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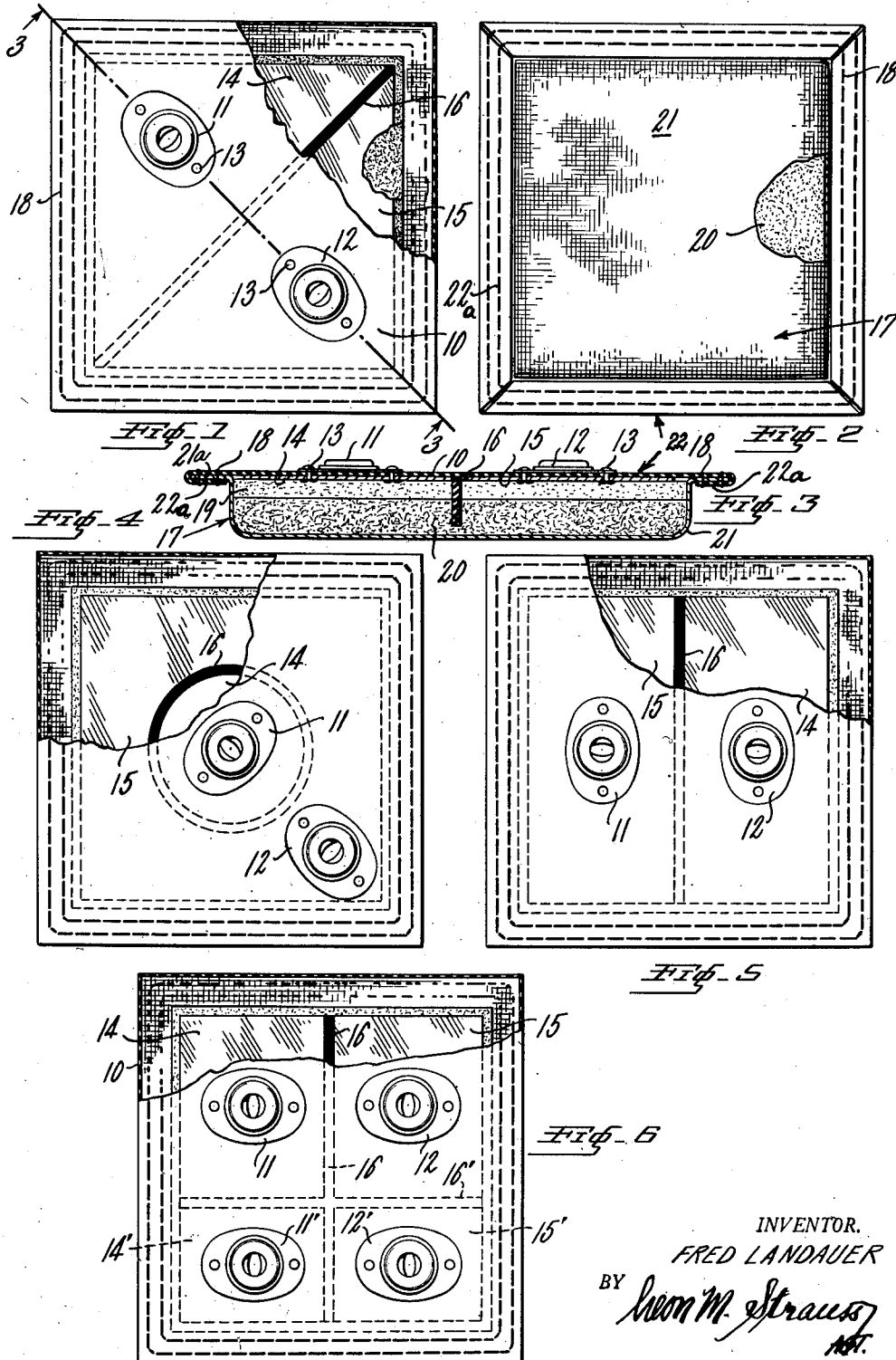
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ELECTRODE FOR ELECTROTHERAPEUTIC TREATMENTS

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2 SHEETS—SHEET 1



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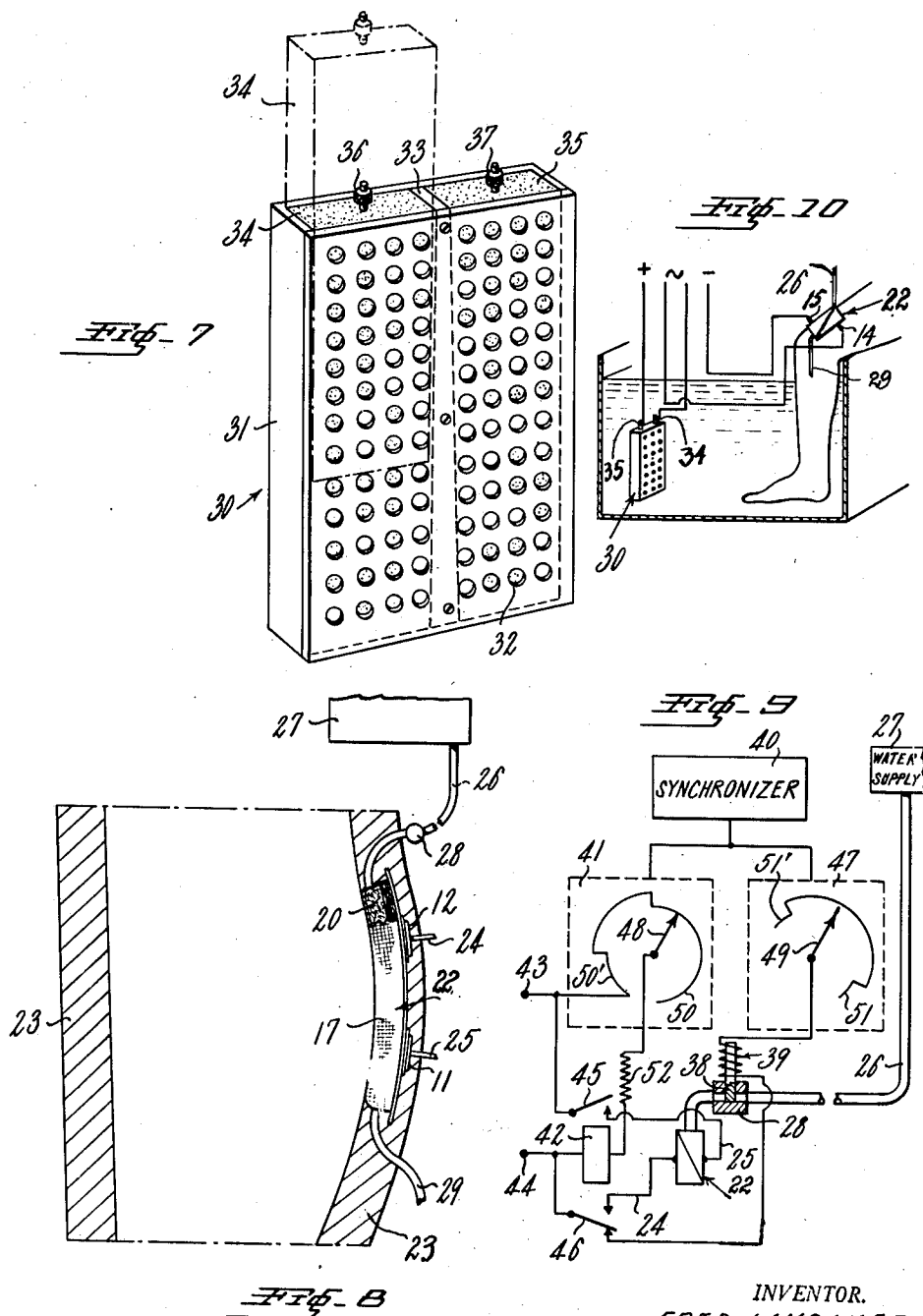
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2 SHEETS—SHEET 2



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ELECTRODE FOR ELECTROTHERAPEUTIC TREATMENTS

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5 Claims. (Cl. 128-417)

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This invention relates to electrode structures and more particularly to composite electrodes for use in connection with the electro-therapeutic treatment of human body parts.

It is one of the main objects of the invention to provide means facilitating the construction of compact, conveniently operable and efficient electrodes which may be placed for operation simultaneously in sinusoidal and direct current circuits.

It is another object of the invention to provide means affording the accommodation of a plurality of electrodes within a single or common housing which, if desired, may be readily conformed to the shape of the body part to which these electrodes are to be applied.

It is still another object of the invention to provide means ensuring the operation of the electrode structure on a body part, which is surrounded by a cast and, therefore, not accessible from the outside, the operation being performed either continuously or intermittently.

A further object of the invention resides in the provision of means offering the possibility of supplying a conductive medium as well as electric current or currents of various modes or types to electrodes within a substantially closed cast of plaster of Paris, in which the human body part which is subjected to treatments is embedded.

Yet a still further object of the invention is the provision of means for increasing the efficiency of and for obtaining versatility in the application and operation of multiple electrode structures in the hydro-electric treatment of human body parts, whether they be within a bath or not.

Still another object of the invention is to provide means for improving the conductivity of electrodes and retaining an electric current conductive medium between the electrodes and the body parts under treatment.

Still a further object of the invention resides in the provision of means permitting intermittent supply of water or other suitable liquid to the electrode or electrodes for facilitating electric current flow from or to said electrodes.

With the above and other objects in view, the invention will be hereinafter more particularly described and the combination and arrangements of parts will be shown in the accompanying drawings and pointed out in the claims which form part of the specification.

In the drawings:

Fig. 1 is a rear view, and

Fig. 2 a front view of an electrode structure

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according to the invention, parts being broken away to expose to view the interior of said electrode structure;

Fig. 3 is a cross-sectional view of the electrode structure taken on the line 3-3 of Fig. 1;

Figs. 4, 5 and 6 are views (similar to Fig. 1) of electrodes in various modified forms, respectively;

Fig. 7 is a perspective view of a further modified form of electrode embodying the invention.

Fig. 8 is a cross-sectional view of a plaster cast applied to a part of a leg of the human body and enclosing an electrode according to the invention;

Fig. 9 is a wiring diagram representing the control circuit for regulating the water and electric current supply to one of the electrode structures according to the invention.

Fig. 10 shows schematically one mode of application of the invention to which reference is made in the description.

Referring now more particularly to Fig. 3, each of the electrode units or structures of Figs. 1-6 comprises generally a carrier element or sheet 10 of insulating material, a plurality of spaced apart terminals, such as 11, 12 fixed to this sheet as by rivets 13 which pass through sheet 10, and tin or metal electrodes 14, 15 positioned opposite these terminals, respectively. An insulation strip 16 separates these electrodes from each other, which are in contact with a pad 17 as well as with said insulation strip 16. Pad 17 is secured to the carrier element 10 in any convenient manner, as by stitching 18.

Pad 17 preferably consists of an asbestos layer 19, of a further outer layer 20 of absorbent material, such as heavy felt and of a cover 21 of fabric or similar porous material. The edge 21a of the cover 21 is preferably secured to a turned-over flange portion 22a of the carrier element 10, which may be made of rubber, rubberized fabric and the like. Electrodes 14, 15 may be flexible tin foils or plates, so that the entire structure may be bendable and readily conformed to the contour of a body part to which the electrode unit may be applied.

The number and/or location of the electrodes and associated terminals in an electrode structure according to the invention may be varied as shown, by way of example, in Figs. 4, 5 and 6.

Whereas, in the embodiment of Fig. 1, electrodes 14, 15 are of triangular form and separated by an insulating strip 16 extending diagonally across pad 17, they may also be concen-

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trically arranged as in Fig. 4, in which the insulating strip element 16 is of annular configuration. The electrodes may be of rectangular configuration as seen in Fig. 5, arranged side by side, with the insulation strip 16 disposed along an orthogonal line of symmetry. Fig. 6, finally, shows the provision of two additional electrodes 14', 15', having associated therewith two additional terminals 11', 12' respectively, the insulation layer between these electrodes being of cross formation and consisting of a longitudinal part 16 and a transverse part 16'. In the latter embodiment, it will be possible, for example, to supply direct current to the electrodes 14, 15 and alternating or sinusoidal current to the electrodes 14', 15'.

The use of any of the aforesaid electrodes for the purpose of electro-therapeutic treatments is illustrated in Fig. 8. In this figure, an electrode structure 22, which may be of the type shown in Fig. 1 or Fig. 6, for example, is seen to be embedded in a plaster cast or envelope 23. The cast or envelope 23 may be assumed to surround a body part (not shown) to be subjected to electro-therapeutic treatment, e. g. the calf of a human leg, the pad portion of the structure 22 being in direct contact with the skin of the body part to be treated.

Thus, prior to the application of the cast, the structure 22 is placed upon a desired portion of the skin and, being made of flexible material throughout, is formed or bent so as to rest with substantially the entire face of pad 17 against the skin surface. Conductors 24, 25 serve to supply current to the electrodes of the structure 22 by way of terminals 11 and 12, respectively.

With the arrangement so far described, the electrodes of the structure 22 will be open-circuited when the conductors 24, 25 are connected to a source of electric power and no current will flow. According to the invention, now, the porous pad 17 is permeated by a conductive liquid (preferably water) whereby an electric circuit may be completed, this circuit including one or more portions of the body part to be treated. The structure 22 is, for this purpose, connected through an inlet rubber duct or pipe 26 to a source of liquid, such as the water supply 27, a valve 28 in the pipe 26 serving to regulate the admission of water to the structure 22 in a manner more fully described hereinafter. The pipe 26 enters the felt portion 20 of the pad 17 adjacent the upper end of the latter, while an overflow pipe or outlet duct 29 communicates with the lower end of the pad to drain off excess liquid.

It will now be possible to establish a flow of electric current through the pad 17 by simply connecting the wires 24, 25 to opposite terminals of a source of electric current (not shown).

Current will then flow between the respective electrodes associated with terminals 11 and 12 and, since a voltage difference will exist between different points on the face of pad 17 as the result of the penetration of cover 21 by the liquid, current will also flow through adjacent skin portions of the body part under treatment. Yet, it is also possible to connect only one electrode of the structure 22 to a terminal of the current source or to connect the electrodes 11 and 12 to said terminal in parallel, while completing the circuit through one or more electrodes located externally of the electrode structure 22. Thus, one may use as a counter-electrode one of the electrodes of a second structure 22 imbedded in

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a different portion of the cast 23, or in a different cast applied to the same body part; or any other portion of the body under treatment may be immersed in a bath liquid having an additional electrode inserted therein, said additional electrode being connected to a terminal of the aforementioned power source to complete the circuit.

An electrode structure suitable for immersion in a bath liquid, for the purpose just described, is shown in Fig. 7. This electrode structure 30 comprises a casing 31 of insulating material, e. g. wood, a perforated front panel 32 forming the front wall of said casing, an insulating, preferably rubber partition 33 dividing the casing into two compartments and a pair of electrodes 34 and 35 held in these compartments, respectively.

The partition 33 and if desired the electrodes 34, 35 are preferably wedge-shaped to facilitate fixation and withdrawal of the latter, as indicated in dotted lines. Electrodes 34, 35 may consist of compressed graphite and are provided with respective terminals 36, 37 for making external connections thereto.

In order to reduce to a minimum the variations in current during repeated or protracted use of a given unit 22, say, during an entire day treatment it will be necessary to maintain the resistance or the conductivity of said unit at or near a predetermined value by keeping the moisture content thereof substantially constant. According to the invention, this can be done by repeatedly wetting the pad 17 with liquid which is introduced through inlet pipe 26 and permitting overflow liquid to escape by way of the drain pipe 29, whereby the amount of liquid retained in the structure 22 will be represented by the quantity of moisture capable of being held by capillary action in the interstices and pores of the pad 17. This quantity having an essential constant value and taking into account the losses due to evaporation, galvanic dissociation and other forms of dissipation of the liquid, it will be seen that the moisture content of the pad will more nearly remain close to a predetermined value if the supply of fluid or liquid is effected at relatively short intervals. In practice, it has been found that admission of water to the pad over short periods once or twice every hour is satisfactory in most instances.

Since, however, the source of liquid, such as the water tank 27, will generally be grounded, a path will be provided for the flow of undesired currents to earth by way of pipe 26, should the supply of water to the electrode structure occur while either or both of the terminals 11, 12 are connected to potential; or if tank 27 were insulated, dangerous potentials might be built up thereon. The invention, therefore, contemplates the use of a timer circuit which causes the flow of current through the otherwise inaccessible electrode unit 22 at specified intervals and maintains the regulatable valve 28 closed except for certain time periods during which no current flows.

Such a timer or control circuit is illustrated in Fig. 9 in which the valve 28, inserted in the pipe line 26 between water supply 27 and electrode unit 22, is shown, which is made of insulating material and which is adapted to be closed by the insulating head 38 of the plunger of a solenoid 39. In this manner, the tank 27 and the unit 22 will be electrically separated when the valve 28 is closed, i. e. when the solenoid 39 is without current. A synchronizer 40 controls

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the operation of a timer 41 which effects the intermittent energization of a relay 42, the latter serving to connect the conductors 24, 25 to respective terminals 43, 44 of a source of alternating or direct current (not shown) by way of contacts and armatures 45, 46. The synchronizer 40 also controls a delay unit 47, the latter serving to energize the solenoid 39 a predetermined time after the relay 42 has been released by the timer 41, thereby admitting liquid from tank 27 to the electrode unit 22.

The timer 41 and the delay unit 47 may be of any suitable and well known construction and are shown to be equipped respectively, with arms 48, 49 which may be assumed to rotate in, say, one hour through an angle of 360 degrees. Purely by way of example, the arm 48 of timer 41 has been shown to engage its associated bank contacts 50, 50' during a 30-minute interval and again, after a pause of five minutes, during another 10-minute interval, whereas the arm 49 of delay unit 47 has been shown to engage its contacts 51, 51' during two five-minute intervals starting 20 and 50 minutes after the hour, respectively. The circuit of solenoid 39 leads, however, over the back contact of armature 46 of relay 42, thereby preventing the opening of valve 28 when this relay is energized. A resistor 52 is shown in series with the winding of relay 42, the provision of such resistor being desirable since the relay is connected in shunt with the electrode structure 22 when the armatures 45, 46 are attracted.

Analyzing the operation of the control circuit of Fig. 9, one finds that the arm 48 of timer 41 stands on its contact 50 during the first half-hour interval, thus energizing the relay 42 which connects the electrodes of unit 22 to the terminals 43, 44 of the power source. At 20 minutes after the hour, the arm 49 of delay unit 47 establishes contact with the bank element 51, yet the solenoid 39 will not be energized since its circuit is open at the back contact of relay 42.

After the first half hour, relay 42 releases and the current through unit 22 is interrupted for five minutes, whereupon the arm 48 engages bank contact 50' for a period of ten minutes. During the last quarter-hour period, the relay 42 remains de-energized. Within this latter period, however, arm 49 of delay unit 47 wipes on the contact element 51' throughout the 50-55 minutes interval and the solenoid 39 is thus energized. Valve 28 opens and water is admitted to the unit 22 from supply tank 27, the water supply being disconnected five minutes before current is again permitted to flow through the electrode structure 22. It will be apparent that, should the timer 41 be switched off, valve 28 will function every half hour to admit water to unit 22.

Although the circuit arrangement of Fig. 9 shows the terminals 43 and 44 connectable to respective electrodes of the same unit 22, it will be understood from the foregoing remarks that such need not be the case and that electrodes appertaining to a plurality of different structures may be used, including the electrode structure 30 shown in Fig. 7.

Thus, in accordance with one mode of practicing the invention, alternating current may be caused to flow in a circuit including the electrode 34 of a unit 30, immersed in a tub of suitable liquid (e. g. medicated water), as well as the electrode 14 of structure 22 imbedded in a cast 23 of plaster of Paris, while direct current may be caused to flow in a circuit including the

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electrodes 35 and 15 of the same units 30 and 22, respectively. This has been diagrammatically shown in Fig. 10.

It will be noticed that the two circuits may be controlled by contacts of the same relay, by different relays associated with the same timer, by different timers synchronized in some manner, or by any other convenient means.

It is to be understood that valve 28 for the water supply may be set to various regulated openings, if desired and that valve 28 may also be hand-operated.

Finally, it may be mentioned that both pipes or ducts 26 and 29 may be used to respectively keep those portions of the absorbent material moist which are positioned opposite the respective electrodes of any of the units disclosed in Figs. 1-6. It will be further clear from the above that two or more of the units shown and described in connection with Figs. 1-6 may be employed to establish respective electric circuits between predetermined electrodes for full as well as local electro-therapeutic treatments of the human body.

It will thus be seen that there has been provided by this invention an electrode structure of the character described in which the various objects hereinabove set forth, together with many thoroughly practical advantages, are successfully achieved.

As many possible embodiments may be made of the above invention, and as many changes might be made in the embodiments above set forth, it is to be understood that all matters hereinbefore set forth or shown in the accompanying drawings are to be interpreted as illustrative and not a limiting sense.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent, is:

1. In an electro-therapeutic treatment plant for body parts; the combination of at least one flexible electrode having terminal means, a porous layer of electrically non-conductive material in contact with said electrode, with a support of insulating material holding in position said terminal means, said electrode and said porous layer so as to establish contact of the latter with a body part to be treated, conductor means carried by said support and connected to said terminal means, and conduit means held in position by said support and in communication with said porous layer whereby an electrically conductive liquid may be admitted to the latter to establish electric connections between said electrode, said layer and said body part.

2. A treatment plant for body parts comprising, in combination, an electrode structure provided with at least one electrode, terminal means for said electrode, and a layer of porous and electrically non-conductive material in contact with said electrode, an envelope of insulating material surrounding said electrode structure so as to maintain said layer in contact with the body part to be treated, a supply conduit extending through said envelope and connecting said layer to a liquid source, valve means in said conduit for hydraulically and electrically separating said layer from said liquid source, an overflow conduit extending from said envelope and communicating with said layer, whereby water may be drained off from within said pad, circuit means connected to said electrode and adapted to establish a path for electric current through said electrode, said layer and at least a portion of

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the body part to be treated, said circuit means including conductor means extending through said envelope and connected to said terminal means; and switch means for connecting a source of electric power to said circuit means.

3. A plant according to claim 2, including an electric control circuit adapted to operate said switch means so as to connect said source of power intermittently to said circuit means, said control circuit being further adapted to operate said valve means so as to admit liquid to said layer only during intervals.

4. A self-contained electrical pad structure for therapeutic use, comprising carrier means of electrical insulating material, a plurality of electrodes arranged in coaxial relation to each other on said carrier means, a plurality of separate terminals, each terminal for a respective electrode connected to said carrier means, a porous layer of electrically non-conductive material in contact with said electrode, a layer of absorbent material adjacent said layer of electrically non-conductive material, insulating strip means shaped for placement intermediate said electrodes to maintain the latter spaced from each other and extending into said layer of ab-

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sorbent material, a porous cover affixed to said carrier means and extending over and beyond said layer of absorbent material, and means fixing said cover to said carrier means to thereby constitute a self-contained pad structure enclosing a plurality of electrodes having different polarities.

5. A pad structure according to claim 4, including a conduit for the supply of liquid connected to one end of said layer of absorbent material, and a further conduit positioned at the opposite end of said layer of absorbent material, whereby a flow of liquid may be directed through said layer of absorbent material and through it for contact with said electrodes.

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