Sept. 20, 1938. E. J. ROSE 2,130,758

ELECTRODE FOR DIATHERMY TREATMENT AND THE LIKE

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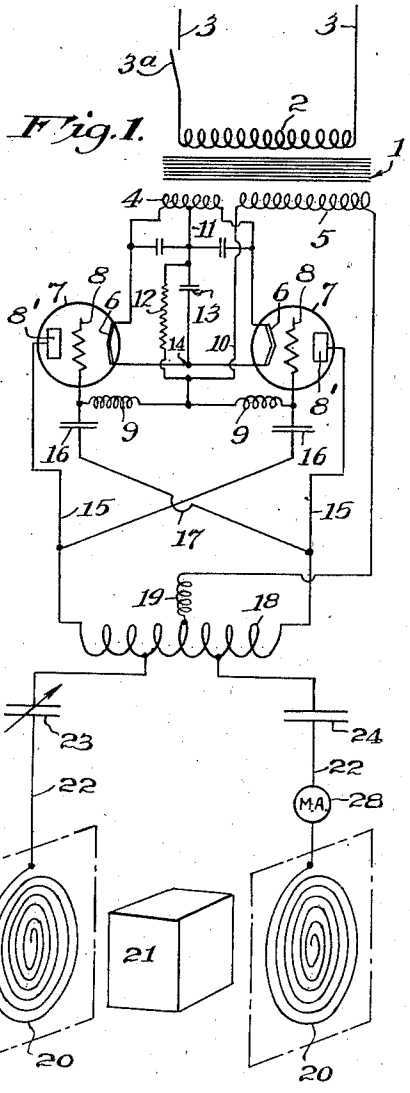

Fig. 1.

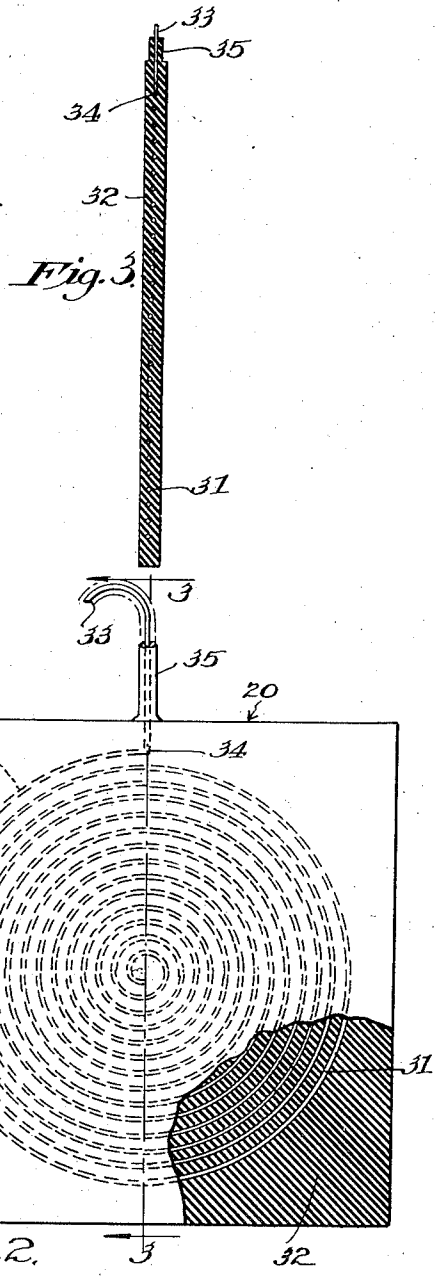

Fig. 3.

Fig. 2.

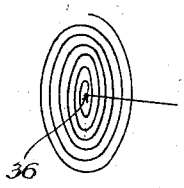

Fig. 4.

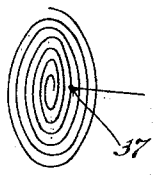

Fig. 5.

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ELECTRODE FOR DIATHERMY TREATMENT AND THE LIKE

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5 Claims. (Cl. 128—413)

This invention relates to diathermy apparatus and the like, and pertains particularly to an advantageous form of treatment electrode which may be associated with a suitable source of high frequency electrical energy to produce high frequency current flow within body tissues.

The expression "diathermy apparatus and the like", as used herein, is particularly applied to such apparatus as is employed in physio-therapy use, in which high frequency oscillations are employed to engender a temperature rise in body tissues, but it will be apparent that the scope of employment of the apparatus herein described is not limited specifically to use on body tissues, inasmuch as such oscillations may be advantageously applied to other uses, as in the sterilization of grains or the like.

Numerous forms of apparatus have been suggested for causing a high frequency current flow within body tissues whereby the normal body heat may be raised to an appreciable extent in somewhat localized areas. Two general types of apparatus have been hitherto suggested, namely, the "condenser" type and the "electromagnetic" type. The condenser type includes a pair of spaced electrodes between which the desired portion of the patient's body may be disposed and caused to function as a dielectric, the two electrodes constituting opposing plates of a condenser. The electromagnetic type of apparatus establishes high frequency current flow in a closed circuit, a portion of which is disposed in helical, i. e., solenoidal, shape, whereby an electromagnetic field is established, and the portion of the patient's body to be treated is disposed within this magnetic field.

The condenser type of apparatus, when the customary flat plate electrodes are employed, is somewhat inefficient as far as utilization of the supplied energy is concerned, in that a considerable proportion of the supplied energy is dissipated in the leads which connect the electrodes to the source of energy. This requires the employment of a high frequency generator of relatively high power output in order to produce satisfactory heating effects. Furthermore, the heating effect on body tissue is confined substantially wholly to the presence of an oscillating electrostatic field, which causes a noticeable "surface" heating of the member undergoing treatment.

According to the present invention, an improved type of treatment electrode is provided, which may be disposed in close proximity to the body portion under treatment, and which comprises an electrode member adapted to produce combined electrostatic and electromagnetic fields of advantageous characteristics within the body tissue. Two such treatment electrodes are preferably employed in opposing relation after the manner of the conventional "condenser" type of apparatus, the said body portion being disposed between such electrodes. Each of said treatment electrodes preferably also comprises a casing or sheath of insulating material surounding the electrode member and insulating said member from the body of the patient, to form a substantially flat unit which may be applied to the patient's body.

One of the important objects of the present invention is to provide a diathermy electrode arrangement for use in the "condenser type" of apparatus which will produce a greater heating effect on body tissues for a given energy input than electrodes which have been hitherto proposed.

A further object of the invention is to provide an improved form of diathermy treatment electrode adapted to produce a voltage intensification at the portion of the treatment circuit adjacent the position of the body portion undergoing treatment whereby the principal proportion of the total energy dissipated in the treatment circuit is actually dissipated between the electrodes themselves, in position to effectively heat the said body portion.

A further object of the invention is to provide a diathermy electrode formed as a flat spiral of conductive material having a single connection to one side of a source of high frequency electrical energy, which electrode is preferably associated with a similar electrode connected to the opposite side of said source, such two electrodes being spaced apart to define a treatment zone within which the desired portion of the patient's body may be disposed.

The electrode member of the present invention may comprise an open-ended spiral conductor which may be provided with elctrical connection at one point to one side of the source of high frequency energy and spaced from a preferably similarly formed electrode connected to the other side of said source, to define a treatment zone within which the desired portion of the patient's body may be disposed.

Other objects of the invention will be brought out in the following description of a preferred embodiment thereof, or will be apparent from such description. The accompanying drawing illustrates preferred embodiments of the treat-

ment electrode and the manner of application thereof, and referring thereto:

Fig. 1 is a diagrammatic showing of an oscillatory circuit with two electrodes of the present invention associated therewith;

Fig. 2 is a partially broken-away plan view of a preferred form of the treatment electrode;

Fig. 3 is a sectional view thereof taken on line 3—3 in Fig. 2;

Figs. 4 and 5 are diagrammatic showings of electrodes of the present invention, provided with alternative connection to the source of energy.

Referring to Fig. 1, I have shown an advantageous form of oscillator and treatment circuit assembly, which may comprise a power transformer 1 having a primary 2 provided with power leads 3 having a switch means 3a and which may be connected to a suitable source of commercial power supply such as 50–60 cycle alternating current, a low tension secondary 4 and a high tension secondary 5, said low tension secondary being employed for energization of filaments 6 of triodes 7. The grids 8 of the triodes 7 are connected through small radio frequency chokes 9 to one side of the secondary 5 through a suitable lead 10 and to the center tap 11 on the secondary 4 through a grid leak 12, which grid leak in cooperation with a grid condenser 13 connected to the filaments 6 as at 14 constitutes an automatic grid bias. The grids 8 are connected to the plate connection 15 through suitable fixed capacities 16, the grid of each tube being connected to the plate circuit of the other tube as shown by the crossed leads 17. The two plate leads 15 connect the plates 8' of the respective tubes to opposite ends of a tank coil 18 and this coil is center tapped through a suitable radio frequency choke 19 to the other side of the secondary 5. The external or patient's circuit may comprise two treatment electrodes 20 spaced from one another and preferably disposed in spaced parallel planes, between which a portion of the patient's body may be disposed as at 21, it being appreciated that the electrodes 20 preferably include suitable casings of an adequate dielectric material such as rubber or the like, as more fully described hereinafter, whereby direct electrical contact with the patient is prevented, said electrodes being provided with leads 22 connected across the center portion of the tank coil 18 through capacity means 23 and 24. One of said capacity means, for example the condenser 23, is preferably variable, whereby resonance between the internal or oscillator circuit and external circuit may be controlled to establish a desired current flow in said external circuit. It will be understood that any type of oscillating circuit may be employed as a source of high frequency energy for connection to the two electrodes.

Referring to Figs. 2 and 3, an advantageous type of treatment electrode of the present invention is shown at 20, which may comprise a flat open-ended spiral 31 formed of a suitable electrical conducting material such as a brass or copper wire, tubing or the like, encased in a suitable insulating material such as a sheath of rubber or the like 32 to form a substantially flat unit. Electrical connection of the spiral 31 is provided to the lead 22, as through a conductor 33 connected to the spiral 31 as at 34, said conductor 33 being preferably suitably encased in an insulating sheath of rubber or the like 35.

As shown in Figs. 4 and 5, the connection to the spiral electrode may be made at a point other than at the outer end thereof as shown specifically in Fig. 3. Where connection is made to the inner end of the spiral as at 36 in Fig. 4, a considerably greater voltage intensification is attained, which is no doubt due to the increase in average ampere-turns by such connection. Where connection is made to an intermediate portion of the spiral as shown at 37 in Fig. 5, the strength of the magnetic field produced will depend upon the relation between the effective ampere-turns in the two parts of the spiral provided by the intermediate connection. It will thus be apparent that by connecting the spiral according to the above alternative procedures, a maximum electromagnetic field will be obtained with a center connection and any desired decrease in the electromagnetic field may be obtained by shifting the connection along the spiral to any required position.

As shown in Fig. 1, the two spiral electrodes 20 may be arranged in substantially a co-axial relation and electrically connected in such manner that the electromagnetic fields thereof are in "opposition", that is, so that the magnetic fields of the spirals are opposite in direction at any given instant. In view of the fact that the spirals are not placed closely adjacent one another, i. e., the planes of the two spirals are not closely spaced, this does not result in a total cancellation of the fields, but merely means that a body placed centrally between the two spirals as at 21 would have a magnetic field in one direction at the side thereof facing one electrode, and an opposite field at its other side. Where the two electrodes are so connected that the produced fields are in "apposition", the field through the body would be uniform in direction at any one instant. No significant differences in heating effect have been observed in comparable experiments in which the electrodes are energized oppositely and appositely.

The electrodes of the present invention are shown and described as "flat" spirals, and these flat structures are to be preferred for physiotherapy application in view of the convenience of handling and applying a flat pad or the like to the patient's body, and in view of the desirable electrostatic and electromagnetic field characteristics of such flat structures.

From the above results, it will be seen that the spiral type of electrode is capable of inducing a greater temperature rise for a given current flow in the external circuit than a comparable flat plate electrode.

It will be understood that the advantages of the present electrode arrangement are particularly realized when two such electrodes are employed in spaced relation to define the treatment zone, but at the same time, it will be appreciated that a single electrode of the present invention may be employed with any other type of electrode adapted to establish the "condenser" type of circuit, such as a flat plate electrode as above described, without departing from the spirit of the invention.

I claim:

1. A treatment electrode for diathermy treatment and the like, which comprises an electrical conductor wound in substantially flat spiral form and having at least one electrically open end, and electrical conductor means connected to said spiral at one point only for electrical association of said electrode with a source of high frequency energy, said point being removed from said open end.

2. A treatment electrode which comprises an electrical conductor wound in spiral form and having at least one electrically open end, electrical conductor means connected to said spiral

conductor at one point only for electrical association of said electrode with a source of high frequency energy, said point being removed from said open end, and an electrically insulating casing member surrounding said spiral conductor and defining a substantially flat sheath member engaging said spiral conductor and maintaining the same in spiral form.

3. A treatment electrode for diathermy treatment and the like, which comprises an electrical conductor wound in spiral form and having open inner and outer ends, electrical conductor means connected to said spiral conductor at one point only for electrical association of said electrode with a source of high frequency energy, said point being between said open ends, and an electrically insulating casing member surrounding said spiral conductor and defining a substantially flat sheath member engaging said spiral conductor and maintaining the same in spiral form.

4. A treatment electrode for diathermy treatment and the like, which comprises an electrical conductor wound in spiral form and having an outer end and an open inner end, electrical conductor means connected to said spiral conductor at one point only for electrical association of said electrode with a source of high frequency energy, said point being said outer end, and an electrically insulating casing member surrounding said spiral conductor and defining a substantially flat sheath member engaging said spiral conductor and maintaining the same in spiral form.

5. A treatment electrode for diathermy treatment and the like, which comprises an electrical conductor wound in spiral form and having an inner end and an open outer end, electrical conductor means connected to said spiral conductor at one point only for electrical association of said electrode with a source of high frequency energy, said point being said inner end, and an electrically insulating casing member surrounding said spiral conductor and defining a substantially flat sheath member engaging said spiral conductor and maintaining the same in spiral form.

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