Synthesis of signals for Cranial Electrotherapy Stimulation

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Abstract – **"Functional electric stimulation is a very straightforward application for the therapeutic use of electricity. It has been determined that in many cases the low frequency electrical field gives better therapeutic results than static one. This is the case in the Cranial Electrotherapy Stimulation (CES) which is described in the article. The signals used for the stimulation are in a frequency rage from zero to 150 Hz, with a low current rating. Since the procedure requires to stimulate more than one area two electrodes will be used.**

Keywords - **low frequency, electrotherapy.**

I. INTRODUCTION

The electro stimulation therapy is based upon the characteristic of the human tissue to respond to different stimulation, where in this case the application region is the head. This therapy is known as „Cranial Electrotherapy Stimulation". With this therapy different effects in the patients' status are achieved by letting electrical current with specific parameters through the patients' cranial.

After going through this therapy a big number of patients show big improvement, which is achieved with a small number of procedures e.g. very fast patient recover.

This therapy method is known to the medicine since 1930. Since then its popularity increases in the field of psychotherapy and has found a lot of followers. There are still people, who controvert the effectiveness of the method due to the possibility of side effects, which has been seen in the early years, while the effects of the electrical current on the human body ware still studied. Now a day in some definite cases, when it is not advisable for the patient to take medicaments due to different considerations (other disease, ext.) the only one alternative is the electrotherapy. Also in many cases of the therapy a faster reaching of the wanted result is seen in electrotherapy than with medicaments.

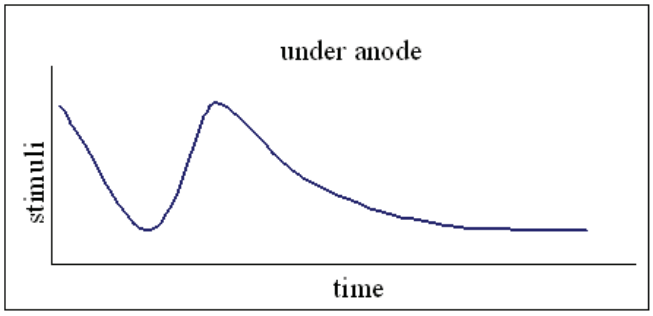

Fig.1. Tissue stimuli under anode

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The tissue is acting as a semiconductor. The electrical current is causing a reaction on the organisms' side. The long current action causes changes in the tissue stimuli. Under the anode the tissue stimuli is first decreasing, than fast increasing and at the end fast decreasing Fig.1.Under the cathode the tissue stimuli is first increasing than fast decreasing. Fig.2.This behavior of the human tissue is taken in consideration by choosing the signals for the cranial electrotherapy stimulation

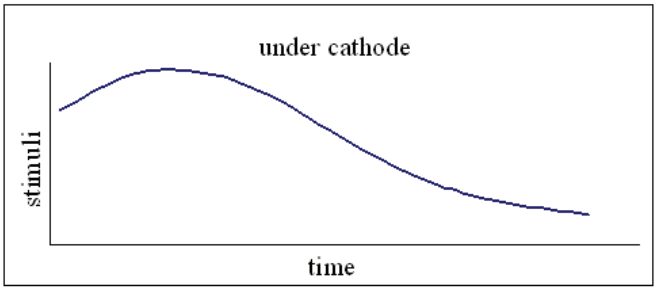

Fig.2. Tissue stimuli under cathode

The effect of these devices has an influence in many directions:

- relaxing action
- helps in treatment of different mental disease simulates the nervous system.

II. SIGNAL DESCRIPTION

Modern devices for cranial electrotherapy stimulation use square signals as well as direct current.

The square impulses used in this application have to meet the requirement that the Timp is much lower than Tpause, due to the specific of the human tissue and to achieve the best result and the average current that flows through the tissue is reduce to minimum.

Since the therapy requires the use of two electrodes, two operation modes of the output generator have to be supported: to generate impulses with same frequency in parallel on both electrodes (Fig.3) and to generate impulses with same frequency in series on both electrodes (Fig.4).

To generate square impulses in the range from 0 Hz to 150 Hz a microcontroller can be used.

The use of a microcontroller with clock rating of 4 MHz has been researched. An algorithm for calculating a specific frequency has been made with the purpose to find out the accuracy of the generated output frequency. A short fragment of the results is shown in Table I.

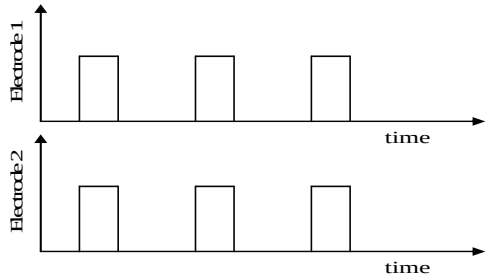

Fig. 3. Output in parallel

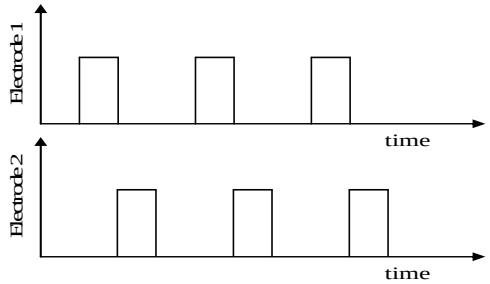

Fig.4. Output in series

TABLE I

F, [Hz]	$T_{calculated}$, [ms]	$T_{measured}$, [ms]	$F_{measured}$, [Hz]	Deviation, [%]
39	25,641	25,5653	39,116	0,2962
40	25,000	24,96	40,064	0,1603
41	24,390	24,363	41,046	0,1118
42	23,810	23,763	42,082	0,1958
43	23,256	23,163	43,172	0,4007
44	22,727	22,563	44,320	0,7281
45	22,222	22,275	44,893	0,2369
46	21,739	21,675	46,136	0,2959
47	21,277	21,275	47,004	0,0075
48	20,833	20,76	48,170	0,3532
49	20,408	20,475	48,840	0,3264
50	20,000	19,875	50,314	0,6289
51	19,608	19,563	51,117	0,2292
52	19,231	19,275	51,881	0,2295
53	18,868	18,875	52,980	0,0375
54	18,519	18,463	54,162	0,3007
55	18,182	18,075	55,325	0,5910
56	17,857	17,763	56,297	0,5300
57	17,544	17,47	57,241	0,4228
58	17,241	17,163	58,265	0,4567
59	16,949	16,875	59,259	0,4394
60	16,667	16,563	60,376	0,6259
61	16,393	16,275	61,444	0,7278
62	16,129	15,993	62,527	0,8506
63	15,873	15,745	63,512	0,8131

As shown in the experimental achieved data and on Fig.5, during the whole frequency band the diversion from the ideal frequency is within 2% and is even within 1% until a certain frequency (100Hz). This diversion originates form the rounding that is made in the calculation of the delay needed to generate certain frequency. The increase of the diversion in higher frequency is due to specific of the used algorithm. If it will be improved, the accuracy will increase as well, but this is not necessary because the achieved accuracy exceed the requirement.

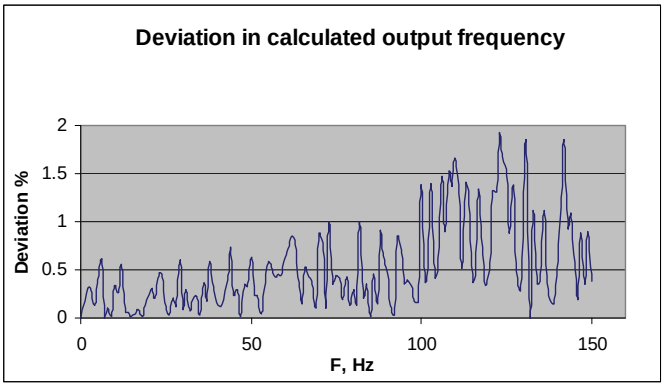

Fig.5

III. CONCLUSION

1. Form and sequence of signals used for a Cranial Electrotherapy device has been described in the paper.
2. Research has been made concerning the frequency range of the signals.
3. Deviation between theoretical and measured frequency has been illustrated.
4. Several working modes are proposed in the paper.
5. The obtained results, described in the paper can be used for further research and development of a Cranial Electrotherapy device.

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