July 16, 1946. C. K. GIERINGER 2,404,283

ELECTRODE FOR DIATHERMY TREATMENTS

Filed Jan. 17, 1942 2 Sheets-Sheet 1

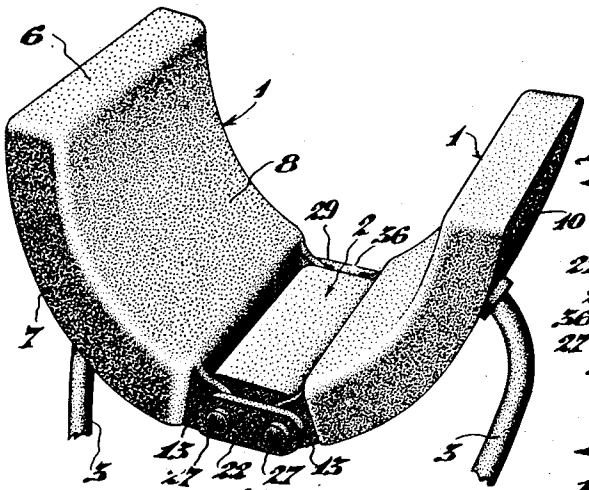

Fig. 1

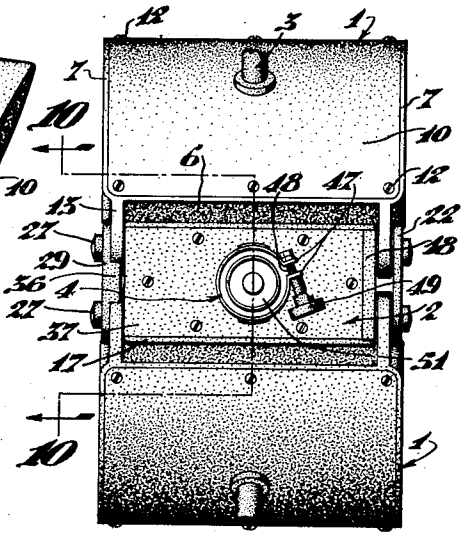

Fig. 2

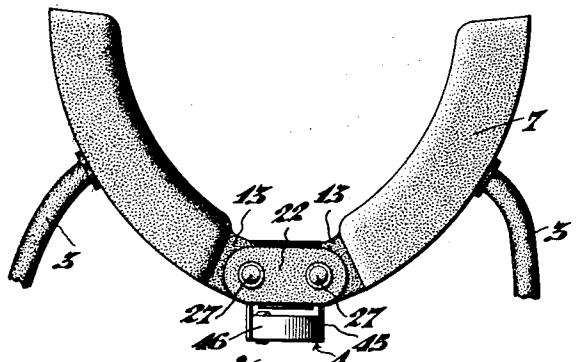

Fig. 3

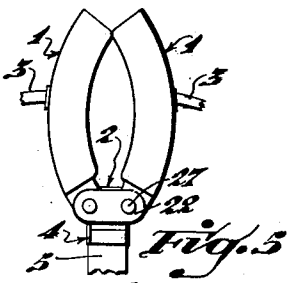

Fig. 5

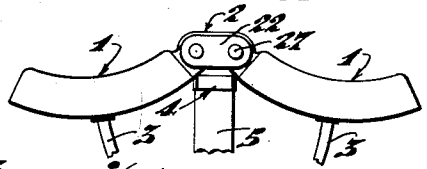

Fig. 6

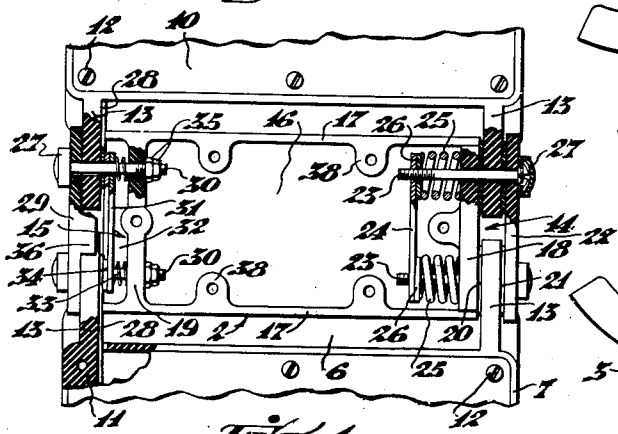

Fig. 4

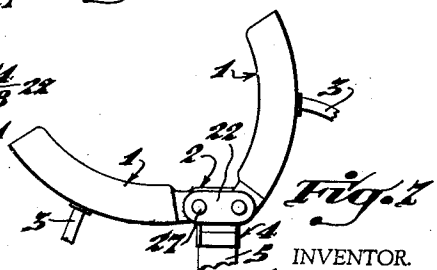

Fig. 7

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ELECTRODE FOR DIATHERMY TREATMENTS

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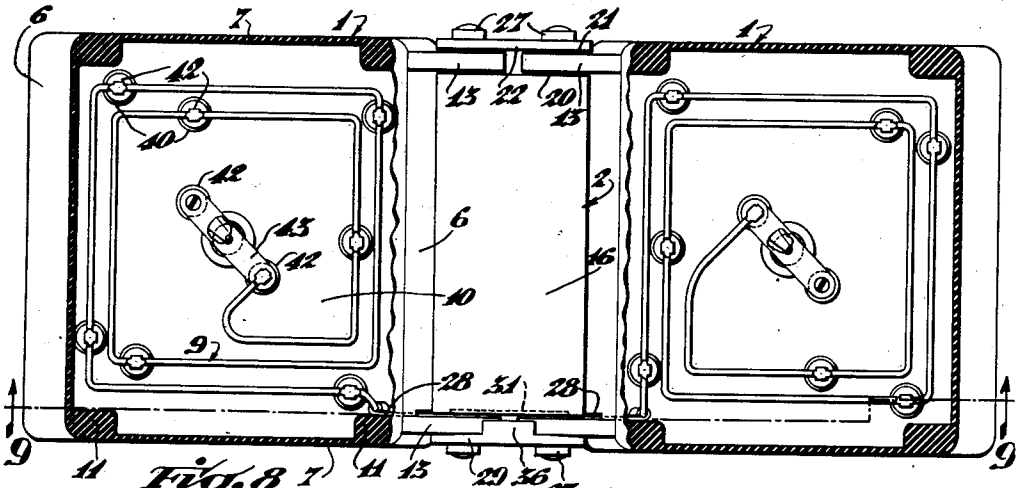

Fig. 8

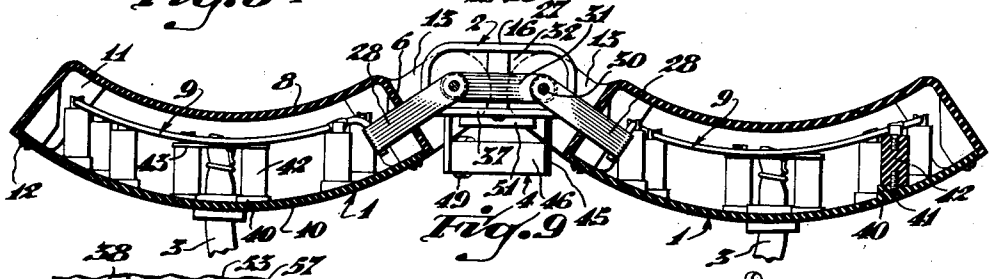

Fig. 9

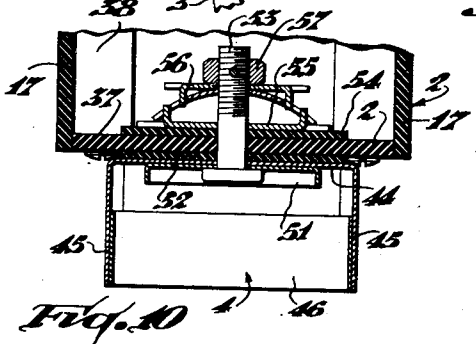

Fig. 10

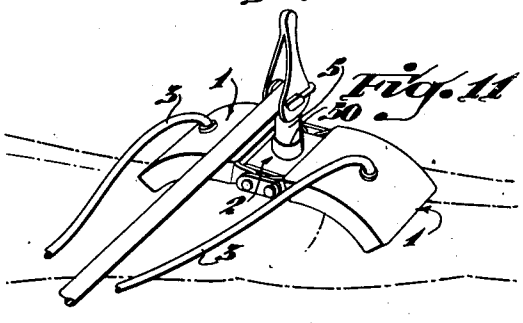

Fig. 11

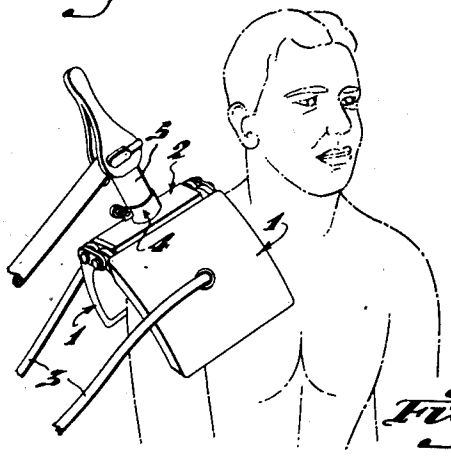

Fig. 12

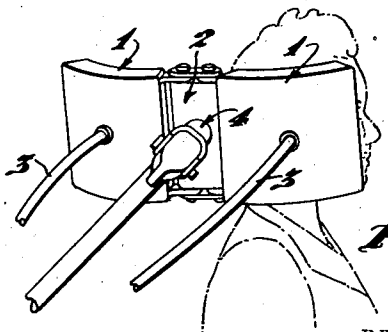

Fig. 13

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UNITED STATES PATENT OFFICE

2,404,283

ELECTRODE FOR DIATHERMY TREATMENTS

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Application January 17, 1942, Serial No. 427,101

3 Claims. (Cl. 128—413)

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This invention relates to electrodes for therapeutic machines and it is directed particularly to an electrode adapted especially to be used in diathermic treatments.

The principal object of the invention has been to provide an electrode which is capable of being adjusted to fit various body contours. In the past, diathermy electrodes have been of three general types: pads and spaced plates, between which the patient is positioned; inductance cables or cords adapted to be wrapped or draped around the body member to be treated; or inductance coils housed permanently within casings. High frequency energy applied to a patient from such latter type electrodes is transferred electromagnetically and varies in accordance with the spacing of the electrodes from the body surface and electrical characteristics of tissue treated. It is sometimes desirable to locate the electrodes as closely as possible to the surface to effect the most efficient transfer of the energy to the patient. However, it is impossible, with electrodes of any of these types, to obtain the desired positioning of the electrode relative to the patient in the treatment of body areas where the contours are irregular so that efficient transfer to patient can be made with a maximum degree of safety and convenience. Even the inductance cord, which is by far the most flexible of the three, is inadequate for some conditions since it is difficult to hold in place and most inconvenient to use.

Briefly, the present invention is directed to an electrode comprised of at least two housings which are movable with respect to one another, with each containing an electrode conductor or electrode element therein. These separate housings or leaves are so arranged as to present concavely fashioned or trough-like surfaces with the troughs or longitudinal axes of the concavities preferably extending in parallel relationship to one another. By virtue of this configuration, the leaves, upon adjustment, may be arranged so that the configurated faces thereof conform to the contour of substantially any part of the body regardless of its regularity or irregularity and such adjustment can be made easily and quickly. When widely separated, the leaves, overall, form a relatively flat surface and the electrode in such instance is useful for treating areas such as the abdomen, back, chest or sacroiliac. As the leaves are moved toward one another they form, in an intermedate position, a substantially semi-cylindrical cavity having the general contour of the thigh, hip, knee or ankle.

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When placed closely adjacent one another the leaves cooperate to define a tubular-like opening which is especially suitable for treating the wrist or ankle. The leaves also may be adjusted to unsymmetrical arrangements, thereby providing dissipating surfaces approximating the contour of the front and back portions of the shoulder or the nape of the neck.

One of the chief advantages of the present apparatus is the ease with which the doctor is enabled to arrange the electrodes relative to the patient. For example, if, say, the wrist is to be treated the leaves are simply closed over the wrist. In the treatment of the sacroiliac or dorsal regions the patient is placed in prone position and the leaves are spread to an open position and then rested upon the patient over the afflicted area. It is also to be noted that the electrode may be supported upon an adjustable arm extending from the diathermy machine in the usual manner. By rotating the electrode relative to the arm and by adjusting the arm to varying positions the electrode can be held in fixed position during the course of a treatment, while the leaves are so arranged as to provide the most efficient arrangement for treatment of the given locality. In cases where an afflicted area is very sensitive to the touch the electrode leaves may be arranged to conform closely to the contour of the area and yet be spaced slightly out of contact with it; in the past this result has been impossible to obtain except where the areas are of such regularity as to be treated satisfactorily by spaced plates. When treatments requiring less than the full electrode effect are indicated, either one of the leaves may be used independently of the other, as in applying heat to the regions adjacent the ear.

Short wave energy is dissipated from these electrodes through conductors housed within the leaves. In the preferred embodiment of the invention the conductors in each leaf are interconnected and cables, one taken to each leaf, are connected with the respective conductor terminals. These cables provide flexible connections between the electrode and the diathermy machine.

From the electrical point of view it is preferable that the electrode elements themselves contained within the housings be of the electromagnetic kind, that is, coils of wire relatively supported in the housings. However, in place of electromagnetic electrode elements, plates capable of furnishing capacitive effect may be employed if desirable. In the preferred structure

the coils contained in the leaf housing are connected in series with one another whereby both are energized simultaneously from cords leading from the diathermy machine.

Short wave energy of the type impressed across electrode conductors of the type utilized is potentially dangerous, and it is necessary that the utmost protection be provided against the leakage of current and shocking of the patient. The problem is aggravated by reason of the fact that the patient usually perspires to some degree, and the moistened surface of the tissue forms a good conductor.

To avoid these dangers it has been an object of the invention to provide a structure in which the various portions of the electrode conductor are so interconnected as to be independently movable, yet well housed and insulated against being accidentally contacted by the patient. In this regard, the present invention contemplates an arrangement in which the circuit in each electrode leaf is permanently mounted, with a commutating or flexible connector extending between the leaves to interconnect the electrode portions contained therein.

A preferred embodiment of the present apparatus is illustrated in the drawings, and from the foregoing description of the principles of the invention and the detailed description which follows, those skilled in the art readily will comprehend the various modifications to which the improvement is susceptible.

In the drawings:

Figure 1 is a perspective view of an electrode constructed in accordance with the invention.

Figure 2 is a rear elevation with the electrode shown in an open position.

Figure 3 is a side view of the electrode.

Figure 4 is a sectional view showing the pivotal mounting of the leaves of the electrode.

Figure 5 is a view showing the leaves of the electrode in closed position.

Figure 6 is a view showing the leaves in the open position.

Figure 7 is a view showing the leaves unsymmetrically arranged.

Figure 8 is a rear elevational view with the parts broken away to show the mounting of the electrode conductors in the leaf housing.

Figure 9 is a sectional view taken on the line 9—9 of Figure 8.

Figure 10 is a sectional view taken on the line 10—10 of Figure 2.

Figures 11, 12 and 13 are views diagrammatically illustrating the application of the electrode to various portions of a patient's body.

The electrode device shown in the drawing consists principally of a pair of leaves indicated generally at 1 which are pivotally mounted or hinged to a central panel indicated generally at 2, with current furnished to the electrode, as for example, from a conventional short wave diathermy machine, through the cords 3—3 which enter the leaves at the rearward portions thereof as shown in Figure 3. The cords 3 are preferably equipped with plug-in jacks (not shown) so that the electrode, as a unit, can be attached to or detached from the machine when desirable. At the rearward portion of the central panel 2 a clamp 4 is provided to fasten the electrode to a support arm 5 when a rigid mounting is desired.

The leaves 1 and the central panel 2, as well as the other parts of the apparatus, are preferably constructed of a non-conducting plastic material, as for example, Bakelite or other suitable material. Each of the leaves is a hollow box-like member constructed of side walls 6, top and bottom walls 7, and a face 8 which constitutes the portion of the electrode adapted to be placed adjacent the tissue being treated. The surface of each electrode leaf preferably is of substantial concavity in a direction parallel with the axis longitudinally through the central panel 2, with the top and bottom walls being fashioned so as to interconnect the side walls 6 and form therewith a box for containing the electrode conductors; these are indicated generally at 9 (Figures 8 and 9).

For enclosing the cavities within the electrode leaves they are provided with back wall members 10 which preferably are curved similarly to the curvature of the faces 8. At the interior corners of the cavities bosses 11 are provided, both for reenforcement of the structure and for receiving attachment screws 12 through which the back wall members 10 are fastened to the housings. It is desirable that the reenforcement portions of the casing terminate inwardly of the end and top and bottom walls to permit the back cover to be recessed in the housing in flush relationship with the rearward edges of the walls thereof.

Hinge members 13 extend outwardly from the side walls 6 of the housings to provide for pivotal connection of the housings to the central panel 2. Each housing is preferably equipped with two of these projections, one adjacent the top and one adjacent the bottom so that the central panel may be received therebetween.

The central panel 2 is preferably a box-like unit provided with the main pivot means for the leaves at one end thereof, as indicated at 14 in Figure 4 and supplemental pivot means located at the other end thereof as indicated at 15. The electrical interconnection between the conductors in the leaves preferably is located at the end of the panel opposite the main pivots for the leaves and constitutes part of the supplemental pivot means. In the preferred structure the panel 2 consists of a face 16, side walls 17—17, an end wall 18 at one end, and a bridge wall 19 at the other, interconnecting the side walls 17 and spaced inwardly from the ends thereof.

At the main pivot connection 14 the projections or wings 13 extend toward one another from the corresponding side walls of the leaves and part way across the end wall 18 of the central panel 2. Friction washers 20 are disposed between the end of the panel and the inner face of each projecting wing member.

On the other side of each projecting wing 13 similar washers 21 are provided, and a strap 22 extends across these washers. Pivot screws 23—23 pass through bores in the strap 22, the projecting wings 13 and the end wall 18 of the central panel. These screws are threaded into a compression plate 24 located in the interior cavity of the central panel. Compression springs 25 are interposed respectively between the end wall 18 of the central panel and washers 26 and these are thus pressed against the compression plate 24. The compression springs cause the inner face of the strap 22 and the outer face of the end wall 18 to be pressed against the washers at the opposite faces of the projecting member 13 to provide a frictional bearing of the surfaces against one another. It will be seen that by adjustment of the screws 23 the ease with which the leaves of the electrode are separated may be readily adjusted, so that the electrodes

remain in any position to which they may be set by the operator.

Insulating caps 27 are mounted over the exposed heads of the screws 23. The caps preferably are so constructed that they fit over the heads of the screws and snap into place on a spring washer provided under each screw head; they may be pried loose for disassembly of the apparatus.

At the other end of the central panel the ends of the side walls 17 thereof are spaced slightly from the inner faces of the projecting hinge wings 13, and conductor members 28 respectively pass through these clearance spaces along the inner faces of the members 13. These members emerge from the cavities of the electrode leaves wherein they are connected with the conductors thereof as described at a later point in the specification. Insulator strap 29 extends across the projecting members 13 at the outer faces thereof and bolts 30 constituting the hinge pins at this end of the apparatus, pass through bores appropriately arranged in the strap 29, the hinge members 13, the conductor members 28 adjacent thereto, and through the bridge wall 19 of the central panel.

An electrical connector 31, having its opposite ends respectively journalled on the pivot bolts 30, electrically bridges the connector members 28. This interconnecting member is housed in the cavity 32 intermediate the end of the central panel and bridge wall 19. Compression spring members 33, which surround the pivot bolts 30, are interposed between the cross wall 19 and the connector piece 31 to press the connector piece 31 toward the conductor members 28. Washers 34, made of conducting material, are located between the connector members 28 and the interconnector 31. The bolts 30 are provided with nuts 35 at the inner face of the bridge wall 19 and the heads exposed at the strap 29 are provided with insulating caps 27, as previously described.

In the preferred structure the ends of the projecting wings 13 are of rounded configuration so as not to obstruct one another during pivotal movement of the leaves, and at the end of the central panel to which the electrical interconnection 15 is arranged, the insulator strap 29 is provided with a protrusion 36 on its inner surface, configurated to fit within the nip constituted by the rounded edges of the projecting members 13, so as to obstruct this passageway and prevent accidental contact from being made with the connector 31.

A cover plate 37 fits over the back portion of the central panel and over the cavity portion 32. The cover plate is fastened by means of screws engaging tapped holes provided in the bosses 38.

The arrangement and mounting of the electrodes in the cavities of the hinged leaves is shown best in Figures 8 and 9. Cords 3 enter the back walls 11 of the housings at the central portions thereof. Within each cavity each electrode conductor therefor has its one end fastened electrically to the cord. From this point each conductor passes spirally, though preferably in a somewhat rectangular arrangement, to its conducting member 28.

In the preferred structure the back wall member 11 of each housing is provided with bosses 40 having threaded studs 41 projecting therefrom. Insulator posts 42 are threaded onto the studs and project forwardly from the inner face of the back wall member. At the top of each post a connection is provided; this unit preferably is a split or forked projection having arms arranged to straddle the electrode conductor and so that the

conductor can be fastened in place as, for example, by soldering. Posts 42 provide firm support for the flat spiral-like coiled arrangement in which the electrode is wound. It is desirable to arrange the coils 9 within the housings in such manner that they are spaced slightly from the dissipating faces T thereof; the intervening layer of air acts as an insulator to prevent sparking even when the drums are in contact with moist or wet tissue.

The two posts 42 are arranged at opposite sides of the opening in the back wall 11 through which the cord 3 passes and a metallic strap 43 is rigidly fastened across these members. This strap is provided with a central aperture and the bared end of the conductor within the cable 3 is inserted through the opening, bent over and soldered to the strap, while the electrode conductor 9 is fastened to a split lock extending from one of the posts. It is also desirable, as shown particularly in Figure 9, to fasten a relatively stiff wire member to the connecting strap 43 and wrap the depending end of this wire around the insulation of the cable 3 so as to prevent the cable from becoming detached. In this manner the insulation of the cable is held securely to the housing and the electrode conductor therein is relieved of the mechanical strains to which the cable is subjected during normal usage thereof. Each of the other ends of the electrode conductors is bent downwardly respectively to engage the connector members 28 and the connection between the two is made by wrapping the connector strap 28 around the electrode wire and soldering the two together.

In the preferred structure the flat coil arrangement into which each electrode is wound, is curved convexly in order that it be spaced evenly from the dissipating face of each electrode leaf over its entire surface. This provides a uniform field of distribution of diathermic energy. It is desirable to wind the coils in the housings in such directions that the fields produced by them are additive. The arrows shown along the coil windings in Figure 8 illustrate the preferred arrangement. It will be seen that current in the coil windings at the right hand side of the right hand coil is moving in the same direction as current in the left hand side of the coil in the left hand housing. These currents therefore cooperate with one another to produce a field of very high intensity when the leaves are facing or partially facing one another, as when the leaves are in a closed position as shown in Figure 5. This field of high intensity is particularly useful in treating body extremities such as the hands or wrists which heretofore have been always very difficult to treat because of the relatively small mass that they offer.

When the leaves are in the open position there is relatively little coupling between the coils in the respective leaves and the field of each is not appreciably affected by the field of the other. Thus, considering the field produced by each coil independently of the other as unity, it will be seen that when the leaves are arranged in the wide open position the total field has a relative value of approximately 2, while the total field approaches 4 when the leaves face one another and the windings are arranged for mutual cooperation. The high intensity field produced by this arrangement permits sufficient treatment to be given to small body areas; in the treatment of the larger body areas, such as the chest or abdomen, the coupling between the patient and

the electrode is such that the field need not be of such high intensity.

From the electrical connections which have been described it will be seen that a circuit through the complete electrode is constituted through the cord 3 entering one leaf, through the electrode contained in that leaf, through the commutating connector member 28 emerging from that leaf to the interconnecting strap 31, thence through the other connector member 26 entering the other leaf, through the electrode contained in that leaf and out the cord 3.

The entrance of the cords through the back of the electrode leaves is desirable for several reasons. The cords do not interfere with the positioning of the electrode upon the body and in this position attachment of the electrodes in the leaves to the cords is easily effected. However, in place of the structure shown, it is to be observed that the cords may be connected to the electrodes at other points, as for example, through the top or bottom or outer side walls, and also that the circuits in the leaves may be independent of one another.

In many diathermy treatments it is desirable to position the electrodes stationarily with respect to the patient, as when contact of the electrode with the patient is to be avoided. For this purpose the diathermy machines may be equipped with suitable adjustable support arms. To fasten the electrodes of the present invention to such support members a clamp ring is provided at the back part of the central panel 2, as indicated at 4. This unit is comprised of a base piece 44 having a pair of upstanding arms 45—45. A split ring 46 is carried by these arms and it is equipped with outwardly extending tangs 47—47 oppositely arranged. A bolt 48 passes through these tangs and threadedly carries a lock nut 49. By adjustment of the lock nut the diameter of the split ring can be varied so that when the ring is inserted over the end of the support arm, as indicated at 50 in Figure 11, the lock nut can be tightened to clamp the ring to the support arm.

A washer 51 rests on the inner face of the base piece 44 of the attachment device which in turn rests on a washer 52 positioned between it and the back of the central panel 2. A bolt 53 passes through the cup 51, the base piece 44 and washer 52 and through a bore in the back plate of the panel 2 to rotatively journal the clamping unit to the panel. At the inner face of the back plate friction means is provided for controlling the rotation of the clamp piece with respect to the panel. Bolt 53 passes through a washer 54 at the inner face of the back plate and also through a pair of interlocking washers 55 and 56 which are separated by a cup spring. The cup spring has slots cut in its periphery and tangs are struck from

the washers arranged at opposite sides of it so as to fit within the slots, thereby holding the spring in non-rotatable relationship with the washers. A nut 57 which preferably is welded to the washer 56 is threaded on the inner end of the bolt 53, with the nut being tightened until the desired friction is attained and then being pinned to the bolt. As will be seen, the cup-compressed spring draws all of the parts together to provide the desired friction.

Figures 5, 6 and 7 show various positions to which the leaves of the electrode may be moved and Figures 11, 12 and 13 show practical applications of the apparatus. The types of treatment shown in these latter illustrations, especially Figure 12, are difficult, if not impossible, to conduct satisfactorily with electrodes of the type heretofore available, whereas such treatments are conducted easily and efficiently with the present apparatus.

Having described my invention, I claim:

1. An electrode for therapeutic treatments comprising housing members having cavities therein and being hinged together and being constructed of insulating material, portions of an inductive electrode contained respectively in each leaf in the form of coils, and an electrical interconnection between the respective electrode portions contained within said housings, whereby the respective electrode portions are connected in series with one another.

2. An electrode for therapeutic treatments comprising housing members having cavities therein and being hinged together, respective portions of an inductive electrode coiled and housed in each housing member, and an electrical interconnection between the respective electrode portions contained within said housings, each housing having an electrode face which is curved convexly, and with the coiled conductor portions in said housings being configurated to conform to the curved faces thereof.

3. Apparatus adapted to be used in diathermic treatments comprising a pair of insulating housings, at least one of which presents a trough-shaped face, inductive electrode conductor means contained in the form of coils within said housings for dissipating diathermic energy therefrom, means for applying diathermic current to said conductor means, the housings being pivotally interconnected with one another on a pivotal axis parallel with the trough-shaped concavity in the said one of said housings, and the coiled conductor which is contained in the housings having the trough shaped face being configurated to conform substantially to the curvature of said face.

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