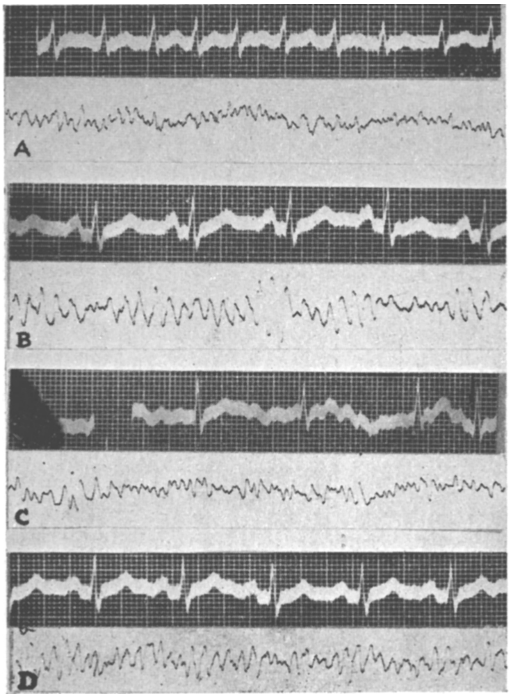

FIG. 1.
Electroencephalograms and electrocardiograms in a case of paroxysmal auricular fibrillation-flutter.
A. 3-20-47. C. 6-20-47 (Readmission).
B. and D. After conversion to normal cardiac and encephalic rhythm, using quinidine.
B. 5-8-47. D. 7-16-47.
EKG—Lead II. EEG—Left.

into 2 general groups: Those in which there is EKG history and physical evidence of myocardial damage, and those without such evidence. Cases 1, 2, 3, 4, and 5 fall within the second category. Reverse cerebral excitation is not supported by findings in cases 6, 7 and 8. EEG abnormality in a case with a history of long-standing paroxysmal arrhythmia without definite evidence of myocardial damage (Cases 4, 5) may or may not be pertinent to the cardiac arrhythmia. Experimental[4] and clinical[13] demonstration of the variety of possible neurogenic cardiac arrhythmias does not make feasible any separation at this time on the basis of type of arrhythmia. Factors not associated with the arrhythmia may cause an abnormal EEG and therefore the indication that an abnormal EEG may accompany a central excitation causing the cardiac arrhythmia is gained only from Cases 1-1a, and 2. Even here it will be necessary to investigate the possibility of cerebral circulatory insufficiency secondary to the cardiac arrhythmia.

Summary. Evidence is presented to indicate that electroencephalographic abnormality coincident with neurogenic cardiac arrhythmia may disappear with restoration of normal cardiac rhythm.

16008 P

Pressure Stimulation of Peripheral Nerves.

ROBERT B. AIRD* AND CARL PFAFFMANN.† (Introduced by D. W. Bronk.)

From the Eldridge Reeves Johnson Foundation for Medical Physics, University of Pennsylvania.

Clinical experience suggests that pressure upon peripheral nerves or nerve roots is accompanied by pain, as well as by alterations in sensation and other neurological changes. The radicular pains caused by neoplasms of the spinal canal, the root pains arising from herniations of the intervertebral discs and the pain caused by pressure on the brachial plexus of cervical ribs or thickened scalenus muscles are common examples. Pain occurs early and persists throughout the course of these conditions and has been attributed to the stimulating effect of the steady pressure against the nerve.

On the other hand, experimental physiological studies have repeatedly demonstrated that nerve fibers are relatively inexcitable to steady or even slowly changing stimuli. The classical studies on electrical stimulation of

* University of California Medical School, San Francisco.

† Department of Psychology, Brown University.

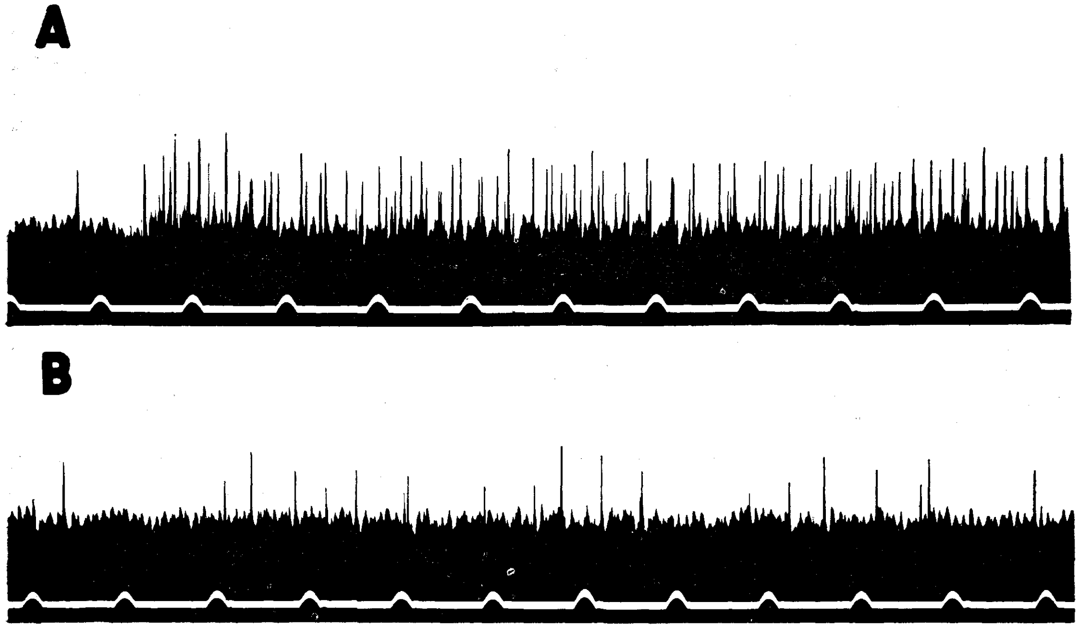

FIG. 1.

Impulses in the sciatic nerve of a frog, initiated by compression of a 5 mm length of nerve with a 40 g weight. Record A shows the impulses discharged when the weight was first suddenly applied, record B after the same weight had been kept on the nerve continuously for 10 minutes. Timer indicates 1/5 seconds.

A few larger and briefer impulses appeared during the first 1/5 second after application of the weight, as described in the text, but their oscillograph tracings were too faint for photographic reproduction.

nerve emphasize that stimulation ordinarily occurs only on the make and break of a circuit, whereas constant currents do not stimulate at all. It is obvious, therefore, that there is a discrepancy between the clinical and experimental views. This may mean that the effects observed clinically are more than the effects of simple pressure stimulation or that the classical notions of stimulation have tended to minimize certain properties of nerve which might allow for repetitive response to steady, unchanging stimuli. Recent experiments have indeed shown that under suitable conditions constant electric currents may evoke a repetitive response (Erlanger and Blair,[1] and Rosenblueth[2]). Moreover, very long sustained activity can be caused by steady chemical stimulation (Brink and Bronk,[3] Lehman[4]). The experiments described in the present paper were undertaken to determine whether steady pressures applied to an isolated nerve preparation can similarly give rise to a continuous series of nerve impulses.

Pressure transients, that is, sudden, noninjurious increases or decreases in pressure, have been shown to initiate impulses in the sciatic nerve of the frog (Blair,[5] Schmitz and Schaefer[6]) whereas steady pressure of sufficient intensity will block conduction (Gasser[7]). It is known also that, if the nerve is subjected to an increased hydro-static pressure throughout its entire length, its excitability will be modified (Grundfest[8]). To the writers' knowledge, however, there has been no laboratory demonstration that the application of

1 Erlanger, J., and Blair, E. A., *Am. J. Physiol.*, 1936, **114**, 328.

2 Rosenblueth, A., *Am. J. Physiol.*, 1941, **132**, 99.

3 Brink, F., Bronk, D. W., and Larrabee, M. G., *Ann. N. Y. Acad. Sci.*, 1946, **47**, 457.

4 Lehman, J. E., *Am. J. Physiol.*, 1937, **118**, 613.

5 Blair, H. A., *Am. J. Physiology*, 1935, **114**, 586.

6 Schmitz, W., and Schaefer, H., *Arch. f. d. ges. Physiol.*, 1933, **232**, 7.

7 Gasser, H. S., *Assn. for Research in Nervous and Mental Diseases*, 1935, ch. 2, p. 35.

8 Grundfest, H., *Cold Spring Harbor Symposium on Quantitative Biology*, 1936, **14**, 179.

steady pressure to a localized portion of a peripheral nerve will produce a steady discharge of impulses. The purpose of this paper is to report such observations on the sciatic nerve of the frog by means of an amplifier and oscillographic recording.

Methods. The sciatic nerve was removed from the leg of a frog and placed in a moist chamber so that the large proximal portion of the nerve rested on a waxed ebonite platform. A second ebonite block fitted over this platform and, when in position, pressed directly on a 5 mm length of the nerve. Pressures were graded by loading the block with various weights. Nerve impulses initiated by this pressure were recorded as action potentials in the smaller distal branches of the nerve.

Results. When weights of from 30-50 g were dropped on the nerve from a height of 2 mm, two types of response were elicited. At the moment of contact a transitory burst of fast, large action potentials was recorded. At the same time there was a discharge of slower and smaller impulses, which continued as long as the pressure was applied (Fig. 1). During this period the asynchronous discharge of the nerve showed a diminution in frequency analogous to "adaptation". Some fibres would "adapt" completely after a few minutes, *i.e.*, cease to respond, whereas others continued to discharge for as long as 15 minutes. Observations were terminated at the end of this period, at which time the activity had reached a fairly constant level. Gradual application of the weight elicited a discharge of the slower impulses only. When the response had attained a fairly constant level some minutes after application of the stimulus, further increase of pressure increased the frequency of discharge and occasionally brought in additional fibers. Withdrawal of the weight was followed by a gradual cessation of the response.

In another series of experiments the sciatic nerve was freed by dissection in the thigh region of the frog's leg, leaving the nerve in functional continuity with the spinal cord. The spinal canal was opened to expose the sensory and motor roots which were then cut close to the cord and placed in turn on the recording electrodes. The dissected peripheral end of the nerve was arranged for pressure stimulation as in the above experiments. With this arrangement it was possible to determine whether the impulses initiated by pressure were traveling in motor or sensory fibers. A repetition of the foregoing procedures showed that the prolonged response to pressure occurred only in the dorsal roots, *i.e.* sensory fibers. The sole response from the motor roots was the transitory burst of fast impulses when the stimulus was applied. The fact that later activity was restricted to sensory fibers may depend on the presence of small as well as large fibers in this category, while the motor nerves consist almost exclusively of large diameter fibers. The prolonged phase of the pressure response occurs in fibers of small diameter as indicated by the relatively small amplitude and relatively long duration of the individual action potentials.