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Multifunctional Adaptive System for Physiotherapy with Measurement Devices

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Introduction

One new tendency in medicine is connected with application of multifunctional adaptive systems for physiotherapy. These systems can provide not only separate influence of different external influences, but simultaneously influence of these external influences of on one or on different part of the human body. Some times a physical interaction between these external influences can be seen as in the case of simultaneously influence of low frequency electrical and magnetic fields. In other cases there is not formal physical interaction between external influences, but there is physiological interaction as in the cases of simultaneously influence of low frequency magnetic field and acupressure or acupressure and Cranial Electrotherapy Stimulation (CES). It would be very convenient for physicians if much more units for different external influences would be available as parts of one multifunctional adaptive system for physiotherapy. For instance this system can provide influence of low frequency magnetic field, low frequency electrical field (including Cranial Electrotherapy Stimulation) and acupressure.

Design of devices for creating of low frequency magnetic field

The application of China's method for acupressure is very actual in medical therapy, now. Usually physicians provide application of acupressure by his hands. The results of therapy by acupressure would be more good if there would be provided more intensive movement of the blood in around the points of acupressure. This activation of blood's movement can be provided by application of low frequency magnetic field together with acupressure.

Usually the low frequency magnetic field can be created using two coils, connected to the output of apparatus for magneto-therapy. This apparatus is a source of special electrical signals for the coils. Often the application of above described method for therapy is on the hand because there are situated many points of acupunctures (Fig. 1).

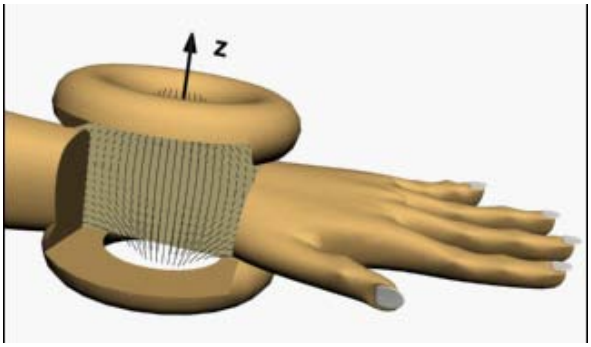

Fig. 1. A possibility for disposition of two coils on the hand

It's well known that on the spine there are many points of acupuncture, also. Some examples for disposition of coils on the spine can be seen on Fig. 2.

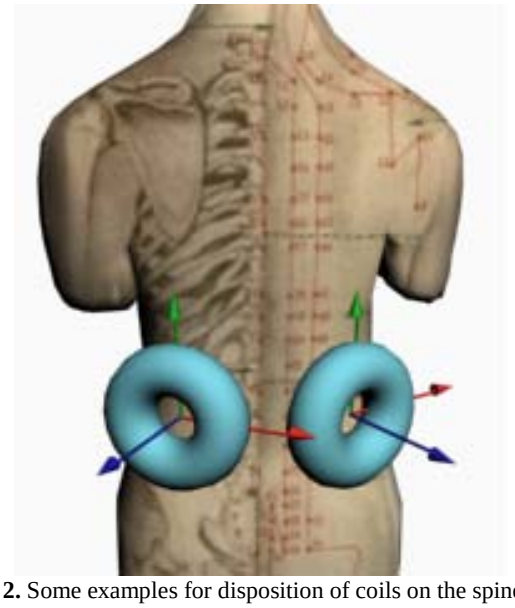

Fig. 2. Some examples for disposition of coils on the spine

Simultaneously application of low frequency magnetic field and ionophoresis in the case of diabetes

One important application of low frequency magnetic field simultaneously with permanent electrical field in environment of mineral water is in the case of diabetes neuropathology (Fig. 3). There are four independent pairs of coils for magnetotherapy – one for every wash-tub. In every wash-tub there are two electrodes for ionophoresis, also.

Fig. 3. System for simultaneously application of magnetotherapy together with permanent electrical field and mineral water – ionophoresis for hands and foods in the case of diabetes

A girdle coil (Fig. 4) can be used for magneto-therapy, also.

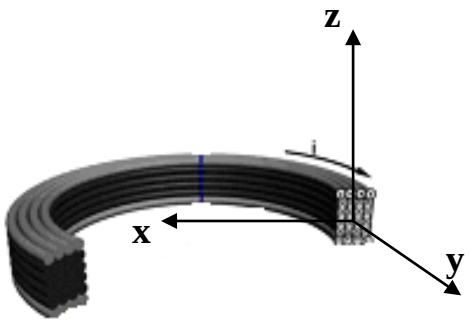

Fig. 4. A girdle coil

Measurement of parameters of low frequency magnetic field

First of all it's important to provide measurement of the value of magnetic induction in the process of magneto-therapy. A small coil (diameter $d = 8mm$, height $h = 10mm$ and current turns $w = 2x300$) has been used as sensor for measurement of the value of magnetic induction. This coil has been connected with the inputs of differential amplifier in the input of apparatus for measurement of magnetic induction of low frequency magnetic field. The measurement has been done for the sinusoidal current in the girdle coil with frequency $f = 50Hz$. It's well known that the frequency band $f = 10Hz - 100Hz$ is used in the process of magnetotherapy. The sensor has been putted in different points around the girdle coil. The measurement of the gidle coil's current has been done by ordinary ampermeter. The measurement of module of magnetic induction on the axes X and Z (Fig. 3) has been done. The results of experimental measurements together with the results of calculation of the module of magnetic induction on axis X

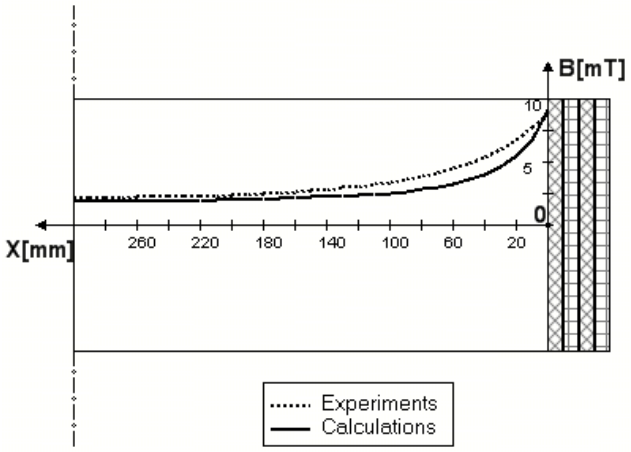

Fig. 5. Module of magnetic induction on the axis X

The results of experimental measurements together with the results of calculation of the module of magnetic induction on axis Z can be seen on Fig. 6.

Level of errors of measurement of the value of magnetic induction

The main causes for errors between calculated and measurement results are: the finite sizes of the sensor, the permanent error of the place of sensors in it's putting in different points and orientation of it's axis (the angle between the vector of magnetic induction and the axis of sensor), the error of the measurement of current in the girdle coil, the influence of other magnetic fields with the same frequency $f = 50Hz$. Some of these errors have been reduced using differential coil as sensors. The results of calculation and results of experimental measurements are similar. It was the main goal of investigation. Of course it's possible to obtain more precise methods and measurement devices, but it's not necessary in the case of magnetotherapy, where usually the values of magnetic induction are 10-30mT and 10% error is acceptable. It's clear that only one small translation of the human body in the girdle coil would be enough for an error of the value of module of magnetic induction in an arbitrary point of the human body, more than 10%. The value of relative magnetic permeability of live tissue $\mu_r \approx 1$ as in the air. Therefore computer simulation can be used successfully for future investigation of space configuration of low-frequency magnetic field in the human body, also. This is the main conclusion of the above investigations.

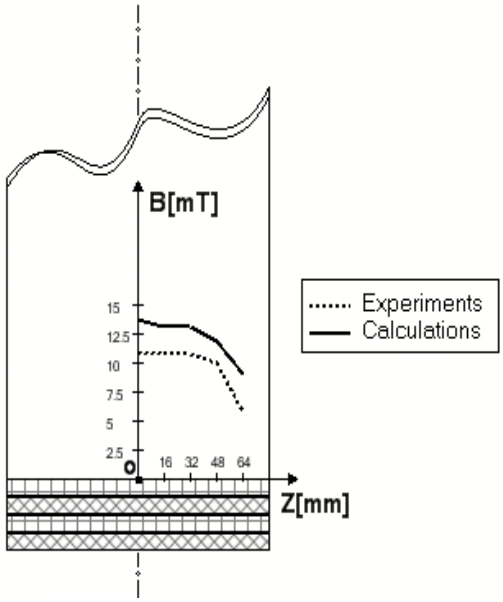

Fig. 6. Module of magnetic induction on the axis Z

Design of devices for creating of Cranial Electrotherapy Stimulation

Often, in the last time there is application of therapy by acupressure simultaneously with electrotherapy especially with Cranial Electrotherapy Stimulation [1]. Usually physicians provide application of acupressure by his hands and he should be very careful because this therapy is on head [2]. Of course it's possible to be used separately one by one both therapy by acupressure and Cranial Electrotherapy Stimulation, but the effect of therapy especially effect of relaxation would be better in the case of simultaneously application.

Sometimes in the cases of high values of the blood pressure, stress and loss of the sleep physicians use successfully a unit for magneto-therapy for decreasing of blood pressure and Cranial Electrotherapy Stimulation for sleeping using another unit for electro-seeping [3]. In the last time often physicians use both magneto-therapy and electro-sleeping simultaneously. This allows them to obtain more good effect of therapy. The method of Cranial Electrotherapy Stimulation is new one since the end of last century. Therefore some preliminary separate investigation of this method has been done before simultaneously application of the method together wit magneto-therapy or/and acupressure.

CES treatment may result indirectly in increased blood flow to the brain [4]. Hence its possible contraindication in recent hemorrhagic stroke patients. This same effect can cause brief increased blood flow beneath the electrodes behind the ears [5]. This redness should not be cause for concern. This is an extremely rare occurrence. Most CES devices should produce a pulse repetition rate (PRR) of 100 Hz.Some produce a PRR as low as 0.5, or as high as 15,000 Hz. Most CES units are user friendly. A CES generates an adjustable current of 80 to 600 μA that flows through clips placed on the earlobes. The waveform of this device is a 400 milliseconds positive pulse followed by a negative one of the same duration, then a pause of 1.2 seconds. The main frequency is 0.5 Hz, i.e. a double pulse every 2 seconds. Current output is limited to 600µA max. and can be regulated from 80 to 600µA. A LED can flash every 2 seconds signaling proper operation and can also be used for setting purposes.

A common CES configuration is 100 Hz with a maximum current output of 1.5 mA, current amplitude similar to that in the human body. A device of CES as part of multifunctional system for physiotherapy can be seen on Fig.7.

Fig. 7. Device for Cranial Electro Stimulation

Design of mechanical device for acupressure

The design of mechanical devices for acupressure should be connected with design of coils for magneto-therapy as the multifunctional system should provide simultaneously application of acupressure and magneto-therapy. Usually the line of mechanical pressure is the axis of coils. The sizes of coils can be different according to the sizes of "active" area around of the acupuncture points.

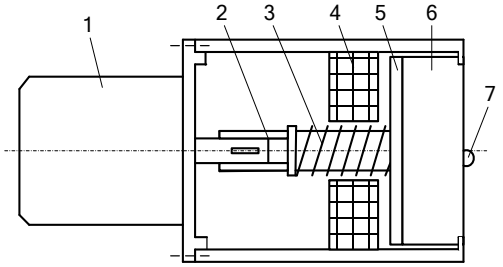

Fig. 8. Mechanical device for acupressure: 1 – motor; 2 – axle; 3 – shaft; 4 – a coil, which provides axial movement of the shaft; 5 – metal disk; 6 – plastics body; 7 – massage pimple (osezatel)

The modified device for acupressure simultaneously with low frequency magnetic field can be seen on Fig. 9. It can be seen that the shaft is in the coil for magnetotherapy.

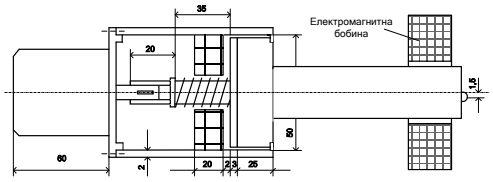

Fig. 9. Modified mechanical device for acupressure simultaneously with application of low frequency magnetic filed

Conclusion

It's clear that the process of physiotherapy can be more effective in the case of simultaneously application of several unites (apparatuses or/and devices) for different physical influences on the human body than separate application of these unites one by one.

The big advantage of one multifunctional system for physiotherapy is that it's flexible and user friendly.
Therefore it's easy to be obtained different configuration of system and to provide applications of many methods for physiotherapy. Because of that the system is adaptive to medical methods for therapy.

Usually every multifunctional system can be developed easy. It's enough to add new units which should be compatible with the rest system's units.

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An investigation on structure of one multifunctional adaptive system for physiotherapy with measurement devices has been done in the paper. In the paper there are descriptions of different parts of the multifunctional system. Some characteristics and properties of different units of multifunctional system have been done, also. Some possibilities for simultaneously applications of different system's units are described, also. It's important to provide simultaneously application of different system's units only when their physiological influences on the human body are compatible. Simultaneously application of magneto-therapy, mechanical acupressure and cranial electro stimulation or ionophoresis is described in the paper. Ill. 9, bibl. 5 (in English; abstracts in English, Russian and Lithuanian).

Д. Ц. Димитров, С. Гергов, Н. Д. Ралев. Мультифункциональная адаптивная система для физиотерапии содержащая измеряющие устройства // Электроника и электротехника. – Каунас: Технология, 2010. – № 5(101). – С. 111–114.

Описываются исследования структур мультифункциональной адаптивной системы для физиотерапии, содержащей измеряющие устройства. Анализируются разные части мультифункциональной адаптивной системы. Описаны некоторые характеристики и свойства мультифункциональной адаптивной системы, а также разные возможности совместного применения устройства мультифункиональной адаптивной системы. Важно отметить, что совместное применение устройства мультифункиональной адаптивной системы возможно, если физиологические воздействия разных устройств мультифункциональной адаптивной системы совместимы. В статье описывается совместное применение магнитотерапии, акупрессуры и электростимуляции мозга или ионофореза. Ил. 9, библ. 5 (на английском языке; рефераты на английском, русском и литовском яз.).

D. Tz. Dimitrov, S. Guergov, N. D. Ralev. Fizioterapijos matavimo įtaisų daugiafunkcė adaptyvioji sistema // Elektronika ir elektrotechnika. – Kaunas: Technologija, 2010. – Nr. 5(101). – P. 111–114.

Aprašomi matavimo įtaisai, plačiai naudojami fizioterapijoje. Optimalus sprendimas gaunamas tuo atveju, kai daugiafunkcė adaptyvioji matavimo sistema kartu naudojama ir magnetoterapijai, ir smegenų elektrinei stimuliacijai bei kitiems fizioterapijos procesams. Il. 9, bibl. 5 (anglų kalba; santraukos anglų, rusų ir lietuvių k.).