consin, effect of complete striate muscle paralysis upon learning and thinking; Truman Michelson, ethnologist, Bureau of American Ethnology, Smithsonian Institution, study of special data upon the ethnology of the Fox and Ojibwa Indians; William S. Webb, professor of anthropology and archeology, University of Kentucky, archeological survey of Kentucky.

W. H. HOWELL,
Chairman, National Research Council

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A METHOD OF OUTLINING CUTANEOUS NERVE AREAS

IN 1928 we discovered that the cutaneous area supplied by a nerve may be rendered insensible to light touch by subjecting the nerve trunk to the influence of an alternating current; the area may be outlined by the procedure employed in cases of peripheral nerve lesions. Though we have not explored the literature to its depths, our efforts in this direction have failed to reveal a previous record of such a finding.

This indicated a new experimental approach to some of the problems of cutaneous innervation and sensation; such work has been pursued in this laboratory since 1928, and preliminary reports have appeared.[1] We did not intend to publish the technique apart from the results, but requests for an account of the method indicate that a brief note would place it at the service of others who might find it useful. We shall describe the apparatus used by us, suggesting some desirable modifications; others will occur to those who use the method.

The current from the 110 volt D. C. main was converted into an alternating current by a small Alexanderson alternator (Fig. 1); because of its noise this should be in another room than that wherein the observations are being made. The alternator may be driven by A. C. or by D. C.; Fig. 1 shows the latter arrangement. The frequency was controlled by a variable resistance in the circuit driving the alternator; it was estimated from the number of teeth and the r. p. m. of the alternator, this being ascertained by a Starrett speed indicator. The current strength was controlled by a system of variable resistances in the primary or input circuit (Fig. 1); our method of measuring it was unsatisfactory and need not be described; that this is unimportant is indicated below.

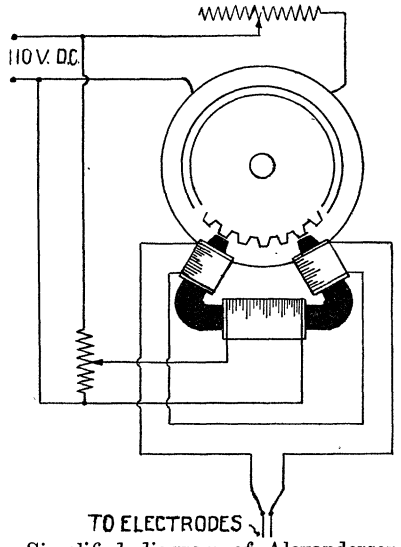

FIG. 1. Simplified diagram of Alexanderson alternator, with driving circuit (above), input circuit (left), and output or stimulating circuit (below).

We have applied the method systematically only to the nerves of the forearm and hand, to which the following account refers. Each nerve to be investigated was subjected to unipolar stimulation through the intact skin. We used metallic electrodes, padded with gauze soaked in a saturated solution of NaCl; subsequently we have found a 4 per cent. solution equally satisfactory. The large inactive electrode was applied to the opposite arm. The stimulating electrode (diameter about 1 cm) being placed on the skin over an appropriate part of the nerve trunk, somewhat as indicated by Hughson,[2] the current was *gradually* turned on by withdrawing resistance from the input circuit. With practice the nerve was soon "picked up"; this was evidenced by the sensation of flutter projected into its cutaneous area, as described by Hughson.[2] As the current was increased, testing with a von Frey hair revealed that at a certain level of current strength tactile sensibility disappeared in the area supplied by the nerve under stimulation, though remaining unaltered elsewhere; to this loss of sensation we apply the provisional term "masking" in preference to anesthesia. Manipulation of the electrode and of the current extended the masked area to a limit beyond which no further manipulation could extend it; it was then outlined on the skin as in the case of a peripheral nerve lesion, every precaution being taken to ensure that the subject received only tactile stimuli.

Fig. 1 shows no apparatus for measuring the frequency and strength of the current, that being unnecessary if one is merely outlining nerve areas: it is sufficient to manipulate the current (and the electrode) until the area is masked. If he so desire, the

[1] I. M. Thompson, V. T. Inman and B. Brownfield, *Anat. Rec.*, 45: 245, 1930; I. M. Thompson and A. Barron, *ibid.*, 48: 35 (Suppl.), 1931; I. M. Thompson, *Jour. Anat.*, 66: 148, 1931.

[2] W. Hughson, *Anat. Rec.*, 23: 371, 1922; *Johns Hopkins Hosp. Bull.*, 33: 338, 1922.

investigator may introduce suitable meters, etc., at appropriate places in the output or stimulating circuit. As a result of further work, we recommend a larger generator than that described above, yielding stronger currents at low frequencies. For the subsequent development of this field of investigation such a generator has been designed and installed in this laboratory, and will be described later; using it, satisfactory masking occurs with currents of about 100 to 300 cycles per second, 5 to 10 volts and 0.5 to 3 milliamperes. All our work on nerve areas, however, was done with the small alternator. Possibly currents generated otherwise may yield similar results.

The space available here precludes reference to the difficulties inherent in such a procedure; these will be discussed in a more detailed publication. The method is not easy, and demands practice and patience on the part of observer and subject alike. We have encountered one or two subjects who, for some obscure reason, possibly physiological or psychological, were unsatisfactory for such work, wherein the importance of reliable subjective responses is obvious. Outlining the same area on the same subject on different occasions has yielded reasonably consistent results.

The nature of the results is indicated in Fig. 2.

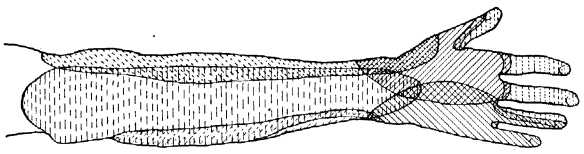

FIG. 2. A sketch of the dorsal aspect of the right forearm and hand of an adult male, showing the cutaneous areas supplied by various nerves; these are not labelled, for anatomists will recognize them. In this individual the median nerve supplied the entire dorsal aspect of the index and middle fingers. The extent of the overlaps is easily seen. In this person certain small areas on the back of the wrist were supplied by three cutaneous nerves: for example, that in the middle is seen to be supplied by the dorsal cutaneous nerve of the forearm, the radial and the ulnar.

So far as we know, ours are the first pictures of the *complete* innervation, *including overlap areas,* of any region of the body in single individuals. We have succeeded in estimating the size of these areas and in studying their variations; preliminary results have been presented by Thompson, Inman and Brownfield, and by Thompson[1]; a detailed analysis is being prepared.

I. MACLAREN THOMPSON
VERNE T. INMAN
UNIVERSITY OF CALIFORNIA
MEDICAL SCHOOL
DIVISION OF ANATOMY
BERKELEY, CALIFORNIA

CELLOPHANE ROLL FILMS AND THE FIXING OF CARBON PAPER TYPING ON CELLOPHANE[1]

THE wide-spread interest in the use of cellophane for slide lanterns[2] seems to justify reference to the paper presented by the authors[3] before the Division of Chemical Education of the American Chemical Society, at Denver, Colorado, on August 24, 1932.

A cellophane roll film carrier was described for using the cellophane in rolls instead of slides. The device is fitted into any ordinary slide lantern with no modification of the lantern necessary. Any one interested in this device will find a scale drawing for one form of it given in the *Journal of Chemical Education.*[3] The cellophane roll film carrier will hold over 33 feet of 0.001 inch thick cellophane. This is equivalent to about 120 slides, yet forms a roll less than ¾ inch in diameter, and weighs less than one glass slide. The article also gives a description of methods of preparing the films, including colored pen work; also uses of such films, and methods of fixing carbon paper typing.

Typing on cellophane slides and films is done with carbon paper. Every one seems to have had trouble with smearing of such typing, but we have worked out a simple method which is so satisfactory that a roll film has been used over 400 times and still shows no evidence of smearing. A brief description of it may be of interest to readers of SCIENCE.

The procedure consists of passing the typed film through a suitable liquid and carefully blotting it between unglazed paper while it is still moist, care being taken that the blotting paper does not slide over the wet surface. The paper removes most of the liquid and the excess ink. The film is then placed between dry paper and pressed for several minutes to complete the fixing.

Of fifty chemicals tried, organic liquids for the most part, the most satisfactory for the purpose are: amyl acetate, ethyl acetate, methyl acetate, acetaldehyde, benzyl alcohol, iso-amyl alcohol, ethylene glycol monoethyl ether ("cellosolve") and a mixture of 75 per cent. di-ethyl ether and 25 per cent. ethyl alcohol.

Other liquids fairly satisfactory are: iso-butyl alcohol, iso-propyl alcohol, methyl-ethyl ketone, acetone, ethylene chloride, ethylene bromide, benzyl

[1] Contribution No. 89 of the Division of Industrial Sciences of West Virginia University.

[2] "Lantern Slides from Cellophane," John L. Wilson, *Jour. Chem. Educ.*, 8: 2212 (November, 1931); "A New Use for Cellophane," K. L. Warren, SCIENCE, 76: 573, (December 16, 1932); "Cellophane for Slide Lanterns," B. H. Walden, SCIENCE, 77: 91 (January 20, 1933); "The Radio-Mat," F. L. Wells, *ibid.*

[3] "Cellophane Roll Films for Slide Lanterns" was sent to the *Journal of Chemical Education* on July 20, 1932, and appears in a somewhat abbreviated form in *Jour. Chem. Educ.*, 10: 92–94 (February, 1933). Since August numerous brief references to the paper have appeared in the daily press and periodicals.