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A Device For Measuring Body Bioimpedance With Combined Various Physical Affects

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Abstract: A biomedical device is described which is supposed to be used for the purpose of diagnosis and investigation in biomedical tissues and skin, body's different parts. It can externally affect on the skin of human body with different types of currents (i.e. direct, alternate, pulse and so on). Many researches have been done about affecting electrical signals in human body. So, it can be to diagnose the presence of the disease in the patient with the existing results. Several medical procedures can be done by using our suggested the device: electro sleep, electro analgesia, galvanization and etc. The device measures bioimpedance of the person suspended by temperature in the different points of the skin. The affecting direction of active points can be changed. The software will be provided in the second version. Computer will help to save medical data and do long time investigations for every patient.

Keywords: Bioimpedance, transitional impedance, silver electrode , amplipulse .

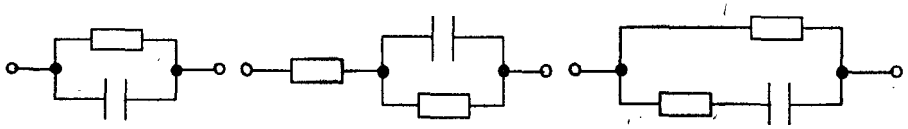
1. Introduction

We must know not only affecting factor but also the reaction of the organism for that factor in diagnostic purposes. The electrical properties of the skin depend on the region structure of the skin. The best factor for that property is the bioimedance. The impedance of tunic of body is tens to hundred $K\Omega$ in different parts of the skin [1].

The current is given from the different points of the skin using electrodes. The current finds the way where impedance is minimal. That current flows through the person and can be changed depending on the rate of blood flow.

At the point of the square of electrode it is desirable to minimize "electrode-skin" transitional impedance, which depends on the substance of the electrode, the properties of the skin, the contacting square of the electrode and med-contacting layers.

Every 'skin-electrode' contact (i.e. SEC) can be foreseen as electrical equivalent scheme, which has impedances and capacitors (Figure 1):



a) b) c)

Figure 1: SEC equivalent schemes in low frequencies (a. simple scheme, b. the scheme when dealing with the layer of the skin and hypodermic nets, c. the other properties accompanied by muscular tissues [2, 3].

Let's see the existing electrode types as they have important role in SEC node. They are divided into 3 groups:

- Metallic electrodes – they have great oxidization which is a disadvantage.
- Metal + soluble salt + that salt's ions.
- Gas electrodes – they are porosity systems, i.e. the mixture of platinum or graphite.

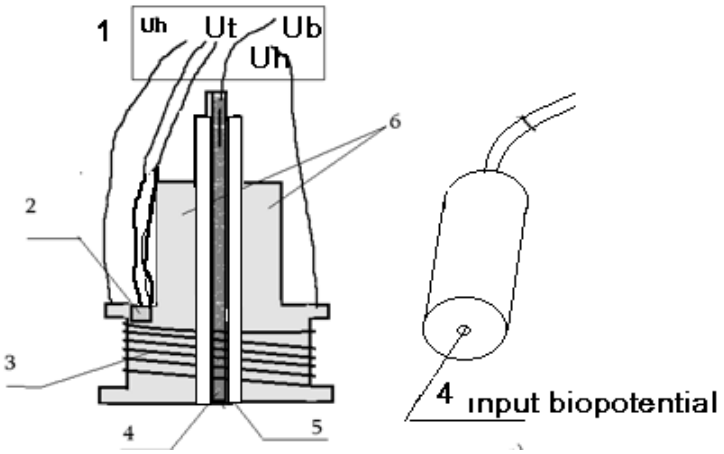
Silver electrodes' advantage is that after the regulations they have minimal noise, theoretically - no noise. Two electrodes are located in different thermal conditions, however it causes small zero deviation [3].

We can do several works with the help of device from existing methods [4-7].

- Amplipulse therapy is an electrotherapy method during which the patient is exposed to alternating modulated currents of low intensity. These currents combine currents of high and low frequencies. Amplipulse therapy uses alternating sinusoidal currents of $2000-10000Hz$ frequency modulated by sinusoidal low-frequency oscillations (ranging $10-150Hz$). [6]
- General, local galvanization stimulates regulatory function of nervous and endocrine systems, normalizes secretory and motor function of digestive tract, stimulates trophic etc., in particular, increases protecting function of the skin.
- Interferential current therapy is a synergistic vibration in the human body resulting from overlaying (interference) of two independent high frequency currents. Normally the current sent via one electrode has constant frequency, while the current in the other electrode has alternating frequency. The low frequencies (up to $50Hz$) cause excitation of neuromuscular structures. $50-100Hz$ currents improve tissue trophism, blood circulation; tone the muscles [7].
- Electro sleep therapy is a method of local action by impulse electric current of the corresponding parameters through electrodes and wet hydrophilic gaskets (or with the help of an electro conductive gel), contact super imposed paired, one polarity - on the skin surface of the eye sockets or the superciliary areas of the head, single, different polarity - on the skin surface of the posterior region of the patient's neck.
- Current strength - up to $10mA$; voltage - up to $18V$; pulse repetition rate - $1-160Hz$; the pulse duration is $0.2-0.5ms$; the shape of the pulse is predominantly rectangular; duty cycle – 10 [4, 5].
- Etc.

2. Device structure

We designed the first prototype of device and measuring body. The measuring body consists of silver electrode which is located in the center of cylindrical heating system and is isolated from it. The heating system insures uniform heat of the electrode environment (Figure 2).



a) b)

Figure 2: The internal part of measuring header (a) and general view (b)

The Measuring header has:

1. Cables which are connected to a device.
2. Semiconductor thermo sensor which insures skin environment's constant temperature watching.
3. Wrapped in nichrome wire which insures the heating of electrode.
4. Silver wire or electrode $(d = 1mm)$ from which we measure bioimpedance.
5. Isolator which is isolated; 4 and 6.
6. The heating surface.

The heating doesn't support in most of devices. The physiological differences are observed in the heating process and other measuring headers can't register it. Besides the doctor has freedom to choose the direction of the affecting voltage.

Our designed device has the following structural scheme (power source scheme and its connections aren't included in the scheme for the simplicity) (Figure 3):

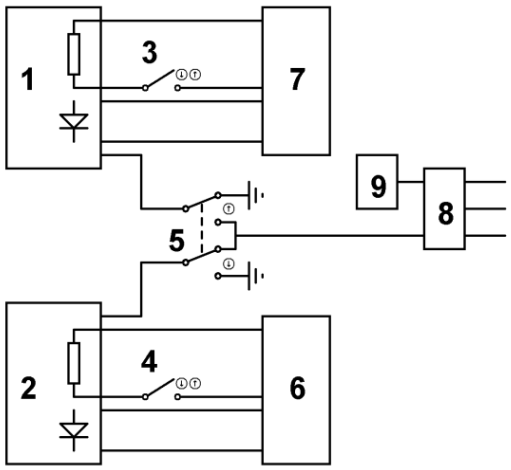


Figure 3: The structural scheme of the device

The 1 and 2 are the headers which are described above. The heating connections of electrodes are done by 3 and 4. The 5 switch defines at what moment which electrode would be the biopotential register and which the grounded. The 6 and 7 are thermo regulators. The 8 is biopotential signal amplifier. One of the inputs of amplifier is given in the 9th functional generator voltage and the other – biopotential voltage. In the output of the 8 we have constant, differential and alternative voltages of the biopotental signal.

The heating header has possibility of heating since 50^0 because the human body will burn above that temperature.

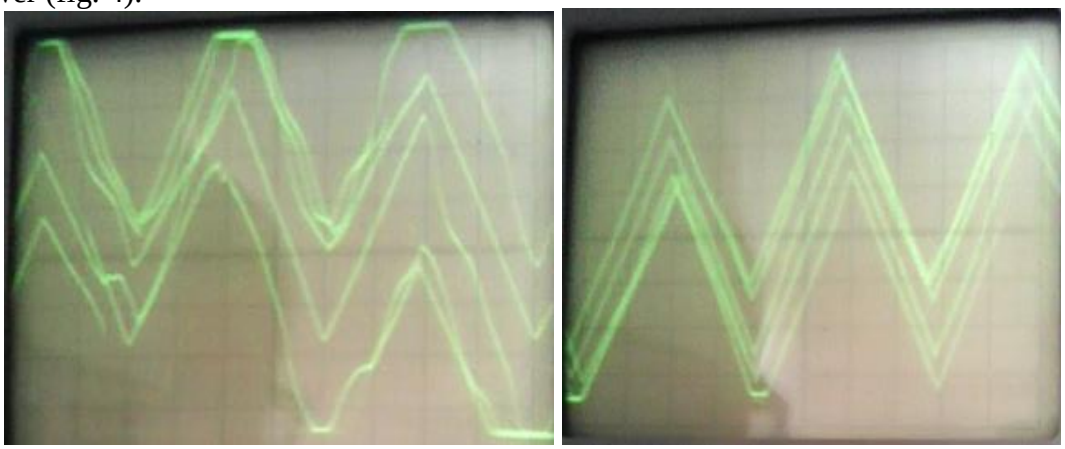
The device works as follows. The doctor switches on the measuring units after that the power. Now the doctor can heat the measuring units or one of it's or none (can be changed while working the device).

Now the doctor starts to do the main part. For example, the constant current is given to the patient while the latter rests. After that the mean voltage is subtracted by using potentiometer (isn't shown in the figure) and the patient is given different types of currents (constant, alternative, pulse, etc.) and the constant and differential voltages are measured in the output. The output voltages can differ by the person's age, illness and the skin's examination parts, etc.

3. Results

The surrounding electricity is everywhere in the buildings, hospitals, etc. and the person also receives $50Hz$ or $60Hz$ notch signals. So in experimental results we must identify it. It has $0.25-1V$ amplitude. For instance, it is small in fingers, knees, but is high in the lower part of the leg. There is no difference while heating in the low frequencies in teenager, but in elder people notch signal is small while heating.

When the frequency is $500Hz$ or higher, the triangle waves have spectral changes and the amplitude is over in tops. The signal is more linear when heating and has $50Hz$ notch signal more lower (fig. 4).



a) No heating b) with heating

Figure 4: The output signal in the ear (500 Hz input triangle signal)

So the device can be used in medical institutions for diagnosis and investigation purposes. The device can be used as stationary system and outside the clinic as it is uses low power.

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