Low-frequency spherical-shell projectors

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a recently developed three-group seven-element lens. These lens developments will be reviewed and the current state of lens technology will be discussed.

9:40

EE2. Historical highlights of the development of free-flooded magnetostrictive ring transducers. J. A. Sinsky (Naval Electronic Systems Command, Washington, DC 20360)

The historical highlights of research activity on magnetostrictive free-flooded ring transducers are presented with emphasis on recent work. The significant achievements of the research, their background, and the ongoing materials research that has been stimulated are summarized. They may have to use at some future time the technology of magnetostrictive ring transducers for high-power active surveillance because of changing conditions affecting undersea surveillance. The highlights include the advantages and disadvantages of free-flooded magnetostrictive transducers. A detailed summary of all of the work done on the subject would be lengthy and far beyond the scope of this. Nevertheless, an attempt is made to present an accurate and complete account of some of the more significant contributions to the technology.

Contributed Papers

10:10

EE3. Low-frequency directional ring hydrophone. Joseph F. Zalesak (Naval Research Laboratory, Underwater Sound Reference Division, Orlando, FL 32806)

In its simplest form, a low-frequency directional ring hydrophone (LFDRH) is a free-flooded circumferentially polarized piezoceramic tube. At some very low frequency an LFDRH has a $\cos^2\theta$ directivity pattern with a maximum along the symmetry axis. For example a 5 cm high, 5 cm outerdiameter, 0.4 cm thick circumferentially polarized ring exhibits this directivity at about 1675 Hz. Since a $\cos^2\theta$ pattern is symmetric, the hydrophone is not acceleration sensitive. The bandwidth of operation is fairly narrow (about $\frac{1}{2}$-octave) but can be extended by using a number of rings and connecting their outputs to a crossover network. An alternate configuration for the LFDRH is a combination of an omnidirectional hydrophone and a free-flooded piezoceramic tube of arbitrary polarization. By properly varying the relative weighting with frequency, a broadband device can be constructed and the frequency of operation can be extended below that of a circumferentially polarized ring of the same size. The outputs of three LFDRH's can be combined to yield a $\cos^2\theta$ pattern which may be rotated in any direction in a plane. Also, the outputs of two hydrophones can be processed to yield target bearing. [Work supported by Naval Electronics Systems Command.]

10:25

EE4. Low-frequency spherical-shell projectors. J. B. Lee (Defence Research Establishment Atlantic, P.O. Box. 1012, Dartmouth, Nova Scotia, Canada)

The spherical-shell projector comprises a piezoelectric ceramic ring driving two concave spherical shell segments in flexure. One model resonant at 600 Hz in water weighs 15 kg and delivers a souce level of 201.5 dB *re* 1 μPa at 1 m. Its mechanical Q is 5 and efficiency 80% at resonance. An axially-symmetric finite element model is being used to study the performance of spherical-shell projectors and generally good agreement is achieved between the calculated and experimental results.

10:40

EE5. Mathematical model for underwater electroacoustic transducer elements. E. L. Skiba, R. B. Allen, and R. G. Charlwood (Acres Consulting Services Limited, P.O. Box 1001, Niagara Falls, Ontario, Canada, L2E 6W1)

A dynamic finite element model was developed to analyze the vibrations and acoustic radiation of a single axisymmetric electroacoustic transducer and its attached mechanical amplifying structure and waterproofing material. Element types are 2-D isotropic solid, axially radially poled and tangentially poled piezoelectric solids, acoustic fluid, membrane, fluid—solid link, spherical Helmholtz radiating boundary and silvered surface. Undamped resonances and antiresonances in air are extracted by the inverse iteration method with eigenvalue shifting. Undamped low-frequency capacitance is found by harmonic voltage driving of the transducer with subsequent calculation of the charge on a silvered surface. In water, the damped (material damping and acoustic radiation) complex response is determined for similar voltage driving and the complex impedance and far-field directional response are calculated. The model is programmed with an overlay structure and makes extensive use of mass disc storage enabling the solution of large problems using a small core allotment. Extensive testing has been successfully carried out against experimental data. [Model developed under contract to the Department of National Defence, Canada.]

10:55

EE6. A Tee-network, containing negative components, suitable for simulating distributed mass-stiffness systems. Harry B. Miller (Naval Underwater Systems Center, New London, CT 06320)

An obstacle existed in the past to simulating distributed parameters by means of a Tee-network. This obstacle was the requirement to represent impedance functions having negative slope, such as – cosecant $\omega l/c$. Such a representation is not possible with passive elements. However, this can now be easily done in several ways. One way is to use lumped impedance elements combined with active circuits, to produce negative components. Another way is to use a desk-top calculator in conjunction with an equivalent-circuit analysis program that uses lumped elements, positive or negative. People who like circuits obtain a certain additional insight from this circuit approach, an insight which is not given by the usual analysis methods. The method is applicable to electromechanical transducer simulation, vocal-tract simulation, and woodwind instrument simulation. Some graphical solutions to a transducer problem, automatically obtained in a few minutes, will be shown.

11:10

EE7. Active acceleration canceling for directional hydrophones. J. Schumann (General Electric Co., Re-Entry & Environmental Systems Division, 3198 Chestnut Street, Philadelphia, PA 19101)

Directional transducers which are suspended from surface floats or moorings are subjects to suspension cable strumming and flow induced vibration. These inputs can mask the desired acoustical signals at low frequencies. A dynamic acceleration canceling system which senses case vibration and removes its response from the output of the acoustical sensor has been developed and tested. A reduction of vibration response by 14 dB has been measured in the laboratory with an additional