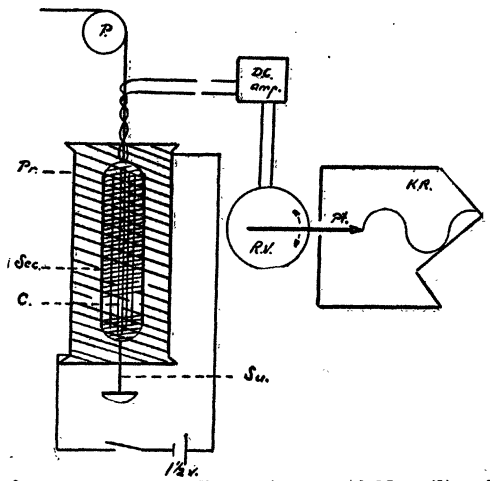

FIG. 1. *P.*, pulley; *Pr.*, primary (field coil); *Sec.*, secondary (moving coil); *C.*, soft iron core; *Su.*, weight support, or spring substitute; *D.C. amp.*, direct current amplifier; *R.V.*, recording voltmeter; *Pt.*, pointer; *K.R.*, kymograph record.

pulley, raises and lowers a specified weight or pulls against a spring of given substitute-weight. In this case, instead of the thread activating a pointer, a soft iron core around which is wound many turns of fine wire is raised and lowered in the magnetic field of a helix of heavy wire through which a small current passes. The core together with its secondary winding cuts the magnetic lines of force in the field, and a current is set up which operates a dead-beat, zero-center, recording voltmeter equipped with a light pointer and so adjusted as to record on a moving kymograph drum. A one or two-step D. C. amplifier in the secondary circuit provides a means of controlling the amplitude of the pointer-arc.

By varying the length of the wires between the movable iron core and the voltmeter it is possible to make records at any convenient distance from the research laboratory in which the activated muscle may be placed, *e.g.*, records may be made before a large class in the lecture room.

A detailed description of the electrodynamic recorder has been omitted because it is assumed that laboratory research means the fitting of fundamental apparatus to specific uses. (For certain uses, the recorder may be wired in such a manner that the movable core carries the energizing current, while the outer helix becomes a part of the secondary circuit.) It is felt, however, that the extreme sensitivity of the device, the simplicity of construction and the advantage of remote recording will recommend the apparatus to experimenters in physiology and psychology.

LYMAN S. JUDSON
P. E. GRIFFITH

UNIVERSITY OF IOWA

A SIMPLE AQUEOUS ELECTRODE

IN threshold studies of sensitivity to high frequency E.M.F. stimulation the writer has devised a simple aqueous electrode which has proved very satisfactory in laboratory experimentation.

The complete electrode, schematized in Fig. 1, is a modified Mandler diatomaceous bacteriological candle

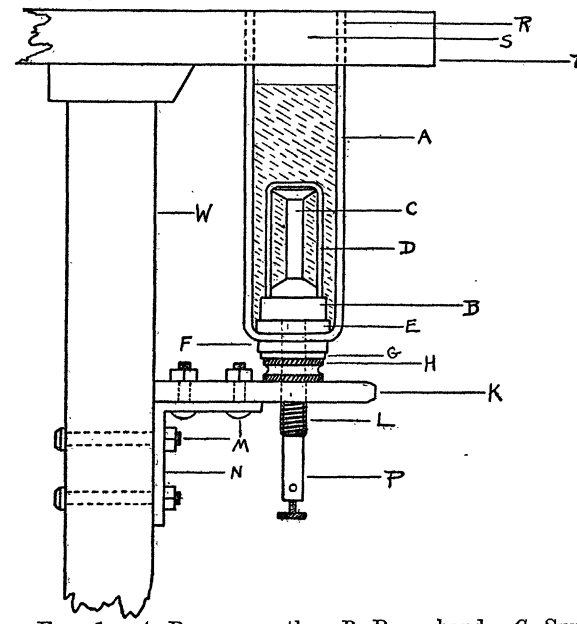

FIG. 1. *A.* Pyrex mantle. *B.* Base band. *C.* Supporting electrode. *D.* Inverted glass tube serving as finger rest. *E. F.* Soft rubber washers. *G.* Fiber washer. *H.* Brass lock-nut. *K.* Wooden base supported by right-angle iron. *L.* Threaded nipple. *M.N.* Fastening bolts. *P.* Binding post. *R.* Mantle protruding through writing ledge, *T.* *S.* Hole in writing ledge through which subject inserts finger. *W.* Fore leg of chair.

enclosed in a pyrex mantle. After the filter is removed, the base band, the concave drainage and the nipple are sealed, thus rendering the mantle liquid tight. By means of interposed cushion-rubber washers, the nipple lock-nut fastens the base band securely against the bottom of the pyrex mantle. A brass binding post is soldered to the lower end of the sealed nipple.

In place of the diatomaceous candle, a T-electrode is substituted which supports an inverted glass tube acting as finger rest. Filtered water is used as the liquid conductor. The electrode is not reliable when used in connection with psychogalvanic direct current circuits. It is quite effective, however, when used in connection with an inductorium as source. Since alternating current of relatively high frequency is employed as the stimulus, danger of polarization is eliminated.

The complete electrode is supported at the lock-nut

juncture by means of a right-angle iron attached to the anterior surface of the fore leg of a study chair. The top of the mantle conveniently passes through a circular hole in the writing ledge of the study chair. The writing ledge acts as an arm and finger rest for the subject. The mantle can be quickly removed from its supporting position and thoroughly cleaned without difficulty.

CHRISTIAN PAUL HEINLEIN
FLORIDA STATE COLLEGE FOR WOMEN

SPECIAL ARTICLES

THE MYOGRAM OF THE ISOLATED SKELETAL MUSCLE CELL

THE determination of the contractile mechanism of a muscle cell from results procured in experiments upon an intact muscle presents the difficulty of differentiating between those factors attributable to the cellular process *per se* and those due either to a statistical distribution of the contractility of the fibers or to mechanical interference of the connective tissue enclosing the fibers. Moreover, the methods employed give no approach to the functional significance of the recognized structural elements within the muscle cell. The present investigation was undertaken, therefore, to develop a method of investigating the contractile and structural properties of single isolated muscle fibers. Opportunity is taken at this time to present a preliminary report of the results. A complete account will be published later.

METHODS

The method is to mount the single muscle fiber upon the tips of two glass needles, one needle being rigid, while the second, the micro-lever, is flexible so that its tip is free to move when the muscle contracts. The needles, mounted in a Chambers' micro-manipulator, are held in the field of a microscope. The image of the movable lever is projected upon the slit of a recording camera and adjusted at right angles to the slit by means of a suitable optical system.

For the glass micro-lever used it has been determined that the displacement of the tip of the lever is a linear function of the force applied.[1] The contraction curve of the muscle, therefore, can be converted into absolute units when necessary.

The micro-levers have a period of about 0.0016 seconds. This is a sufficiently short period for recording the contractions of these muscle fibers.

The muscle cell is stimulated by break induction shocks applied by silver-silver chloride micro-electrodes.

Preparations of the isolated cells of the sartorius muscle, 1 cm to 1.5 cm in length, are used. These are mounted in a hanging drop of frog serum in the customary moist chamber.

[1] The method of calibrating the glass micro-levers will be published elsewhere by the junior author.

RESULTS

The results obtained can be described to the best advantage by reference to the records of the contractions in Fig. 1. These records show the following:

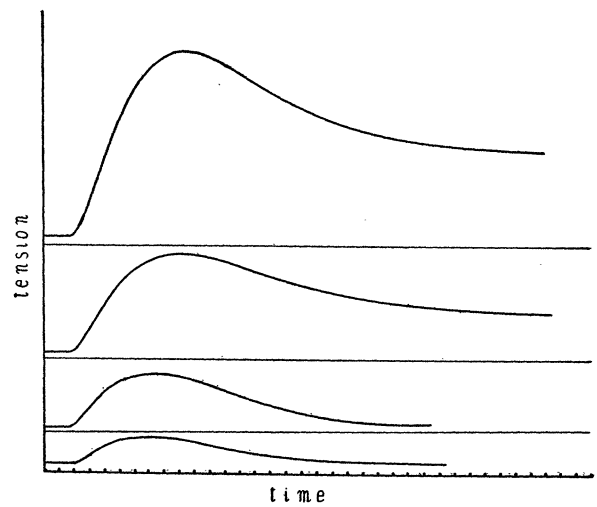

FIG. 1. Myograms from a single isolated fiber of the sartorius muscle showing a progressive increase in the magnitude of each response with increasing strength of stimulus. Temperature 23° ± 2° C. Time intervals represent 0.01 seconds.

(1) In the simple twitch of a skeletal muscle fiber the tension at the beginning of contraction rises abruptly, increases to a maximum, and then decreases to zero in a curve without discontinuities. No plateau or angle such as described by Fulton[2] for the intact muscle exists. These results are in agreement with those of Cooper and Eccles,[3] who ascribe Fulton's results to frictional interference in the muscle lever he used.

(2) An increase in the strength of stimulation results in an increase in the total tension developed and in the duration of the contraction. With strong stimuli the recovery from contraction is not complete, a new base line being reached.

[2] J. F. Fulton, Williams and Wilkins Co., 1926.
[3] S. Cooper and J. C. Eccles, *J. Physiol.*, 69, 1930; *Proc. Physiol. Soc.*, III.