# Books

**Electroacoustics.** By Frederick V. Hunt. 260 pages. Harvard University Press, Cambridge and John Wiley and Sons, Inc., New York, 1954. $6.00. *Reviewed by R. B. Lindsay, Brown University.*

The volume under review is the fifth in the series of Harvard Monographs in Applied Science, being issued under the directorship of a distinguished editorial committee of which the author of this book is chairman. Although electroacoustics is a very old subject ("as old and familiar as thunder and lightning" to quote the author), during the past half century in particular it has tended to absorb larger and larger segments of the practical application of sound. The tremendous parallel advances of both electronics and communications in recent times are familiar to all, and by now every one knows what a transducer is.

The principal theoretical reason for the efficient handling of electromechanical-coupling devices has been the ability to represent them by electric circuit analogs. Unfortunately a completely unified treatment of all such devices has been rendered analytically difficult by Nature's desire to distinguish between electricity and magnetism. This is exemplified by the lack of symmetry in the impedance determinant for electromechanical-coupling manifested by the moving-conductor, moving-armature and magnetostrictive types of transducers (i.e., those involving magnetism) in contrast to the electrostatic and piezoelectric types for which the impedance determinant is symmetrical. Numerous ways are used in practice to circumvent this difficulty, but the author of this book has devised a particularly ingenious scheme which permits a completely unified approach to the treatment of all varieties of transducers. This is by the introduction of a new "space" operator, which operates on any vector following it by rotating its positive direction 90° counterclockwise around the direction of the vector which precedes it. An operator of this kind is really a *versor* in the sense of Hamilton's quaternions, and its resurrection after so many years of comparative neglect would doubtless delight that famous knight and his indefatigable followers.

By the employment of the space operator the author shows that all the machinery of impedance analysis can be applied in straightforward, unified fashion to any electromechanical-coupling problem. He then proceeds in the final three chapters of the book to illustrate by specific application to moving-conductor (dynamic), electrostatic and moving-armature (magnetic) transducer systems. The treatment throughout is marked by grace and clarity. Since the volume is not intended to be a complete text on the subject it contains no detailed analysis of magnetostrictive and piezoelectric transducers.

An interesting and rather unusual feature for a book of this kind is the long historical introduction (91 pages). The reader will find an entertaining account of electroacoustic transduction from the eighteenth century electrostatic machine through the development of the telegraph and telephone, down to the modern microphone and loud-speaker with their multifarious uses. The relation between the basic scientific experiments and theories on the one hand and technological applications on the other is effectively brought out. But the author goes decidedly beyond this point by analyzing the various stages in the invention of the key devices with particular reference to the *patent* litigation which surrounded them. This provides an intriguing succession of stories adequately supported by very thorough references to the original patent literature. Here we have the personality of the scientist-inventor set forth in definitive, fascinating style.

The volume, finely produced with excellent typography and illustrations, should appeal to a wide circle of physicists and engineers.

**Mathematical Structure of the Theories of Viscoelasticity.** By Bernhard Gross. 74 pp. Hermann et C<sup>ie</sup>, Paris, France, 1953. Paperbound. *Reviewed by John D. Ferry, University of Wisconsin.*

The phenomenological theory of linear viscoelasticity is based on the superposition principle which was formulated 80 years ago by Boltzmann for mechanical properties and by Hopkinson for dielectric properties. It can provide interrelations among four different observable functions—creep, stress relaxation, complex modulus, and complex compliance—as well as between these functions and the continuous or discrete spectra of relaxation or retardation times. Responding to the keen current interest in this aspect of rheology, especially as applied to high polymer systems, various authors have developed portions of the theory within the past 10 years and have proposed approximate solutions for specific problems. The most comprehensive and elegant treatment has been that in a series of papers by Professor Gross. He has now admirably summarized the theory in this small volume.

The author's profound knowledge of the literature of both dielectric and viscoelastic phenomena has enabled him to place the features of the theory in a perspective which is rarely appreciated by contemporary experimentalists, and to point out a number of little-known relationships which should prove to be very useful.

The value of the phenomenological theory is enhanced by the recent appearance of molecular theories by Rouse and Bueche which give physical interpretations of the empirical functions. Further progress may