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QUARTERLY PROGRESS REPORT NO. 1

ULTRASONICS APPLIED TO ELECTRODE REACTIONS

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OBJECT OF THE RESEARCH

The problem is the use of ultrasonics produced by magnetostriction as a means of studying phenomena at the interface between electrode and electrolyte.

LITERATURE SURVEY

The literature on the subject of ultrasonics is very extensive, including hundreds of articles and several books. However the application to electrode reactions has been very limited and the results inconclusive. Nevertheless, in embarking on a project of this nature, the background material must first be explored thoroughly; this requires the survey of the entire field and the assembly of a complete bibliography of those publications which relate in any way to the present project. During this quarter, most of this phase of the project was completed with the collection of nearly 700 references, including brief abstracts for about 400 of these. Useful information was also obtained through correspondence and interviews with specialists in various phases of the general field of ultrasonics and instrumentation.

APPARATUS

It is well known that two general methods are available for the production of ultrasonic vibrations: the vibrating-crystal method and the magnetostriction method. While most of the work in the literature was done by the vibrating-crystal method, it was our conviction, based on extensive experience in the study of electrode phenomena, that the magnetostriction method represents the more logical first approach to the present problem.

In earlier work on electrode processes it was demonstrated that the effect becomes increasingly pronounced as the agitation of the solution approaches the electrode-solution interface. It appeared logical, therefore, that the ultimate effect could be observed by vibrating the electrode itself. The plan adopted was to attach the electrode to the end of the magnetostriction tube.

In accordance with the original plan to observe the effects of magnetostriction, it was necessary to design and assemble apparatus as follows:

- 1) A suitable electrolytic cell in which one of the electrodes is attached to the end of the magnetostriction tube; reference electrodes are also provided.
- 2) A circuit for the application of a continuous series of known electrolyzing currents.
- 3) Several nickel tubes of different lengths and corresponding natural frequencies.
- 4) The necessary electrical components for the excitation of the magnetostriction tube to various amplitudes and frequencies. This required the construction of separate exciting coils for each tube.
- 5) The necessary electrical measuring instruments for the determination of charging current and of the static potentials between various combinations of the polarized and reference electrodes, both with and without magnetostriction.

As the work progressed, it appeared that it would be possible to add materially to the significance of the information otherwise obtainable by including precise measurements of amplitude and frequency of the vibrating tube and of the rate of change of potential with time. The principle involved in

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the amplitude measurement is the variation of the capacitance of a highly sensitive test condenser as a result of changes in the amplitude of the vibrating system. To apply this principle, supplementary apparatus was borrowed from the General Motors Research Laboratory and from the Electrical Engineering Department of the University.

Apparatus for the observation of changes in the potentials as a function of time includes a high-precision cathode-ray oscillograph, together with a high-gain amplifier and a camera for photographic recording. These pieces were temporarily diverted from other research projects in the Chemistry Department. With this borrowed equipment the possibility of making such measurements has been demonstrated.

SUMMARY OF THE PERIOD

During this period information gained from tests confirmed the suitability of the general plan and equipment, but indicated the advisability of alteration of certain details. Many of the components purchased for the project had not yet been delivered at the conclusion of this period, thus limiting the measurements made to preliminary ones.

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