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ULTRASONICS APPLIED TO ELECTRODE REACTIONS

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OBJECT OF THE STUDY

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

RESEARCH DURING THE PERIOD

The programming device mentioned in the previous report was completed and tested. Controlled by a single pushbutton, it turns on and off, according to a preset sequence, the CRO sweep, a multivibrator which produces a dim spot on the oscilloscope, the two energizing coils for the magnetostriction tube, and a synchronous timing device that produces a brilliant spot every 4 seconds and operates the shutter of the recording camera. The sweep control is not as smooth as a purely electrical device, but it is adequate for the requirements of this research. However, attempts to improve it will be made as time permits. All other functions of the programming device are performed in an entirely satisfactory manner.

Design and construction of the electrolytic cell assembly, subject to the rigorous requirements of this research, was completed. This assembly consists of the following units:

(1) the magnetostriction tube mounted vertically in the field of the energizing coils and carrying on its upper end the metallic cathode under study;

(2) the cathode chamber containing the solution and surrounding the upper end of the magnetostriction tube (the connection is made in a necessarily nonrigid but nevertheless leakproof manner by use of a thin rubber diaphragm cemented to the cathode in such a way as to expose a circular center section to the solution);

(3) an anode chamber consisting of a large, and therefore relatively unpolarizable, mercurous sulfate electrode, removed from the influence of the vibrations but communicating with the cathode chamber by means of a long thin glass tube;

(4) two mercurous sulfate reference electrodes, one for the anode and the other for the cathode (these also are out of range of the vibrations, connection with the rest of the cell being provided by thin glass tubing);

(5) auxiliary glass chambers providing means of flushing out the communicating tubes between the reference electrodes and the anode and cathode chambers;

(6) a lucite shelf, rigidly clamped to a steel rod and so arranged as to permit precise repositioning of the various components of the cell assembly; and

(7) a micrometer pickup applied to the lower end of the magnetostriction tube to provide for determination of the amplitude and frequency of vibration.

Since the individual units of the electrolytic cell are necessarily interconnected with ground-glass joints and even though they are supported by nonrigid clamps, extensive glass work was required in order to incorporate the numerous parts of the assembly within the restricted space available. An auxiliary to the cell assembly is a purification train for the saturating gas to be used.

With this assembly a series of preliminary photographs was taken. The first of these served to establish the optimal photographic conditions, suitable illumination of the grid coordinates, and intensity of the spot on the oscilloscope, both for recording of the potential trace and for the time and potential calibration dots and diaphragm opening of the camera. During this work some trouble was experienced with the cable release of the camera, which finally had to be replaced. The remainder of the photographs were taken for the purpose of standardizing the remaining conditions of operation and were therefore preliminary in character. Indications were generally satisfactory, although it appeared that the oscillator was not delivering as much power as previously.

The only respects in which the procedure differed from the one finally to be used was that a saturating gas was not used and that no special attention was given to the electrolyzing current. Initial results appeared to be entirely satisfactory: the automatic programming switches operated with precision and the photographic records showed the expected depolarizing effects of magnetostrictive vibrations. However, as more records were taken certain inconsistencies from an electrochemical point of

view forced the conclusion that some spurious effects were present. To track these down it will be necessary to substitute one element after another of the complex assembly. The first step in this procedure showed one difficulty to be the rubber diaphragm attached to the cathode and providing the liquid-tight closure for the bottom of the cell. It seems strongly probable that an electrostatic potential is generated in the flexing rubber diaphragm. It appears that suitable grounding of the diaphragm or of the cathode itself partially eliminates the difficulty. Oscillograms taken with the grounding technique appear much more satisfactory. A large number of photographic records were taken in the final month of the period to test the functioning of the complete assembly. The records all indicate a pronounced change in potential when the oscillator is on; however, there are some indications which raise strong doubts as to the cause for the potential changes. This must receive some very careful study to determine whether there is some other factor than depolarization involved. Also, it is evident that modifications must be made in the oscillator to increase the power output.