October through December, 1958

IBM Technical Papers Published in Other Journals

Automatic Data Reduction of Spot Diagram Information, W. E. Goetz and N. J. Woodland, *Journal of the Optical Society of America,* **48,** No. 12, 965-968 (December, 1958).

Modern electronic computers can produce spot-diagram data at a pace which makes human selection of a best spot diagram impracticable. In a particular mechanical image dissector the energy falling onto the photocathode redistributes as the scan progresses from field point to field point. The receiving surface is considered to be a rectangular network. Rays representing unit energy are traced through the system and for each field point the total energy in each square is determined. After chi-squared methods are applied to the numerical matrices derived for the field point in a scan, the redistribution between field points is numerically evaluated. This digital evaluation makes feasible automatic data reduction of spot diagram information. The technique may provide the basis for reducing data in similar spot diagram applications.

Completely Nonmagnetic Alloy for Instrumentation in Magnetic Fields, E. W. Pugh, *The Review of Scientific Instruments,* **29,** No. 12, 118-119 (December, 1958).

A high-purity copper-nickel alloy is described which has zero magnetic moment at room temperature and less than a tenth the moment of pure copper at all temperatures down to 2°K. The alloy has been used with considerable advantage in sample holders for magnetic force measurements, and other uses are anticipated. A method of preparing the alloy is discussed which requires limited metallurgical equipment.

Control of a Job Machine Floor, W. R. Elmendorf, *Mechanical Engineering,* **80,** No. 10, 61-64 (October, 1958).

This paper describes a data-processing system designed to handle the record keeping, scheduling, and load reporting for a job-shop type of manufacturing in a medium-sized plant. The system provides for "in-line" file maintenance and for periodic rescheduling of all open orders on the basis of the latest material requirements, inventory status, and shop capacity. The resulting machine floor and subcontract priority schedules control day-to-day operations, while the machine floor load report analyzes the past operation and forecasts the future operation of the shop.

Development of a Single-Fired Phosphorescent Porcelain Enamel, Barlane R. Eichbaum, *The Institute of Vitreous Enamellers Bulletin,* **9,** No. 4, 61-67 (December, 1958).

A technique has been developed by which a phosphorescent pigment can be permanently contained in a porcelain enamel. In order to produce such a phosphorescent enamel, three factors had to be controlled, namely: (1) Reduction of phosphor particle size, (2) Prevention of oxidation of the phosphor and (3) Prevention of phosphor quenching due to the presence of quenching metals. The above factors were controlled with a 3- or 4-layer preparation technique prior to a single firing to obtain a desirable phosphorescent or electroluminescent porcelain.

Developments in Computer Logical Organization, W. J. Lawless, *Advances in Electronics and Electron Physics,* **10,** 153-184 (November, 1958).

This paper discusses some of the important steps in the development of the logical organization in digital computers and in data processing equipment. The logical organization of today's computers is reviewed, including some aspects of internal organization and of system organization. The need for further work in the theory for organization is stressed.

The Digital Computer, A Necessary Controller Tool, K. W. Kowalke, *Journal of the Air Traffic Control Association,* **1,** No. 2, 10-12 and 21 (October, 1958).

Digital computers will relieve air traffic controllers of many routine, time-consuming tasks, thus enabling controllers to concentrate on the control of air traffic. The functions of the major components of a digital computer are discussed, including the reason for and concept of binary arithmetic. The various commonly used memory systems are described, including relative speeds and capacities.

Digital computers used in the air-traffic control system must be able to communicate with each other and to display data to many controllers simultaneously. There are many problems in updating displayed information that must be solved.

Controllers need not be apprehensive of computers, because the controllers' duties will be less tedious. Computers will also offer new and challenging job opportunities.

Extraction of Roots by Repeated Subtractions for Digital Computers,* Iwao Sugai, *Communications of the Association for Computing Machinery,* **1,** No. 12, 6-8 (December, 1958).

Extraction of roots of any real number is obtained as the result of repetitive subtractions. Special number elements formed by $m^n-(m-1)^n$, n=any positive integer, $m=1, 2, 3, \ldots\ldots 9, 10$ are used for $X^{1/n}$, where x is any real number. This method is applicable for as large a number of digit places of the extracted root as one desires. As a guide for the general nth order extraction of roots, the program is given for the cube root.

*Work done at Polytechnic Institute of Brooklyn.

Formation of a Ni-Ge Phase in Molten Lead, M. E. Steidlitz,* *Transactions of The Metallurgical Society of AIME,* **212,** No. 5, 676-678 (October, 1958).

A brief study was made of the characteristics and possible formation mechanisms of Ge-Pe-Ni systems. Lead-coated nickel washers were bonded to germanium discs at 500° or 600°C. The resulting formation of foil was analyzed for various bonding conditions.

*Now at International Resistance Co., Philadelphia, Pa.

General Relativity and Particle Dynamics, L. H. Thomas, *Physical Review,* **112,** 2129-2134 (December 15, 1958).

In order to adapt the Hamiltonian dynamics of a system of classical (nonquantum) particles to general relativity, it seems necessary to generalize the transformations used from contact transformations of phase space to extended point transformations of a joint observer and phase space. When this is done the curvature of observer space is seen to arise from the physical interaction of particles without the introduction of new gravitational field variables.

In order to extend this theory to quantized particle and field theory, it seems necessary to extend the unitary transformations of quantum mechanics in a similar manner to linear transformations of matrices maintaining the trace of the product of two matrices, the Hermitean nature of a matrix, and the unit matrix. Such transformations do not preserve the phases of wave functions or the product of two matrices, but do preserve the characteristic values of matrices and the traces of the products of any number of matrices. That observers should be designated by q numbers, not c numbers, makes it difficult to interpret the theory except in the classical limit.

Heterogeneous Equilibria in The Systems Li_2O-, Ag_2O-Nb_2O_5 and Oxide-Models, Arnold Reisman and Frederic Holtzberg, *Journal of the American Chemical Society,* **80,** 6503 (December 20, 1958).

On the basis of the relative structural stability of interacting oxide end members, a qualitative model system theory for complex reactions is discussed. The heterogeneous equilibria in the Li_2O-, Ag_2O-Nb_2O_5 systems have been examined using DTA, X-ray and density techniques, and compared with the system Na_2O-Nb_2O_5. All three generate compounds having base-to-acid ratios of (I) 1:14, (II) 1:4, (III) 1:1 and (IV) 3:1. The silver and sodium analogues are believed to be isostructural.

In the Li_2O-Nb_2O_5 system (I) and (II) melt incongruently at 1268° and 1231°C, respectively; (III) and (IV) melt congruently at 1253° and 1408° respectively; (III) exhibited no first-order heat anomalies in the temperature interval, room temperature to its melting point; (IV) undergoes a sluggish phase transformation at 1056°.

$AgNbO_3$ exhibits thermal anomalies at 292° and 578°, and dielectric anomalies at 60° and 292°. Ceramics of the silver salt gave fairly well defined hysteresis loops characteristic of a ferroelectric compound, but X-ray data show the presence of "extra lines" which are indicative of a multiple unit cell and are normally attributed to an antiferroelectric structure.

Improving Your Wrinkle Painting, H. D. Kaiser and T. G. O'Brien, *Products Finishing Magazine,* **23,** No. 3, 24-29 (December, 1958).

In the past, IBM and its subcontractors experienced considerable difficulty in using wrinkle enamels in production operations. IBM personnel conducted an extensive study of the manufacture and application of these paints. This article describes and summarizes the problems encountered in application, baking and reworking, and recommends methods that may be used to correct these problems.

Interpretation of Electron Paramagnetic Resonance in $BaTiO_3$, A. W. Hornig, R. C. Remper* and H. E. Weaver,* *Physical Review Letters,* **1,** No. 8, 284-285 (October 15, 1958).

This letter summarizes conclusions on the origin and interpretation of electron paramagnetic resonance in $BaTiO_3$ single crystals and points out major disagreement with other published results. It is believed the resonance is due to the Fe^{3+} ion located at normal titanium sites. The tetragonal electric field plus applied magnetic field completely lifts all degeneracy of energy levels giving five principal lines as expected of a $^6S_{5/2}$ state. Measurements were made in the tetragonal and cubic phases, electric fields were applied and orientation effects were observed. The zero field splittings in the tetragonal (ferroelectric) phase were observed and found to be 11.7 and 4.9 kMc/sec at room temperature. A more comprehensive paper is to be published in the *Journal of Physics and Chemistry of Solids.*

*Instrument Division, Varian Associates, Palo Alto, California

Investigation of Excess-Noise in Magnetically Focussed Electron Beams, Helmut Louis, *Technische Mitteilungen P.T.T.,* **9,** 333-348 (September, 1958).*

Microwave tubes with a convergent electron gun and a magnetically shielded cathode occasionally have a noise figure which is about two orders of magnitude higher than for an ordinary space-charge limited, electron beam. When the measuring probe is curved along the beam, the noise figure suddenly rises at a distance of some inches from the cathode. An experimental tube and measurements on this excess-noise phenomenon are described. It is found that the excess-noise is initiated by a scalloped-beam amplification and is essentially dependent on the nonlaminarity of electron flow in the beam. The beam finally reaches a state of high thermal equilibrium which is characterized by an increased longitudinal and transverse velocity distribution. An estimation shows that strong electron-interaction should be theoretically possible to transfer the energy from the scalloped-beam, amplified frequency band into white noise.

*Published during the period July through September, 1958.

Lattice Vibrational Spectra of Si and Ge, H. Cole and E. Kineke, *Physical Review Letters,* **1,** No. 10, 360-361 (November 15, 1958).

A program based on the Born-von Kármán theory of lattice vibrations has been written for the IBM 704 which permits calculation of the frequencies and polarization vectors and/or the frequency for elastic waves in certain crystals if the interatomic force constants are known. The calculated frequency distributions for Ge and Si are reported. The force constants used were derived from x-ray and neutron scattering data, reported by other investigators.

Mirror Anastigmat with Two Concentric Spherical Surfaces, Paul Erdös, *Helvetica Physica Acta,* **XXXI,** 556-557 (December, 1958).

An optical system for the imaging of small objects at finite distances has been developed. The system consists of two concentric spherical mirrors, convex and concave respectively. Due to the absence of chromatic aberrations, the arrangement is especially suited for imaging a polychromatic light source. Third-order (SEIDEL) spherical aberration, coma and astigmatism are cancelled and fifth-order (SCHWARZSCHILD) aberrations may be reduced by the correct choice of parameters as described in the text.

Molecular and Ionic Interactions, T. D. Callinan, *Digest of Literature on Dielectrics,* **Chapter III,** 26-52 (November, 1958).

This is a digest of the theoretical literature on dielectrics published in 1957 and contains 116 references.

New Experimental Test of Relativity, J. P. Cedarholm, G. F. Bland, B. L. Havens and C. Townes,* *Physical Review Letters* **1,** 342-343 (November 1, 1958).

The dependence of the velocity of light upon the velocity of the frame of reference was tested using the relative frequency stability of two beam-type maser oscillators. The velocity of the earth with respect to an ether in a plane perpendicular to the earth's axis was found to be less than 1/30 kilometer per second.

*At Columbia University.

Nuclear Spinlattice Relaxation Time in Superconducting Aluminum, A. G. Redfield and A. G. Anderson, *Physica,* S150, No. 54 (September, 1958). (Proceedings of the Kamerlingh Onnes Conference on Low Temperature Physics, Leiden, The Netherlands, June 23-28, 1958).

The nuclear spin-lattice relaxation time τ_1 has been measured from 0.6° to 1.2°K in pure aluminum by the method of Hebel and Slichter,* using techniques described in part elsewhere.† τ_1 drops continuously from the normal value of 0.55 seconds at the critical temperature, T_c, to 0.25 ± 0.02 seconds at 0.065 degree below T_c. τ_1 has a value of 0.26 ± 0.08 sec at 1.05° and is roughly proportional to T^{-1} down to 0.8°, below which it increases more rapidly, being 1.25 ±0.45 sec at 0.6°. Below 0.6° the temperature is uncertain because of the magneto-caloric effect, but τ_1 becomes of the order of 15 sec at 0.4°. These observations are consistent with a gap model, as discussed by Hebel and Slichter, and are in reasonable agreement with their calculation of τ_1 based on the Bardeen, Cooper and Schrieffer theory, assuming an electronic level width of about $0.02kT_c$.

*L. C. Hebel and C. P. Slichter, *Phys. Rev.,* **107,** 901 (1957).
†A. G. Redfield, Meeting of the International Institute of Refrigeration, Delft, The Netherlands (1958).

Observations on the Differential Thermal Analysis of Copper Sulfate Pentahydrate, A. Reisman and J. Karlak, *Journal of the American Chemical Society,* **80,** 6500 (December 20, 1958).

An analysis of the applicability of differential thermal analysis to processes involving the depletion of one component is presented using $CuSO_4 \cdot 5H_2O$ as an example. It is demonstrated that the complex nature of the non-equilibrium dehydration process can readily lead to a misinterpretation of the nature of the observed differential peaks. In addition, it is shown that slight variations of experimental conditions affect the results considerably, thereby accounting for the apparent discrepancies between different studies.

Photochemistry of Complex Ions. I. Some Photochemical Reactions of Aqueous $PtBr_6^{-2}$, $Mo(CN)_8^{-4}$ and Various Co(III) and Cr(III) Complex Ions, Arthur W. Adamson* and A. H. Sporer, *Journal of the American Chemical Society,* **80,** No. 15, 3865-3870 (August 5, 1958).

Studies have been made of the photochemistry of aqueous $Co(NH_3)_6^{+3}$, $Co(NH_3)_5X^{+2}$ (X=SCN, Cl, I), $Co(CN)_5X^{-3}$ (X = CN, Cl, Br, I), $Co(C_2O_4)_3^{-3}$, $Cr(NH_3)_5SCN^{+2}$, $Cr(NH_3)_2(SCN)_4^-$, $Cr(C_2O_4)_3^{-3}$, $Mo(CN)_8^{-4}$, and the exchange system $PtBr_6^{-2}$ - Br^-. Quantum yields were obtained for the oxidation-reduction decompositions, aquation, racemization or exchange reactions that occurred, usually for two wavelengths, one in the ligand field band region and one in the electron transfer band region of the absorption spectra. The results are interpreted to indicate that the chemical nature of the excited state is qualitatively independent of the wavelength of the light used. On the other hand, the net consequence of light absorption depends upon which of several possible courses is taken subsequent to the formation of the primary excited state.

*Department of Chemistry, University of Southern California

A Poynting Theorem for Moving Bodies and the Relativistic Mechanics of Extended Objects,* Norman H. Meyers, *Journal of the Franklin Institute,* **256,** No. 6, 439-464 (December, 1958).

Maxwell's macroscopic field equations have long been regarded as the correct formulation of electrodynamic behavior, even in the presence of moving materials. However, they do not lead to a Poynting theorem which can be given a reasonable physical interpretation with moving media present. The difficulty is that Maxwell's equations are not sufficiently general. Recently Lan J. Chu postulated a modified set of electrodynamic relationships which are self-consistent and which reduces to Maxwell's equations in the presence of motionless material. It is shown that these equations lead to a Poynting-type theorem which is easy to interpret physically even in the presence of moving media.

The thorough interpretation of this Poynting theorem requires a study of the macroscopic meaning of force and power. An approach to the relativistic mechanics of extended objects is postulated which is consistent with macroscopic electrodynamics and the requirements of special relativity.

*This work was done under the sponsorship of The Energy Conversion Group, Servomechanisms Laboratory, MIT.

The Present Status and Anticipated Progress in the Field of Electrical Insulation,* T. D. Callinan, *Insulation,* **4,** 21-22 (July, 1958).

A large number of insulating materials are now available for the design of power equipment. Fewer such materials are available to the telecommunications designer and very few materials are specifically produced for the designer of auto-

matic detection and control equipment. The prospects are good that in the foreseeable future many materials capable of withstanding high temperatures will become available to the power engineer, that the reason dielectrics have low electric strength at high frequencies will be understood, and that fatigue in ferroelectrics will be eliminated.

*Published during the period July through September, 1958.

Self-Diffusion, Mutual Diffusion and Nuclear Spin Relaxation Measurements in He^3, R. L. Garwin and H. A. Reich, *Physica,* S133, No. 4 (September, 1958), Proceedings of the Kamerlingh Onnes Conference on Low Temperature Physics, Leiden, The Netherlands (June 23-28, 1958).

Spin-echo measurements of diffusion and relaxation in He^3 liquid show a diffusion coefficient which falls only slightly between 3° and 1.8°K and extrapolates from 1.1° to 0°K at a finite D (about $2 \times 10^{-5} cm^2/sec$). D varies with molar volume V in the liquid as V^3 over a factor 6 in D, but simultaneous measurements of D and relaxation time T_2 in the coexisting liquid and solid show that the solid has T_2 and D three orders of magnitude less than the liquid at the same P, T, and similar V. D is expected to rise for pure He^3 below the degeneracy temperature, and this question is being investigated to 0.5°K with a He^3 refrigeration system and lower with a continuous demagnetization refrigerator. Two percent He^3 in He^4 shows the expected rise in D with decreasing T below $T\lambda$ as the excitations are frozen out of the He^4, leaving only the He^4 ground state, analogous to the vacuum of quantum electrodynamics. T_1 for the He^3 does not increase as the square of the dilution, the relaxation remaining a bulk phenomenon, giving perhaps an indication of a clustering of the He^3 atoms in the solution.

A Two-Hour Course in Report Writing, R. E. Hohmann, *IRE WESCON Convention Record,* **2,** 30-34 (Part 9, 1958).

The two basic problems in technical writing (particularly in report-writing for research and development projects) are: (1) choosing an organizational format; and (2) adopting a writing style that is clear, concise, and effective. This paper describes a two-page organizational format that is applicable to 90% of the writing requirements (reports) required by research and development programs. The organizational format is complemented by four recommended writing practices which, in themselves, account for 75% of the effectiveness of writing style. These two techniques (organizational format and writing style) can be learned in one two-hour session.

Water Vapor Pressures above Sodium Hydroxide and Mixtures of Sodium Hydroxide and Sodium Oxide in the Vicinity of 300°, Eric Kay and N. W. Gregory,* *Journal of the American Chemical Society,* **80,** No. 21, 5648-5651 (November 5, 1958).

An effusion study of the $NaOH$-Na_2O-H_2 system between 260° and 310°C yields water pressures significantly higher than expected from reported thermodynamic properties. Vaporization of NaOH was not detected below 310°. Limited solubility of Na_2O in NaOH in the solid phase, less than 10% at 305°, is indicated. Thermodynamic properties are discussed.

*Department of Chemistry, University of Washington.

What You Should Know About Designing for Reliability, Dimitris N. Chorafas,* *Product Engineering,* **29,** No. 46, 76-77 (November 10, 1958).

A review was made of the concept of reliability of mechanical parts. The probability of equipment failure is expressed as an exponential curve, which changes in shape according to the status of basic research, applied research and development, mass production, and operation. An example is given, showing percentage reliability of manned aircraft and guided missiles over a period of five years.

*IBM World Trade Corp., and The Catholic University of America.