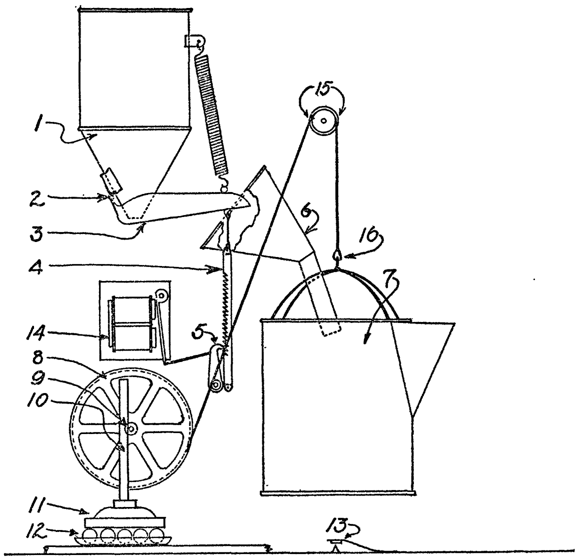

1, Reservoir for lead shot; 2, hinge; 3, movable pouring spout; 4, ratchet for holding spout at a given angle; 5, pawl to engage with ratchet bar 4; 6, guide funnel to direct shot into bucket 7; 7, detachable shot bucket; 8, grooved pulley; 9, pinion coaxial with pulley 7; 10, rack bar driven by pinion 9; 11, platen of glass which crushes peas; 12, receptacle for peas; 13, electrical contact for stopping shot at a predetermined position of the bucket; 14, electro-magnet which lifts pawl 5; 15, braided steel wire passing over pulley; 16, wire loop and hook for detaching bucket for weighing. It should be mentioned that parts 8, 9, 10, 11 and 12 are the essential parts of the device for determining the crushing value of peas described in N. Y. Agr. Exp. Sta. Tech. Bulletin 176, (Geneva) p. 12.

too large to be stopped up by the wedging of the shot or "bridging over." There is some latitude in its size, but it should be neither too large nor too small. One that has been found satisfactory for air rifle shot is 18 mm in diameter and will pass a dime but will retain a nickel.

Below the funnel a pouring spout is fastened by a hinge, so that shot passing through the funnel opening forms a pile upon its floor. This pile of shot grows until it surrounds the opening, whereupon the flow of shot from the reservoir is checked. If the inclination of the spout does not allow the shot to run out, the movement of shot from the reservoir stops instantly and completely. If the spout is tilted so that shot roll out the size of the pile is maintained from the reservoir, and a remarkably regular flow is kept up from the tip of the spout as long as there is any shot in the reservoir. A wide range of choice of rates of flow was found to be possible. The notches on the bar shown in the figure for holding the spout in any given position are 5 mm apart.

For an automatic cut-off the spout may be pulled back to the "off" position by the release of a spring. To prevent the violence of this motion from spilling some of the shot in the spout this is covered almost to the tip, and a suitably designed guide funnel is provided to direct all the shot that leaves the spout into the weighing bucket.

The drawing illustrates a device of this sort that was used with a previously described crushing tester for peas throughout an active season without requiring attention from the operator. The load reading is taken by detaching the bucket at leisure and weighing it upon a platform balance. It is emptied into the reservoir before attaching again and a pour-out is provided to make this more expeditious. It is not necessary to touch the shot with the hands.

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VOLTAGE-FREQUENCY RELATIONSHIPS IN ACTION CURRENTS

THE common method for studying action currents has been to record photographically their frequencies, amplitudes and phase angles. It has yielded noteworthy results. However, certain questions have arisen not only in regard to the interpretation but also in connection with the reading of such recordings. The most of us have read the time interval between successive peaks in the wave train in order to obtain the frequency. This method is both inaccurate and inadequate. Granted that pictorially all the fundamental frequencies and their harmonic contents are present there is no known method for reading a non-repeating electrical wave such as we have represented in the action currents of nerve and muscle. In the vast majority of our action current records we could not fit even approximately a Fourier Series which proceeds by sines or cosines or multiples of a variable.

There is a method which overcomes, partially at least, the difficulties confronting us in a wave analysis of action currents. It amounts to determining what proportion of the total voltage generated lies within a certain frequency band. The frequency-intensity-phase angle relationships are·thus resolved into a common denominator, voltage which for practical purposes may be thought of as power. Power equals the voltage squared divided by resistance and as we may hold the latter constant the voltage may be read as a direct expression of power. This unit of analysis is not only accurate but practical.

We have used two three-stage amplifiers, one of the resistance and the other of the impedance coupled type, a filter circuit and an alternating current voltmeter to study voltage-frequency relationships in action currents (Fig. 1). The overall frequency

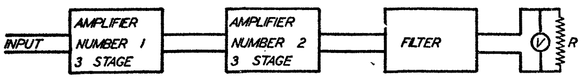

FIG. 1. A diagrammatic sketch of the voltage-frequency measuring unit.

deflection characteristic of the two amplifiers was linear between 100 and 6,000 cycles per second. The voltmeter had no frequency discrimination between 80 and 5,000 cycles per second. All the commonly studied muscles of the human body have been scouted in this preliminary report. The subject was asked to tense the muscles from which action currents were being led off until a full-scale deflection of 9 volts was obtained on the voltmeter. Then as each filter circuit was introduced the new reduced voltmeter deflection was noted. Thus it was possible to determine what proportion of the voltage generated by the contracting muscles was within the frequency range being passed by the filter circuit.

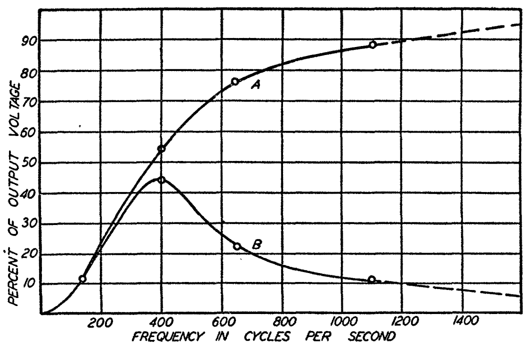

FIG. 2. Voltage-frequency curves for action currents from the tongue.

Curve B of Fig 2 shows the proportion of the total action current voltage in a given action current frequency band.[1] Several features of this curve strike our attention. Its general shape resembles that of a probability curve. The largest percentage of the voltage (44 per cent.) is expressed at 400 cycles per second and half of the total voltage generated falls between 130 and 450 cycles per second. This may be taken to mean that a large portion of the fundamental frequency is in the neighborhood of 400 cycles and that the second harmonic is an appreciable portion of the fundamental. Eleven per cent. of the voltage is above 1,100 cycles per second.

Curve A of Fig. 2 is an accumulative curve which shows what percentage of the total action current voltage may be expected to fall above or below a given action current frequency.

From these curves we may assume that the action current wave is a very complex one. It is indicative probably of direct, pulsating direct and alternating currents which may not have direct relationships with each other in respect to phase or time. The action current waves may not present harmonics. Rather they may be composed of fundamental, pure sine waves which are generated more or less crazily by the extremely complicated electrical generating network. If this is true then we should be able to isolate certain generating points by means of a system of filters having very narrow band widths.

It remains to test this method in a wide variety of problems in electrophysiology.

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SPECIAL ARTICLES

THE EFFECT OF CORTICO-ADRENAL EXTRACT ON ENERGY OUTPUT[1]

THE effect of extracts of the adrenal gland on the activity of muscle has been reported by many observers;[2] it is to be noted that attention has been directed primarily, however, to the action of epinephrine. More recently workers have reported on the effects produced by extracts of the adrenal cortex.[3] These investigations were in all cases carried out with nerve-muscle preparations. The intact, normal animal has not hitherto been used to demonstrate the effect of cortico-adrenal extract on the capacity to perform work. The substances used, furthermore, were of doubtful potency.

Dogs have been trained in this laboratory to run in a treadmill, and their total energy output in excess of basal metabolism has been determined in a series of experiments. The action of cortico-adrenal extract, prepared as previously described[4] according to the method of Swingle and Pfiffner,[5] and proved to be

[1] Reported in brief at the joint session of the Federation of American Societies for Experimental Biology, Montreal, Canada, April 11, 1931.

[2] M. Yoshimoto, *Quart. Jour. Exp. Physiol.*, 13: 5, 1922.

[3] A. Obré, *Compt. rend. soc. biol.*, 88: 585, 1923; J. Stefl, *ibid.*, 99: 985, 1928; F. de Mira and J. Fontes, *ibid.*, 98: 987, 1928; and 100: 602, 1929.

[1] Filter transmission characteristics were known and evaluated.

[4] S. W. Britton and H. Silvette, SCIENCE, 73: 322, March 20, 1931; *ibid.*, 373, April 3, 1931; *Amer. Jour. Physiol.*, 99: 15, 1931.

[5] W. W. Swingle and J. J. Pfiffner, *Amer. Jour. Physiol.*, 96: 153, 1931.