

Abstracts of Technical Articles by Bell System Authors

*Network Analysis and Feedback Amplifier Design.*¹ H. W. BODE. The material for this book was originally prepared as a text for an informal course at Bell Telephone Laboratories. It is the outgrowth of a research directed at the problem of designing degenerative feedback amplifiers to provide substantial feedback without instability. The solution of the feedback problem is, however, dependent upon certain propositions in general network theory which are applicable also to other situations. With the addition of other logically related material, this has made the book primarily a text on general network theory.

Earlier texts on networks have been concerned primarily with transmission line and filter theory. The present book emphasizes the broad-band aspects of network theory. In other words, it is concerned with the problem of providing characteristics which vary smoothly, and in some prescribed manner over a broad frequency range. This aspect of network theory is stressed because it is the one which best fits the feedback problem. It also has applications, however, to the many broad-band problems which arise in television, frequency modulation, multi-channel carrier telephone and other modern communication systems.

The emphasis on broad-band problems has a number of consequences. For example, it gives special importance to networks including resistances as well as reactances, since it is frequently only by the use of controlled dissipation that network characteristics can be made to vary smoothly over broad ranges. The emphasis on broad-band applications also requires special attention to the effects of parasitic elements, and several sections of the book are devoted to the development of design methods for networks including prescribed parasites. A final consequence is the importance which is assumed by the limitations on the characteristics which can be obtained from physical networks. Over very narrow bands only very mild limitations exist, but as the band becomes broader the available characteristics become more and more restricted.

The other principal point of emphasis of the book is on the use of networks in association with vacuum tubes, rather than as purely passive structures. The primary theoretical development of the book is stated in terms of general active circuits. Otherwise the effort to extend network

¹ Published by D. Van Nostrand Company, Inc., New York, N. Y., 1945.

theory to vacuum tube circuits consists chiefly in giving special emphasis to network design problems ordinarily found as part of vacuum tube amplifier design. The design of an over-all feedback loop is, of course, an outstanding example. In addition, special attention is also given to the design of such individual network units as input and output circuits, inter-stage networks, and local feedback circuits, especially when they appear as constituents of a broad-band amplifier.

*Judging Mica Quality Electrically.*² K. G. COUTLEE. A threatened mica shortage resulting from an unprecedented wartime demand for mica capacitors used in electronic communication equipment by the Armed Forces was forestalled by rigid conservation measures, use of alternate materials, and the use of electrically selected mica from types previously considered unsuitable for capacitor use. By employing two electrical tests, developed by Bell Telephone Laboratories, Inc. for the War Production Board, in combination with visual and physical requirements, mica was selected from plentiful stocks of lower visual quality types of mica, effectively increasing the supply of capacitor mica by 60 per cent. This method of electrically judging the quality of raw mica was given a thorough commercial trial and found both practicable and reliable.

*A Simple Optical Method for the Synthesis and Evaluation of Television Images.*³ R. E. GRAHAM and F. W. REYNOLDS. A combination of a 35-millimeter motion-picture projector and a line screen enables the projection of still or motion pictures closely similar in appearance to those produced by television. This similarity of appearance is checked theoretically by an analysis of the type previously reported by Mertz and Gray in a discussion of the theory of scanning. From the analysis it is shown that five parameters of the optical-simulation system may be varied to obtain the equivalent of variations in television factors such as number of scanning lines, size and configuration of scanning apertures, and width of frequency band.

Photographs of simulated television pictures projected by this method are presented. These pictures include subject matter of general interest as well as as selected subjects to illustrate the spurious detail components introduced by the television scanning process. These components produce moiré patterns, "steps" on diagonal lines, and impairment of vertical resolution. Simulation pictures projected by this method have been compared with those produced by a television system and the expected agreement observed.

Calculations are given of the diffraction effects in optical systems of this type and it is shown that the departure from geometrical theory is small in the arrangements described.

² *Elec. Engg., Trans. Sec.*, November 1945.

³ *Proc. I. R. E. and Waves and Electrons*, January 1946 (pp. 18W-30W).

*A Coil-Neutralized Vacuum-Tube Amplifier at Very High Frequencies.*⁴ R. J. KIRCHER. This paper describes a two-stage single-side coil-neutralized amplifier employing an experimental triode operating in the vicinity of 140 megacycles. Circuit features are described and typical operating conditions are indicated. Typical distortion characteristics at low-power levels are also included.

*Fundamental Theory of Servomechanisms.*⁵ LEROY A. MACCOLL. The use of servomechanisms and related devices for automatic control and regulation is very old, dating back to the latter part of the eighteenth century. However, it is only recently, approximately since the beginning of the war, that it has been recognized that these devices are essentially feedback amplifiers in a mechanical, or partly mechanical, form. From the recognition of this fact it follows that the highly developed theory of electrical feedback amplifiers can be applied at once to servomechanisms and similar devices.

This book, which was originally intended to be a National Defense Research Committee report, is an introduction to the theory of linear servomechanisms, considered as a special application of the general theory of feedback amplifiers. The steady-state theory of the systems is taken as fundamental, and the various problems concerning the stability and performance of the systems are discussed in terms of it. In the several chapters a variety of types of linear servomechanisms are considered. A brief discussion of one simple non-linear servomechanism is given in the Appendix.

*Corrosion Protection for Transcontinental Cable West of Salt Lake City, Utah.*⁶ T. J. MAITLAND. This paper discusses the problems involved in maintaining the effectiveness of the thermoplastic covering provided on buried toll cables for installation in areas where corrosion is anticipated. It also describes the method used to obtain the required supplemental electrical drainage for the Transcontinental Cables across the Great Salt Desert west of Salt Lake City where the low earth resistivity and high concentration of alkali salts preclude the use of rectifiers connected between cable sheath and a made ground generally employed for drainage purposes. Such installations would result in negative potentials between cable and earth of sufficient magnitude to create conditions conducive to cathodic corrosion of the lead sheath in the presence of an alkali salt electrolyte.

To provide electrical drainage without incurring these excessive negative potentials a method was developed utilizing the normal potential difference between zinc and lead as the source of drainage current. Twenty-four pound zinc bars of commercially available zinc, 99 per cent pure, were installed directly in the ground a short distance from the cables at 12-mile

⁴ *Proc. I. R. E.*, December, 1945.

⁵ Published by D. Van Nostrand Company, Inc., New York, N. Y., 1945.

⁶ *Corrosion*, June 1945.

intervals, making connection between the zinc anodes and the cable sheaths by buried wire. The cable-to-earth potentials were appreciably affected throughout the entire 120 route miles across the Great Salt Desert by this procedure.

During the year these anodes have been in place, the cables have remained at a satisfactory negative potential to earth (.20 to .50 volt) with a small current being constantly drained to the zinc anodes. It is considered from the results to date that for similar areas the use of metallic anodes offers an economical and satisfactory means for protecting buried cables against corrosion.

*Transmission Networks for Frequency Modulation and Television.*⁷ HAROLD S. OSBORNE. Looking forward to a great post war expansion in the arts of frequency modulation and television this paper discusses plans of the Bell System for providing transmission networks required for the interconnection of broadcast stations. A review of cable and open-wire carrier systems shows how developments for purely message telephone business have at the same time put the Bell System in a position of being able at the present time to meet such network transmission requirements for frequency modulation as the broadcasters may select as desirable. Coaxial developments are reviewed briefly, including the application of these developments to television transmission. Future developments, together with the coaxial construction plans now under way, are expected to provide by about 1950 a fairly comprehensive nationwide network of facilities capable of providing for such transmission requirements as may be desired by the television industry. The important features involved in the operation of such networks are discussed, indicating a requirement for a highly trained nationwide organization and much equipment—a requirement which the Telephone Companies can face with confidence because of their experience in handling nationwide communications.

*Visible Patterns of Sound.*⁸ RALPH K. POTTER. New ways of translating sounds into pictures are described. These methods of sound portrayal are unique because what may be seen in the sound patterns is consistent with what is heard in the original sound. The pictures display the three basic dimensions of sound—pitch, loudness and time—in a form somewhat analogous to a musical score. Experimental training has shown that with practice one may learn to read such patterns of speech so that the development offers the ultimate possibility of aid to the severely deafened in learning to speak correctly and to use the telephone by seeing rather than hearing the voice of the distant speaker. The patterns will also be of considerable interest in the fields of speech science and music.

⁷ *Elec. Engg.*, November 1945.

⁸ *Science*, November 9, 1945; *Bell Tel. Sys. Monograph B-1368*.

*General Formulas for "T"- and "Π"- Network Equivalents.*⁹ MYRIL B. REED. This paper presents the development of two sets of general formulas which determine a set of "T" or "Π" impedances equivalent to any linear, lumped-constant, four-terminal network.

*Concerning Hallén's Integral Equation for Cylindrical Antennas.*¹⁰ S. A. SCHELKUNOFF. The main purpose of this paper is to explain the substantial quantitative discrepancy between Hallén's formula for the impedance of cylindrical antennas, and ours. Hallén's first approximation involves a tacit assumption that the antenna is short compared with the wavelength. Since the subsequent approximations depend on the first, they are degraded by this initial assumption.

The approximations involved in his integral equation itself are justified; and, if properly handled, the equation yields results in much better agreement with ours. The last section of the paper is devoted to infinitely long antennas. Such antennas can be treated by at least three very different methods and a comparison is instructive. In practice, the solution for this case is an approximation to a long antenna designed to carry progressive waves.

*Principal and Complementary Waves in Antennas.*¹¹ S. A. SCHELKUNOFF. In response to an increased interest in mathematical aspects of antenna theory, this paper presents details of analysis of cylindrical and other non-conical antennas as a supplement to a previous paper containing the outline of the method and the main results. In the course of the present discussion the theory of principal waves on cylindrical conductors is extended to include the case in which the diameter is not small compared with the wavelength.

*Research Revolutionizes Materials.*¹² J. R. TOWNSEND. A technological lesson to be drawn from defeated Germany is that whereas Germans had been noted for their fundamental contributions to science, they were unable to compete with the United Nations in the field of applied science and particularly in high-speed production methods. Their defeat was due more to the overwhelming number than to the individual superiority of the arms brought against them. The miracle of American production is based on a design related to obtaining the most from the process used, materials of uniform quality, and high-speed production methods using high-power automatic machinery. Germany's failure was due to standardizing too early and too inflexibly and this meant that they could not compete with the steady improvements in the art. The usual procedure is the development of methods of test followed by collection of data and the formulation of specific requirements controlling the useful quality of the material. Modern

⁹ *Proc. I. R. E.*, December, 1945.

¹⁰ *Proc. I. R. E.*, December, 1945.

¹¹ *Proc. I. R. E.*, January, 1946.

¹² *A.S.T.M. Bulletin*, December, 1945.

industry is based upon such specifications because materials must be so controlled since the action of the machine is unvarying. Modern statistical methods can be applied to provide the tolerances and allowances necessary to achieve a uniform product. The work of the American Society for Testing Materials broadly covers the field of research in materials, methods of test, and quality control. The benefits of this work extend to vast improvement in process methods, more uniform and higher-quality material and result in economic gains of extensive character. Three examples were cited illustrating extensive projects of great use to the war effort. These were the development of requirements for sheet brass, which was applied specifically to production of cartridge cases, high-quality die-casting specifications resulting in the production of many parts used in communication and aviation equipment, and the development of a method of test for inspecting mica by an electrical rather than a visual test. This last resulted in a large economic saving of this scarce material.

*Infantry Combat Communications.*¹³ RALPH E. WILLEY. Communications within an infantry division during combat involve not only the efficient installation, operation and maintenance of all means of communication normally provided and adopted for specific functions but also the use of standard equipment in improvised methods adapted to the needs of the particular situation. The paper covers a brief description of the major items of signal equipment issued to an infantry division together with their normal use. In addition, there is discussed the solution to many field problems based on the combat experience of the writer in Belgium, Holland and Germany.

Interesting information is given on the signal supply problem and combat losses over a six-month period of combat. Improvised field radio-link installations and remote controls for the protection of operating personnel are discussed briefly. Photographs included with the paper show pictorially the majority of the items of equipment described.

¹³ *Elec. Engg.*, January, 1946.