nied by a significant decrease in the mean diameter of the microvessels (by 26%) at this same time relative to their value on the 35th day, and this naturally led to a decrease in the total area of the microvascular bed studied (by 33%) and to a decrease in the vascularization index. The mean diameter under these circumstances was virtually indistinguishable from that in animals of the two control groups. Thus by the 49th day of observation, after injection of $PGF_{2\alpha}$ into the animals, not only was the formation of new microvessels delayed, but existing microvessels with large diameters were constricted.

The results on the whole indicate that toward the end of the first month after implantation of the chamber formation of the microvascular network in it, under the experimental conditions specified, was complete. Chronic intravenous injection of $PGF_{2\alpha}$ in the doses used delayed growth of new microvessels, mainly capillaries. Moreover, in the later stages (about 2 months) after implantation of the chambers treatment with $PGF_{2\alpha}$ affected the state of the larger microvessels, leading to constriction of the arterioles and venules. This reaction may be both a manifestation of the direct vasoconstrictor action of the PG studied and the result of the action of mechanisms controlling the inflow of blood to the capillary bed, the volume of which, in the case under consideration, was reduced through the action of $PGF_{2\alpha}$. These results showing a constrictor effect of $PGF_{2\alpha}$ agree with those obtained by other workers [5, 7] who observed a similar effect after local application of $PGF_{2\alpha}$ to microvessels of the rat urinary bladder and meseometrium.

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A BIOPOTENTIAL AMPLIFIER WITH NONLINEAR CURRENT-VOLTAGE CHARACTERISTIC CURVE FOR RECORDING LOW-AMPLITUDE SPIKES

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KEY WORDS: diode; nonlinear current-voltage characteristic curve.

During electrophysiological research it is sometimes necessary to quantify the frequency of spikes transmitted along nerve trunks or generated by single neurons. For convenience of processing of the results and evaluation of the data in the course of the experiment, specialized instruments are used: frequency meters, integrators, and threshold discriminators [1-5].

Furthermore, if a computer is used in the experiments, it is necessary not only to distinguish spikes of a certain amplitude, but also to form standard spikes with parameters required for leading into the computer. As a rule, the first element of these instruments is a Schmitt trigger. If the useful signal is considerably stronger than noise, tuning the trigger to pick out spikes of a certain amplitude present no difficulty. The task is made difficult if the signal exceeds the noise level of the amplifier or electrodes only a little, for in that case distinguishing spikes above noise by means of the trigger becomes not only difficult, but often impossible. Improvement of the signal to noise ratio by reducing internal noise of the biopotentials amplifier (BPA) and electrodes is not enough. It is essential to obtain a

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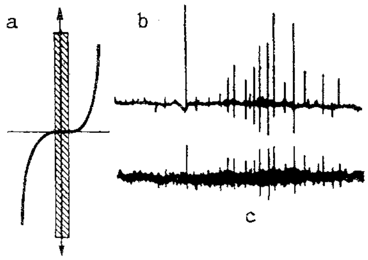

Fig. 1

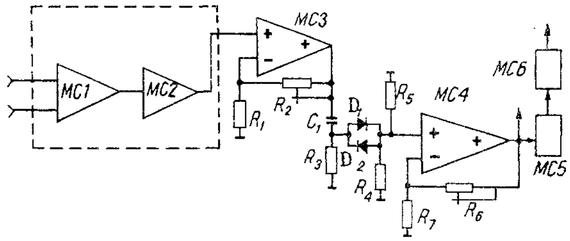

Fig. 2

Fig. 1. Graph showing output voltage of a function of input voltage for the given system (a) and spike discharge of a nerve before (c) and after (b) transformation by the system. The "zone of insensitivity" is shaded in Fig. 1a.

Fig. 2. Block-diagram of the system. MC_1) K284D1A, MC_2, MC_3 and MC_4) K140UD1B, MC_5) K118TL1D, MC_6) K218AG, R_1) 9.1 kΩ, R_2) 150 kΩ, R_3, R_4, R_5) 30 kΩ, R_6) 150 kΩ, D_1, D_2) KD102B, C_1) 2 μF.

signal of such a level that effective discrimination of low-amplitude spikes becomes possible with sufficient accuracy.

Provided that the shape of the spike does not carry inforamtion, the problem of discrimination can be solved by incorporating in the recording system a nonlinear decision element (NDE), with functional transformation such that the useful signal is amplified much more than noise. The most convenient device from the point of view of technical realization is an NDE with a quadratic current-voltage characteristic curve (CVC), in which the output voltage is the square of the input voltage $U_{out} = U_{in}^2$. For example, with an intrinsic noise level of the amplifying system of 5 μV, and with a signal of 10 μV, the output signal will be 25 μV for noise and 100 μV for the useful signal, respectively; a significant increase in the signal to noise ratio takes place.

To solve this problem a system was used whose principle of action is based on the nonlinear CVC of silicon diodes of the KD102 type, which have a region of CVC of quadratic type and a "zone of insensitivity." If the input voltage of the diode is below 200 μV its direct resistance is several milliohms. If the voltage exceeds 200 mV, the direct resistance falls sharply and only the signal which has passed through the zone of insensitivity undergoes further amplification (Fig. 1). A block diagram of the apparatus is shown in Fig. 2. The scheme operates as follows: The signal, preamplified by the BPA (MC_1 and MC_2), is led to the input of the operating amplifier MC_3. By means of the resistor R_2 amplification is controlled so that undesirable noise or signals cannot cross the "zone of insensitivity" of the NDE, which activates the capacitor C_1, the resistor R_3, and diodes D_1 and D_2; tuning under these circumstances is monitored on the oscilloscope screen ("Output 1"). The signal which has passed through the zone of insensitivity is amplified by the amplifier MC_4 and led to the input of the Schmitt trigger MC_5, which triggers the driven multivibrator MC_6, which generates standard pulses.

This scheme makes it possible to distinguish a useful signal which is 2-5 μV above the noise level. The system can be used to record low-amplitude over-all spike activity of rats during stimulation of the tactile and taste receptors of the tongue.

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