mucous and submucous layers with sclerotic manifestations. We also noted that the lymph nodes became enlarged to 1.5 cm, exhibiting a picture of reactive lymphoadenitis. Stromal edema and plethora of the muscular and outer layers of the stomach were also observed.

Anatomicopathological investigation of the cardia and of the lesser curvature of the stomach demonstrated a nonspecific inflammatory reaction in the form of reactive lymphoadenitis.

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METHODS

The Multimiostim-04, a Portable Compact Device for Electroneurostimulation and Electropuncture

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The Multimiostim-04, a multichannel electrostimulator, has been developed. Its advantage lies in its powerful effect on the neuromuscular structures and neurons around the focus of injury, due to an enhancement of the impulse flow from several muscle groups of the injured extremities. The afferent effect on neurons in the zone where the synaptic contacts have been lost is also boosted by electrostimulation of the symmetrical muscles of the healthy extremities.

Key Words: *electroneurostimulation; electropuncture; neuromuscular system; treatment of locomotor apparatus*

The Multimiostim-04 device, designed to improve the functional state of the organism and to treat diseases of the locomotor apparatus, is intended to be used for electrostimulation (ES) of the human neuromuscular system and for electrical treatment via acupuncture points. The device was developed on the basis of earlier prototypes [1,2].

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A block-diagram of the device is shown in Fig. 1. The electronic assembly consists of two plates connected by permanent connections to the control unit and power unit. The numbering of the amplitude regulators corresponds to the numbers of the regulated channels. The signal attenuator, which reduces the signal to the level of the ES signal for electropuncture (EP), is installed in the power-unit assembly.

The main units of the device are a master oscillator, a unit producing the stimulating pulses,

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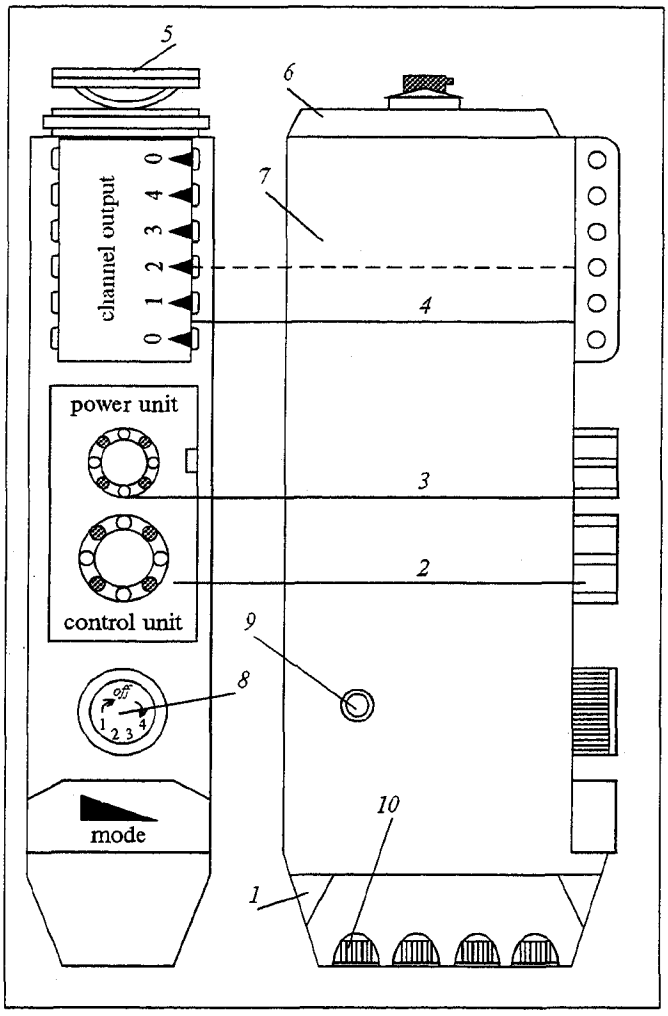

Fig. 1. Schematic diagram of the Multimiostim – 04. *1*) case; *2* and *3*) control unit and power unit; *4*) channel outputs and electrode sockets: the end sockets are for the common electrode and the remaining sockets are for active electrodes for ES and electropuncture (EP); *5*) handle for putting the power unit (*6*) in the power compartment (*7*); *8*) mode selector and on – off switch of device; *9*) photodiode; *10*) four amplitude regulators.

a controller of the phase pattern and mode selector, a control unit, and an electronic selector switch (Fig. 2).

The master oscillator produces a continuous series of timing pulses, which enter a single unit that produces stimulating pulses for all the channels. Two monopolar parts of a bipolar pulse produced by a driven two-phase generator for every timing pulse enter the output stage. The latter provides for the produciton of bipolar pulses and estabishment of the required signal level, and it also functions as an electronic switch, distributing the pulses to the channels.

The phase-pattern controller determines the period of the pulse packets, the ratio between the pulse length and the duration of the pause, the phasing of the channel operation, and the amplitude and frequency modulation of the pulses (Table 1). The repetition period of the packets of pulses is formed from several time intervals (t, which is equal to the oscillation period of the modulation signal generator) in the phase-distribution unit. The repetition interval of the packets is regulated by changing t. The packet-to-pause ratio is established by changing t in the pause with a corresponding change in the duration of a packet, which helps maintain a constant repetition period of the pulse packets. When the latter are distributed among the channels at a certain t within their period, we obtaine either a simultaneous or successive appearance of the packets in the chan-

TABLE 1. Parameters of the Multimiostim – 04 ($M \pm m$)

Parameter	Mode			
	1	2	3	4
1. Number of signals	4		2 (1 and 4)	
2. Description of electrostimulating signal	Packets of pulses. Channels 1 and 4, 2 and 3 operate in phase simultaneously; pairs 1 – 4 and 2 – 3 operate in antiphase successively		Continuous series of pulses	
3. Ratio between duration of pulse packet and duration of pause	1:1	1:2	–	
4. Period of pulse packets, sec	4±0.4	9±0.9	–	
5. Pulse frequency, Hz	Frequency modulation in range: at beginning of packet 20±2; in middle of packet 120±12; at end of packet 20±2		100±5	25±2
6. Amplitude modulation of pulses in packet	Trapezoidal pulses with front duration from 10 to 15% of packet duration		–	

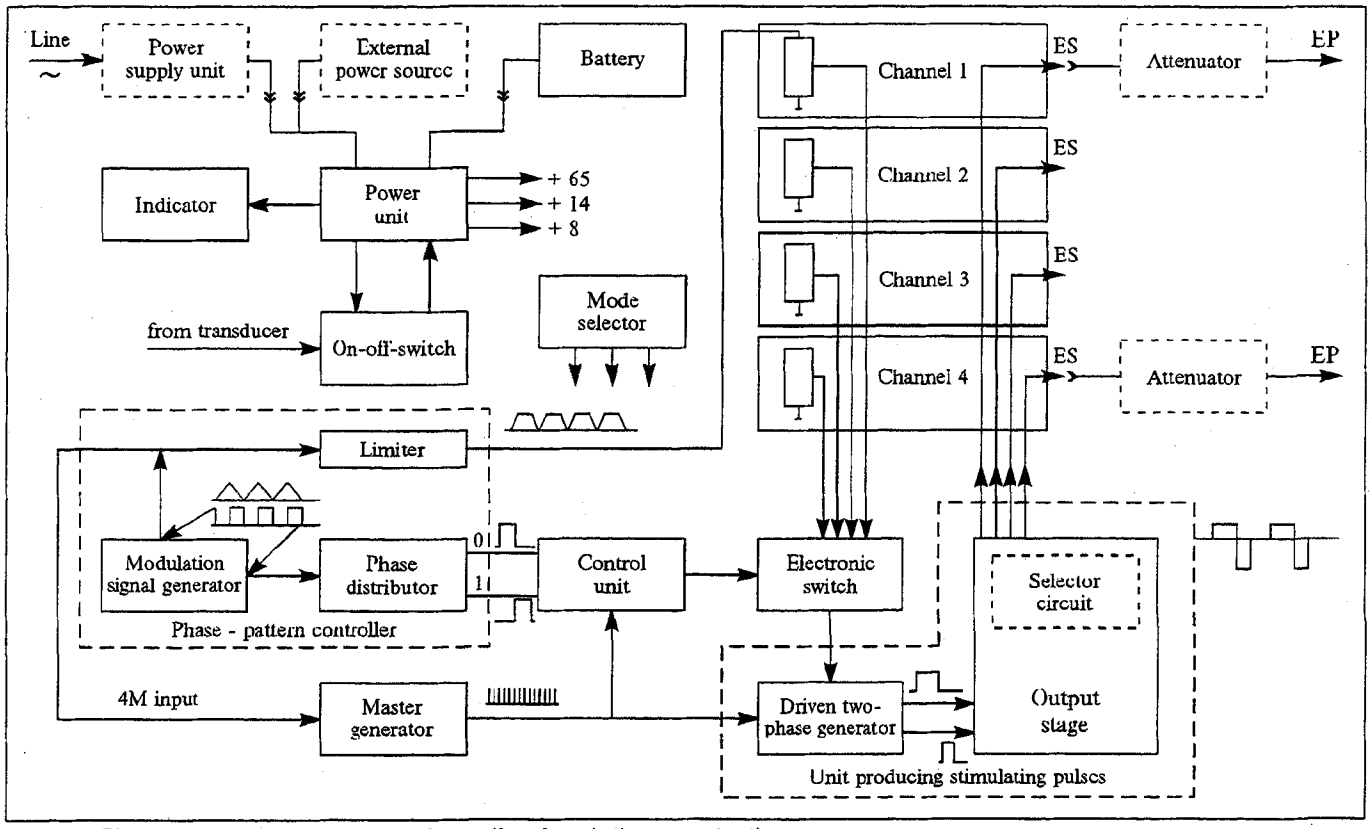

Fig. 2. Block diagram of electrostimulator (for description, see text).

nels. The signals of duration t, enabling packets to appear at the output of the device, are taken from the outputs of the phase distributor. The channels controlled by the same output of the phase distributor operate in phase, while the channels controlled by different outputs operate alternately.

Generation of the amplitude and frequency modulation signals is also an important function of the phase-pattern controller. A triangular modulation signal is produced by the modulation-signal generator and used for frequency modulation of the pulses produced by the driven generator. The associated synchronous pulse signal is taken from the other output and enters the phase distributor. The triangular signal is transformed into a trapezoidal signal in the limiter and then used for amplitude modulation in the packet.

The timing pulses and discriminating potentials arriving at the control unit connect the channel elements to the unit producing the stimulating pulses. The mode selector ensures the required parameters of the pulses via switching of the corresponding circuits.

A schematic diagram of the ES signal is presented in Fig. 3. In modes 1 and 2 a signal is produced in 4 channels. In every channel the signal comprises alternating pulse packets and pauses. In channels 1 and 4, 2 and 3 the packets are in phase, and between the pairs of channels they are in opposite phase, which is in accordance with the natural coordination of muscle operation.

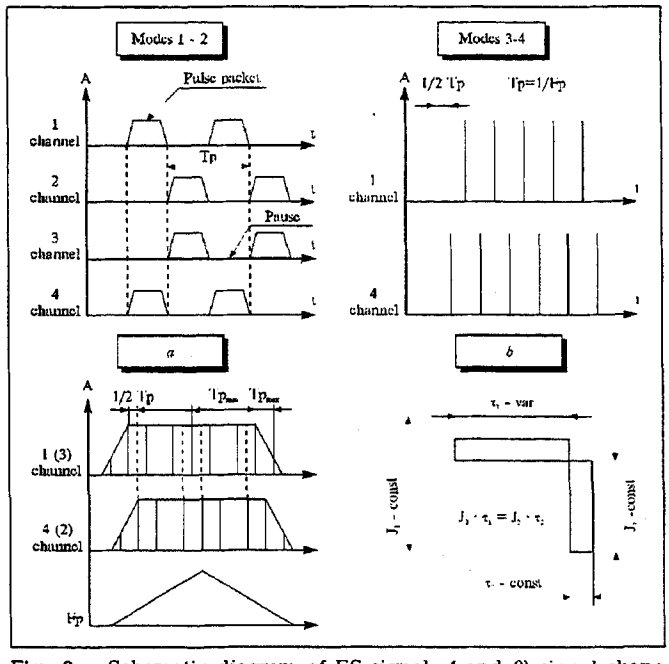

Fig. 3. Schematic diagram of ES signal. *1* and *2*) signal shape in modes 1, 2, 3, and 4; *3*) shape of pulse packets; *4*) ES pulses. *Tp* is period of pulses; *Fp* is frequency of pulses; I_1 and I_2, τ_1 and τ_2 are current and duration of positive and negative portions of signal, respectively.

The pulses in a packet are modulated in amplitude and frequency; in the channels operating in phase they are shifted relative to one another by half the interval between pulses (*Tp*), thereby providing a time separation of the pulses.

The signal in modes 3 and 4 is produced in two channels (1 and 4) and it comprises a continuous series of pulses with a time separation of the pulses in the channels.

Thus, the Multimiostim-04, which is now being mass produced, has evident advantages over other similar devices: 1) a more intensive effect on both the neuromuscular structures and the neurons around the foci of injury, owing to an increased afferent impulse flow from several muscle groups of the injured extremities; 2) an enhancement of the afferent effect on neurons in the zone of functional loss of synaptic contact, which, according to the theory of the structure and function of the locomotor analyzer, is also achieved by ES of the symmetrical muscles in the healthy extremities; 3) the ability to perform, along with ES, EP using two channels (1 and 4), which is attained by attenuation of the ES pulses.

The device is compact (0.6 kg; 28×95×187 mm) and is designed for individual use; the procedures can be performed independently by the recipient either in the hospital or in the workplace.

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