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ELECTROMAGNETIC METHOD FOR THE DIAGNOSIS OF CHRONIC DISEASES

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Introduction. One of the conditions of the sovereignty of any country is its energy independence. Ukraine has a large reserves of coal, and coal industry was, is, and will stay the energy supplier of the country. However, mining has the most dangerous, hazardous and difficult working conditions. Machines used in mining create a huge amount of coal dust and many other negative factors causing occupational diseases. This is enhanced by mine microclimate (high humidity, high temperature, etc.). Prevalence of pulmonary anthracosis («coalminer's lungs», «black lung») among workers is on average 12%, and among those over 20 years engaged in coal mining, about 50%, so the incidence of anthracosis is of great socio-economic and medical importance [1,2].

The most common types of anthracosis diagnostic is radiography and spirography.

In general, X-ray is a radiation, which can cause ionization of even the most complex molecules and atoms of the human body. Clinical studies have shown that a radiological examination of the chest is equal to the amount of radiation exposure that affects a person within ten days of ordinary life. And one X-ray result can not provide information on the state of the patient.

A more informative method is to perform a tomography, but this scan is also based on the variative absorption of harmful X-rays by different tissues of the body.

Spirography is not harmful to the body and studies lung function by measuring pulmonary respiratory volumes. In conducting spirometry patient inhales and exhales on his own to determine how easily the lungs can cope with their work, but spirography data do not provide information about what exactly is the reason for the change of the respiratory volume of a lung.

The aim of the study is to find an alternative method of anthracosis diagnosis.

Main part. In this paper we investigate the extent of «black lung» disease using electromagnetic control, because coal has a much higher conductivity than a tissue.

The method of electromagnetic diagnostic is harmless. It will allow us to measure the accumulation of coal dust in the lungs periodicaly, to assess the threat to health in the dynamic and to take a timely action to treatment.

To measure the concentration of dust in the lungs of a man through the electromagnetic field, we need to place a coil winding on one side of the chest and coil, which is the receiver, on the other side.

Current spreads in human body mainly through the blood and lymph vessels, muscles, membranes of nerve trunks. Resistance of the skin, in turn, is determined by the condition: thickness, age, humidity, etc. This causes difficulties measuring the electrical resistance of living biological systems. Electrical conductivity of individual sections of the body located between the electrodes, superimposed directly on the surface of the body, essentially depends on the resistance of the skin and subcutaneous layers.

Electrical conductivity of tissues and organs depends on their functional state and thus can be used as a diagnostic indicator. For example, inflammation when cells swell, decreases section of intercellular connections and increases electrical resistance; physiological phenomena that cause sweating, accompanied by increasing skin conductivity, etc.

Tissues of the body can conduct not only constant, but also alternating current. Experiments showed that in this case the force of the current that passes through biological tissue, is behind the applied voltage phase. Thus, the capacitive impedance is bigger than inductive.

Hence, to model the electrical properties of biological tissues we can use resistors that have active resistance, and capacitors as a capacitive resistance carriers [3].

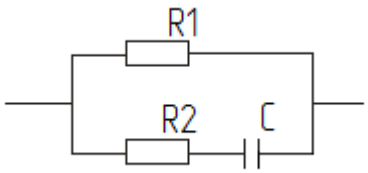

Figure. 1 – Body tissues equivalent circuit diagram

A commonly used equivalent circuit diagram of body tissues model is a circuit consisting of resistors and capacitors (Fig. 1), frequency dependence (dispersion) impedance of which is close to the frequency dependence of the impedance of biological tissue. In this scheme, the frequency dependence of the impedance (1) may be at L = 0:

$$Z = \sqrt{R^2 + \frac{1}{(C \cdot \omega)^2}} \qquad (1).$$

This combination of resistors and capacitors can be taken as an equivalent circuit diagram of body

tissues. Frequency dependence of the impedance of the equivalent electric circuit corresponds to the general course of experimental impedance depending on frequency. It is important to note that electricity intensity and hence the dielectric coefficient remains constant.

Eddy current methods are based on an analysis of external electromagnetic field interaction with the electromagnetic field of eddy currents induced in the electrically excitable coil control facility. The density of eddy currents in the object depends on the geometric and electromagnetic parameters of the object and the relative position of the measuring transducer and the object. As a rule inductive transducer coils (one or more) are used. Sinusoidal or pulsed current from coils converter creates an electromagnetic field that thumps eddy currents in electroconductive object. The electromagnetic field of eddy currents affect the coils transducer, resulting in them changing their EMF or full electric resistance. Registering the voltage at the terminals of the coil or their resistance we can receive information about the properties of the object and the transducer [4].

To calculate how EMF depends on the amount of dust that was in the lungs of the human body, we propose a model that includes three main areas:

- body tissues zone on the top of the lungs with the total thickness of 4.5 cm;
- lung zone (initially lungs without other substances), the distance from the front to the rear of the lungs is 16 cm;
- lung area that is contaminated with coal dust.

Coal is deposited in the lungs in the lower part. But for calculation and the mathematical model we suggest that coal is deposited in the lung and occupies the entire plane of section. In large concentrations of carbon in the lungs layer thickness increases.

Implementation of electromagnrtical method is achieved with the use of this block diagram (Fig. 2).

Sinusoidal signal from basic frequency generator (G) goes to the parametric amplifier (PA). Parametric amplifier sets such parameters of winding that cause resonance, so if the inductance parameters chosed correcpondingly to capacity, there is a resonance voltage, ie the voltage will increase by 3-5 times.

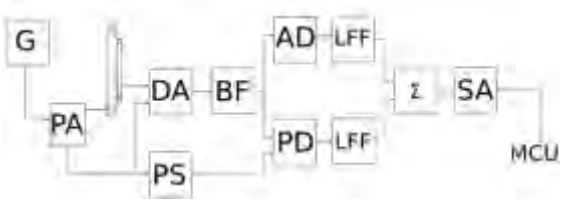

Figure 2 – Block diagram of the device for early antracosis diagnosis

Differential amplifier (DA) provides a circuit voltage subtraction from information signal measuring winding. To improve selective channel processing, output signal is fed to the band filter (BF), which is set according to a generator frequency. Given the small output signal band filter provides increased noise suppress and prevents the inclusion in the measuring channel interference from surrounding environment.

For phase detector (PD) operation there is a phase shifter (PS), that provides compensation for phase output. Also diagram includes an AM detector circuit (AD). On the output of each detector low frequency filter (LFF) is set to smooth the fluctuations.

Both signals are summed by the adder (Σ), thus improving the sensitivity factor twofold. With the scaling amplifier (SA) signal is increased to the desired level and transmitted to the digital processing unit.

The obtained results allow to create a database that can be used for grouping teaching samples, i. e. the group of so-called rules, in order to timely assess the extent of disease.

Conclusion. According to statistics, more than 20% of the working population is at antracosis risk group. However, existing methods of diagnosis have significant drawbacks. Therefore, a new method for electromagnetic control for antracosis diagnostic is proposed. The method is harmless and more informative. Implementation of this method will allow to reveal metallic inclusions in the body for individual selection of dental materials and diagnostic galvanosis and so on.

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