Abstracts of Bell System Technical Papers* Not Published in This Journal

Universal Equalizer Chart. D. A. Alsberg[1]. *Electronics*, **24**, pp. 132, 134, Nov., 1951.

Modification of familiar Smith chart consolidates on one time-saving plot all positive-value solutions to the two general equations for series, shunt, and bridged-T audio equalizers.

Limits on the Energy of the Antiferromagnetic Ground State. P. W. Anderson[1]. *Phys. Rev.*, **83**, p. 1260, Sept. 15, 1951.

Post-War Achievements of Bell Laboratories, *I.* O. E. Buckley[1]. *Bell Tel. Mag.*, **30**, pp. 163–173, Autumn, 1951.

Filamentary Growths on Metal Surfaces—"Whiskers". K. G. Compton[1], A. Mendizza[1], and S. M. Arnold[1]. *Corrosion*, **7**, pp. 327–334, Oct., 1951. (Monograph 1885).

Filamentary growths have been found on metal surfaces of some of the parts used in telephone communications equipment, particularly on parts shielded from free circulation of air. The growths are of the same character as those known as "whiskers," which developed between the leaves of cadmium plated variable air condensers and caused considerable trouble in military equipment during the early part of World War II. An investigation has been under way in an attempt to determine the mechanism of growth of the whiskers, found not only on cadmium plated parts but also on other metals. This paper summarizes the findings to date as revealed by the study of approximately one thousand test specimens of different metals, solid and plated, exposed under various environmental conditions. The study is being extended in the light of the findings which have developed during the course of the work.

An Unattended Broad-Band Microwave Repeater for the TD-2 Radio Relay System. R. W. Friis[1] and K. D. Smith[1]. *Elec. Eng.*, **70**, pp. 976–981, Nov., 1951. (Similar article in The Bell System Technical Journal,

* Certain of these papers are available as Bell System Monographs and may be obtained on request to the Publacation Department, Bell Telephone Laboratories, Inc., 463 West Street, New York 14, N. Y. For papers available in this form, the monograph number is given in parentheses following the date of publication, and this number should be given in all requests.

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October, 1951, Part II, entitled *The DT-2 Microwave Radio System* reprinted as Monograph 1921).

To meet the stringent requirements of the 4,000-mile transcontinental microwave relay system, a number of new developments had to be included in the design of the repeater stations. The circuits of these uuattended stations, and how they are maintained, are the subject of this article.

The Bell System's Part in Defending the Nation. F. R. KAPPEL[2]. *Bell Tel. Mag.*, **30**, pp. 141–152, Autumn, 1951.

Quickly and accurately checks performance of private or common-carrier p-m or f-m mobile telephone transmitters, such as those used in 30 to 44 -mc highway and 152 to 175-mc urban service. Measures r-f power output, audio sensitivity, signal-to-noise ratio and harmonic distortion and gives speech intelligibility check in few minutes.

Mobile Transmitter Testing Set. G. J. KENT[3]. *Electronics*, **24**, pp. 106–109, Nov., 1951.

A New Electrolysis Switch for Underground Lead Sheath Cable Drainage Systems. V. B. PIKE[1]. *Corrosion*, **7**, p. 1, Oct., 1951.

A High Temperature Stage for the Polarizing Microscope. E. A. WOOD[1]. *Am. Mineral.*, **36**, pp. 768–772, Sept.–Oct., 1951.

A Precise Sweep-Frequency Method of Vector Impedance Measurement. D. A. ALSBERG[1]. *Proc. I.R.E.*, **39**, pp. 1393–1400, Nov., 1951. (Monograph 1911).

The impedance of a two-terminal network is defined completely by the insertion loss and phase shift it produces when inserted between known sending and receiving impedances. Recent advances in precise wide-band phase and transmission measuring circuits have permitted practical use of this principle. Reactive and resistive impedance components are read directly from a simple graphical chart in which frequency is not a parameter. The basic principle described promises attractive possibilities in many cases of impedance measurements where present methods are inadequate.

Electron-Vibration Interactions and Superconductivity. J. BARDEEN[1]. *Revs. Modern Phys.*, **23**, pp. 261–270, July, 1951. (Monograph 1912).

The Copper Oxide Rectifier. W. H. BRATTAIN[1]. *Revs. Modern Phys.*, **23**, pp. 203–212, July, 1951.

It is shown that the conductivity in the ohmic part of the cuprous oxide layer can be explained with the usual band picture of semiconductors only by assum-

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ing the presence of some donor-type impurities in addition to the usual acceptor type. The energy difference between the acceptors and the filled band is 0.3 electron volt, and the total number of impurity atoms is about 10^{14} to 10^{16} per cm^3, the number of donors being less than but of the same order as the number of acceptors. One finds that the density of ion charge in the rectifying layer is of the same order of magnitude as the difference between the donors and acceptors found from the conductivity. The field at the copper-cuprous oxide interface is about 2 x 10^4 volts/cm; the height of the potential at the surface as compared with the oxide interior is about 0.5 volt; and the thickness of the space charge layer about 5.0 x 10^{-5} cm. The diffusion equation for flow of current through this space charge region can be integrated to give the current in terms of the field at the interface and the applied potential across the space charge layer. Two currents are involved, one from the semi-conductor to the metal (I_s) and one from the metal to the semiconductor (I_m) which is similar to a thermionic emission current into the semiconductor. The net current is, of course, $I = I_m - I_s$. One can get this "emission" current (I_m) by dividing the true current by the factor 1 - exp $(-eV_a/kT)$, where V_a is the applied potential. This emission current depends on the absolute temperature and on the field at the copper-cuprous oxide interface. At high fields the logarithm of the current is proportional to the square root of the field, and at low fields the current decreases more rapidly indicating a patchy surface having small areas of low potential maximum from which all the emission comes when the field is large.

Effect of Packaging on Corrosion of Zinc Plated Equipment. K. G. COMPTON[1], S. M. ARNOLD[1], and A. MENDIZZA[1]. *Corrosion*, **7**, pp. 365–372, Nov., 1951.

Physics as a Science and an Art. K. K. DARROW[1]. *Phys. Today*, **4**, pp. 6–11, Nov., 1951. (Monograph 1914).

The last of six invited papers presented on October 25th during the symposium on "physics today" which keynoted the 20th Anniversary Meeting of the American Institute of Physics in Chicago.

Ionization by Electron Impact in CO, N_2, NO, and O_2. H. D. HAGSTRUM[1]. *Revs. Modern Phys.*, **23**, pp. 185–203, July, 1951. (Monograph 1916).

Ionization by electron impact in diatomic gases has been studied in this work with a mass spectrometer designed to measure m/e, appearance potential, and initial kinetic energy for each ion observed. Results have been obtained for the gases CO, N_2 NO, and O_2 with some confirmatory work in H_2. Discussion is included of the nature and identification of dissociative ionization processes and of the retarding potential and appearance potential measurements. Values of important quantities such as the dissociation energies of CO, N_2, and NO; the sublimation energy of C; the electron affinity of O; and the excitation energy of O^- are determined again by electron impact in this work.

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Equivalent Temperature of an Electron Beam. M. E. HINES[1]., Letter to the Editor., *J. Appl. Phys.*, **22**, pp. 1385–1386, Nov., 1951.

Bell System Cable Sheath Problems and Designs. F. W. HORN[1] and R. B. RAMSEY[1]., *Elec. Eng.*, **70**, pp. 1070–1075, Dec., 1951. (Monograph 1917).

Engineering Planning. H. S. OSBORNE[2]. *J. Eng. Educ.*, **42**, pp. 121–125, Nov., 1951.

Acceptance Inspection of Purchased Material. J. E. PALMER[3] and E. G. D. PATERSON[1]. *Ind. Quality Control*, **8**, pp. 23–27, Nov., 1951.

A Note on the Partial Differential Equations Describing Steady Current Flow in Intrinsic Semiconductors. R. C. PRIM[1]. Letter to the Editor. *J. Appl. Phys.*, **22**, pp. 1388–1389, Nov., 1951.

General Theory of Symmetric Biconical Antennas. S. A. SCHELKUNOFF[1]. *J. Appl. Phys.*, **22**, pp. 1330–1332, Nov., 1951. (Monograph 1922).

This paper presents the input admittance of a symmetric biconical antenna of an arbitrary angle as the limit of a certain sequence of functions. The first term of this sequence approaches the exact expressions for the input admittance as the cone angle approaches either zero or 90°. For this reason our conjecture is that this term represents a good first approximation for all angles.

Artificial Dielectrics for Microwaves. W. M. SHARPLESS[1]. *Proc. I. R. E.*, **39**, pp. 1389–1393, Nov., 1951. (Monograph 1923).

This paper presents a procedure for measuring the dielectric properties of metal-loaded artificial dielectrics in the microwave region by the use of the short-circuited line method. Formulas, based on transmission-line theory, are included and serve as guides in predicting the approximate dielectric properties of certain loading configurations.

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