

Abstracts of Technical Articles from Bell System Sources

*Directional Ferromagnetic Properties of Metals.*¹ R. M. BOZORTH. This is a review of the magnetic properties of single crystals of iron, cobalt and nickel and their alloys with each other. After a general introduction and a description of recently developed technique some new results are described which show for the first time that such crystals are anisotropic in low as well as in high fields. The amount of anisotropy is expressed usually by one "anisotropy constant" but sometimes a second constant is necessary. These constants vary with composition and temperature and their values are shown in tables and curves. When the constants are small the material is especially sensitive to strain and heat-treatment; this condition applies to some of the iron-nickel alloys (permalloys). Small amounts of impurities affect the magnetic properties in low fields. By careful purification and heat-treatment several crystals have been made which have permeabilities of over 1,000,000.

*Use of Negative Regeneration in Radio Receivers.*² C. B. FISHER. This paper gives a brief and simple explanation of gain stabilization which can be secured by employment of the feedback property of an amplifier.

*Electron Diffraction Studies of Cuprous Oxide.*³ L. H. GERMER. Etched surfaces of single crystals of cuprous oxide produce electron diffraction patterns consisting of spots and Kikuchi lines. In some cases lines are observed corresponding to all of the most widely spaced planes of copper atoms which are so situated as to be able to give reflections on the photographic plate. An example is given, however, of a diffraction pattern from which lines due to the most widely spaced plane of atoms (111), are missing when this plane lies parallel to the primary beam direction; the lines appear when the crystal is rotated to destroy this parallelism. The existence of Kikuchi line patterns indicates that the surfaces of etched cuprous oxide single crystals are relatively smooth. When spot patterns also appear they show anomalies which seem attributable to refraction, thus confirming the conclusion regarding smoothness. An example is given of an array of

¹ *Jour. of Applied Physics*, September 1937.

² *R. M. A. Engineer*, November 1937.

³ *Phys. Rev.*, November 1, 1937.

spots made up of three distinct patterns which are displaced with respect to each other and with respect to the primary beam position. Polycrystalline surfaces made up of rather large crystals produce patterns of spots which are often drawn out into streaks lying approximately parallel to the plane of incidence. This effect, which is attributable to refraction and is a proof of smoothness of the surface, is most pronounced after etching in nitric acid. It is rarely, or never, found after etching in a mixture of hydrogen peroxide and ammonium hydroxide. Nitric acid etch produces upon the surface of a single crystal of cuprous oxide, or upon a polycrystalline surface made up of rather large crystals, crystals of some new compound which are cubic with cell edge 8.35A. These are sharply oriented with one or another of the most important planes parallel to the gross surface plane of the oxide. The sharpness of this orientation is proof of the flatness of the underlying oxide surface upon which the crystals are formed. This new 8.35A structure is produced by potassium cyanide etch as well as nitric acid, but never by sulphuric acid nor by ammonium hydroxide.

*On the Ionization of the F₂ Region.*⁴ W. M. GOODALL. In this paper the available data on F₂ region ionization for Peru, Australia, and this country are analyzed in a way that permits the separation of effects due to variations in solar ionizing force from effects due to seasonal and annual changes. It is shown that for constant solar activity the expected curves of critical frequency for Australia and this country appear to indicate both seasonal and annual tendencies. It is suggested as a possibility that the apparent "annual" effect may in fact be due to meteorological conditions which cannot be eliminated without data from more locations.

*Coupling Between Parallel Earth-Return Circuits Under D-C Transient Conditions.*⁵ K. E. GOULD. In tests conducted in connection with several d-c railway electrifications, the induced voltages recorded in paralleling communication circuits at times of short circuit on the railway have shown marked divergences from values computed on the basis of uniform earth resistivity and a rate of change of earth current determined from measurements in trolley and rail circuits. Due to the numerous factors which might contribute to these divergences, such as non-uniform division of transient current along the tracks and associated return conductors, the presence of shielding conductors along or near the right-of-way, etc., it was felt that a better understanding of the problem of induction under d-c transient conditions

⁴ *Proc. I. R. E.*, November 1937.

⁵ *Elec. Engg.*, September 1937.

could be obtained by experimental studies of the transient coupling between parallel earth-return circuits, free from the effects of shielding conductors, and with concentrated, rather than distributed, grounds. The study described in this paper was undertaken for this purpose.

*Energy of Lattice Distortion in Cold Worked Permalloy.*⁶ F. E. HAWORTH. The lattice distortion produced by severe cold working of permalloy of 70 per cent Ni content has been studied by measuring the broadening of the reflection of the Fe $K\alpha$ doublet by the (311) planes, with a focusing camera. The broadening decreases upon annealing and recovery is complete at 650° C, when the breadth of the x-ray intensity curve at half-maximum is as small as that obtained by use of the two-crystal spectrometer. The mean square distortion in the lattice spacing due to cold work is derived from the X-ray measurements after photometering the x-ray film, converting the curve into an x-ray intensity curve, fitting the latter with an empirical equation and using an analysis worked out by S. O. Rice. The energy of the distortion is then calculated by using an equation derived by G. R. Stibitz. The root-mean-square distortion was found to be 0.31 per cent of the lattice spacing after the material had been reduced 96 per cent in cross-sectional area by cold working. The energy of distortion in the hard worked condition is thus found to be 23×10^6 ergs/cm³ or 0.065 calorie/gram.

*Optical Constants of Rubidium and Cesium.*⁷ HERBERT E. IVES AND H. B. BRIGGS. In previous papers the authors have presented the results of measurements of the optical constants of potassium and sodium in the ultra-violet and visible ranges of the spectrum, with a description of the apparatus used and the method of making measurements. The present paper deals with the results of measurements of the optical constants of rubidium and cesium by the same methods and for the same wave-length range. As with sodium and potassium, previous investigations of the optical constants of these metals were confined to the visible region of the spectrum.

The author's original interest in these constants lay in their application to the theory of photoelectric emission from thin films. In order to test this theory a knowledge of both the refractive index and the extinction coefficient of the metals concerned is needed for the spectral range embracing the characteristic photoelectric emission of the thin films. The work described in this paper is intended to supply this need.

⁶ *Phys. Rev.*, September 15, 1937.

⁷ *Jour. Opt. Soc. Amer.*, November 1937.

*Minimum Noise Levels Obtained on Short-Wave Radio Receiving Systems.*⁸ KARL G. JANSKY. The theoretical minimum noise level of receivers in the absence of any interference, the source of which is external to the receiver, is discussed and compared with the limit actually measured on various antennas over a limited frequency range in the short-wave spectrum. It is pointed out that, on the shorter wave lengths and in the absence of man-made interference, the usable signal strength is generally limited by noise of interstellar origin. The powers obtained from this noise with the various antennas and for different times of the day are given.

Recently, man-made interference, of which that caused by diathermy machines constitutes the greatest part, has become so extensive that it is now the limiting noise during most of the daylight hours. Data are given on the intensity and extent of this form of interference.

*Superstructures in Alloy Systems.*⁹ FOSTER C. NIX. A review of the literature treating superstructures in alloys. The presence of a superstructure produces new X-ray diffraction lines,—commonly called superstructure lines. The elements of superstructure theories are presented including the Bragg-Williams and Bethe-Peierls treatments. The author discusses the effect of a superstructure or an ordered phase on the thermal, mechanical, electrical and magnetic properties of alloys. A comparison is made between the theoretical predictions and the experimental results for both the specific heat and the energy of transformation. A Cu_3Au alloy becomes disordered more rapidly near the critical temperature of order, T_c , than the theories predict. A large anomalous specific heat is observed above T_c ,—as predicted by the Bethe-Peierls theory.

*Moment Recurrence Relations for Binomial, Poisson and Hypergeometric Frequency Distributions.*¹⁰ JOHN RIORDAN. This paper gives a uniform development of recurrence relations for moments about the origin and mean of binomial, Poisson, and hypergeometric frequency distributions. Uniformity is obtained through the use of the moment arrays of H. E. Soper. Both types of moments are expressed in terms of coefficients which are alike for the three distributions; for the moments about the origin these coefficients are the Stirling numbers of the second kind. Moment recurrence relations follow from recurrence relations for these coefficients. The recurrences for the hypergeometric moments appear to be new. For working purposes,

⁸ *Proc. I. R. E.*, December 1937.

⁹ *Jour. Applied Physics*, December 1937.

¹⁰ *Annals of Math. Statistics*, June, 1937.

moments about the mean of binomial and Poisson distributions are expressed in terms of auxiliary moment coefficients with recurrence relations which also appear to be new.

*Extending the Frequency Range of the Negative Grid Tube.*¹¹ A. L. SAMUEL. The conventional vacuum tube when adapted for use at ultra-high frequencies carries with it many of the desirable attributes which it possesses at lower frequencies, such for example as its ability to amplify and the ease with which satisfactory frequency stability can be obtained. However, difficulties are encountered because of the effects of the finite electron transit time and because of certain circuit limitations. Methods of circumventing these restrictions are discussed and illustrated by reference to specific tubes. The paper closes with a brief review of recent work directed toward extending the frequency range of the negative grid tube both as an oscillator and as an amplifier.

*Transmission Theory of Plane Electromagnetic Waves.*¹² S. A. SCHELKUNOFF. This paper deals with transmission theory of plane electromagnetic waves in free space and in cylindrical regions of arbitrary cross section. Transmission properties of such waves can be expressed very simply in the same terms as the properties of electric waves guided by a pair of parallel wires. The earlier parts of the paper are concerned with general theorems and the latter parts with their application to plane waves in metal tubes of circular and rectangular cross sections.

*The Empty Lattice Test of the Cellular Method in Solids.*¹³ W. SHOCKLEY. The cellular method of constructing wave functions for electrons in crystals developed principally by Wigner and Seitz and Slater is tested by applying it to an artificial crystal in which the potential is constant. Knowledge of the exact solutions for this case, plane waves, shows that the cellular method is quite accurate in the first Brillouin zone but may be in error by a factor of two in the second. Hence calculations of occupied levels in Li and Na are probably quite good; for Cu, Ca, diamond, LiF, and NaCl the errors will be larger. Calculations of excited states are likely to be very much in error. The accuracy of the cellular method is shown to improve very slowly with increasing number of continuity conditions.

*Sound Propagation in Ducts Lined with Absorbing Materials.*¹⁴ L. J. SIVIAN. In ventilator and exhaust systems it is desirable to provide

¹¹ *Jour. of Applied Physics*, October 1937.

¹² *Proc. I. R. E.*, November 1937.

¹³ *Phys. Rev.*, October 15, 1937.

¹⁴ *Jour. Acous. Soc. Amer.*, October 1937.

a high degree of attenuation for audio-frequency waves while offering low resistance to continuous or slowly pulsating air flow. For that purpose ducts lined with absorbing materials are sometimes used. This paper deals with sound propagation, particularly with its attenuation constant, in such ducts. Two types of lining are considered: (a) non-vibratile, i.e., a lining in which there is no wave motion propagated in the direction of the duct axis; (b) vibratile, i.e., a lining admitting of such motion. Methods for computing the propagation constants in terms of the acoustic constants of the lining, are given. Some experimental data are presented. Comparison of observed and computed values indicates that the computational procedure is substantially valid up to a frequency at which the sound wave-length is about twice the internal duct diameter.

*New Experimental Methods Applicable to Ultra-Short Waves.*¹⁵ G. C. SOUTHWORTH. This paper presents a new approach to the problem of electrical measurements at extremely high frequencies. It makes use of a relatively new principle whereby electromagnetic waves may be propagated through the interiors of hollow metal tubes. These tubes have for convenience been called wave guides. Their diameters must be at least 0.585 wave-length in order that power may be propagated. Some of the difficulties of previous methods have been incidental to radiation and spurious coupling effects. These have been largely eliminated by this method since the power resides almost entirely within the pipe. Short sections of wave guide may be made to resonate electrically much as organ pipes and air columns resonate acoustically. A high degree of sharpness may be obtained. Such a pipe may, therefore, play the role of a resonant circuit and become effectively a wave meter, a frequency determining unit for an oscillating vacuum tube or an impedance matching device. Specimens under study may be placed inside a resonant chamber and be subjected to electric fields of controlled intensities.

*Preparation of Large Single Crystals of Sodium Chloride.*¹⁶ H. WALTHER. An apparatus and a method are described, whereby single crystals of sodium chloride are produced in the form of bars 2 cm in diameter and 30 cm long. The crystal is drawn from the melt by means of a platinum rod which is dipped into it and which is raised and rotated simultaneously by a clock mechanism. An air stream from a circular nozzle surrounding the growing crystal immediately above the surface of the molten salt provides the steep

¹⁵ *Jour. Applied Phys.* October 1937.

¹⁶ *Rev. Sci. Instruments*, November 1937.

temperature gradient necessary for the continuous growth of the crystal. The orientation of the crystal with respect to the axis of the bar may be chosen at will.

*Magnetic Properties of Single Crystals of Silicon Iron.*¹⁷ H. J. WILLIAMS. The magnetization curves for the [100], [110] and [111] directions of single crystals of iron containing 3.85 per cent silicon were obtained from single crystal specimens cut in the form of hollow parallelograms so that the sides of each specimen were parallel to the tetragonal, digonal or trigonal axes, respectively. This method avoids the errors due to demagnetizing fields, inherent in previous measurements on single crystals. In addition to the well-known anisotropy at magnetizations above half of saturation, the data show for the first time considerable anisotropy at low magnetizations. A maximum permeability of 1,380,000, by far the highest ever reported for silicon iron, was observed in the [100] specimen after careful annealing. The magnetic anisotropy constants K_1 and K_2 were obtained from the magnetization curves and from torque measurements on a disk cut parallel to a (110) plane.

*The Quest of Vitamin B₁.*¹⁸ R. R. WILLIAMS. An account is given in semi-popular form of the events which led to a recognition of a dietary deficiency as the cause of Oriental beriberi. The steps are indicated which led to the isolation and synthesis of the lacking substance which is now known as vitamin B₁. The author began his researches on this subject in Manila in 1910 and has prosecuted them continuously since that time. In 1936 he had the gratification of effecting with Dr. J. K. Cline of Merck and Company a practical synthesis of this vital compound so that it is now produced artificially much more cheaply than it can be obtained in pure form from nature.

In presenting his work on the architecture of the molecule and its artificial reconstruction from synthetic sources, the author endeavors to make clear to the layman by analogy and otherwise the methods which the organic chemist employs in such a study. The highly inferential deductions concerning complex interatomic relationships which result from tearing the natural molecule apart reach a dramatic verification only when one finds he has actually reproduced in the laboratory the precise product of nature's art.

¹⁷ *Phys. Rev.*, October 1, 1937.

¹⁸ *Jour. Franklin Institute*, November 1937.