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The Effect of Inhomogeneities on the Electrical Properties of Diamond.
A. J. AHEARN[1]. *Phys. Rev.*, **84**, pp. 798–802, Nov. 15, 1951.

To account for the non-uniformities in the electrical properties of diamond, particularly those observed in bombardment conduction, the proposal is made that the well-known lattice imperfections are not distributed homogeneously in the physical crystal, and that the resulting fluctuations in the height of the energy bands relative to the Fermi level might produce interspersed "pools of mobile charge" separated by barriers within the diamond. These pools and barriers should lead to dielectric losses at high frequencies. A single conducting channel, in series with a barrier, could be represented by a series resistance R_s and capacity C_s or by the equivalent parallel resistance R_p and capacity C_p.

With some, but not all, diamonds measurable dielectric losses at 70 mc/sec were observed. R_p varied from 5×10^6 ohms, the limit of measurement, to 4×10^5 ohms. Furthermore, the proposed model suggests that, in some cases, these barriers might be sufficiently lowered to establish a dc conducting channel all the way through a crystal. With a few of the lossy diamonds precisely this phenomenon of "high conduction" has been observed, in which a resistance of the order of a megohm is obtained with a dc voltage applied. This current appears abruptly in time but it lags behind the application of the voltage. This lag is influenced by irradiation with light or alpha-particles or by previous treatment.

The proposed pools of mobile charge are a sufficient but not necessary description of the dielectric loss observations, but the high conduction phenomenon lends further support to this idea of conducting channels with barriers in lossy diamonds. Such localized conducting channels would introduce inhomogeneities into an otherwise uniform electric field applied across an insulator. In bombardment conduction, measurements of counting efficiency could be very sensitive to field inhomogeneities.

Under alpha-particle bombardment a large variation in counting efficiency over the surface of typical diamonds is shown. In a group of 20 diamonds, most of those that exhibited definite losses also had high (≥ 25 per cent) counting efficiencies in some region, and the majority of the remainder had low counting efficiencies. These experiments lend further support to the suggestion that in-

homogeneous fields at least partially account for the inhomogeneities in bombardment conduction.

Serious errors in the normal estimates of range and mobility of electrons or holes in insulators can be introduced by neglecting these field inhomogeneities.

Diffusion in Alloys and the Kirkendall Effect. J. BARDEEN[1] and C. HERRING[1]. Pp. 87–111. *Am. Soc. for Metals.* Atom movements; a seminar . . . held during the thirty-second National Metal Congress and Exposition, Chicago, Oct. 21–27, 1950. Cleveland, Ohio, Am. Soc. for Metals, 1951. 240 p.

Some Roots of an Equation Involving Bessel Functions. B. P. BOGERT[1]. *Jl. Math. Phys.,* **30,** pp. 102–105, July, 1951. (Monograph 1903).

Creep Test Methods for Determining Cracking Sensitivity of Polyethylene Polymers. W. C. ELLIS[1] and J. D. CUMMINGS[1]. *A.S.T.M. Bull.,* No. 178, pp. 47–49, Dec., 1951.

Conventional creep testing methods for evaluating the cracking sensitivity of polyethylene polymers are described. The tests show that sensitivity to cracking in the presence of an active agent decreases with increasing average molecular weight of the polymer. For a given stress condition and environment, there appears to be a threshold value of stress and strain for the occurrence of cracking.

Observer Reaction to Video Crosstalk. A. D. FOWLER[1]. *J. Soc. Motion Picture and Television Engrs.,* **57,** pp. 416–424, Nov., 1951. (Monograph 1928).

Presented here are results of tests to determine how much video crosstalk can be tolerated in black-and-white television pictures. Experienced observers viewed a television picture and rated the disturbing effects of controlled amounts of crosstalk from another video system. Crosstalk coupling was simulated by a network which permitted changes in frequency characteristic as well as in coupling loss. Tolerable limits for crosstalk coupling are derived from the test results.

Mass Spectrometric Studies of Molecular Ions in the Noble Gases. J. A. HORNBECK[1] and J. P. MOLNAR[1]. *Phys. Rev.,* **84,** pp. 621–625, Nov. 15, 1951.

Molecular ions of the rare gases (He_2^+, Ne_2^+, A_2^+, Kr_2^+, and Xe_2^+) produced by electron impact at gas pressures from 10^{-4} to 10^{-2} mm Hg have been studied with a small mass spectrometer. The ion intensity increased linearly with electron current and with the square of the gas pressure. The form of the ionization versus electron energy curves resembles closely curves of excitation probability by electron collision. The appearance potentials of the molecular ions were less

than those of the atomic ions by $1.4^{+0.7}_{-0.2}$ volts in He, $0.7^{+0.7}_{-0.3}$ volt in Ne, $0.7^{+0.7}_{-0.2}$ volt in A, $0.7^{+0.7}_{-0.3}$ volt in Kr. These results can be interpreted, we believe, only by assuming that the process of formation of the molecular ions observed in this experiment is, using helium as an example, an excitation by electron impact, He + e + K.E. → He* + e, followed by the collision process, He* + He → He$_2^+$ + e, where He* stands for a helium atom raised to a high-lying excited state. Our results differ from those of Arnot and M'Ewen on helium particularly in that they reported the appearance potential low enough to permit metastable atoms to form molecular ions.

The Drift Velocities of Molecular and Atomic Ions in Helium, Neon, and Argon. J. A. HORNBECK[1]. *Phys. Rev.*, **84**, pp. 615–620, Nov. 15, 1951.

Drift velocity measurements as a function of E/p_0, the ratio of field strength to normalized gas pressure, are presented for atomic and molecular ions of He, Ne, and A in their respective parent gases. Identification of the molecular ions is based upon the time resolution of the apparatus and the dependence of ion concentration on pressure, applied voltage, and gas purity. Extrapolation of the low field measurements to zero field yields mobility values for atomic ions, μ_0 (He$^+$) = 10.8 cm^2/volt sec, μ_0 (Ne$^+$) = 4.4, and μ_0 (A$^+$) = 1.63 in good agreement with theory: Massey and Mohr compute μ_0 (He$^+$) = 11, and Holstein gives μ_0 (Ne$^+$) = 4.1 and μ_0 (A$^+$) = 1.64. Drift velocity data at low field for the molecular ions agree within experimental error with data of Tyndall and Powell (He), and Munson and Tyndall (Ne and A), which they assigned to atomic ions. A qualitative description in terms of ion-atom interaction forces is given for the observed field variation of the atomic ion drift velocities up to high E/p_0.

Checking Analogue Computer Solutions. E. LAKATOS[1]. *Proc. Inst. Radio Engrs.*, **39**, p. 1571, Dec., 1951.

Experimental Heat Contents of SrO, BaO, CaO, BaCO$_3$ and SrCO$_3$ at High Temperatures. Dissociation Pressures of BaCO$_3$ and SrCO$_3$. J. J. LANDER[1]. *J. Am. Chem. Soc.*, **73**, pp. 5794–5797, Dec., 1951. (Monograph 1930).

The high temperature heat contents of SrO, BaO, CaO, BaCO$_3$ and SrCO$_3$ have been measured using the "drop" method. Values have been obtained for the heats of the transitions of the carbonates. The dissociation pressures of the carbonates have been measured to pressures below 0.1 mm and values calculated for lower pressures from the observed heat contents and observed dissociation pressures at higher temperatures.

Electron-Hole Production in Germanium by Alpha-Particles. K. G. McKAY[1]. *Phys. Rev.*, **84**, pp. 829–832, Nov. 15, 1951.

The number of electron-hole pairs produced in germanium by alpha-particle

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bombardment has been determined by collecting the internally produced carriers across a reverse-biased n-p junction. No evidence is found for trapping of carriers in the barrier region. Studies of individual pulses show that the carriers are swept across the barrier in a time of less than 2×10^{-8} sec. The counting efficiency is 100 per cent. The energy lost by an alpha-particle per internally produced electron-hole pair is 3.0 ± 0.4 ev. The difference between this and the energy gap is attributed to losses to the lattice by the internal carriers. It is concluded that recombination due to columnar ionization is negligible in germanium.

The n-p-n *Junction as a Model for Secondary Photoconductivity.* K. G. McKay[1]. *Phys. Rev.*, **84**, pp. 833–835, Nov. 15, 1951.

A germanium n-p-n junction with the p region floating, has been subjected to alpha-particle bombardment. The transient currents resulting from individual incident alphas have been studied. This enables one to study the rate of decay of excess holes in the p-region. This decay time appears to increase with applied bias, pass through a maximum, and eventually approach a constant value. The total charge flowing across the unit, as a result of the bombardment by a single alpha-particle, may become large; quantum yields of greater than 60 have been observed. The unit possesses many of the important characteristics of materials which exhibit "secondary photoconductivity." It is concluded that various forms of n-p-n barriers must therefore play an important role in such materials and that their understanding can be greatly facilitated by studies of n-p-n barriers in germanium.

Frequency Detection and Speech Formants. E. Peterson[1]. *Acoustical Soc. Am., Jl.*, **23**, pp. 668–674, Nov., 1951.

This study is aimed primarily at evaluating the utility of axis-crossing detectors in tracking speech formants. Detectors of the usual type are found subject to an error, fundamental in nature. To remove this source of error speech is modulated up in frequency as a single sideband before limiting and detecting processes are applied. Experimental results with this carrier type of detector on a small number of speech samples are presented, and compared with spectrograms. Conclusions are that the average axis-crossing rates cannot be trusted in general to follow specific formants, whether the speech is normal or differentiated. But when the formants are sufficiently localized by frequency selectivity, prospects of tracking the lower formants look promising.

Transistor Circuit Design. G. Raisbeck[1]. *Electronics*, **24**, pp. 128–132, 134, Dec., 1951. (Monograph 1932).

How to derive amplifier, oscillator, modulator and multi-vibrator transistor circuits from known vacuum-tube circuits. Technique, known as duality, is explained in detail and may be applied to any complex vacuum-tube circuit to find the corresponding transistor circuit.

Communication Theory—Exposition of Fundamentals. C. E. Shannon[1]. Pp. 44–47. General treatment of the problem of Coding. Pp. 102–104.

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Great Britain. Ministry of Supply. Symposium on Information Theory. Report of Proceedings held . . . Royal Soc., Burlington House, Lond., Sept. 26–29, 1950.

On the Relation Between the Sound Fields Radiated and Diffracted by Plane Obstacles. F. M. WIENER[1]. *J. Acoust. Soc. Am.,* **23,** pp. 697–700, Nov., 1951.

In the past, acoustic diffraction and radiation problems have often been treated separately, although their intimate connection is clear from theory. In the case of plane piston radiators and plane rigid scatterers exposed to a perpendicularly incident plane wave, this connection becomes particularly simple and useful. It is easy to show that the radiated sound field is everywhere the same as the field scattered (diffracted) in the diffraction case, except for a factor of proportionality. It is also shown that the reaction of the medium on the radiator, as expressed by the mechanical radiation impedance, is equal to the force per unit incident pressure exerted on the same obstacle, held rigid as a scatterer, except for a factor of proportionality. By way of illustration, the foregoing principles are applied to the important case of the circular disk.

Magnetic Modulators. E. P. FELCH[1], V. E. LEGG[1], and F. G. MERRILL[1]. References. *Electronics,* **25,** pp. 113–117, Feb., 1952.

Conversion of low-level, low-frequency or dc signals to ac signals capable of being amplified by conventional means is accomplished by magnetic-amplifier-type device that combines high efficiency and reliability with extreme ruggedness.

Conservation of Nickel. G. R. GOHN[1]. *A.S.T.M., Bull.,* No. 179, p. 32, Jan., 1952.

The Mechanism of Electrolytic Rectification. H. E. HARING[1]. *Electrochem. Soc., Jl.,* **99,** pp. 30–37, Jan., 1952. (Monograph 1929).

An electrochemical theory is proposed for rectification, as exemplified by the tantalum (or aluminum) electrolytic rectifier and capacitor. A detailed consideration of the mechanism of formation of the oxide film which constitutes the rectification barrier leads to the conclusion that this barrier consists of an electrolytic polarization, in the form of a concentration gradient of excess metal ions, permanently fixed or "frozen" in position in an otherwise insulating matrix of electrolytically-formed oxide. The physical structure which has been described functions as (a) a current-blocking ionic space charge or (b) a current-passing electronic semiconductor, depending solely upon the direction of the applied voltage. The movement of electrons only is required. An explanation for breakdown of the barrier at excessively high voltages is suggested. This explanation may be applicable to dielectric breakdown of other kinds.

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Nullification of Space-Charge Effects in a Converging Electron Beam by a Magnetic Field. M. E. HINES[1]. *Proc. Inst. Radio Engrs.,* **40,** pp. 61–64, Jan., 1952. (Monograph 1935).

This paper presents the conditions necessary for maintaining a uniformly converging conical electron beam in the presence of space charge. It is an extension of the Brillouin focusing condition to conical flow, requiring a converging rather than a uniform magnetic field. In this type of electron flow, the diverging effects of space charge are balanced against magnetic reaction forces for reasonably small cone angles of convergence. Though the balance of forces is exact only for infinitesimal angles, it is reasonably accurate for cones of half-angle as great as 10 degrees. The minimum beam size will be limited only by the effects of thermal velocities, by gun aberrations, and by the magnetic field obtainable.

Continuous Motion Picture Projector for Use in Television Film Scanning. A. G. JENSEN[1], R. E. GRAHAM[1], and C. F. MATTKE[1]. Bibliography. *J. Soc. Motion Picture and Television Engrs.,* **58,** pp. 1–21, Jan., 1952.

The projector used for this equipment drives a 35-mm motion picture film at the standard (nonintermittent) speed of 24 frame/sec and produces a television signal of 525 lines and 30 frames interlaced 2 to 1. The projector utilizes a system of movable plane mirrors mounted on a rotating drum and controlled by a single stationary cam. Vertical jitter in the television image is minimized by means of an electronic servo system operating on the film sprocket holes, resulting in a residual vertical motion of about 1/2000 of a picture height. A second electronic servo system is incorporated to suppress flicker. The combination of this scanner and a high-grade monitor is capable of producing a television picture with a resolution corresponding to about 8 mc and with good tone rendition over a range up to 200 to 1.

Low Temperature Polymorphic Transformation in WO_3. B. T. MATTHIAS[1] and E. A. WOOD[1]. *Phys. Rev.,* **84,** p. 1255, Dec. 15, 1951.

The Concentration of Molecules on Internal Surfaces in Ice. E. J. MURPHY[1]. *J. Chem. Phys.,* **19,** pp. 1516–1518, Dec., 1951.

In this paper the experimental expression for the "local conductivity" of ice is given. This expression has two terms, one of which has already been discussed and brought into close relation with the structure of ice, that is, with its heat of sublimation and its lattice constant. This paper brings out another relation, deriving it from the second term of the experimental expression. It is concluded from an analysis outlined here that the second term of the local conductivity gives the concentration of molecules in "internal surfaces". For the specimen of ice to which this method was applied the concentration of molecules on internal surfaces comes out as 1.03×10^{17} molecules/cc. This is proposed as a new method of studying imperfections (internal surfaces) in dielectric crystals, and one which seems to be well suited to this purpose. It gains its advantages from

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the fact that it is not dependent upon the regularity of the imperfections, as in x-ray diffraction methods, or upon the connectivity of the system of internal surfaces, as in direct current condution.

Meditations on Physics Today. J. R. PIERCE[1]. *Phy. Today,* **5,** p. 3, Jan., 1952.

Stabilization of Dielectrics Operating Under Direct Current Potential. H. A. SAUER[1], D. A. McLEAN[1], and L. EGERTON[1]. *Ind. Eng. Chem.,* **44,** pp. 135–140, Jan., 1952.

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