Effect of Initial Stress on the Propagation of Flexural Waves in Elastic Rectangular Bars

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Reflection of elastic waves under initial stress at a free surface: P and SV motion
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Texas 77004.—It is shown that the application of Webster's theory to sinusoidal and conical horns leads to the conclusion that such horns, used as receivers and terminating in cusps, should act as sound traps. This result is further discussed in light of three-dimensional conical horn theory. Experimental work to verify the theory is in progress.

9:30

NN3. Transmission-Line Analogs For Stacked Crystals with Piezoelectric Excitation. A. BALLATO, *U. S. Army Electronics Technology & Devices Laboratory, U. S. Army Electronics Command, Fort Monmouth, New Jersey 07703,* H. L. BERTONI AND T. TAMIR, *Department of Electrical Engineering and Electrophysics, Polytechnic Institute of Brooklyn, New York 11201.* —A piezoelectrically driven thickness-mode structure containing any number of stacked crystal layers is shown to be rigorously representable by equivalent circuits, which consist of transmission lines and lumped elements. Each crystal stratum is homogeneous but may be arbitrarily anisotropic; the piezoelectric excitation may be applied to a single plate or several plates in combination, its field orientation being either normal or parallel to the layers. The equivalent representation is derived by considering a canonic two-layered element, which is thereafter utilized as a building block for the analysis of general multilayered stacks. In such a configuration, the material in each layer is accounted for by at most three acoustic transmission lines; each layer boundary, on the other hand, is represented by lumped transformer elements that serve to interconnect all of the six transmission lines arriving at that particular boundary. The piezoelectric drive appears as an additional simple network which is also connected to the coupling transformers. This establishes a procedure for a systematic treatment of theoretical and practical problems concerning crystal resonators and filters, delay lines, pulse and code generators, and related applications.

9:45

NN4. Effect of Initial Stress on the Propagation of Flexural Waves in Elastic Rectangular Bars. J. A. CLARK, A. J. DURELLI, AND P. A. LAURA, *Electrical Engineering Department, The Catholic University of America, Washington, D. C. 20017.*—The dynamics of continuous media subjected to initial stress is of great interest in several fields of applied science and technology: geophysics, oceanography, underwater acoustics, and structural design. Pioneering analytical work in this field was done by Biot. Few contributions have been made, however, to the experimental treatment of the problems of determining dynamic stress distributions within statically prestressed continuous media. The present paper deals with an experimental analysis of the propagation of flexural waves in prismatic elastic bars with and without prestressing. A complete, direct, full-field optical determination of dynamic stress distributions associated with the flexural waves is obtained by a combination of photoelastic and interferometric measurements. The effects of prestressing by axial tension, axial compression, and pure bending are illustrated. Comparisons are made with an approximate theory. The results are extended to bars of other materials by scaling laws.

10:00

NN5. "Clackers" Noise. D. G. HOLMES AND R. H. LYON, *Department of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139.*—Impact sounds are normally the result of acoustic radiation from the vibrations of the impacting bodies. The energy pathway is from the preimpact kinetic energy of translation, via the energy of vibration, to the radiated acoustic energy. An alternative mechanism exists, which does not require vibrations

of the impacting bodies. The sound radiation is a result of the sudden accelerations of the bodies during impact, and can be said to draw on the kinetic energy, not of the bodies themselves, but of the added mass of the fluid motion. The sound radiated from the impact of two small, hard spheres is a good example. Experiments are described which identify clearly the sound source as the sudden accelerations due to impact; vibrations of the spheres make a negligible contribution to the total energy radiated. The energy spectrum and directivity of the radiation agree very closely with calculated values.

10:15

NN6. Transient Response Analysis and Experiment on a Transducer with an Intermediate Layer of a Quarter Wavelength for the Generation of Short Ultrasonic Pulses. YOSHIMITSU KIKUSHI, DAITARO OKUYAMA, AND CHIHIRO KASAI, *Research Institute of Electrical Communication, Tohoku University, Sendai 980, Japan.*—In the field of ultrasonic flaw detection, ultrasonic diagnosis, etc., generation and detection of short ultrasonic pulses are very important for high range resolution. In this paper, the transient characteristics of the transducer with an intermediate layer of a quarter wavelength is analyzed by an impulse response method, and the optimum acoustic impedance of the layer for the generation and detection of the shortest ultrasonic pulses is given as a function of specific impedances of the transducer and an acoustic load. The features of this analysis are that the calculation is much simpler than that in the usual frequency response method, and especially that the pulse length which is the final object of the art can be directly derived. From the calculation, it is found that the transducer with the layer of the optimum impedance can generate fairly short ultrasonic pulses without any acoustic backing, and that consequently the transducer sensitivity is considerably higher than that of the usual transducers with backing. Experiments were carried on in megahertz range with PZT disks using Bakelite or tungsten–resin mixture for the intermediate layer. The results showed fairly good agreement with the theory.

10:30

NN7. A New Broad-Band Ultrasonic Technique with Biomedical Implications. I. Background and Theoretical Discussion. JOIE PIERCE JONES AND HUGH A. WRIGHT, *Bolt Beranek and Newman Inc., 50 Moulton Street, Cambridge, Massachusetts 02138.*—Ultrasonic techniques presently used for medical diagnosis make use of narrow-band or single-frequency pulse-echo devices. Recent studies at BBN indicate that a new broad-band technique should significantly improve present diagnostic capabilities. This new technique makes use of acoustic impulses, which are short in time but broad in frequency content, and a time domain deconvolution procedure. The result is a temporal waveform which can be related to physical parameters such as specific acoustic impedance and frequency-dependent attenuation. Thus, the new technique allows us to measure quantitatively to a high degree of accuracy the specific acoustic impedance at an arbitrary position within a test object.

10:45

NN8. A New Broad-Band Ultrasonic Technique with Biomedical Implications. II. Preliminary Experiments Involving Human Skull Bone. JOIE PIERCE JONES AND HUGH A. WRIGHT, *Bolt Beranek and Newman Inc., 50 Moulton Street, Cambridge, Massachusetts 02138.*—A broad-band acoustic pulse, produced by a spark source operating in water, was used to illuminate several test objects. The reflected signal was analyzed using a deconvolution procedure and the specific acoustic impedance obtained as a function of time. In one particular experiment,