Abstracts of Technical Articles by Bell System Authors

Crossbar Toll Switching System.[1] L. G. ABRAHAM, A. J. BUSCH, AND F. F. SHIPLEY. A new crossbar toll switching system was placed in service in Philadelphia in August 1943. Important improvements offered by this system include:

1. Transmission objectives are met more readily and substantial economies are obtained in outside plant and in repeater equipment.
2. Extended use of toll dialing results in operating economies and improved service to subscribers. Calls over circuits still on a ringdown basis are also handled more expeditiously and with operating economies.
3. Flexibility due to the use of sender and markers to control establishing connections will be useful in meeting future toll switching requirements.

Low-Frequency Quartz-Crystal Cuts having Low Temperature Coefficients.[2] W. P. MASON AND R. A. SYKES. This paper discusses low-frequency, low-temperature-coefficient crystals which are suitable for use in filters and oscillators in the frequency range from 4 to 100 kilocycles. Two new cuts, the MT and NT, are described. These are related to the +5-degree X-cut crystal, which is the quartz crystal having the lowest temperature coefficient for any orientation of a bar cut from the natural crystal. When the width of the +5-degree X-cut crystal approaches in value the length, the motion has a shear component, and this introduces a negative temperature coefficient which causes the temperature coefficient of the crystal to become increasingly negative as the ratio of width to length increases.

The MT crystal has its length along nearly the same axis as the +5-degree X-cut crystal, but its major surface is rotated by 35 to 50 degrees around the length axis. This results in giving the shear component a zero or positive temperature coefficient and results in a crystal with a uniformly low temperature coefficient independent of the width-length ratio. A slightly higher rotation about the length axis results in a crystal which has a low-temperature coefficient when vibrating in flexure and this crystal has been called the NT crystal. The NT crystal can be used in a frequency range from 4 to 50 kilocycles, while the MT is useful from 50 kilocycles to 500 kilocycles.

A special oscillator circuit is described which can drive a high-impedance NT flexure crystal. This circuit, together with the NT crystal, has been used to control the mean frequency of the Western Electric frequency-modulated radio transmitter.

[1] *Elec. Engg., Transactions Section,* June, 1944.
[2] *Proc. I. R. E.,* April 1944.

Electronics; Today and Tomorrow.[3] JOHN MILLS. John Mills, scientist, teacher, author, telephone and radio engineer, was first introduced to the electron while still a fledgling under the tutelage of that eminent scientist R. A. Millikan at Chicago University. That was before Millikan had, to quote the author, "first put salt on its tail." Electronics, as a special branch of physics and engineering, has come to adulthood under the eyes of this observant author. From intimate association with this and allied fields John Mills writes knowingly. It is a book intended for the intelligent layman rather than for the expert.

"Electronics; Today and Tomorrow" likewise contains much of interest concerning the electronics of yesterday but, as one would expect, very little about the electronics of tomorrow because, as the author points out, much of this "should await the victorious conclusion of the present conflict." The book generally presents an interesting introduction to many things electronic and throughout is interspersed with examples of present day techniques which employ electronic devices. All line drawings, diagrams and photographs have been omitted.

The author begins his latest book with a brief capitulation of familiar engineering applications such as long-distance telephony, broadcasting, sound motion pictures and television which have been achieved through the use of electronic devices. He goes on to an historical account of some underlying discoveries and a discussion of atomic structure. An introduction to static electricity with the classical concepts of positive and negative charge is followed by establishment of the ideas of charges in motion, electrical current, discharges in gases, X-rays and their generation.

The remainder of the book is divided into Part I—Electron Tubes, and Part II—Electronic Devices. In Part I the author follows the development of the art in nearly chronological order from diodes through the modern multi-electrode tubes giving uses and applications of each and explaining the purpose of the grids introduced. Part II discusses more complicated structures such as cathode-ray tubes, kinescopes, iconoscopes, electron microscopes, kodatrons, magnetrons, rumbatrons, klystrons, etc. and elaborates upon their practical applications. This is, in fact, a wondrous field of developments. Finally there is a chapter on cyclotrons which the author says "comes into this book because it requires for its operation a powerful oscillator—or oscillator plus powerful electron amplifier—which will supply a high voltage at a frequency of megacycles." While many industrial applications, such perhaps as tin plating, might be included on the same basis, nevertheless the discussion of the cyclotron does give an opportunity to explain the concepts of modern physics more completely than was undertaken earlier in the book and is very interesting reading.

[3] Published by D. Van Nostrand Company, Inc., New York, N. Y., 1944.

Impedance Concept in Wave Guides.[4] S. A. Schelkunoff. The impedance concept is the foundation of engineering transmission theory. If wave guides are to be fully utilized as transmission systems or parts thereof, their properties must be expressed in terms of appropriately chosen impedances or else a new transmission theory must be developed. The gradual extension of the concept has necessitated a broader point of view without which an exploitation of its full potentialities would be impossible.

In the course of various private discussions it has been noted that there exists some uneasiness with regard to the applicability of the concept at very high frequencies. In part this may be attributed to relative unfamiliarity with the wave guide phenomena and in part to the evolution of the concept itself. Some particular aspects of the concept have to be sacrificed in the process of generalization and although these aspects may be logically unimportant, they frequently become psychological obstacles to understanding in the early stages of the development. For this reason several sections of this paper are devoted to a general discussion of the impedance concept before more specific applications are given; then by way of illustration it is proved that an infinitely thin perfectly conducting iris between two *different* wave guides behaves as if between the admittances of its faces there existed an ideal transformer. This theorem is a generalization of another theorem to the effect that when the two wave guides are alike, the iris behaves as a shunt reactor. Actual calculation of the admittances and the transformer ratio depends on the solution of an appropriate boundary value problem.

More generally, wave guide discontinuities are representable by T-networks. In some special cases these networks lack series branches, and in other cases the shunt branch.

Theory of Cathode Sputtering in Low Voltage Gaseous Discharges.[5] Charles Hard Townes. To determine the amount of sputtering in a glow discharge three functions must be known: the number of ions of a given energy striking the cathode, the amount of cathode material released from the cathode by each ion, and the fraction of material released from the cathode which diffuses away. Expressions derived for these allow determination of the dependence of total rate of sputtering on the geometry of the discharge, pressure, cathode fall, current, and constants of the gas and cathode surface. The result is most accurate for very low voltage, high pressure discharges. Comparison with experimental data shows quantitative agreement under these conditions.

[4] *Quarterly of Applied Mathematics*, April 1944.
[5] *Phys. Rev.*, June 1 and 15, 1944.