COUNTING THE FREQUENCY OF MUSCLE ACTION CURRENTS ON THE KYMOGRAPH

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The functional state of muscles is determined electrophysiologically by the frequency and amplitude of their action currents, recorded by means of an amplifying and oscillographic apparatus. The principal difficulty in the interpretation of the myograms obtained by this method is that the number of myographic impulses is not easily counted, especially when it is large.

One way of overcoming these difficulties would be by counting the impulses automatically and recording them by means of an apparatus of the PS-64 type. Counters of the PS-64 type are incorporated in certain forms of biophysical apparatus for measuring the radiation from labeled atoms.

When a definite number of electrical impulses is fed into the input of a counting device, a smaller number of impulses is produced at its output in accordance with the particular coefficient of division. For example, when the coefficient of division of the counting system is 64, the apparatus will record every 64th impulse reaching the input of the apparatus. The bioelectrical potentials arising in a muscle must, of course, be first amplified to a value sufficiently large to be fixed by the receiving part of the PS-64 apparatus.

The assembly scheme of such an apparatus is shown in Fig. 1. Action currents of a muscle after amplification (coefficient of amplification of the order of 100,000-200,000), are passed to a PS-64 apparatus, the output of which operates an electromagnetic decimal counter and relay, which sets in motion an electromagnetic marker.

By means of this apparatus it is possible to count the sum total of bioelectrical impulses during a given interval of time, corresponding to various functional states of the muscle, which gives the characteristics of frequency changes, and enables them to be differentiated in time. Impulses whose amplitude after amplification lies below the threshold of operation of the PS-64 apparatus will not, of course, be counted. Practice has shown, however, that this is not an essential failing, and the layout of the apparatus in the form in which it is shown is suitable for the investigation of the work of muscles. This method has been found valuable in the study of hyperkinesis [2].

By way of example of the suitability of the method for the study of the bioelectrical activity of muscles during static and dynamic work, we give the results of our observations, made jointly with A. K. Troshin, on a human subject (a youth of 16 years), in a state of deep hypnotic sleep. In the region of the right biceps brachii muscle were applied two plastic electrodes, 10 mm in diameter, with cotton applicators soaked in a 5% solution of common salt. The electrodes were connected to a counting device (coefficient of division 64) and a kymograph (see Fig. 1).

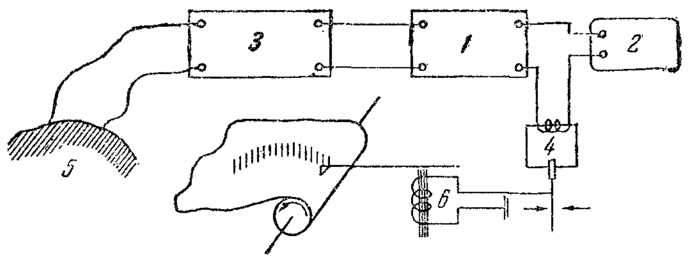

Fig. 1. Layout of the apparatus for counting and recording the bioelectrical impulses of muscles. 1) Counter PS-64; 2) impulse counter SB-1 m/100; 3) amplifier; 4) type RP-7 relay; 5) muscle; 6) kymograph marker.

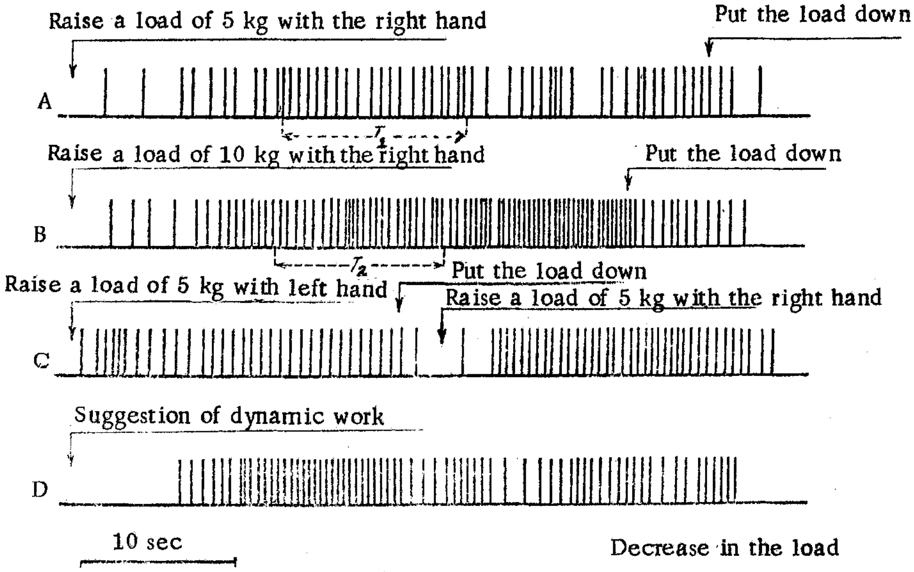

Fig. 2. Kymograms of the bioelectrical impulses from the biceps muscle in man, recorded by means of a PS-64 electronic counting system.

On the kymogram (Fig. 2) are shown the variations in the frequency of the bioelectrical impulses. During tranquil hypnotic sleep impulses were absent. On kymograms A and B may be seen the differential response to suggested static work of differing severity. The tracing C was obtained during the suggestion to the subject that he carry out static work, first with the left hand and then with the right (the action currents were taken as before from the right biceps brachii muscle). The tracing D illustrates the bioelectrical effect during the suggestion to the subject that he carry out dynamic work (work the mincer with the right hand). A reduction in the frequency of the impulses coincided with the suggestion of lightening the load.

The true value of the frequency of the impulses for any interval of time is determined by taking the product of the number of marks and the coefficient of the counting system (in this case 64). The frequency of the bioelectrical impulses in response to the suggestion, "raise 5 kg," during an interval of time T_1 = 10 seconds, is thus $(21 \times 64)/10 = 134.4$ imp/sec. For the interval of time T_2, corresponding to a twofold increase in the load, the frequency of the action currents of the muscle is $(28 \times 64)/10 = 179.1$ imp/sec.

SUMMARY

The author describes a practical method of analyzing the frequency of muscle action currents, based upon the use of the widely employed computer PS-64 and of other apparatus.

The method suggested makes it possible not only to analyze the frequency changes of the bioelectric effect on the muscles, but also to measure the latent periods in various transitional conditions of the muscles—at rest and during work.

LITERATURE CITED

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