyperfine constants measured for a C^{13} atom of an N-C pair are $A'=60.8$ oersted, $B'=25.3$ oersted. The s and p contributions to all 4 measured hyperfine constants are separated to give the values:

$$O_N = \frac{8\pi}{3} \left| \psi(0) \right|_N^2 = 2.41 \text{ atomic units,}$$

$$P_N = \left\langle \frac{z^2 - 1/2(x^2 + y^2)}{r^5} \right\rangle_N = 0.28 \text{ atomic units,}$$

$$O_C = \frac{8\pi}{3} \left| \psi(0) \right|_C^2 = 0.78 \text{ atomic units,}$$

$$P_C = \left\langle \frac{z^2 - 1/2(x^2 + y^2)}{r^5} \right\rangle_C = 0.25 \text{ atomic units.}$$

These are compared with theoretical values obtained by assuming a simple anti-bonding wave function composed of nitrogen and carbon tetrahedral orbitals. An increase of several percent in the N-C separation along the hyperfine axis is strongly implied by the comparison.

Equivalent Sequential Circuits, W. J. Cadden, *IRE Transactions on Circuit Theory*, **CT-6**, No. 1, 30-34 (Sequential Transducer Issue) (March, 1959).*

Three types of sequential circuits are defined, two of which are synchronous and one of which is asynchronous. The concept of equivalent sequential circuits as discussed by Huffman, Mealy, and Moore is extended to circuits of different types. Procedures are given for transforming a state table of one type into state tables of the other types. One of these transformations can also be used to introduce unit delay between corresponding inputs and outputs for a synchronous circuit. The transformation methods allow a comparison of circuits, or state tables, of different types to be made for a given sequential circuit problem. A few general conclusions are drawn about the different types of sequential circuits.

*For the period January through March, 1959.

An Experimental Modulation-Demodulation Scheme for High-Speed Data Transmission, E. Hopner, *Proceedings of the Eastern Joint Computer Conference*, December 3-5, 1958, pp. 38-43 (July, 1959).

An experimental low-cost system was designed to determine

speed and reliability limitations on transmitting binary data over private telephone lines. A brief review of alternative approaches is given, with a description of the laboratory model. Performance of the equipment is reported with the reliabilities experienced at 600, 1000, 1600, and 2400 bits per second.

The Fundamental Properties of Plastics, T. D. Callinan and A. E. Javitz,* *Electrical Manufacturing*, **64**, No. 2, 105-120 (August, 1959).

The basic science of polymers is interpreted for the design engineer in terms of molecular, chemical and electron mechanisms, and their effect on functional applications of plastics.

*Special Features Editor, *Electrical Manufacturing*.

Ground State Λ -Doubling Transitions of OH Radical, M. J. Stevenson, G. Ehrenstein,* and C. H. Townes,* *Physical Review Letters*, **3**, 40-41 (July 1, 1959).

The Λ -doubling transitions were observed in the lowest rotational state $J=3/2$ of the OH radical with a Zeeman modulated microwave-absorption spectrometer. These absorption lines are of interest in radio astronomy for determination of presence of the OH radical in interstellar space. The measured frequencies are $1,667.34 \pm 0.03$ Mc/sec for the stronger transition $F=2 \leftarrow F=2$ and $1,665.46 \pm 0.10$ Mc/sec for the weaker transition $F=1 \leftarrow F=1$. A brief description of a coaxial Zeeman modulation technique is also given.

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IBM 7070 Data Processing System, J. Svigals, *Proceedings of the Western Joint Computer Conference*, March 3-5, 1959, pp. 222-231 (September 9, 1959).

A description is given of the IBM 7070 System, particular emphasis being placed upon the new system features and the engineering packaging and production techniques utilized.

The IBM 7070 Data Processing System, R. W. Avery, S. H. Blackford, and J. A. McDonnell, *Proceedings of the Eastern Joint Computer Conference*, Dec. 3-5, 1958, pp. 165-168 (July, 1959).

The IBM 7070 is a completely solid-state data processing system with both tape and random-access memory. With the addition of floating-decimal arithmetic its speed and memory are such that it is also applicable to scientific work. The logic of the IBM 7070 is centered about a core memory which is multiplexed to provide parallel data transmission at a high rate to input-output, program control, and arithmetic units. Magnetics are predominantly used in the data flow paths, while transistors (Complimentary-Transistor-Diode-Logic) are used in the logic and control sections. Maximum advantage is also obtained from transistor current-mode operation

in the high-speed portions of the system. Circuits were rigorously designed to assure maximum reliability. A comprehensive set of automatic programs, of the compiler type, have been prepared for simplified programming.

The Information Machine, D. N. Chorafas, *Systems and Procedures*, **10**, 30-35 (August 1959).

This review article discusses the role of computers in taking over certain functions of controlling and planning work in industry. Applications of high-speed computers are shown for engineering design, business data processing, technological control and mathematical simulation. Examples are cited of the use of computers for direction and control of manufacturing processes, airline reservation systems, traffic control, department store sales and inventory, and numerical control of machine tools.

Inverse Elliptic Functions and Legendre Polynomials, R. P. Kelisky, *American Mathematical Monthly*, **66**, 480-483 (June-July, 1959).

Series expansions for the complete elliptic integrals $K(k)$ and $E(k)$ which involve the Legendre polynomial with argument $\cos \theta$ (θ real) are well known. Here, series expansions of $K(k)$ in which the argument of the Legendre polynomial is greater than one are obtained. The series for $K(k)$ appear as special cases of power-series expansions of the three Jacobian inverse elliptic functions $sn^{-1}(x, k)$, $cn^{-1}(x, k)$ and $dn^{-1}(x, k)$.

Lattice Vibrations, H. Cole, *Physics Today*, **12**, No. 8, 18-24 (August, 1959).

A review article on lattice vibrations. The basic ideas involved in the theory of atomic vibrations in large perfect crystals is reviewed, and the X-ray and neutron-scattering data used to verify these concepts is presented.

Magnetic Core Logic in a High-Speed Card-to-Tape Converter, E. Bloch and R. C. Paulsen, *IRE Transactions on Electronic Computers*, **EC-8**, No. 2, 169-181 (June, 1959).*

This report describes a static magnetic-shift circuit and the logical connectives derived from it. The prime advantages of magnetic circuits are their low cost, high reliability, and ease of maintenance. The application of these circuits to the design of a card-to-tape converter is discussed.

*For the period April through June, 1959.

Magnetic Core Memories Using Multiple Coincidence, H. P. Schlaeppli and I. P. V. Carter, *Elektronisch Rechenanlagen*, **1**, H. 3, 127-133 (August, 1959).

The growing interest in large-capacity and very-high-speed

stores with cycle times below one microsecond makes an increase in the selection ratio of coincident current core stores highly desirable. It is shown that a high selection ratio brings with it important changes in structure and operating mode of the storage system, and that the classical core switch does not fulfill these new requirements. The "two-core switch" is then described: it permits an elegant solution of the switching problems which occur at high selection ratios. This in turn allows an economic embodiment of the multiple coincidence principles of Minnick and Ashenhurst. The system design and operating mode of a 3:1 and a 7:1 memory are described functionally and illustrated by oscillograms for models built to test the ideas presented.

Mice Can't Be Programmers, Mandalay D. Grems, *Computing News*, **7**, No. 15, 154-7 to 154-10 (August 1, 1959).

This article encourages the re-evaluation of administrative policies of computing installations and hints at the use of the scientific method for handling supervisory problems of scientific personnel.

Molecular and Ionic Interactions in Dielectrics, Thomas D. Callinan, *Digest of Literature on Dielectrics*, Chapter III, **22**, 57-73 (1959); Publication 713, National Academy of Sciences — National Research Council, Washington, D. C.

This is a critical digest of the literature which appeared on the subject of molecular and ionic interactions in dielectrics during 1958. While an enormous increase in dielectric studies appeared, much of the work reported is pedestrian. The reason for this is thought to arise from the inauguration of many new journals sponsored by nationalist-minded governments anxious to present an image of scientific prowess to other nations.

Nuclear Spin Relaxation Time in Superconducting Aluminum, A. G. Redfield, *Physical Review Letters*, **3**, 85 (August 15, 1959).

The nuclear spin relaxation time T_{1s} in superconductors was first measured by Hebel and Slichter just below the transition temperature in aluminum, and by Reif well below the transition temperature in mercury. These measurements indicated that T_{1s} decreases rapidly just below T_c , and then rapidly increases again well below the transition temperature, becoming greater than the normal state relaxation time at very low temperatures. Hebel and Slichter pointed out that the decrease in T_1 near T_c could be easily explained only in terms of an energy-gap model of superconductivity. They supported their explanation with a detailed calculation based on the Bardeen, Cooper, and Schrieffer (BCS) theory of superconductivity. Comparison of the temperature dependence of T_1 as contrasted with that of acoustic attenuation provides confirmation of the spin-dependent correlation of the wave functions used in the BCS theory.

Preliminary measurements of T_1 in aluminum by Anderson and the writer, were in reasonable agreement with the Hebel-Slichter-BCS theory; accuracy of these measurements has now

been improved using a He³ cryostat. The experimental method was basically the same as that used previously. The sample was soaked in a 3000-gauss field for a time long compared to T_1 , so that the spin magnetization built up to its equilibrium value in this field. The field was then turned off in about 1/10 sec and left off for a variable time τ ; during this time the sample is in the superconducting phase and the spin polarization relaxes toward zero. The field is then turned on to 1000 gauss and within 2/10 second the spin polarization is measured in the normal state by applying suitable rf and sweep fields.

Optical Properties of Activated and Unactivated Hexagonal ZnS Single Crystals, S. P. Keller and G. D. Pettit, *Physical Review*, **115**, 526-537 (August 1, 1959).

Single crystals of hexagonal ZnS, unactivated and activated with Cu, Al, or Mn, have been examined. The polarization effects in the transmission spectrum of unactivated ZnS were measured further into the fundamental absorption than were previously measured. The theoretical prediction that, for direct transitions at $k=0$, light polarized perpendicular to the c axis is more strongly absorbed than light polarized parallel to the c axis, is borne out throughout the fundamental absorption region except in the wavelength region between 290 and 325 $m\mu$. The wavelength dependence and the polarization of the excitation and fluorescence spectra of the activated and unactivated crystals were measured at room temperature and at 77°K. The excitation spectra showed an agreement with the selection rule at the edge of the fundamental absorption, but there was a reversal of the selection rule deep in the absorption region. There was also an impurity absorption exhibiting the same polarization properties as the edge. Some fluorescent emissions were polarized perpendicular and some were polarized parallel to the c axis. Speculations are made on the reversal of the polarization deep in the fundamental absorption and on the symmetry and the nature of the sites causing the various fluorescence bands.

Paramagnetic Resonance Detection of the Optical Excitation of an Infrared Stimulable Phosphor, R. S. Title, *Physical Review Letters*, **3**, 273-274 (September 15, 1959).

The phosphor SrS:Eu,Sm has the property of storing energy when irradiated with ultraviolet or blue light. This stored energy may subsequently be released when irradiated with infrared or orange light. The simplified band-theory model proposed by Keller¹ for this phosphor shows that the result of irradiation by ultraviolet or blue light is to ionize the europium which is normally present as Eu²⁺ to Eu³⁺. The liberated electron is subsequently trapped by samarium present as Sm³⁺ to become Sm²⁺. The ground state of Eu²⁺ is ⁸S_{7/2} and paramagnetic. The excitation of this phosphor should therefore manifest itself as a diminution of the Eu²⁺ paramagnetic spectrum. This diminution has been observed. A plot of the relative stored energy as a function of exciting wavelengths was carried out, the diminution in the paramagnetic resonance of Eu²⁺ being used as a measure of the stored energy.

¹S. P. Keller, J. E. Mapes and G. Cheroft, *Phys. Rev.* **108**, 663 (1957).

Polarography of Mixtures. Simultaneous Determination of Iron and Nickel, Sidney L. Phillips and Evan Morgan, *Analytical Chemistry*, **31**, 1467-1469 (September, 1959).

Methods are described for rapidly analyzing mixtures of iron and nickel without the necessity of a separation. In ammoniacal or pyridinical supporting electrolytes containing an excess of 5-sulfosalicylic acid, iron and nickel may be determined with a precision to $\pm 2\%$.

Processing Data in Bits and Pieces, F. P. Brooks, Jr., G. A. Blaauw, and W. Buchholz, *IRE Transactions on Electronic Computers*, **EC8**, No. 2, 118-124 (June, 1959).*

A data-handling unit is described which permits binary or decimal arithmetic to be performed on data fields of any length from one to sixty-four bits. Within the field, character structure can be further specified: these processing entities, called bytes, may be from one to eight bits long. Fields may be stored with or without algebraic sign. On all operations, the relative offset or shift between the operand from memory and that from the accumulator can be specified. Besides the arithmetic operations, three new logical instructions allow any of the sixteen logical connectives of two variables to operate upon each pair of bits in the memory and accumulator operands. The variable field length, variable byte-size features, extend the use of connective operations to a surprisingly wide variety of logical, housekeeping, and editing tasks.

*For the period April through June, 1959

A Program to Draw Multilevel Flow Charts, Lois M. Haibt, *Proceedings of the Western Joint Computer Conference*, March 3-5, 1959, pp. 131-137 (September, 1959).

A program called the Flowcharter is being written for the IBM 704, which will accept as input another program, analyze this program, and give the results of the analysis as a series of graphic flow charts. The program analyzed may be written in any of a variety of programming languages. In addition to a description of the Flowcharter and its output, a discussion is included of the problems encountered and the solutions used.

A Proposal for a Generalized Card Code for 256 Characters, R. W. Bemer, *Communications of the ACM*, **2**, No. 9, 19 (September, 1959).

This paper shows one phase of the current pressures to increase the number of usable characters for computer use, particularly in programming. The expansion proposed here is intermediate, being possible to implement on some existing equipment. Present IBM card codes are retained and used to create new character codes by superimposition of two of the present codes in a single card column. The choice of particular pairs of characters is on a mnemonic basis. Thus the left bracket is represented by LB, and the resultant code is 12-11-2-3 when these two characters are multipunched in the same column.

A Quantitative Study of the Relation Between Molecular Structure and Adsorption Affinity on Silicic Acid-Celite Columns, A. H. Sporer and K. N. Trueblood,* *Journal of Chromatography*, **2**, 499-512 (1959).

The development rates of a variety of monofunctional and

polyfunctional aromatic compounds dissolved in benzene have been measured on columns of activated silicic acid-celite under conditions which at least closely approximate equilibrium. From these rates, extrapolated to the linear region of the isotherm, equilibrium constants for the adsorption process ("adsorption affinities") have been calculated by least-squares methods. It is shown that the adsorption affinities of simple polyfunctional compounds can be predicted with reasonable accuracy from individual group adsorption affinities deduced from studies on monofunctional compounds. Quantitative values for the adsorption affinities of some common functional groups in the silicic acid-benzene system are listed.

*Department of Chemistry, University of California, Los Angeles.

Remarks on ALGOL and Symbol Manipulation, Julien Green, R. M. Shapiro, F. R. Helt, Jr., R. G. Franciotti, and E. H. Theil, *Communications of the ACM*, **2**, No. 9, 25-27 (September, 1959).

The paper discusses (1) the relationship between external and internal representation, (2) addition to the ALGOL OF statements and DO statements, and (3) the basis of symbol manipulation language which will enable the ALGOL processor to be described as an algorithm in the ALGOL language.

The Role of Digital Computers in the Dynamic Optimization of Chemical Reactions, R. E. Kalman* and R.W. Koepcke, *Proceedings of the Western Joint Computer Conference, March 3-5, 1959*, pp. 107-116 (September 9, 1959).

This paper outlines the new general approach to the static and dynamic optimization of chemical processes, particularly chemical reactions. The underlying motivation of the new approach is the efficient utilization of high-speed digital computing devices. After an exposition of the fundamental concepts of dynamic optimization, the optimization equations are derived in analytic form for the linear case and applied to a numerical example.

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Simulation of an Information Channel on the IBM 704 Computer,* E. G. Newman and L. O. Nippe, *Proceedings of the Western Joint Computer Conference, March 3-5, 1959*, pp. 87-92 (September 9, 1959).

Approximate probabilities of multiple-error patterns in symbols consisting of any number of bits may be obtained by means of a statistical simulation process for a binary information channel which is asymmetric and where a certain regional error dependence exists. The channel symmetry, *a priori* error probabilities, and the type of error dependence may be varied at will.

The simulation program described in this paper was designed with the characteristics of a magnetic tape channel in mind. With slight modifications it can be used to simulate any information channel.

The accuracy of this method is indicated for special test cases. Examples showing the effects of error dependence on multiple-error probabilities are also given.

*This work has been supported by the U. S. Department of Defense.

The Social Responsibility of Engineers and Scientists, F. B. Wood, *Proceedings of the Western Joint Computer Conference, March 3-5, 1959*, pp. 310-313 (September, 1959).

Some recent papers on the social responsibility of computer scientists and the social problems of automation are reviewed. The responsibility of citizens in a democracy is discussed and the additional responsibilities of specialists who have knowledge not readily accessible to the layman are reviewed. The hypothesis is proposed that the social responsibility of the engineer is to be a kind of coordinator to make certain that the social problems related to his physical engineering work are being studied and that provisions are made by our society to explain the basic principles and significance of science to the voters in our democracy. As an aid to an engineer in analyzing his social responsibilities, a simple checking chart is constructed. A sample case of the checking chart is discussed in the case of the development of a hypothetical computer and data-communication system which eliminates the need for money. Here the chart is used to display the potential social problems and to point to the areas where social scientists may need to be consulted in regard to the consequent problems.

Spin-Orbit Contributions to the H^3 -He 3 Magnetic Moments, J. M. Berger, *Physical Review*, **115**, 384-389 (July 15, 1959).

The contributions to the magnetic moments of the triton and He 3 from the phenomenological spin-orbit potentials have been calculated. The results indicate an isotopic spin dependence of the form $(3 + \tau_i \tau_j)$ for the spin-orbit potentials, and also that they cannot account for the H^3 -He 3 magnetic moment anomalies.

The Statistical Dynamics of Preventive Replacements, D. M. Brender, *The 1959 IRE WESCON Convention Record, Part IV* (August 18, 1959).

This paper considers the problem of determining an optimum maintenance schedule, based on cost and age criteria, for the preventive replacement of components. The proposed schedule is flexible in that the next preventive replacement in a component position is rescheduled when a failure in that position results in the unexpected introduction of a new component. This rescheduling procedure prevents a recently installed component from being unnecessarily replaced, as would occur when a fixed preset replacement schedule is used. The effect of deviations from the optimum schedule is handled as an integral part of the analysis. Thus by considering a distribution function for time-to-failure and a distribution function for time-to-a-scheduled replacement, the reliability in a given component position and the maintenance cost can be derived. One may thus vary the replacement schedule for a fixed type of component in order to determine minimum cost or in order to achieve a "prescribed" reliability. Furthermore, the consequences of using a component of a different quality can also be evaluated in terms of maintenance cost and reliability. The cost for any specific interval of time is expressed in terms of the expected number of failures and the expected number of preventive replacements in this interval. Consequently, the modified renewal process analyzed here permits the optimal scheduling of maintenance both for systems which will be used for a known period of time and for systems which will be used indefinitely.

Theory of Negative Mass Cyclotron Resonance, D. C. Mattis and M. J. Stevenson, *Physical Review Letters*, **3**, 18-20 (July 1, 1959).

Recent experiments reporting negative mass cyclotron resonance are examined from a theoretical viewpoint. It is concluded that for distributions characterized by a function of energy only, negative mass holes can exhibit emissive cyclotron resonance spectrum only if the distribution function is inverted over a range of energies and the negative mass holes have effective mass in this energy range sufficiently different so that their emissive contribution can be experimentally resolved. Similar conclusions hold for positive mass carriers.

Use of Capacity-Controlled rf Energized Ionization Transducer for Balancing Rotors, W. A. Gross, *The Review of Scientific Instruments*, **30**, No. 7, 522-523 (July, 1959).

A rotor-balancing technique is described in which conventional laboratory equipment may be used. The orbiting motion

of a rotating shaft within its own fixed bearings is detected by capacitor probes. After being passed through the transducer circuit, the signal is displayed on an oscilloscope. It is therefore possible to obtain the necessary balancing information at operating conditions.

Simulation of Human Problem-Solving, W. G. Bouricius and J. M. Keller, *Proceedings of the Western Joint Computer Conference, March 3-5, 1959*, pp. 116-119 (September 1959).

Simulating human problem-solving on a digital computer looks deceptively simple. All one must do is program computers to solve problems in such a manner that the computer employs the identical strategies and tactics that humans do. This will probably be as simple in theory and as hard in actual practice as was the development of reliable digital computers. This paper describes a few of the pitfalls that seem to lie in the path of anyone trying to program machines to "think" and gives the results of two experimental programs in some detail.