Sonics, Techniques for the Use of Sound and Ultrasound in Engineering and Science

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Published in 2000; Originally Published in 1954

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Preface to the Original Edition

During the past few years we have received many inquiries regarding industrial uses of sound and ultrasound: metals testing, spot welding, drilling, gas analysis, medical diagnosis, aerosol agglomeration, fish location, clothes washing, degreasing--these and many other real or imaginary uses of sound have come up for discussion. In trying to solve some of these problems and in studying the expanding literature on these seemingly unrelated subjects, we began to see that to see that a new area of technology was taking shape. The multiplicity of concepts and techniques could be designated by the name *sonics*, much as electronics and nucleonics connote particular areas of technical practice.

Sonics encompasses the analysis, testing, and processing of materials and products by the use of mechanical vibratory energy. The particular frequency that is best suited for a given task is determined by the special requirements and limitations of that task. All applications, however, are based on the same physical principals, and the relation of the frequency to the range of audibility for man's ear is irrelevant from this point of view.

The unity of *sonics* is, therefore, the keynote of this book. The common principles are presented in general form and then applied in many special ways to the design of sonic techniques for a particular medium or frequency range. The relevant fundamentals of vibration and sound are given in Chapters 2 and 3, and general aspects of transducers for sound generation and reception are presented in Chapters 4 and 5. The applications are divided into two branches: sonic processing, Chapters 6 and 7; and sonic analysis, Chapter 8. Molecular aspects of sound propagation in fluids, a topic of particular interest in modern physics, are discussed in the Appendix following Chapter 8.

The wide diversity in the possible applications of sonics and in the professional backgrounds of its potential users has posed our most challenging problem. A book that was understandable only to an advanced physicist would be of limited usefulness in many industrial developments. A purely practical discussion of devices and design formulas would not provide an adequate basis for the exploration of entirely new applications. We have tried to find a middle ground. The underlying physics is presented as simply as possible, with plausibility arguments frequently used in place of rigorous derivations. The associated mathematical expressions are also given in simple form, but in many cases the implications of a fuller mathematical treatment are pointed out in a footnote or in small type, as in our discussion of the tensor notation for crystal transducers.

Wherever possible a discussion is concluded with simplified engineering formulas and with practical instructions for their use. We have deliberately not discussed, or even enumerated, all of the applications that have been mentioned in the literature. Instead, typical examples have been selected that illustrate the operating principles and that suggest other uses in many fields. We have tried to make this book understandable to anyone with college training or its equivalent in any branch of science or engineering. In particular, we have assumed that the reader has little or no specialized training in acoustics, but that he has some understanding of electronics.

The bibliography and the references to collateral reading have been selected with particular care. We have included only those that are most informative on a given subject or that give the most recent review of earlier developments along a particular line. Extensive bibliographies, to more that 5000 entries, are contained in other publications to which we refer.

We are indebted to many colleagues and industrial organizations for making available much interesting and timely information as noted in specific acknowledgments throughout the text. We are grateful to S.J. Lukasik and M.S. Cohen for careful reading and assistance with some of the material; to C. Twardzik for skillful drawing of the illustrations; and especially to F. Massa for critical review and many helpful suggestions. We also express deepest appreciation to our wives, whose complaints during out protracted period of writing lay strictly outside the audible range.

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November, 1954

18. T. F. Hueter R. H. Bolt Sonics: Techniques for the Use of Sound and Ultrasound in Engineering and Science New York:Wiley 1955. 19. Advanced Design System 2006 [online] Available: www.agilent.com. 20. H. Campanella P. Nouet A. Uranga P. de Paco N. Barniol J. Esteve "Automated on-wafer extraction of equivalent-circuit parameters in thin-film bulk acoustic wave resonators and substrate" Microw. Opt. Technol. Lett. vol. 50 no. 1 pp. 4-7 2008. 21. F. Purroy L. Pradell "New theoretical analysis of the LRRM calibration technique for vector network analyzers" IEEE Trans. Instru Sonics, Techniques for the Use of Sound and Ultrasound in Engineering and Science. Article. Jan 1955.Â Consequently, a reverse engineering approach was applied in order the hydrodynamic impact pressure from the implosion of an individual cavitation bubble to be determined. The characteristic parameters of the cavitation implosion process such as hydrodynamic impact pressure and liquid micro-jet impact velocity as well as the hydrodynamic severity of the cavitation impacts were quantified.