METHODS

A TRANSISTORIZED TENSOMETRIC AMPLIFIER

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R. S. Orlov and O. E. Guzeev

Department of Normal Physiology (Head, Dr. Med. Sci. R. S. Orlov),
Sverdlovsk Medical Institute
(Presented by Active Member AMN SSSR V. V. Parin)
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For electrophysiological investigations of the heart and of skeletal and smooth muscle, recording of the biopotentials on cathode-ray or loop oscillographs must be accompanied by synchronized recording of the mechanical activity of the muscles. For this purpose. A suitable apparatus for this purpose is the simple and small transistorized tensometric amplifier the circuit of which is given in Fig. 1.

The tensometric detectors R_1 and R_4, bonded to a metal spring plate are included in the circuit of a dc bridge. the elasticity of the plate, made from strip steel or phosphor bronze, is chosen to correspond to the strength of the muscle to be tested, and is measured in fractions of a gram. Bending the metal plate causes deformation of the tensometric detectors, leading to unbalancing of the bridge and to the formation of potential differences in its diagonals, the size of which is proportional to the effort of bending the metal plate and to the angle of its deviation from its initial position.

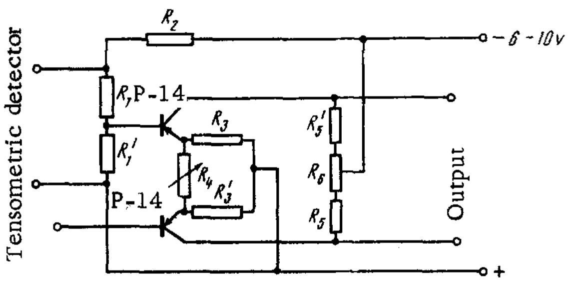

Fig. 1. Circuit of transistorized tensometric amplifier. Resistors (in Ω): constant: R_1 200, R_2 120, R_3 510, R_5 1500; variable: R_4 470, R_6 680. Transistors—P-14.

The potential difference is magnified by a differential amplifier on two transistors and fed into the input of a cathode-ray amplifier (type ÉNO-1, C1-19, etc.) or to loop 8 of an oscillograph. By comparison with an electron-tube amplifier, the differential transistorized amplifier possesses better stabilization of the zero position and it has no constant component at its output.

The resistors R_3 and R_3' in the emitter circuit are intended for automatic displacement and, at the same time, act as temperature stabilizer. The constant resistors R_5 and R_5' in the collector circuit act as load, and the variable resistor R_6 is necessary for balancing the constant component of the output voltage. The variable resistor R_4 is for regulating the depth of the negative feedback, thereby varying the degree of amplification.

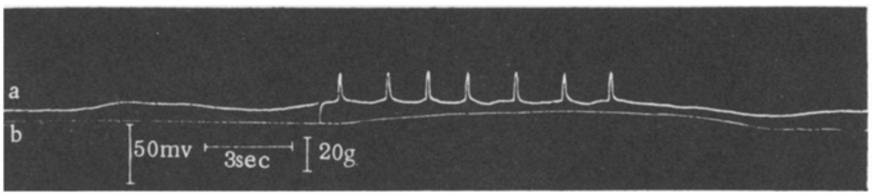

Fig. 2. Potentials (a) of individual smooth muscle cells of the retractor penis muscle and tension of the muscle (b).

The amplifier is supplied by a 6-12 V dry cell or battery. The amplifier is capable of increasing the strength of the input signal by 80-150 times. Its characteristic curve is linear: if the deviation of the spring plate is ± 45° from the neutral position, the magnitude of the output voltage varies in proportion to the angle of deviation. The frequency of the recorded oscillations is dependent on the intrinsic frequency of oscillation of the spring plate, the characteristics of the loop, and the frequency characteristics of the amplifier of the cathode-ray oscillograph.

The measuring bridge is supplied from the amplifier battery through a damping resistor R_2. The detector is connected to the amplifier by a 1.5-2 m cord.

As an example we show an oscillogram on which simultaneous recordings have been made of the biopotentials of the individual cells of a smooth muscle of a dog detected by means of a microelectrode (Fig. 2, top curve) and of the contractions of the muscle, using the transistorized tensometric amplifier with loop 8 of a type MPO-2 oscillograph (Fig. 2, bottom curve).