NEWSLETTER

IRE Professional Group on ULTRASONICS ENGINEERING

THE PROFESSIONAL GROUP ON ULTRASONICS ENGINEERING (PGUE) IS AN ASSOCIATION OF IRE MEMBERS WITH PROFESSIONAL INTEREST IN THE FIELD OF ULTRASONICS ENGINEERING. ALL IRE MEMBERS ARE ELIGIBLE FOR MEMBERSHIP AND WILL RECEIVE ALL PGUE PUBLICATIONS UPON PAYMENT OF THE PRESCRIBED ASSESSMENT.

Number 17 June 30, 1959

NEW MEMBERS OF THE ADMINISTRATIVE COMMITTEE

As a result of the recent ballot submitted to the general membership, the following were elected to the PGUE Administrative Committee:

Mr. Donald A. Berlincourt
Clevite Research Center
540 East 105th Street
Cleveland 8, Ohio

Dr. W. P. Raney
Harvard University
Cambridge, Massachusetts

Dr. Vincent Salmon
Stanford Research Institute
Menlo Park, California

Elected for three year terms of office, the new Administrative Committee members replace the following whose terms of office expire on July 1, 1959:

Mr. Laurence Batchelder
Raytheon Manufacturing Company
Wayland, Massachusetts

Dr. John E. May, Jr.
Bell Telephone Laboratories, Inc.
Whippany, New Jersey

Dr. Otto H. Schmitt
University of Minnesota
Minneapolis 14, Minnesota

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MESSAGE FROM THE CHAIRMAN

With this issue of the Newsletter, your Chairman turns over the reins to your new Chairman, Dr. Wilfred Roth. PGUE has made several important strides in the direction of improving its communications functions during the last year. Some of these improvements are at the moment only potential. The results will become evident in the future.

1. The system of election by the general membership was inaugurated. Only about 25% of the members voted, but this is average for a group of this type.

2. In addition to the annual meeting at the IRE National Convention in New York, PGUE has planned the first National Ultrasonics Symposium at Stanford, August 17, 1959. Response to the call for papers has been very gratifying and Dr. Salmon has planned a very interesting program.

3. The PGUE TRANSACTIONS will henceforth appear in letterpress format, thus assuring a better looking, easier to read journal.

4. Papers presented at the IRE National Convention, the National Ultrasonics Symposium and at WESCON will be reviewed, edited and published in the TRANSACTIONS. Not only does this provide all of the PGUE papers in one journal but it tends to produce better quality papers since the author has the benefit of the reviewer's and the audience's comments. In addition, the reprints being in letter press will be of better quality than those available from the Convention Record.

5. A Papers Procurement Committee has been established. The first evidence as to the value of this committee is to be seen in the number of papers submitted for the Symposium. As this committee gets into full scale operation there should be a good supply of high quality papers available for meetings and the TRANSACTIONS.

I want to take this opportunity to thank all those who have served on the various PGUE committees during the last year for their kind cooperation and excellent assistance. I also wish to extend to Dr. Roth and his Administrative Committee my best wishes for success in their endeavors.

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NATIONAL ULTRASONICS SYMPOSIUM

Plans are nearing completion for the National Ultrasonics Symposium (NUS) to be held at Stanford University, Stanford, California on August 17, 1959. PGUE has planned this Symposium together with a session at WESCON in San Francisco on August 18, 1959 to provide a two-day program on Ultrasonics.

Dr. Vincent Salmon, Chairman of the Symposium Committee has arranged a program of fifteen papers to be given in two sessions at Stanford, seven in the 9:30 a.m. to 12:00 noon morning session and eight in the 1:45 p.m. to 5:00 p.m. afternoon session. In order to provide more opportunity for the members to become better acquainted, PGUE has planned its first social event, a cocktail hour from 6:30 p.m. to 7:30 p.m. followed by a banquet from 7:30 p.m. to 10:00 p.m. at Rickey's Studio Inn in Palo Alto.

Reservations:

Those attending both NUS and WESCON are urged to place their reservations on forms provided by WESCON. For those wishing to spend a pleasant weekend on the Peninsula, the following motels are among the many good ones available. The costs given are the minimum for single (S), double (D), and twin (T).

Rickey's Studio Inn, 4219 El Camino, Palo Alto.
(Heated pool, TV, restaurant) S, $8.00, D, $11.00.

Flamingo Motor Lodge, 3398 El Camino, Palo Alto.
(Heated pool, TV, kitchenettes, restaurant)
S, $7.00; D, $8.50; T, $10.50.

Palo Alto Travelodge, 3255 El Camino, Palo Alto.
(Heated pool, TV, kitchenettes) S, $6,00; D, $7.00;
T, $8.00.

Dinah's Motor Hotel, 4269 El Camino, Palo Alto. (Heated pool, TV, restaurant) S, $8.00; D, $10.00; T, $12.00.

Your reservation should be placed directly and early.

Transportation:

Public transportation from San Francisco to the Southern Pacific Railroad Station in Palo Alto is available by train leaving 7:05 a.m., arriving 8:08 a.m. or by Greyhound Bus leaving 7:35 a.m. or 8:15 a.m. and arriving 8:40 a.m. or 9:10 a.m. respectively. Buses leaving the Southern Pacific Station at 8:15 a.m., 8:50 a.m. and 9:30 a.m. will provide free transportation to Stanford University. Free bus transportation will be provided from the University at 5:15 p.m. and at 6:00 p.m. to Rickey's Studio Inn and from the latter to the Southern Pacific Station after the banquet to meet the San Francisco bound train at 10:27 p.m. and the Greyhound Buses leaving Palo Alto at 9:35 p.m. and 10:59 p.m.

Registration:

Registration will be in the lobby of Memorial Auditorium starting at 8:00 a.m. Registration fees will be around $3.00. Banquet tickets will be $5.00 and cocktail hour prices will be $.70 per cocktail. No advance registration will be required. However, to assist in planning transportation and facilities, those planning to attend should fill out and return to the Symposium Chairman, the enclosed postcard questionnaire.

Program:

Morning Session

Little Theatre 9:30 a.m. - 12:00 noon

1. The Specification of Multiply-Tapped Delay Lines. Robert M. Lerner, Lincoln Laboratories, Mass. Institute of Technology, Lexington, Massachusetts.

It has been customary to specify the performance of delay lines in terms of bandwidth, attenuation, and spurious response in terms of a more or less arbitrary set of standards. In those cases in which a multiply-tapped delay line is used to synthesize and filter signals, it is possible to relate the departure from an ideal delay structure to the degradation that results in the performance of the signalling system in which it is used. In particular, the performance of a so-called matched filter system in the presence of Gaussian noise is used to place reasonable limits on the allowable variability in output and delay error from tap to tap, on the transient response of the delay line, on the phase distortion that can be tolerated, and on the temperature coefficient. The effects of spurious responses are noted, with special attention to small systematic reflections that may occur at each tap. Several simple tests using sequences of periodic pulses are described, from which the performance of a tapped delay line can be predicted.

2. Low Temperature Coefficient Ultrasonic Delay Lines. Weston H. Jenkins, Corning Glass Works, Corning, N.Y.

The nature of fused silica and fused quartz delay lines is such that they exhibit a temperature coefficient of time delay of approximately -80 PPM/^{o}C. They also display an appreciable negative temperature coefficient of acoustic attentuation which can be troublesome.

To avoid the use of heated enclosures, which become major encumbrances in applications where weight and power are important considerations, and especially when relatively short delay lines are involved, effort has been given over to search for glasses of improved characteristics.

Glass composition work has led to the development of sses usable for delay lines of up to a few hundred microonds length characterized by essentially zero temperature coefficient of attenuation relative to the apparent value for fused silica and/or fused quartz.

Curves are shown, where appropriate, to illustrate the points under discussion.

3. Ultrasonic Strip Delay Lines. A.H. Meitzler, Bell Telephone Laboratories, Whippany, New Jersey

A new type of ultrasonic delay line is described which uses piezoelectric transducers to generate an elastic wave motion in a delay medium having the form of a strip. By suitably arranging the transducers and the delay medium it is possible to obtain either dispersive or non-dispersive propagation characteristics. An analysis of the elastic wave motion in the [illegible] is given and formulas useful in the design and application of strip delay lines are derived. Results are given for the performance of experimental models operating in both dispersive and non-dispersive conditions of pulse propagation.
(This work performed under contract with Bureau of Ordnance, U.S. Army).

4. Wire Type Dispersive Ultrasonic Delay Lines. John E. May, Jr., Bell Telephone Laboratories, Whippany, New Jersey

Ultrasonic delay lines are described which utilize the dispersion of longitudinal waves in cylindrical wires to provide a delay which is variable with frequency. Existence of an inflection point in the delay-versus-frequency characteristic for the first longitudinal mode allows delay characteristics either approximately linear or with positive or negative curvature. By operating below the cut-off frequency for the second longitudinal mode the unwanted responses are limited mainly to flexural modes. One model to be described departs by $\pm$ 5 microseconds from a linear delay slope of 2080 microseconds over a 16% band centered near two megacycles. (This work performed under contract with Bureau of Ordnance, U.S. Army).

5. Dispersive Ultrasonic Delay Lines Using the First Longitudinal Mode in a Strip. T.R. Meeker, Bell Telephone Laboratories, Whippany, New Jersey

The existence of a dispersive longitudinal type mode in a narrow strip is demonstrated experimentally. This mode corresponds to that predicted theoretically for the infinite plane. The dispersive longitudinal wire delay line is compared experimentally with the dispersive longitudinal strip delay line with respect to the amount of dispersion per unit length, the departures from nonlinearity in the frequency-delay characteristics, the nominal delay per unit length of material, the types of undesired propagation, and the loss characteristics. (This work is performed under contract with Bureau of Ordnance, U.S. Army).

6. An Improved Deep Water Sonar Transducer. Dan G. McAnally, Texas Instruments Incorporated, Dallas, Texas

This paper describes a design improvement made on a high level echo ranging sonar transducer which resulted in preventing efficiency degradation with static pressure and water The transducer is of the search light type composed of radial resonant thin wall ceramic cylinders each inserted in a pressure release cavity and forming a half wave open resonant pipe. A multiplicity of these basic radiators form a plane piston array resulting in the desired search light radiation pattern.

The paper describes the cause of the efficiency change and the basic design properties which resulted in a satisfactory efficiency of -4 db at static pressures up to 160 psig. The paper concludes with a description of the acoustic measurements made verifying the expected results, and a prediction of the maximum probable pressures to which the design approach would be exposed.

7. A Compact Electromechanical Band-Pass Filter for Frequencies Below 20 KC. W.P. Mason and R.N. Thurston, Bell Telephone Laboratories, Murray Hill, New Jersey

The filter structure, which can be milled or stamped from a single sheet of metal, consists of several bars parallel to each other, coupled at their midpoints by short torsionally vibrating shafts which are aligned at right angles to the bars. The torsional vibration of the couplers excites antisymmetric flexural vibration in the bars. The pass band is associated with the frequency of flexural resonance of the bars.

A composite piezoelectric (or electrostrictive) transducer for this filter also vibrates in antisymmetric flexure, the torsional [illegible] resulting from the rotation of the central portion.

The theoretical capabilities of this arrangement are compared with the performance of the first research models.

Afternoon Session

Little Theatre 1:45 - 5:00 p.m.

8. Lamb Waves at Ultrasonic Frequencies. D. C. Worlton, Testing Methods Operation, Hanford Atomic Products Operation, General Electric Company, Richland, Washington

An experimental method of generating waves in plates is described and it is shown that a given plate can be excited in any one of numerous possible modes, depending upon plate thickness, frequency and wave velocity, in good agreement with a theory presented by Horace Lamb in 1916. Experimental data shows that using ultrasonic techniques these modes can be excited in finite plates, and solid objects of flat, concave and convex surfaces, and that they can be used to measure bond integrity, weld integrity, and grain structure in metals. The distinguishing characteristics of various modes are described and their salient features for various testing applications are pointed out.

9. The Reduction of Static Friction by Sonic Vibrations. Hans D. Fridman and Pascal Levesque, Research Division, Raytheon Manufacturing Company, Waltham, Massachusetts. (Hans Fridman now at Lincoln Laboratory, Massachusetts Institute of Technology, Lexington, Massachusetts.)

Two metallic surfaces moving against each other at creep speeds experience frictional relaxation oscillations between their surfaces in contact. This phenomenon causes instability of motion and can be reduced by controlling the coefficient of friction between the surfaces.

Such an experiment was performed by vibrating ultrasonically one steel surface against another at frequencies between 6 and 42 kc and vibration amplitudes estimated at 7.5×10^{-6}cm.

It is found that the coefficient of static friction between highly polished, ground and sand-pitted surfaces can be reduced by 100% as a function of vibration frequency and amplitude.

These phenomena are explained in terms of weakening of the frictional welds by the vibrations and by the concept of acoustic streaming.

10. Application of Ultrasonic Light Modulation to Signal Recording, Display, Analysis, and Communication, A. H. Rosenthal, Fairchild Camera and Instrument Corp., Syosset, Long Island, N. Y.

Ultrasonic light modulation systems have been developed and investigated for various applications to information handling. The light modulator systems can provide high dynamic range recording and display of signals in the megacycle region, and are being applied to various recording and display devices for radar, infrared, etc. Ultrasonic light modulators constitute diffraction gratings with electrically controllable grating constant and can therefore be used for intensity as well as frequency (color) modulation of light and for simultaneous frequency analysis in the megacycle region. The high linearity of their transfer characteristics together with their inherent signal storage and delay capability makes them useful in various correlation applications. Their efficient light intensity and color modulation can be applied in directional or omni-directional communication systems in visible or invisible spectral regions.

11. Ultrasonic Diffraction of a Narrow Light Beam and its Relation to Ultrasonic Pressure Measurements and Ultrasonic Stroboscopes. K. L. Zankel and E. A. Hiedemann, Department of Physics, Michigan State University, East Lansing, Michigan

A light beam that is much narrower than one ultrasonic wavelength and which passes through the ultrasonic wave becomes deflected periodically. This effect is usually referred to as "refraction". This causes broadening of an image formed by the light. The effects of the slit that limit the size of the light beam is included in an explanation of this phenomenon for progressive ultrasonic waves. The expressions derived include the usual experimental conditions. It is shown that for these conditions the effects of the limiting slit cannot be ignored. These expressions are related to ultrasonic intensity measurements and ultrasonic stroboscopes. (This work was supported by ONR).

12. Ultrasonic Doppler for Distance Measurement. Melvin H. Wachspress, Arma Division, American Bosch Arma Corp., Garden City, New York

High efficiency transducers are utilized in a Janus Doppler system for distance measurement.

Equations for the Janus system are developed for sound waves in a moving medium.

A light weight sonic Doppler system is described which is comparable in size and weight to a modern auto radio. An experimental Janus system is discussed. Spectrum photographs for various road surfaces are presented.

13. A High Efficiency Transducer for Transmission to Air. Jack Kritz, Arma Division, American Bosch Arma Corporation, Garden City, New York

The basic problems of transduction to low acoustic impedance media are considered. The advantages offered by flexure mode vibration of driving elements are shown. Selection of a driving element consisting of a free disk supported at the nodal circle is made. Fabrication in a quartz and ceramic is described. Test results on transducers in the range 5 kc to 200 kc is given with a maximum transducer efficiency of 97% obtained. Transducer mounting in parabolic reflectors and the resultant beam patterns are shown.

14. An Analytic Study of the Vibrating Free Disk. Raymond N. House, Jr., and Jack Kritz, Arma Division, American Bosch Arma Corporation, Garden City, New York

A piezoelectrically driven free disk vibrating in the first symmetrical mode has been shown to possess advantageous properties as a sonic generating source. It is necessary to evaluate the properties, and develop the equivalent circuit of this free disk to enable proper transducer design. An expression for the deflection curve is developed which satisfies the boundary conditions at the edge. The potential and kinetic energies are derived and equivalent mass and stiffness are obtained. The expressions for the radiation impedance is developed using equivalent piston concepts. The electromechanical transformer is derived and constants evaluated for quartz. The equivalent circuit referenced to center displacement is constructed. The analysis is then compared to experimentally obtained data.

15. Ultrasonic Doppler Measurement of Human Body Motion in Three Dimensions. Donald K. Ross, 7908 Bonhomme, Clayton 5, Missouri

An equipment has been designed and constructed which permits accurate determination of movements of a human body member as a function of time in three dimensions. The information obtained has application in physiological and psychological studies as well as in the work-measurement area of industrial engineering.

A radiating transducer is attached to the body member under study. Ultrasonic energy emitted from the transducer is received at three microphones, located along three separate axes from the approximate center of movement. Doppler signals corresponding to velocity in the three axes are detected and recorded. Further operation on the signals permit determination of both displacement and acceleration in three dimensions, together with resultant vectors.

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PGUE SESSION AT WESCON

On August 18, 1959, the day following the National Ultrasonics Symposium, PGUE is sponsoring a session on ultrasonics at WESCON, to be held in the Cow Palace, San Francisco. The program is as follows:

Session 1 - Ultrasonics
Tuesday, August 18th, 10:00 a.m. to 12:30 p.m.
Cow Palace, Room A
Chairman: Vincent Salmon, Stanford Research Institute

1. "An Ultrasonic Method for the Determination of Stress", by R. W. Benson, Armour Research Foundation, Chicago, Illinois.

2. "A New Type Directive Sound Source for Long Range Sonar", by Donald R. Church, Acoustics Associates, Incorporated, Mineola, New York.

3. "Non-destructive Measurement of Tensile and Compressive Stresses", by Rabah Shahbender, RCA, David Sarnoff Research Center, Princeton, New Jersey.

John E. May, Jr.
Chairman, IRE-PGUE