

## Abstracts of Technical Articles by Bell System Authors

*Audio-Frequency Measurements.*<sup>1</sup> † W. L. BLACK\* and H. H. SCOTT. This paper indicates the theory involved in making measurements of gain, frequency response, distortion, and noise at audio frequencies, with particular emphasis on such measurements made on high-gain systems. There are also discussed techniques of measurement and factors affecting the accuracy of results. This subject is not new art but has not previously been published in correlated form, to the knowledge of the authors.

*Growing Quartz Crystals.*<sup>2</sup> † E. BUEHLER and A. C. WALKER. The Bell Telephone Laboratories started an investigation of this subject in March 1946, based on information gleaned from several investigators who visited Germany after the war, particularly Mr. J. R. Townsend of these Laboratories, and Professor A. C. Swinnerton of Antioch College. After a relatively few experiments made with equipment similar to that used by Professor Richard Nacken in Germany, and with the process he described, it became apparent that Nacken had made substantial progress in the art of growing quartz at temperatures and pressures near the critical state of water, i.e., about 374°C, and 3,200 pounds per square inch. This report summarizes further progress that has been made in the Laboratories since March 1946.

*Corrosion of Telephone Outside Plant Material.*<sup>3</sup> † K. C. COMPTON and A. MENDIZZA. Problems resulting from corrosion in the telephone outside plant are many and varied. In this article an attempt is made to give a broad overall picture of these problems and the manner in which they are met and solved by the telephone plant engineer.

*Magnetic Recording in Motion Picture Techniques.*<sup>4</sup> JOHN G. FRAYNE and HALLEY WOLFE. Development of magnetic recording at the Bell Telephone Laboratories is described with the application of such facilities to Western Electric recording and reproducing systems. A method of driving 35-mm. magnetic film with a flutter content not greater than 0.1 per cent is described, as is a multigap erasing head.

*Semi-Conducting Properties in Oxide Cathodes.*<sup>5</sup> † N. B. HANNAY, D. MACNAIR, and A. H. WHITE. It has been widely assumed, without ade-

<sup>1</sup> *Proc. I. R. E.*, v. 37, pp. 1108-1115, October 1949.

\* Of Bell Tel. Labs.

<sup>2</sup> *Sci. Monthly*, v. 69, pp. 148-155, September 1949.

<sup>3</sup> *Corrosion*, v. 5, pp. 194-197, June 1949.

<sup>4</sup> *S. M. P. E. Jour.*, v. 53, pp. 217-234, September 1949.

<sup>5</sup> *Jour. Applied Physics*, v. 20, pp. 669-681, July 1949.

† A reprint of this article may be obtained by writing to the Editor of the Bell System Technical Journal.

quate experimental verification, that barium-strontium oxide, as used in the oxide cathode, is an excess electronic semi-conductor. Accordingly, the electrical conductivity of  $(\text{Ba},\text{Sr})\text{O}$  has been studied as a function of temperature before and after activation with methane, extensive precautions being taken to exclude spurious effects. The increase in conductivity obtained characterizes  $(\text{Ba},\text{Sr})\text{O}$  as a "reduction" semi-conductor, and hence very probably as an electronic semi-conductor whose conduction electrons arise from a stoichiometric excess of  $(\text{Ba},\text{Sr})$  atoms in solid solution.

A basic prediction of the semi-conductor theory has been tested quantitatively with the finding that the electrical conductivity and the thermionic emission of a  $(\text{Ba},\text{Sr})\text{O}$  cathode are directly proportional through three orders of magnitude of activation; well-defined chemical and electrical activation and deactivation procedures were used in obtaining this result. It may be concluded that activation represents an increase in the chemical potential of the electrons in the oxide, little or no change in the state of the surface occurring. It has also been found that deviations from the proportionality of conductivity and emission may be expected under conditions leading to inhomogeneity in the oxide, in agreement with the semi-conductor theory also.

*Electron Microscope and Diffraction Study of Metal Crystal Textures by Means of Thin Sections.*<sup>6</sup> † R. D. HEIDENREICH. Bethe's dynamical theory of electron diffraction in crystals is developed using the approximation of nearly free electrons and Brillouin zones.

The use of Brillouin zones in describing electron diffraction phenomena proves to be illuminating since the energy discontinuity at a zone boundary is a fundamental quantity determining the existence of a Bragg reflection. The perturbation of the energy levels at a corner of a Brillouin zone is briefly discussed and the manner in which forbidden reflections may arise at a corner pointed out. It is concluded that the kinematic theory is inadequate for interpreting electron images of crystalline films.

An electrolytic method for preparing thin metal sections for electron microscopy and diffraction is introduced and its application to the structure of cold-worked aluminum and an aluminum-copper alloy demonstrated. It is concluded that cold-worked aluminum initially consists of small, inhomogeneously strained and disoriented blocks about 200A in size. These blocks are not revealed by etching but would contribute to line broadening in conventional diffraction experiments. By means of a reorientation of the blocks through a nucleation and growth process, larger disoriented domains about 1-3 $\mu$  in size found experimentally could be accounted for. It is sug-

<sup>6</sup> *Jour. Applied Physics*, v. 20, pp. 993-1010, October 1949.

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gested that such a nucleation and growth reorientation phenomenon is responsible for self-recovering in cold-worked metals.

The formation of  $\text{CuAl}_2$  precipitate particles is demonstrated with both electron micrographs and diffraction patterns. A fine lamellar structure found in the quenched Al-4 per cent Cu alloy is at present unexplained.

*Path-Length Microwave Lenses.*<sup>7†</sup> WINSTON E. KOCK. Lens antennas for microwave applications are described which produce a focusing effect by physically increasing the path lengths, compared to free space, of radio waves passing through the lens. This is accomplished by means of baffle plates which extend parallel to the magnetic vector, and which are either tilted or bent into serpentine shape so as to force the waves to travel the longer-inclined or serpentine path. The three-dimensional contour of the plate array is shaped to correspond to a convex lens. The advantages over previous metallic lenses are: broader band performance, greater simplicity, and less severe tolerances.

*Refracting Sound Waves.*<sup>8†</sup> WINSTON E. KOCK and F. K. HARVEY. Structures are described which refract and focus sound waves. They are similar in principle to certain recently developed electromagnetic wave lenses in that they consist of arrays of obstacles which are small compared to the wave-length. These obstacles increase the effective density of the medium and thus effect a reduced propagation velocity of sound waves passing through the array. This reduced velocity is synonymous with refractive power so that lenses and prisms can be designed. When the obstacles approach a half wave-length in size, the refractive index varies with wave-length and prisms then cause a dispersion of the waves (sound spectrum analyzer). Path length delay type lenses for focusing sound waves are also described. A diverging lens is discussed which produces a more uniform angular distribution of high frequencies from a loud speaker.

*Double-Stream Amplifiers.*<sup>9†</sup> J. R. PIERCE. This paper presents expressions useful in evaluating the gain of a double-stream amplifier having thin concentric electron streams of different velocity and input and output gaps across which both streams pass.

*Direct Voltage Performance Test for Capacitor Paper.*<sup>10†</sup> H. A. SAUER and D. A. McLEAN. Performance of capacitors on accelerated life test may vary over a wide range depending upon the capacitor paper used. Indeed, at present a life test appears to be the only practical means for evaluating

<sup>7</sup> *Proc. I. R. E.*, v. 37, pp. 852-855, August 1949.

<sup>8</sup> *Acous. Soc. Amer. Jour.*, v. 21, pp. 471-481, September 1949.

<sup>9</sup> *Proc. I. R. E.*, v. 37, pp. 980-985, September 1949.

<sup>10</sup> *Proc. I. R. E.*, v. 37, pp. 927-931, August 1949.

† A reprint of this article may be obtained by writing to the Editor of the Bell System Technical Journal.

capacitor paper, since, within the limits observed in commercial material, the chemical and physical tests usually made do not correlate with life. Lack of correlation is ascribed to obscure physical factors which have not yet been identified.

Generally, several weeks are required to evaluate a paper by life tests of the usual severity. Unfortunately, the duration of these tests is too long for quality control of paper.

The desire for a life test which requires no more than a day or two for evaluation led to the development of a rapid d-c. test. The philosophy of rapid life testing is based upon the experimental evidence that the process of deterioration under selected temperature and voltage conditions is principally of a chemical nature, and also upon the well-known fact that rates of chemical reaction increase exponentially with temperature.

Life tests on two-layer capacitors conducted at 130°C. provide an acceleration in deterioration many fold more than that obtained in the lower-temperature life tests, and correlate well with these tests.