Elastic Wave Propagation in a Semi-Infinite Solid Medium

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Session J. Waves and Vibration

R. BRUCE LINDSAY, *Chairman*

Contributed Papers

J1. Propagation of Audio-Frequency Sound in Free Air. L. P. DELSASSO, *University of California, Los Angeles, California.*—The attenuation and velocity of sound pulses in the frequency range 500 to 3500 cps have been measured over a 1500-ft path at sea level. Large attenuation fluctuations are observed even for time intervals as short as two seconds. The corresponding changes in velocity were found to be small. Comparison is made with laboratory measurements and with existing theory. (This research was partially supported by Sandia Corporation, U. S. Atomic Energy Commission.)

J2. Absorption of Sound in Humid Air at Low Frequencies. I. HORIUCHI, *Electronics Research Laboratories, Columbia University, New York 27, New York.*—This paper represents a continuation of the work in absorption of sound in humid air initially reported on at the Fifty-First Meeting. Results have been obtained at temperatures of 0°C and 55°C for the range of pressures from 20 cm Hg to atmospheric and water vapor concentrations from 2% relative humidity to 80% relative humidity, in the audible range 300 cps to 1100 cps. It is found that the absorption coefficients in general closely conform to the Knudsen-Kneser curves but exhibit large departures at extreme relative humidity values. Secondary maxima were not found. (This work was supported by subcontract with the University of Michigan under Signal Corps Contract DA-36-039-sc-52654.)

J3. Some Experimental Results Concerning the Propagation of Sound over Ground. DAVID N. KEAST AND FRANCIS M. WIENER, *Bolt Beranek and Newman Inc., Cambridge, Massachusetts.*—Under contract with the U. S. Army Signal Corps (contract No. DA-36-039-sc-64503), field studies have been undertaken to investigate the physics of outdoor sound. The propagation of sound over ground in the speech frequency range was studied as a function of distance, terrain, ground cover, wind speed and direction, temperature, and humidity, etc. Propagation over open, level ground, through dense evergreen forests, and between mountain tops was studied in the frequency range between 300 cps and 5000 cps. Extensive micrometeorological instrumentation was utilized. Results were generally expressed as attenuation in excess of inverse square law as a function of distance and frequency for a wide range of meteorological and terrain conditions. Over level ground, the excess attenuation was found to be greater for upwind than for downwind propagation by as much as 30 db. This is due to the presence of vertical temperature and wind gradients, and is in general agreement with Ingard's findings. In hilltop-to-hilltop propagation, large, long-period fluctuations in the received sound pressure level were observed; wind direction appears to be of secondary importance. In dense forests, sound absorption and scattering control. Attenuation coefficients measured in evergreen forests are comparable to those obtained by Eyring in Panamanian jungles.

J4. Oppositely Directed Finite Waves. R. D. FAY, *Acoustics Laboratory, Massachusetts Institute of Technology, Cambridge, Massachusetts.*—The general method of attack that was found to be successful in the analysis of plane progressive finite waves has been adapted to the analysis of a sound field that comprises two such waves progressing in opposite directions. The interference phenomena associated with the meeting of two isolated pulses are first investigated. Neglecting viscous losses, it is found that the pulses are transmitted through each other unchanged except that the speed of transmission of each pulse is modified by the other in the region of interference. It is further found that, to the zero and first orders of approximation, the particle velocity in the region of interference is the vector sum of the particle velocities in the isolated component pulses. With these relationships established, the nature of the phenomena in a sound field of the indicated type in a steady state can be predicted to the indicated order of approximation. (This investigation is supported by the Office of Naval Research, contract N5 ori-07861.)

J5. Elastic Wave Propagation in a Semi-Infinite Solid Medium. J. W. C. SHERWOOD, *Applied Physics Division, National Research Council, Ottawa, Canada.*—Plane waves possessing complex angles of propagation play an important role in the theory of elastic wave radiation. A simple physical picture is given of these waves and their utility illustrated by employing them in the study of continuous sinusoidal wave propagation in the neighborhood of an unstressed, plane boundary in a semi-infinite, homogeneous, and isotropic solid medium. The Rayleigh wave and the von Schmidt, or Head wave are particular features of the study. A simpler solution than Sauter's [Z. angew Math. Mech. (1950)] has been found for the displacement field radiated by an impulsive force acting at a line in the surface. By reciprocity this gives the surface displacement due to an internal line force. An equivalent problem is provided by an impulsive force acting at the edge and in the plane of a semi-infinite thin sheet, provided that the bulk dilatation wave velocity is replaced by the thin sheet dilatation wave velocity. This has been simulated experimentally by detonating small explosive charges at the edge of an aluminum sheet, 0.5 mm thick. Displacements detected by a novel condenser microphone technique are in excellent agreement with those determined theoretically.

J6. Some Characteristics of the Flexural Vibrations of Orthogonally Stiffened Cylindrical Shells. W. H. HOPPMANN II, *The Johns Hopkins University, Baltimore, Maryland.*—The paper presents a résumé of a theoretical study of the problem of flexural vibrations of the walls of orthogonally stiffened cylindrical shells. Frequency equations are given for the stiffened shells. In addition an experimental method of verifying the theory is described. Experimentally determined frequencies for an isotropic as well as two different designs of orthogonally stiffened shells are given in tables. The experimental and corresponding theoretical results are discussed. A peculiar dip in the frequency spectrum which was discovered by Arnold and Warburton for uniform isotropic shells is shown to exist theoretically and verified experimentally for stiffened shells. In addition, there is shown to be a bias in the excitability of the modes of vibration as determined experimentally. The reason for this phenomenon is discussed. The principal axes of stiffness are in the longitudinal and transverse directions for the shells under study. In one case the axis of maximum stiffness is in the longitudinal direction in the other case it is in the transverse direction. As the stiffness tensor is the same for the two cases, except for orientation, an opportunity is provided for examining the effect of rotating the stiffness axes through 90°.

J7. Nonaxially-Symmetric Motions of Cylindrical Shells. I. MIRSKY AND G. HERRMANN, *Columbia University, New York 27, New York.*—A Timoshenko-type theory of cylin-