Field distribution of electrical parameters of low- and middle-frequent current in inhomogenous media.
Local modification of stimulating parameters using interferential currents

Hansjürgens, A.[1], Meyer-Waarden, K.[2], Friedmann, B.[2]

[1] Deutsche Nemectron GmbH Karlsruhe
[2] Institut fUr Biokybernetik und Biomedizinische Technik
Universität Karlsruhe

In our representation, we would like to show the comparison between electrical field distributions for direct current and interferential current In the middle-frequency range (more than 1000 - 100 000 c.p.s.). In the calculation. we considered the different conductivities of the skin and the tissue.
As descriptive parameter in the case of middle-frequent stimulation, the maximum amplitude of modulation of the resulting electrical field intensity, according to magnitude and direction, was considered in evaluating the method of interferential middle-frequent currents. Points of equal Sectorial magnitudes have been connected by means of lines. The direction of the vectors has been marked by means of small arrows (Figures 1 and 2).

Own investigations (6) have shown that the skin impedance in case of direct currents and with the Present geometrical conditions of the arbitrary cross-section of the arm is about 1,7 kOhms, and it is 700 Ohms in case of a sinusoidal alternating voltage of 4.000 c.p.s. This impedance reduction can be explained by the electrical circuit diagram of the skin -which consists of the parallel configuration of an ohmic resistance and a capacitor.
With increasing frequency, the capacitive component of the impedance decreases while the ohmic resistance remains constant, so that the

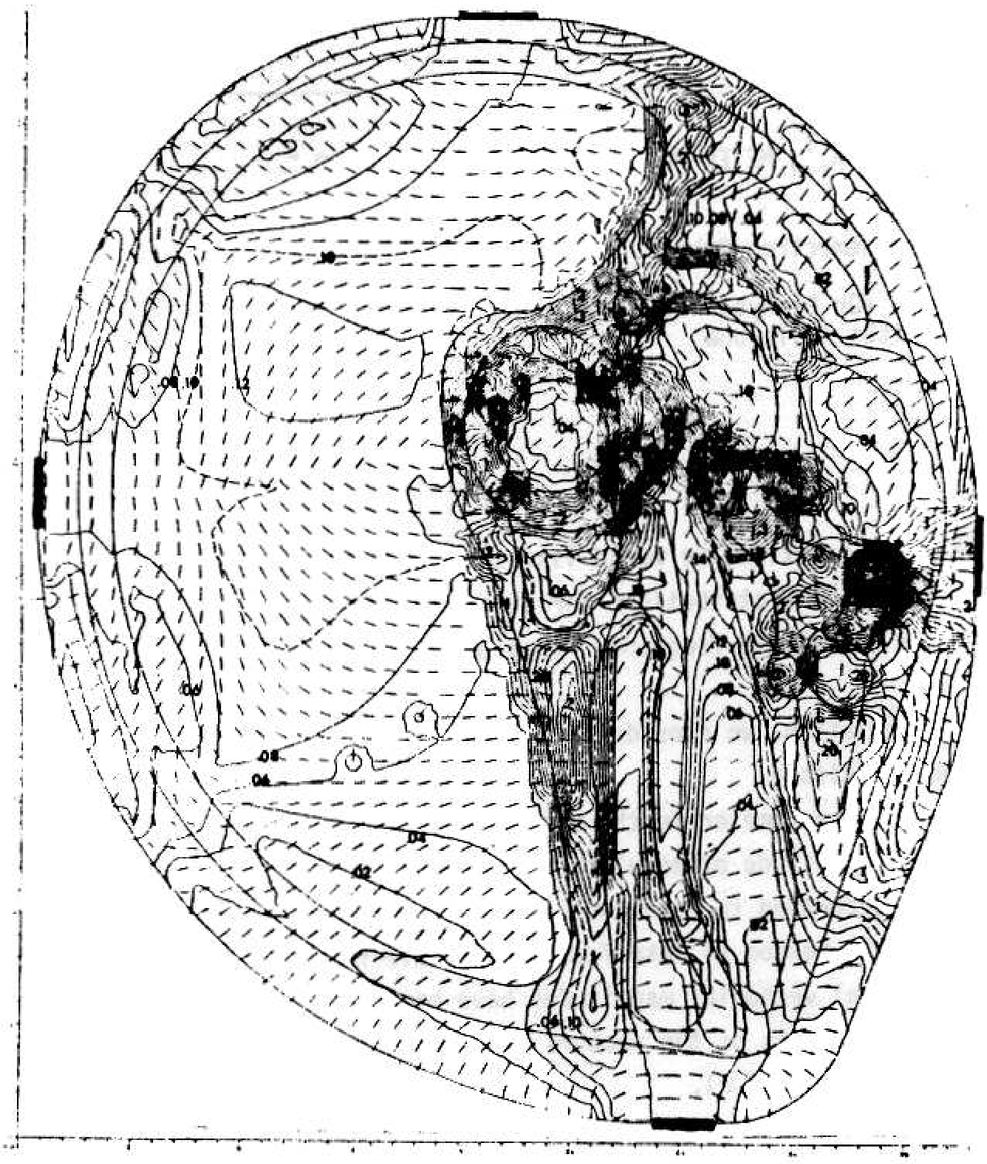


Figure 1: Distribution of the maximal modulation amplitude (MMA) in an arm cross section (1). The solid lines indicate regions of constant MMA-intensity (volts/length unit), the arrows the direction in which the MMA-intensity has its maximum value. The potential value of the applied stimulation electrodes of both current circuits is ± 10 volts.

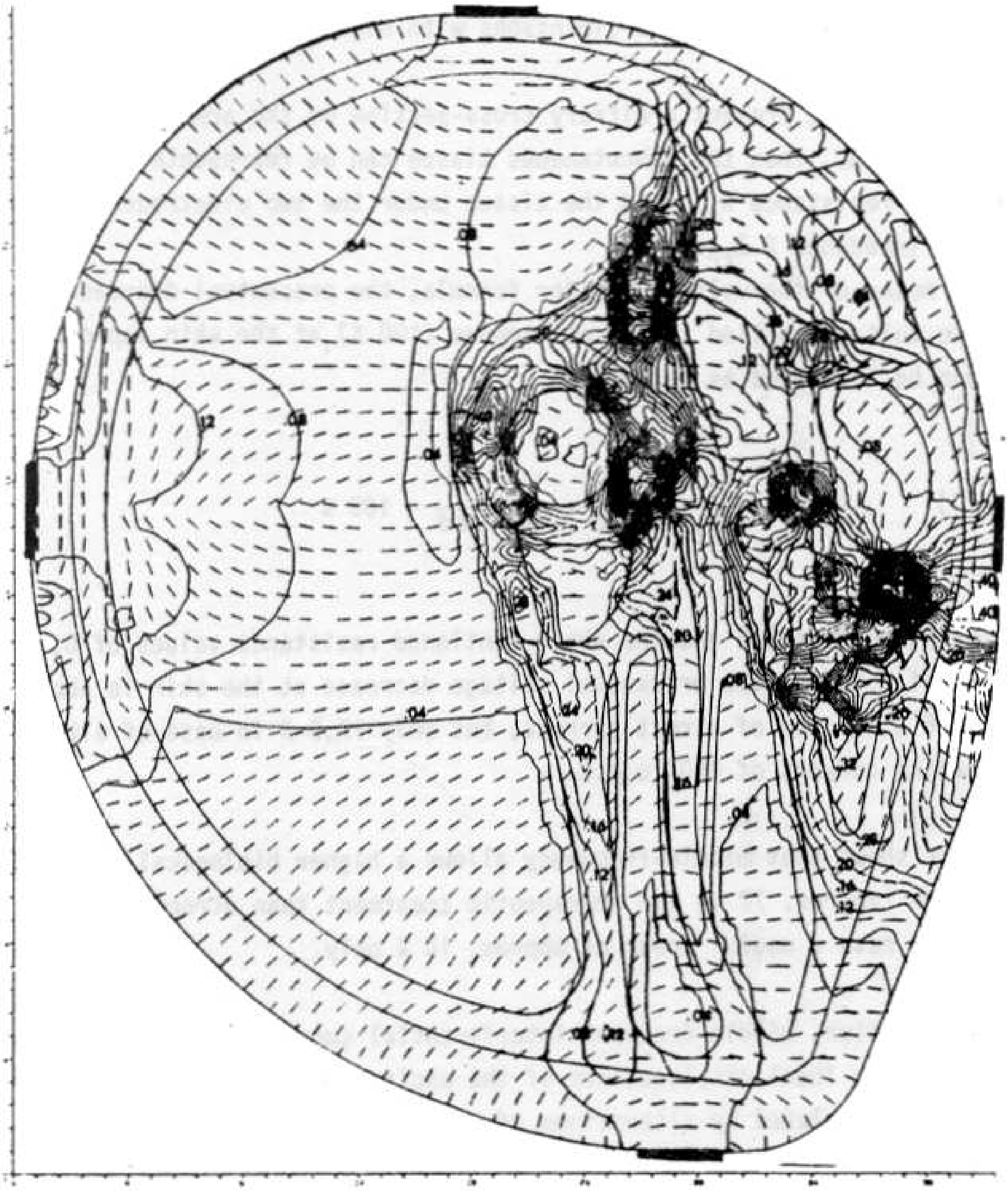


Figure 2: Distribution of the maximal modulation amplitude (MMA) in an arm cross section (1). The solid lines indicate regions of constant MMA-intensity (volts/length unit), the arrows the direction in which the MMA-intensity has its maximum value. The potential value of the applied stimulation electrodes of both current circuits is + 8 volts and - 15 volts.

resulting skin impedance diminishes with higher frequencies.

Assuming the present arbitrary cross-section of the arm to be homogenous, then the subcutaneous tissue can be represented by the ohmic resistance R_{aq}, and the tissue under the two electrodes by the impedance 2 Z_{tr}.
By means of the voltage divider formula, the percentual decrease of the voltage applied to the electrodes (100%) at the skin impedance can be indicated as follows:

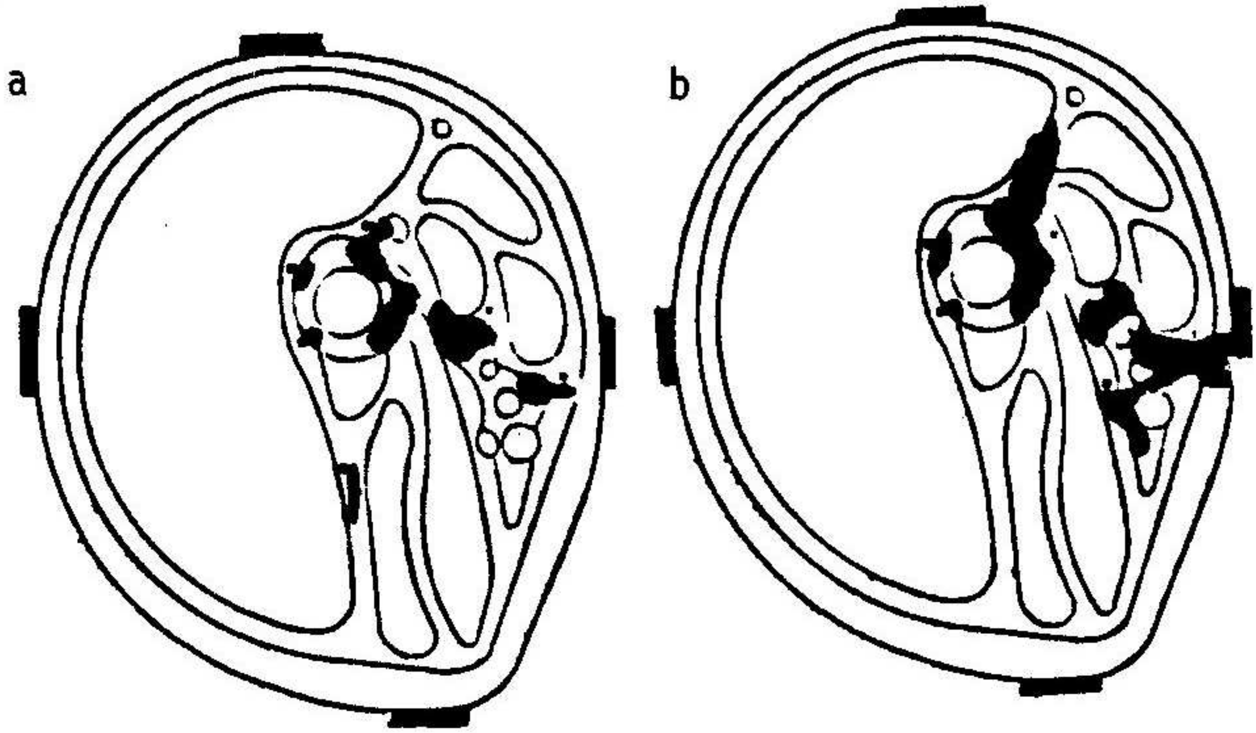
(1) $$\Delta U_{tr} = \frac{R_{tr}}{R_{tr} + 1{,}8 \cdot 10^3 Ohms} = 100\%$$

With equation (1) and the above mentioned resistance values of 0,7 and 1,7 kOhms, the percentual voltage decrease at the skin is about 90,6% in case of direct current, but only 17,9% in case of alternating current of 4000 c.p.s

This shows that middle-frequency allows a higher biological useful power (approx. 72 %) for therapeutic treatment than direct currents which have a useful power of approx. 10 % only.

In addition, middle-frequent interferential currents make it possible to obtain local displacements of the excitation parameter in the area to be stimulated by alterations of the potential value at the stimulating electrodes.

Figures 3a and 3b show a comparison of the local displacement of the stimulation area within a arbitrary selected constant value of the maximum modulation amplitude of 0,32 volts/length unit.



Figures 3a, 3b. Displacement of the stimulation area within an arbitrary selected, constant value of MMA-intensity (0,32 volts/length unit) of Figure 1 and Figure 2.
a: The potential value of the applied stimulation electrodes of both current circuits is ± 10 volts.
b: The potential value of the applied stimulation electrodes is + 8 volts and - 15 volts.

The basic potential value (+ 10 volts) of the stimulation electrodes of both current circuits changes to + 8 and - 15 volts. The potential values of + 8 and - 15 volts are expected to lead to the greatest field alterations on account of biological media.

Figures 3a, 3b, show different potential values of the stimulation electrodes of both current circuits. It is to be mentioned that the potential values are being opposed in a low-frequent rhythm (< 1/2 c.p.s.) in both current circuits.
Figure 3b only shows an instantaneous recording when reaching an extreme value. Including these temporal changes in our considerations, then the local displacements of the stimulation area will be much more extensive. Therefore, the analysis of the field distribution makes it possible to create defined, predetermined stimulating conditions in a preselected area in which the potential values as well as the position of the electrodes are changed.

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