

Abstracts of Recent Technical Books and Papers from Bell System Sources

Theory of Vibrating Systems and Sound. I. B. CRANDALL. Recent years have witnessed a great revival in Acoustics, both as a subject of industrial research and as a field for academic cultivation. This development has been carried on most actively in America and in Germany, and has been measurably due to the demands of the public for commercial acoustic devices in the public address and radio fields. In addition, there has evolved the new subject of Architectural Acoustics, largely through the researches of the late W. C. Sabine and his followers in this country.

In this situation, with an ever increasing body of technical literature, it may be noted that the standard textbooks on Sound have maintained their classical character, although new impedance methods and terminology have come into use (closely parallel to those of electrical theory) and many new fields of study have been opened up. The need for a connected treatment involving the new subject matter and methods the present author has attempted to supply, and while necessarily building on the classical treatises as a foundation, he has included a chapter on complex vibrating systems with a treatment of acoustic filters; two chapters on the theories of sound generation and radiation with applications to tubes and horns and a chapter on the essentials of architectural acoustics and absorbing materials. An extended bibliographic appendix serves as an entry to many branches of Applied Acoustics—for example, loud speaking telephones, piezoelectric resonators, recent work on speech and hearing, and submarine signalling, to cite only a few examples.

The author has purposely avoided duplicating classical material such as the theories of bars or of Fourier's series, feeling that the newer ideas and developments deserve the emphasis gained thereby.

The book aims to organize Acoustics as now practiced, and research workers will probably find it useful, not only in their classes, but as a starting point for acoustic research.

The book is produced by D. Van Nostrand & Co. (\$5.00).

Contemporary Physics. KARL K. DARROW. During the twenty-five years since this century began, the science of physics has undergone amazing enlargements and transformations which may well be ranked among the most significant attainments of our times. Through

discoveries and improvements in the arts of experimentation, it became possible to measure the charge and the mass of the atom of negative electricity; to measure the charges, masses and magnetic moments of the atoms of the chemical elements; to study the processes of detaching atoms of electricity from atoms of matter; and to extend the spectra of the elements by detecting a host of radiations previously unknown and determining their frequencies. The data so assembled, together with observations upon the encounters of electrified particles with atoms, illuminated the relations between the elements, and contributed to the design of an atom-model which has already inspired many discoveries. Among these the greatest was the discovery of the Stationary States, which replaced the early way of interpreting spectra by a new and strikingly fruitful procedure, and taught experimenters to seek after and find a multitude of new phenomena of the most varied interest and importance in almost every field of physics. To name only two of the fields thus enriched: the flow of electricity through gases, and the conditions for the excitation of radiation, have been clarified in most unexpected fashion since the recognition of the Stationary States.

The book "Contemporary Physics," by Dr. Darrow, is devoted to these fundamental discoveries and to some of their consequences. It might be described as an introduction to the Theory of Atomic Structure, in the present day acceptance of this phrase; for the phenomena with which it deals have nearly all been used in designing atom models, and reciprocally a great many of them have been discovered in the course of making experimental tests of predictions based upon atom-models. These models are in fact among the most important features of contemporary physics and it would neither be possible nor desirable to omit them from such a book; for they are undoubtedly valuable, and the phenomena could hardly be described briefly and clearly without making use of them. Nevertheless, the actual facts of experience receive the greater emphasis, for they are the permanent and unassailable parts of the recent extensions of physics.

The book is developed from articles which have been appearing in the BELL SYSTEM TECHNICAL JOURNAL under the general title *Some Contemporary Advances in Physics*, apart from the articles concerning Hertzian waves and conduction of electricity in solids, which fall outside of the field to which it is restricted. The remaining articles, which were originally self-contained and separate, were largely rewritten in order to build out of them a coherent presentation of a unified field, and in the course of the rewriting they were nearly doubled in length by addition of new material. The book may

be described as an elementary treatise, and although hardly of popular nature it will be intelligible to anyone who has had a fairly thorough college course in physics.

Published by D. Van Nostrand & Co. (\$6.00).

Electric Circuit Theory and the Operational Calculus. JOHN R. CARSON. This book is based upon a course of fifteen lectures delivered recently at the Moore School of Electrical Engineering of the University of Pennsylvania.

The name of Oliver Heaviside is known to engineers the world over. His Operational Calculus, however, is known to and employed by only a relatively few specialists and this, notwithstanding its remarkable properties and wide applicability not only to electric circuit theory but also to the differential equations of mathematical physics. The present author ventures the suggestion that this neglect is due less to the intrinsic difficulties of the subject than to unfortunate obscurities in Heaviside's own exposition. In the present work, the Operational Calculus is made to depend on an integral equation from which the Heaviside rules and formulas are simply but rigorously deducible. It is his hope that this method of approach and exposition will secure a wider use of the Operational Calculus by engineers and physicists and a fuller and more just appreciation of its unique advantages.

The second part of the volume deals with advanced problems of electric circuit theory and in particular with the theory of the propagation of current and voltage in electrical transmission systems. It is hoped that this part will be of interest to electrical engineers generally because, while only a few of the results are original with the present work, most of the transmission theory dealt with is to be found only in scattered memoirs and there accompanied by formidable mathematical difficulties. While the method of solution employed in the second part is largely that of the Operational Calculus, the author has not hesitated to employ developments and explanations not to be found in Heaviside. For example, the formulation of the problem as a Poisson integral equation is an original development which has proved quite useful in the numerical solution of complicated problems. The same may be said of the chapter on Variable Electric Circuit Theory.

In view of its two-fold aspect, this work may therefore be regarded either as an exposition and development of the operational calculus with applications to electric circuit theory or as a contribution to advanced electric circuit theory depending upon whether the reader's viewpoint is that of the mathematician or the engineer,

No effort has been spared by the author to make his treatment clear and as simple as the subject matter will permit. The method of presentation is distinctly pedagogic. To electrical engineers and to electrical instructors this exposition of the fundamentals of electric circuit theory and the operational calculus should be of more than ordinary value. An appendix furnishes a list of original papers and memoirs which gives a fairly complete bibliographic survey of the field.

The volume is published by McGraw-Hill Book Co., price \$3.00.

Exploring Life: the Autobiography of Thomas A. Watson. To have been the youth who at the age of twenty was assigned to build Alexander Graham Bell's original telephone apparatus, and then to share with him and Sanders and Hubbard the cares of rearing the telephone industry in the United States to healthy childhood, and finally to share the handsome profits which accrued therefrom, would doubtless satisfy the desires of the average ambitious individual. But to look upon this as merely a beginning and before the age of thirty to separate himself voluntarily from the business he had helped to found and set forth in quest of achievement in other and entirely unrelated fields attests an eagerness to play the game of life which cannot fail to be an inspiration to everyone.

So interesting is the life the author has led and so charmingly has he related his varied activities that the book would be welcome at any time, but coming during the semicentennial of the invention of the telephone, it is appropriate as well. To those who are desirous of obtaining further light on the early career of the telephone, particularly in the United States, the book brings several chapters of new material. But to the much wider circle who find enjoyment in a document which is at once homely and adventurous, every page of this autobiography will yield delight.

Published by D. Appleton & Co., price \$3.50.

*Some Measurements of Short Wave Transmission.*¹ R. A. HEISING and J. C. SCHELLENG and G. C. SOUTHWORTH. Quantitative data on field strength and telephonic intelligibility are given for radio transmission at frequencies between 2.7 megacycles (111 m.) and 18 megacycles (16 m.) and for distances up to 1,000 miles, with some data at 3,400 miles. The data are presented in the form of curves and surfaces, the variables being time of day, frequency and distance. Comparisons are made between transmission over land and over water, between night effects and day effects, and between transmission from

¹ Proceedings of I. R. E., Oct., 1926.

horizontal and from vertical antennas. Fading, speech quality and noise are discussed. The results are briefly interpreted in terms of present day short wave theories.

*An Introduction to Ultra-Violet Metallography.*² FRANCIS F. LUCAS. This paper describes the ultra-violet microscope and the technique of its application to the study of metal surfaces. The ultra-violet microscope can be said to have lived up to expectations. Crisp brilliant images can be obtained which surpass in quality those obtainable with the apochromatic system. The potential resolving ability of the monochromats can be realized in practice and the practical application of the ultra-violet microscope should develop much new information. The ultra-violet microscope is the most complicated of any within the realm of technical or scientific microscopy. It requires a highly developed technique for its successful manipulation and the specimens must be prepared with great care. The ultra-violet equipment appears to have a potential resolving ability probably greater than twice that of the apochromatic system.

*Portable Receiving Sets for Measuring Field Strengths.*³ AXEL G. JENSEN. Describes a measuring set involving the use of a current-dividing potentiometer accurate for frequencies up to about 1,500 kilocycles and having a field-strength range of about 20 to 200,000 microvolts per meter.

*Thermionic and Adsorption Characteristics of Caesium on Tungsten and Oxidized Tungsten.*⁴ JOSEPH A. BECKER. Curves showing the logarithm of the electron current per cm^2 from tungsten and oxidized tungsten over a wide range of filament temperatures are given for several vapor pressures of caesium. At high temperatures the tungsten is covered only to a slight extent with adsorbed caesium. As the filament temperature is lowered more caesium is adsorbed. This lowers the electron work function and increases the emission many thousandfold. The process continues until a temperature is reached at which the tungsten is just covered with a monatomic layer when the work function has a minimum value. At still lower temperatures the surface is more than completely covered, the work function increases again, and the emission decreases rapidly.

² Presented before the American Institute of Mining and Metallurgical Engineers, New York, N. Y., February, 1926. Published as Pamphlet No. 1576-E, issued with *Mining and Metallurgy*.

³ Proceedings I. R. E., page 333, June, 1926.

⁴ *Physical Review*, Vol. 28, pp. 341-361, August, 1926.

The positive ion emission is constant while the temperature decreases from a high value to a low critical temperature. Here the ion emission drops suddenly while some caesium sticks to the filament. Further decreases in temperature are followed by increased adsorption and decreased ion emission. If the temperature is then increased in steps the ion current retraces its path. At an upper critical temperature, about 50° higher than the lower critical temperature, the filament cleans itself spontaneously, the caesium comes off as ions and registers as a sudden rush of current. At higher temperatures the ion current has its initial constant value which is limited by the arrival rate of caesium atoms. The critical temperatures are raised by an increase in the vapor pressure or by a decrease in the plate potential.

A method of determining the amount of adsorbed caesium is developed. At a sufficiently high filament temperature the surface is clean. At a sufficiently low temperature every atom that strikes the filament sticks to it, at least until the optimum activity is reached. The product of the arrival rate, which is given by the steady positive ion current, and the time to attain the optimum activity gives the number of caesium atoms at the optimum activity. At an intermediate temperature the surface is only partly covered. If the temperature is suddenly dropped, to a low value, it takes a shorter time to reach the optimum activity. From these times the amount of adsorbed caesium at various temperatures, plate potentials, and vapor pressures can be determined. At the optimum activity there are 3.7×10^{14} atoms of caesium on a cm^2 of tungsten. This is very nearly the same as the number of caesium atoms that could be packed in a single layer, but is considerably smaller than the number of caesium ions in such a layer.

The adsorption or evaporation characteristics are illustrated by curves. Caesium can evaporate either as ions or as atoms. The atomic rate depends only on the temperature and on θ , the fraction of the surface covered with caesium. For a given temperature it increases very rapidly with θ . The ions can permanently escape from the filament only if the potential is in the right direction. A typical isothermal ion rate curve increases rapidly with θ , comes to a maximum when θ is about .01, then decreases continuously for larger θ . These curves explain all the observed phenomena of these adsorbed films. They show that while the ion work function increases as θ increases, the work to remove an atom decreases with θ . The ion work function for a given θ can be decreased by increasing the potential gradient at the filament.

*The Significance of Magnetostriction in Permalloy.*⁵ L. W. MCKEEHAN. Magnetostriction in permalloy confirms qualitatively the existence of atomic magnetostriction as previously proposed, and the explanation, based thereon, for high magnetic permeability and low hysteresis in these alloys. The effect of tension upon magnetostriction suggests that orientation of the magnetic axes of iron and nickel atoms precisely like that due to the application of magnetic fields may be effected by mechanical stresses within the elastic limit. Acceptance of this view makes it possible to explain the large effects of tension upon magnetic hysteresis and the observed relation between the changes in electrical resistance produced by tension and by magnetization. The occurrence of a reversal of magnetostriction in a stretched wire containing 80 per cent nickel is covered by the same explanation. A connection between magnetic hysteresis and mechanical hysteresis is suggested and the molecular field postulated by Weiss is interpreted as the integrated effect of local mechanical stresses.

*Magnetostriction in Permalloy.*⁶ L. W. MCKEEHAN and P. P. CIOFFI. The materials studied comprised iron, nickel, and permalloys containing 46, 64, 74, 78, 80, 84, and 89 per cent nickel. The method permitted simultaneous measurement of magnetization and magnetostriction in about 12 cm. at the middle of a 40 cm. wire, 1 mm. in diameter, in an approximately uniform field not exceeding 40 gauss, and either with or without applied tension (within the elastic limit).

The magnetostriction was measured by a combination of a mechanical lever, an optical lever, a multiple slit and a photoelectric cell. The magnifying power of this combination, as used, was about 2×10^6 , and magnetostrictive strains from 2×10^9 to 3×10^5 were detected and measured without changing the sensitivity.

The magnetostriction-magnetization curve has initial slope zero in all the cases studied. When the attainable field was sufficient for magnetic saturation the magnetostriction reached a limiting value. In iron there is evidence for the existence of a Villari reversal in fields too great to be attained in the apparatus. In nickel there is no sign of such reversal. In the permalloys with more than 81 per cent Ni the magnetostriction is a contraction. In the permalloys with less than 81 per cent Ni the magnetostriction is an expansion. The limiting values of magnetostriction, when plotted against chemical composition, fall on a smooth curve.

⁵ *Physical Review*, Vol. 28, page 158, July, 1926.

⁶ *Physical Review*, Vol. 28, page 146, July, 1926.

Tension increases magnetostrictive contraction and diminishes magnetostrictive expansion. It causes a reversal in the sign of magnetostriction in permalloy with 80 per cent Ni, a small contraction preceding the final small expansion.

*Transmission Features of Transcontinental Telephony.*⁷ H. H. NANCE and O. B. JACOBS. In this paper, the various steps in the establishment of the existing network of transcontinental type circuits and the transmission design considerations are reviewed. The discussion covers the communication channels obtained from transcontinental type facilities and the bands of frequencies employed, and includes carrier-current systems, telephone repeaters and signalling systems. Mention is made of special uses of transcontinental telephone circuits, such as the transmission of program material for broadcasting and the transmission of pictures. Finally, the maintenance methods required to keep the system at full efficiency are outlined.

⁷ Presented at the Pacific Coast Convention of the A. I. E. E., Salt Lake City, Utah, Sept. 6-9, 1926.