Abstracts of Technical Articles by Bell System Authors

Commercial Broadcasting Pioneer. The WEAF Experiment: 1922–1926.[1] WILLIAM PECK BANNING. *WEAF*, the radio call letters which for nearly a quarter of a century designated a broadcasting station famous for its pioneering achievements, ceased last November to have its old significance. *WNBC* are the new call letters. This book is an excellent record of the four years during which this station was the experimental radio broadcasting medium of the American Telephone and Telegraph Company.

The author indicates that the WEAF experiment aided the development of radio broadcasting in three ways:

First, in the scientific and technological field.

Second, in the emphasis of a high standard for radio programs.

Third, in determining the means whereby radio broadcasting could support itself.

When *WEAF* changed hands from the American Telephone and Telegraph Company to new ownership, public reaction to almost every type of broadcast had been tested, network broadcasting had been established and the economic basis upon which nationwide broadcasting now rests had been founded. A trail had been blazed that thereafter could be followed without hesitation.

In so far as radio broadcasting is concerned, this book is a significant chapter in communication history.

A Multichannel Microwave Radio Relay System.[2] H. S. BLACK, J. W. BEYER, T. J. GRIESER, F. A. POLKINGHORN. An 8-channel microwave relay system is described. Known to the Army and Navy as AN/TRC-6, the system uses radio frequencies approaching 5,000 megacycles. At these frequencies, there is a complete absence of static and most man-made interference. The waves are concentrated into a sharp beam and do not travel along the earth much beyond seeing distances. Other systems using the same frequencies can be operated in the near vicinity. The transmitter power is only one four-millionth as great as would be required with nondirectional antennas. The distance between sets is limited but by using intermediate repeaters communications are extended readily to longer distances. Short pulses of microwave power carry the intelligence of the eight messages utilizing *pulse position modulation* to modulate the

[1] Published by Harvard University Press, Cambridge, Massachusetts, 1946.
[2] *Elec. Engg., Trans. Sec.*, December 1946.

pulses and *time division* to multiplex the channels. The eight message circuits which each *AN/TRC*-6 system provides are high-grade telephone circuits and can be used for signaling, dialing, facsimile, picture transmission, or multichannel voice frequency telegraph. Two-way voice transmission over radio links totaling 1,600 miles, and one-way over 3,200 miles have been accomplished successfully in demonstrations.

Further Observations of the Angle of Arrival of Microwaves.[3] A. B. CRAWFORD and WILLIAM M. SHARPLESS. Microwave propagation measurements made in the summer of 1945 are described. This work, a continuation of the 1944 work reported elsewhere in this issue of the *Proceedings of the I.R.E. and Waves and Electrons*, was characterized by the use of an antenna with a beam width of 0.12 degree for angle-of-arrival measurements and by observations of multiple-path transmission.

The Effect of Non-Uniform Wall Distributions of Absorbing Material on the Acoustics of Rooms.[4] HERMAN FESHBACH and CYRIL M. HARRIS. The acoustics of rectangular rooms, whose walls have been covered by the non-uniform application of absorbing materials, is treated theoretically. Using appropriate Green's functions a general integral equation for the pressure distribution on the walls is derived. These equations show immediately that it is necessary to know *only* the pressure distribution on the treated surfaces to predict completely the acoustical properties of the room, such as the resonant frequencies, the decay constants, and the spatial pressure distribution. The integral equation is solved approximately using (1) perturbation method, and (2) approximate reduction of the integral equation to an equivalent transmission line. Criteria giving the range of validity of these approximations are derived. It was found useful to introduce a new concept, that of "*effective admittance*," to express the results for the resonant frequency and absorption for then the amount of computation is reduced and the accuracy of the results is increased. The absorption of a patch of material was found as a function of the position of the absorbing material and was checked experimentally for a convenient case, an absorbing strip mounted on the otherwise hard walls of a rectangular room. Particular attention is given to the case where the acoustic material is applied in the form of strips. The results may then be expressed in series which converge very rapidly and are, therefore, amenable to numerical calculation. Approximate formulas are obtained which permit estimates of the diffusion of sound in a non-uniformly covered room. In agreement with experience, these equations show that diffusion increases with frequency and with the

[3] *Proc. I.R.E. and Waves and Electrons*, November 1946.
[4] *Jour. Acous. Soc. America*, October 1946.

number of nodes on the treated walls. The "interaction effect" of one strip on another is shown to decrease with an increase of the number of nodes. The results are then applied to the case of ducts with non-uniform distribution of absorbing material on its walls. Results are given which permit the calculation of the attenuation per unit length of duct. The methods of this paper hold for any distribution of absorbing material and also if the admittance is a function of angle of incidence.

High Current Electron Guns.[5] L. M. FIELD. This paper presents a survey of some of the problems and methods which arise in dealing with the design of high current and high current-density electron guns. A discussion of the general limitations on all electron gun designs is followed by discussion of single and multiple potential guns using electrostatic fields only. A further discussion of guns using combined electrostatic and magnetic fields and their limitations, advantages, and some possible design procedures follows.

Reflection of Sound Signals in the Troposphere.[6] G. W. GILMAN, H. B. COXHEAD, and F. H. WILLIS. Experiments directed toward the detection of non-homogeneities in the first few hundred feet of the atmosphere were carried out with a low power sonic "radar." The device has been named the *sodar*. Trains of audiofrequency sound waves were launched vertically upward from the ground, and echoes of sufficient magnitude to be displayed on an oscilloscope were found. Strong displays tended to accompany strong temperature inversions. During these periods, transmission on a microwave radio path along which the sodar was located tended to be disturbed by fading. In addition, relatively strong echoes were received when the atmosphere was in a state of considerable turbulence. There was a well-defined fine-weather diurnal characteristic. The strength of the echoes was such as to lead to the conclusion that a more complicated distribution of boundaries than those measured by ordinary meteorological methods is required in the physical picture of the lower troposphere.

A Cathode-Ray Tube for Viewing Continuous Patterns.[7] J. B. JOHNSON. A cathode-ray tube is described in which the screen of persistent phosphor is laid on a cylindrical portion of the glass. A stationary magnetic field bends the electron beam on to the screen, while rotation of the tube produces the time axis. When the beam is deflected and modulated, a continuous pattern may be viewed on the screen.

[5] *Rev. Mod. Phys.*, July 1946.
[6] *Jour. Acous. Soc. Amer.*, October 1946.
[7] *Jour. Applied Physics*, November 1946.

The Molecular Beam Magnetic Resonance Method. The Radiofrequency Spectra of Atoms and Molecules.[8] J. B. M. KELLOGG and S. MILLMAN. A new method known as the "Magnetic Resonance Method" which makes possible accurate spectroscopy in the low frequency range ordinarily known as the "radiofrequency" range was announced in 1938 by Rabi, Zacharias, Millman, and Kusch (R6, R5). This method reverses the ordinary procedures of spectroscopy and instead of analyzing the radiation emitted by atoms or molecules analyzes the energy changes produced by the radiation in the atomic system itself. Recognition of the energy changes is accomplished by means of a molecular beam apparatus. The experiment was first announced as a new method for the determination of nuclear magnetic moments, but it was immediately apparent that its scope was not limited to the measurement of these quantities only. It is the purpose of this article to summarize the more important of those successes which the method has to date achieved.

Metal-Lens Antennas.[9] WINSTON E. KOCK. A new type of antenna is described which utilizes the optical properties of radio waves. It consists of a number of conducting plates of proper shape and spacing and is, in effect, a lens, the focusing action of which is due to the high phase velocity of a wave passing between the plates. Its field of usefulness extends from the very short waves up to wavelengths of perhaps five meters or more. The paper discusses the properties of this antenna, methods of construction, and applications.

Underwater Noise Due to Marine Life.[10] DONALD P. LOYE. The widespread use of underwater acoustical devices during the recent war made it necessary to obtain precise information concerning ambient noise conditions in the sea. Investigations of this subject soon led to the discovery that fish and other marine life, hitherto generally classified with the voiceless giraffe in noisemaking ability, have long been given credit for a virtue they by no means always practice. Certain species, most notably the croaker and the snapping-shrimp, are capable of producing noise which, in air, would compare favorably with that of a moderately busy boiler factory. This paper describes some of the experiments which traced these noises to their source and presents acoustical data on the character and magnitude of the disturbances.

Elastic, Piezoelectric, and Dielectric Properties of Sodium Chlorate and Sodium Bromate.[11] W. P. MASON. The elastic, piezoelectric, and di-

[8] *Rev. Mod. Phys.*, July 1946.
[9] *Proc. I.R.E. and Waves and Electrons*, November 1946.
[10] *Jour. Acous. Soc. America*, October 1946.
[11] *Phys. Rev.*, October 1 and 15, 1946.

electric constants of sodium chlorate ($NaClO_3$) and sodium bromate ($NaBrO_3$) have been measured over a wide temperature range. The value of the piezoelectric constant at room temperature is somewhat larger than that found by Pockels. The value of the Poisson's ratio was found to be positive and equal to 0.23 in contrast to Voigt's measured value of -0.51. At high temperatures the dielectric and piezoelectric constants increase and indicate the presence of a transformation point which occurs at a temperature slightly larger than the melting point. A large dipole piezoelectric constant (ratio of lattice distortion to dipole polarization) results for these crystals but the electromechanical coupling factor is small because the dipole polarization is small compared to the electronic and ionic polarization and little of the applied electrical energy goes into orienting the dipoles.

Paper Capacitors Containing Chlorinated Impregnants. Effects of Sulfur.[12] D. A. McLean, L. Egerton, and C. C. Houtz. Sulfur is an effective stabilizer for paper capacitors containing chlorinated aromatics, in the presence of both tin foil and aluminum foil electrodes. Sulfur has unique beneficial effects on power factor which are especially marked when tin foil electrodes are used. The value of R (Equation 4) can be used as an index of ionic conductivity in the impregnating compound. Diagnostic power factor measurements on impregnated paper are best made at low voltages. Electron diffraction studies give results in line with the previously published theory of stabilization. Several previous findings are reaffirmed: (a) the importance of all components of the capacitor in determining its initial properties and aging characteristics, (b) the superiority of kraft paper over linen, and (c) widely different behavior of capacitors employing different electrode metals.

A New Bridge Photo-Cell Employing a Photo-Conductive Effect in Silicon. Some Properties of High Purity Silicon.[13] G. K. Teal, J. R. Fisher, and A. W. Treptow. A pure photo-conductive effect was found in pyrolytically deposited and vaporized silicon films. An apparatus is described for making bridge type photo-cells by reaction of silicon tetrachloride and hydrogen gases at ceramic or quartz surfaces at high temperatures. The maximum photo-sensitivity occurs at 8400–8600A with considerable response in the visible region of the spectrum. The sensitivity of the cell appears about equivalent to that of the selenium bridge and its stability and speed of response are far better. For pyrolytic films on porcelain there are three distinct regions in the conductivity as a function of temperature. At low temperatures the electronic conductivity is given by the expression

[12] *Indus. & Engg. Chemistry*, November 1946.
[13] *Jour. Applied Physics*, November 1946.

$\sigma = Af(T)exp-(E/2kT)$. At temperatures between 227°C and a higher temperature of 400–500°C $\sigma = Aexp-(E/2kT)$, where E lies between 0.3 and 0.8 ev; and at high temperatures $\sigma = Aexp-(E/2kT)$, where $E = 1.12$ ev. The value 1.12 ev represents the separation of the conducting and non-conducting bands in silicon. The long wave limit of the optical absorption of silicon was found to lie at approximately 10,500A (1.18 ev). The data lead to the conclusion that the same electron bands are concerned in the photoelectric, optical, and thermal processes and that the low values of specific conductances found (1.8×10^{-5} ohm^{-1} cm^{-1}) are caused by the high purity of the silicon rather than by its polycrystalline structure.

Non-Uniform Transmission Lines and Reflection Coefficients.[14] L. R. WALKER and N. WAX. A first-order differential equation for the voltage reflection coefficient of a non-uniform line is obtained and it is shown how this equation may be used to calculate the resonant wave-lengths of tapered lines.

[14] *Jour. Applied Physics*, December 1946.