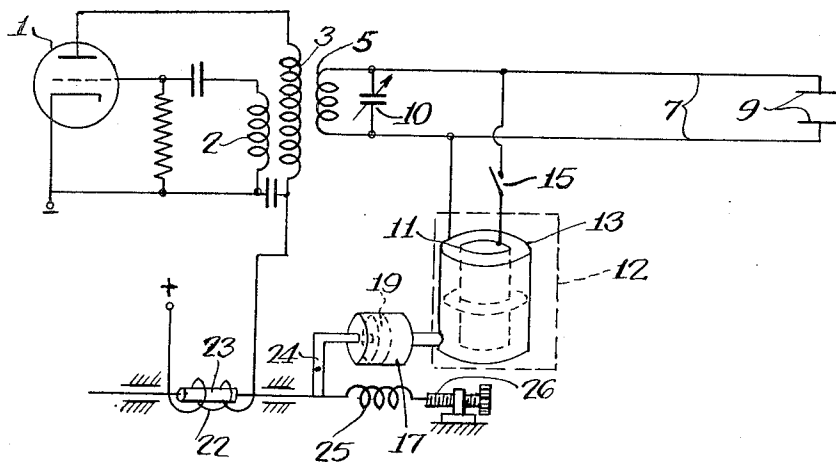


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DEVICE FOR THE MEDICAL TREATMENT OF PERSONS  
WITH HIGH-FREQUENCY ENERGY  
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DEVICE FOR THE MEDICAL TREATMENT  
OF PERSONS WITH HIGH-FREQUENCY  
ENERGY

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The invention relates to a device for the medical treatment of persons by means of high-frequency energy.

Such a device usually consists of a high-frequency oscillator which serves to generate the high-frequency energy required for the treatment and of a treating element, for example a coil or a set of condenser electrodes for producing a magnetic or electric field of high frequency, by means of which the high-frequency energy is supplied to that part of the patient's body which is to be treated.

With devices of this kind there arises in practice the drawback that the impedance formed by the treating element and the part of the body to be treated (load impedance) varies during the treatment due to movements of the treated patient with the result that the device repeatedly loses its exact adjustment, which repeatedly causes variation of the energy supplied to the treating element, which energy is transferred by this element to the patient. This entails the drawback that the amount of energy to be supplied to the patient (dose) cannot be adjusted with sufficient reliability.

The invention has for its object to remove this drawback. According to the invention, there is provided to that end a regulating device which serves to keep the high-frequency energy supplied to the treating element automatically constant or at least substantially constant.

With the device according to the invention the treating physician has the assurance that the amount of energy supplied to the patient (dose) is really equal to the treatment energy adjusted before-hand multiplied by the duration of the treatment. In order to keep the energy supplied to the patient as constant as possible it is desirable that the time constant of the regulating device should be sufficiently small or in other words that the rapidity of the regulation should be great enough to be able to follow any movement of the patient, for example the breathing movement or movements of fright of nerve-patients. This condition can practically be considered fulfilled if the time constant of the regulating device is of the order of magnitude of 0.5 second; in practice, however, the optimum value may appreciably differ from the given value; it may be, for example, ten times as large or ten times as small as that value.

The regulating device is preferably controlled by a regulating magnitude (regulating voltage or current) which depends on the energy supplied to the treating element (treatment energy),

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and this in such manner that, for example, upon an increase of the treatment energy due to the device losing its exact adjustment the produced variation of the regulating magnitude brings about a decrease of this energy until the former value has been attained or at least has approximately been attained. The regulating magnitude may be derived, for example, from the anode current of an oscillator tube which serves to generate the high-frequency energy required for the treatment since this current is approximately proportional to the treatment energy. A further possibility consists in that the regulating voltage is derived from the energy which is taken up by the high-frequency oscillator from the source of supply current to which the device is connected, said energy being also approximately proportional to the treatment energy.

This energy may be maintained constant by automatically regulating the energy generated by the oscillator. For this purpose the regulating voltage may be supplied to one or more electrodes whose bias voltages act upon the energy generated, for example to one or more grids, of one or more oscillator tubes. It is also possible to have the coupling between the load impedance and the oscillator, which coupling influences the energy supplied by the oscillator to the treating element, controlled by the regulating voltage. A third possibility is to have the regulating voltage act upon the tuning of the device. The latter form of construction of the regulating device may be utilized if the impedance formed by the treating element and the part of the body to be treated forms part of a separate oscillatory circuit which is coupled to the high-frequency oscillator and which is tuned to a frequency located in the neighborhood of the frequency of the generated oscillations (load circuit). The regulating voltage preferably controls in this case the tuning of the load circuit, in which event the energy supplied to the treating element is regulated by a more or less great detuning of the load circuit with respect to the frequency of the generated oscillations.

The invention will be explained more fully with reference to the accompanying drawing wherein the single figure illustrates schematically a preferred embodiment of the invention.

The device represented in the figure comprises a tube 1 which is connected in the ordinary manner as an inductively back-coupled oscillator having a coil 2 included in the anode circuit

coupled, by means of a coupling coil 5 and a transmission line 7, to a treating element which is constituted in the instance illustrated by two condenser electrodes 9—9 which are arranged on either side of the part of the body that is to be treated. The coil 5, the transmission line 7—7 and the electrodes 9—9 form a separate oscillatory circuit (load circuit) which may be tuned, by means of a condenser 10 which is connected in parallel with the coil 5, to the frequency of the oscillations generated by the oscillator 1.

In practice it has been found that upon a movement of the person under treatment the load impedance present between the electrodes 9—9 varies with the result that the tuned load circuit 5—7—9—10 loses its exact adjustment. The variation of the load impedance consists in a variation of the resistance component and/or of the reactive component of this impedance; they both cause a variation of the treatment energy. According to the invention, in order to avoid this harmful variation, means are utilized for automatically maintaining the treatment energy substantially constant. In the shown embodiment of the device according to the invention these means include a condenser 12 which is formed by two concentric metal cylinders 11 and 13 and which can be connected in parallel with the tuning condenser 10 by means of a switch 15. The capacity of the condenser 12 can be varied by filling the space between the cylinders 11 and 13 with a liquid having a high dielectric constant, for example with oil. For this purpose, this space communicates with a pump cylinder 17 provided with a piston 19 whose movement is controlled by a driving device dependent upon the anode current of the tube 1. The driving device comprises arm 24 coupled to piston 19 and to an armature 23 of electromagnet 22. The armature 23 is loaded by means of spring 25 which is capable of exerting a varying tension by means of screw adjustment 26. Armature 23 is drawn into the coil 22 to a varying degree depending upon the strength of anode current flowing through the coil.

After the patient is placed between the electrodes 9—9 the treatment is started by adjusting condenser 10 so that the treatment energy supplied to the electrodes 9 is at its maximum, which fact can be ascertained with the aid of a suitable measuring instrument (not shown). Then the condenser 12, which is now, for example, halfway filled with oil, is connected in parallel with the condenser 10 by means of the switch 15, with the result that the oscillatory circuit 5—10 is detuned and the treatment energy decreases. This decreased value is then maintained by the device according to the invention. If, for example, the treatment energy increases the anode current of the tube 1 also increases, which causes such a displacement of the piston 19 that the capacity of the condenser 12 and therefore the detuning of the oscillatory circuit 5—7—9—10 increases until the decrease of the treatment energy, which decrease is due to this additional detuning, has counterbalanced or at least substantially counterbalanced the initial increase of this energy.

The use of a condenser of the type of the condenser 12 for regulating the treatment energy offers, on the one hand, the advantage of a rapid adjustment owing to the fact that the mass of the movable condenser portion, in the present case the oil, need only be small whereas, on the other hand, the viscosity of the oil also causes a

mechanical damping of the regulating movement, which is desirable in such regulations.

What we claim is:

1. A therapeutic device for the treatment of a patient by means of high frequency energy, comprising a generator of high frequency energy, means to supply power to said generator, an oscillatory circuit coupled to said generator and comprising a variable capacitor and means for applying the high frequency energy to said patient, said patient constituting an impedance across said oscillatory circuit which is subject to variation, said oscillatory circuit being tuned by means of said variable capacitor to a frequency approximating the frequency of the generated energy, said variable capacitor comprising two spaced conductors and a liquid of high dielectric constant interposed between said conductors, and means responsive to the power supplied to said generator to vary the amount of said liquid interposed between said conductors to adjust the frequency of said oscillatory circuit and maintain the energy applied to said patient at a substantially constant value regardless of variations in said impedance.

2. A therapeutic device for the treatment of a patient by means of high frequency energy, comprising a generator of high frequency energy, means to supply power to said generator, an oscillatory circuit coupled to said generator and comprising a variable capacitor and means for applying the high frequency energy to said patient, said patient constituting an impedance across said oscillatory circuit which is subject to variation, said oscillatory circuit being tuned to a frequency approximating the frequency of the generated energy, said variable capacitor comprising two spaced concentric conductors electrically insulated from each other and a liquid of high dielectric constant interposed between said conductors, and means responsive to the power supplied to said generator to vary the amount of said liquid between said conductors to vary the frequency of said oscillatory circuit and maintain the energy applied to said patient at a substantially constant value regardless of variations in said impedance.

3. A therapeutic device for treating a patient with high-frequency energy comprising a generator producing high frequency energy including an electron discharge tube having a cathode, a control electrode and an anode, a resonant output circuit coupled between said cathode and said anode, and means establishing direct-current flow between said cathode and said anode; a load circuit coupled to said output circuit for applying high-frequency energy to said patient, said patient constituting in said load circuit an impedance subject to variation; means in the circuit for tuning said load circuit; and means coupled to the output circuit responsive to variations in said direct-current flow for adjusting said tuning means to maintain constant the energy supplied to said patient.

4. A therapeutic device for treating a patient with high-frequency energy comprising a generator producing high-frequency wave energy including an electron discharge tube having a cathode, a grid and an anode, a resonant output circuit coupled between said cathode and said anode, and means establishing direct-current flow between said cathode and said anode; a load circuit coupled to said output circuit for applying high-frequency energy to said patient;

5. A variable condenser coupled to said load circuit

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for tuning same, said patient constituting in said load circuit an impedance subject to variation; and means including an electro-magnet responsive to variations in said direct-current flow for adjusting said condenser to an extent and in a direction maintaining resonance between said load circuit and said output circuit.

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