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ELECTRIC NERVE STIMULATOR

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Attys.
This invention relates to electro-medical apparatus. The area of the electrodes of such apparatus, which lead the electric current to the tissue of the object treated, are small in comparison to the dimensions of the object treated, and as a consequence the greatest current concentration and thus the greatest stimulating effect are resulting next to the electrodes. Thereby an upper limit is set to the intensity of current applicable, said limit lying in many cases below the dosage desirable for medicinal reasons. Small children or over-sensitive individuals frequently feel unbearable already the mere electrifying action at the places of the skin next to the electrodes, even if it lies very far still below the limit of endurance, so that an electro-therapeutic treatment, even if it were accommodated as much as possible, is impracticable.

For the same reason also the utilization of the electric stimulating current for cosmetic purposes could not be carried through despite the fact that the effective possibilities upon the function of the skin, the blood circulation, the facial muscular system and the skin of the face anatomically connected thereto, etc., are in principle extraordinarily superior to all the other processes.

The present invention represents a successive further development of the electro-medical apparatus as described in my copending application Ser. No. 50,889 according to which the currents received from separate sources and supplied by means of separate electrodes are united within the tissue to a predetermined, resulting current field, and has for its object to eliminate any disturbing stimulating effect of the current upon the parts of the skin situated below the electrodes. This invention essentially consists in that the single currents have a frequency, each, lying above the normal stimulating frequency suitable for a permanent excitation, said frequencies being distinguished by a figure of frequency lying within the normal region of frequency suitable for a permanent excitation, so that a resulting current field is brought about inside the object treated, which releases permanent excitations in the rhythm of the difference of the individual frequencies (beat frequency). These excitations consist of pulsating vibrations of the nerves caused directly by electric current at a certain depth of the body, said vibrations resulting for example as to the motor nerves in contractions of the muscles belonging to them. The beat frequency may be varied by hand or automatically. Preferably, the internal resistance of the separate sources of current is great in comparison to the resistance of the circuits of the electrodes (circuits of treatment).

For a better comprehension of the progress attained by this invention in general, and of the following embodiment by way of example in particular, a few electro-physiological facts will be stated.

As is known, the stimulating effect of the electric current is dependent on the form of the individual impulses, the frequency of the succession of the same, as well as on the intensity of the same. Furthermore, the phenomenon known in the entire physiology of the senses may be mentioned, according to which there results an accommodation or habituation to the irritation, and this in fact the faster and the more completely, the more equal said irritation is with regard to its temporal course. This explains that a series of electric impulses with a constant intensity are registered by the sensitive nerves of the skin the less the larger the duration of the action is. Thus, keeping a series of impulses of a constant level is an important means for decreasing the sensitive stimulating effect of said impulses. This fact alone, however, becomes useless, if the electric current is not intended to be used for the purpose of an anaesthesia of the sensitive zones, but is to serve primarily for other therapeutic or cosmetic purposes, such as e. g. in electro-gymnastics, where, as is known, the point is to release rhythmic contractions of the muscles. Here a series of impulses of a constant intensity exciting the motor nerves, too, would bring about a permanent contraction exhausting and injuring the muscle. For this reason, in connection with this field of the electric low frequency therapy up till now the most important there are always used so-called faradic swelling currents, i. e. electric stimulating impulses, the intensity of which is rhythmically increasing and decreasing. From the fact that with the hitherto known apparatus said variations of intensity always appear at the electrodes, too, and thus still further raise the irritation of the skin, which has been increased at the electrodes already in consequence of the great concentration of current, there results the above mentioned restriction, or exclusion of a use of current for therapeutic and cosmetic purposes.

The dependence of the irritations released in the narrow containing fibres of the animal nervous system on the frequency of said irritations is shown by a steady falling off of the stimulating effect with an increasing frequency in consequence of arresting and fatigue phenomena in the refractory period with frequencies of about 100 cycles, until, in the end, with a few thousand cycles, no permanent irritation at all ensues any more, but, observed at the nerve of the muscle, the so-called switching-in convulsions arise at the beginning of a fast growing series of impulses only. Said convulsions ebb down fast, whereupon the muscle remains unexcited despite the fact that the electric cur-
rent is continuing to flow through the muscle.

With a slow, a so-called creeping in increase of the intensity of the current even these stimulating effects would not ensue. Accordingly, there may also be avoided any stimulating phenomenon with the sensitive nerves of the skin, if the series of impulses amounting to a few thousand cycles is being switched on slowly enough.

The technical measures provided according to the invention for utilizing the principles set forth in my copending application Ser. No. 56,689 and at the same time for exploiting the above recognitions in order to provide an apparatus for electro-medicinal, or electro-cosmetic purposes, the currents of which release irritations within the tissue, but are simultaneously without any stimulating quality at the current supplying places of the electrodes, are illustrated, by way of example, in the drawing showing the circuit connections of an apparatus according to this invention.

By means of the net transformer 1 two separate circuits are supplied, which comprise rectifiers 2 and 5, oscillators 3 and 6, and amplifiers 4 and 7, respectively, said circuits supplying sinusoidal alternating current to the treated object 12 through one pair of electrodes 8, 9, and 10, 11, respectively, belonging separately to each circuit. For regulating the intensity of the stimulating current serves a finely stepped double potentiometer 13, which enables a creeping in increase of intensity. Both circuits being symmetric with regard to principle and structure are distinguished by the rotating plate condenser 14 lying parallel to the oscillatory circuit of the oscillator 6. In the turned out position of said condenser the oscillators 3 and 6 are swinging at an equal frequency of 3000 cycles, which may for the oscillator 6 be continually set, or varied, between 3000 and 3100 cycles with the aid of the condensers 14 without altering thereby the oscillatory power delivered. In order to exclude influencing phenomena in the region of small differences of frequency, both oscillatory circuits 3 and 6, respectively, are sufficiently screened.

In the same way, by the use of an internal resistance relatively great with regard to the loading resistance in the circuit of the electrodes, there is avoided that the principally important separation of both circuits be to an inadmissibly great extent diminished by a coupling through the object treated.

With a use of said apparatus, by way of example, for an electro-gymnastic treatment the electrodes illustrated are applied in such a manner that the motor point of irradiation comes to lie in the centre of the arrangement of the electrodes, and the intensity of the partial or component currents of equal frequency supplied by both circuits is so slowly increased in a creeping in manner that neither a sensitive, nor a motor stimulating effect of the current is brought about.

If the frequency of the oscillator 6 is then varied by means of the condenser 14, beats of the resulting current field are produced in the depth of the tissue between the electrodes, where the motor nerve to be treated is situated, which irritate the innervated muscle according to the best frequency to cause individual convulsions, clonic or tetanic contractions, whereas the sensitive main nerves remain unexcited.

While the invention has been shown in the particular embodiment described it is not limited thereto, as modifications thereof may be made without departing from the scope of the appended claims.

I claim:

1. Electro-medical apparatus, comprising two separate generators for producing alternating currents of a frequency between 1000 and 10,000 cycles, but differing as to their frequency by an amount of about 1-100 cycles, pairs of electrodes connected, each, with one of said generators and with the object treated, respectively, for supplying alternating currents producing a maximum permanent stimulating effect upon a nerve of a muscle.

2. Electro-therapy apparatus, comprising at least two means for producing alternating currents of frequencies between 1000 and 10,000 cycles at the most and practically without a permanent stimulating effect for stimulating the nerves of muscles, a rectifier and a variable resistance in each of said means, a separate electric circuit being connected with each of said means, separate pairs of said electrodes being connected to each of said circuits, each of said means being connected with a separate pair of said electrodes, in at least one of said means a condenser and a device, both for regulating the frequency of at least one of said currents to produce as a modulating frequency, a difference of frequencies of the frequencies of said currents of 100 cycles at the most in the range where the currents are super-imposing one another.

3. Electro-therapy apparatus as claimed in claim 2, wherein internal resistances are provided in said circuits, said resistances being greater than the resistances of the circuits of treatment between said connected electrodes.

4. Electro-therapy apparatus as claimed in claim 2, comprising an oscillator and an amplifier in each of said means for producing sine wave alternating currents.

5. Electro-therapy apparatus as claimed in claim 4, comprising a variable condenser for producing said modulating frequency, said condenser being in parallel to the oscillatory circuit of the oscillator.

6. Electro-therapy apparatus, comprising a supply transformer, two separate circuits, each connected with said transformer, an oscillator and an amplifier for producing sine wave alternating currents of substantially equal frequency being arranged in each of said circuits, a condenser in one of said circuits being adapted to vary the frequency of this circuit for producing a beat frequency of the order of from 1 to 100 cycles per second by superposing the frequencies of both circuits, internal resistances greater than the resistances of the circuits of treatment being provided in said circuits.

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