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INVOLVEMENT OF NOISE IMMUNITY SYSTEMS OF MYOELECTRIC CONTROL OF PROSTHESES

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Myoelectrically controlled upper extremity prostheses available at present work rather reliably in standard every day life conditions in amputees with normal level of the stump muscle electrical activity 100-400 μV at an input impedance of a biopotential amplifier higher 0.6 MΩ.

Increased demands for resistance-to interference arise at a low level of the muscle electrical activity, at significant noises in industrial conditions and in the electro-driven transport, in the conditions not allowing even rare failures of the control system work (while car driving, for example).

A low level of the muscle electrical activity in superficial pick-up is a rather widely known phenomenon. It takes place in the muscle atrophy, in a case of a prominent fat layer, scarred tissue on the site of a pick-up. In these cases a maximal level of the muscle electrical activity may comprise 5-20 μV.

Under the influence of environmental noises onto a biopotential amplifier input a human body performing a myoelectric control is a sort of an antenna. The noise level depends on this man positioning, the nearness from the source of the noise, a degree of earthing. In bipolar pick-up of the signals an in-phase interference is playing the main role of suppression. To exclude a factor attributed to the biopotential amplifier features at the assessment of the interference there was measured an in-phase noise the level of which was defined by a voltage between an "earth" electrode, or an electrode "mass", and internal subcutaneous tissues.

The action of an in-phase noise was reproduced by the voltage supply equal to an in-phase noise at the biopotential amplifier inputs through the imitators of a skin transition in consideration of a deviation of its meaning in relation to the average value under each of the two pick-up electrodes.

The measurement was taken in everyday life conditions and industrial conditions, in electrically driven transport. The studies showed that an in-house noise was defined in the general by a network induction of 50 Hz, impulse noises arising in switching on contact switchers, in damage of the contact in current-receiving devices, in process of electrical welding. There was not managed to carry out an evaluation of atmospheric discharges effect during a thunderstorm. The level of 50 Hz induction approached 2-3 V in the housing and in the research laboratory equipped with standard electronic instruments. The highest level of the net induction was observed on a substation territory and under the lines of a high voltage. In this case the level of interference approaches some tens of V. The degree of a man "earthing" perceiving the noise, his contact with the ground, with cases of the instruments, with radiators of the steam-heating are of great importance. There was observed a great impulse noise in a tram because of the contact damage in current-receiving devices. With it the level of an effective synphase noise approached 30-50 V. A high level of noises took place also from collector electromotors of machine-tools, cable-powered electromotors in the transport, even low-powered electromotors of electric shavers and an electric drill in case of a radio-noise filter failure. In this case 20-30 V comprises an effective meaning of an in-phase noise; the noise has a combined impulse-fluctuation character.

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An effective way of the flight against noises is a complex approach. First of all, it is the use of a biopotential amplifier with a high, up to 1 GΩ input impedance in relation to the inphase signal which makes possible to realize a high coefficient of a synphase signal suppression (70-90 db), minimization of the length of the conductors from pick-up electrodes to the biopotential amplifier inputs, the use of networks of impulse noise suppression, selection of a rational frequency characteristic of an amplifying channel of the biopotential amplifier, selection of a rational level of a signal amplitude limitation, the use of a differential method of detection at the control from muscles-antagonists.

It is not always rational to use widely the switching on a rejector filter into the network of the biopotential amplifier tuned in the frequency of a network voltage (50 Hz) since the harmonic action becomes to be of a dominant meaning formed in the amplifying channel at the signal amplitude limitation and its nonlinear distortions. Besides, separate muscles, for example, biceps brachii, have maximum of the frequency characteristics on the frequency approaching 50 Hz.

There seems to be an effective circuit of impulse noise suppression a circuit using differentiation - amplitude limitation - integration.

There seems to be highly efficient a circuit of the biopotential amplifier with isolation by feeding and a signal transmission with a help of optrons. The noise level with it was decreased I0-20 times in other equal conditions.

The effect of the network inductions is eradicated ideally by means of the use of a digital filter suppressing periodical signals with a frequency 50 Hz. Nevertheless its application makes much more complicated the network of the biopotential amplifier.

It may be supposed that an observed process of ratioelectronics will make it possible to use widely isolation amplifiers and digital filters in prostheses with a myoelectric control.

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