THE BLACK VAULT

January 10, 1967

Dear Neal:

Enclosed is a short Progress Report of our work to date pursuant to [redacted]

Very truly yours,

[redacted]

THIRD PROGRESS REPORT

January 5, 1967

Contract No. [redacted]

I. SUMMARY OF ACTIVITY FOR THE QUARTER ENDING December 31, 1966

Contract efforts during this period have been in three areas; literature monitoring, a continuation of efforts to produce an improved piezoelectric generator design, and planning for animal research studies. The results of activity in these areas are summarized separately below.

A. Literature Review

Many articles of peripheral relevance to this study have been scanned. The sources utilized during this period are largely composed of the Biomedical Engineering Journals and publications of NASA and NIH. During this quarter became a subscriber to the services of the Knowledge Availability Systems Center of the University of Pittsburgh. The KASC searches STAR and IAA indexes and provides with documents relevant to our interests. Searching under several descriptors appropriate to this contract began with 1963 documents and is now up to date. Descriptions of recent work of three research groups mentioned in our last formal report are contained in Proceedings of the Annual Conference on Engineering in Medicine and Biology, 1966. The report of P.J. Racine and H.L. Massie addressed the problem of determining the chemical activity present in the Koniksoff-Reynolds Galvanic Electrode System. Data from several metal types in in vitro experiments are discussed, oxidation of electrode metal to its ion and reduction of free oxygen were suggested as principal reactions. Wen H. Ko described a prototype "piezoelectric energy converter for electronic implants." Professor Ko concurs with our analysis of the characteristics of ceramic bimorphs that resonant operation promises higher efficiency. His device, which was not implanted, utilized inertial coupling and the proposed energy source was the mechanical energy of heart motion. Pending

contrary data, the mass and gravity limitations of such coupling discussed under Random Motion in our previous report still apply. His voltage doubler rectifier circuit should be useful. The paper by C.C. Enger and M. Klain, "A Three Gram Self-Powered Pacemaker Implanted on the Surface of the Left Ventricle," discusses recent work on solving the body fluid leakage problems of the Enger-John H. Kennedy device.

B. Piezoelectric Generator Design

The main problem to be overcome by a successful generator design is coupling the available form of host mechanical energy into the piezoelectric element. Fluid seals, overall efficiency, breakage, size and weight are some of the aspects of this problem. In our previous report we offered some suggestions apropos parts of this problem, among them a striker system which was similar to the operation of a music box. The intended performance characteristic was for input mechanical energy to be captured in the piezoelectric element which would subsequently oscillate freely until the energy was all converted into heat (mechanical losses) and electricity. Another method of achieving this characteristic has occurred to us which has the advantage of requiring no sliding off the end of the element thus eliminating a possible wear point. The essence of this new method is to attach a small piece of steel to the piezoelectric element and use a magnet to deform the element. When the magnet's holding force is exceeded, the element is released and allowed to vibrate freely. It appears that a package similar to those used by Dr. Kennedy but incorporating this technique could be constructed quite simply. As has been previously discussed, resonant operation should provide significantly more electrical output than does "direct" drive.

C. Research Experimentation

Arrangements have been made with an experienced animal researcher to conduct a few measurements of the source resistance and power yield characteristics from implant electrode EMG signals.

II. PLANS FOR THE PERIOD JANUARY 1 THROUGH FEBRUARY 28, 1967

Work in the three above areas will continue and a final report summarizing both new data and previous reports will be prepared.