This invention relates to apparatus for the application of electric current, particularly of the so-called diathermy type.

One object of the invention is to provide novel and superior apparatus for the application of diathermy current.

Another object of the invention is to provide a novel and highly efficient plate electrode particularly adapted for use in the application of diathermy current which is durable, practical and highly efficient in operation and with which objectionable sparking may be reduced to a minimum.

With these objects in view and such others as may hereinafter appear, the invention consists in the apparatus and in the structures, arrangements and combinations of parts hereinafter described and claimed.

In the drawing illustrating the preferred embodiment of the invention, Figure 1 is a side elevation illustrating the use of apparatus embodying the present invention; Fig. 2 is a vertical section on line 2–2 of Fig. 1 viewed in the direction of the arrows; Fig. 3 is a detail in side elevation illustrating the present apparatus with electrodes of different size for securing localized effects of different intensities; and Fig. 4 is a vertical sectional detail illustrating the preferred manner of mounting an electrode.

Attempts have heretofore been made to devise apparatus for use in the application of diathermy current, but as far as I am aware such attempts have not proved satisfactory in practice. The use of such current possesses therapeutic value in assisting the process of bone knitting, as in the case of fractures, in assisting blood circulation, and in other known respects. The current has been caused to pass through the portion of the body to be treated, from electrodes composed of block tin or composition foil and in some instances of metallic mesh used over rubber sponges, and in practice the electrodes are applied in direct contact with the tissue upon opposite sides of the portion of the body through which the current is to pass. Both types of electrodes possess a tendency to oxidize and the oxide thus formed prevents a uniform distribution of the current density with the result that undesirable sparking takes place. This sparking has resulted in uncomfortable sensations to the patient and in some instances has caused burns. The block tin or composition foil electrodes after a certain period of use become rough over their surface and the uneven distribution of suitable density, which necessarily follows causes sparking. This fact, together with the tendency of the metal to oxidize, renders the use of these forms of electrodes unsatisfactory in practice. The mesh type of electrode tends to corrode between the individual mesh units, causing sparking between the same. In addition these mesh electrodes are not as sanitary as might be desired and may be only properly sterilized with difficulty.

In accordance with the present invention, the apparatus for applying diathermy current is provided with an electrode and preferably two electrodes of such design and whose contacting surface is of such composition as to eliminate the objectionable sparking above referred to. Provision is also preferably made for removably mounting the electrodes upon electrode supporting members to the end that the electrodes may be easily sterilized and cleaned, and also in order that electrodes of different size may be used in order to produce localized diathermic effects of varying intensities. The preferred form of electrode contemplates a contacting surface of cup shape which functions when the electrode is firmly pressed against the tissue, to produce a vacuum effect holding the tissue in firm contact with the electrode.

Referring now to the drawing, the apparatus illustrated therein comprises two electrode supporting members 10, 12 preferably of insulating material such as wood, and 90 which are provided with notatable slots 13, 14 for the reception of a cross support 15 upon which the electrode supporting members 10, 12 are slidably mounted to constitute a unit. The electrode supporting members 10, 12 at their upper ends are arranged to support plate electrodes 20, 21 in operative position for engagement with the opposite surfaces of the portion of the body to be treated, and for purposes of illustration in...
Fig. 1 the electrodes 20, 21 are illustrated as engaging the opposite sides of a knee. Provision is made for operatively connecting the electrodes with lead wires 22, 24 leading from the usual high frequency machine (not shown), and the lead wires 22, 24 are preferably pressed through guide holes in the electrode supporting members 10, 19 whereby the wires are maintained in a position out of contact with the patient. As illustrated in Fig. 1 and in detail in Fig. 4, each one of the electrodes 20, 21 is operatively supported upon its electrode supporting member by means of a bolt 25 extended through a hole in the electrode supporting member and having a shoulder 26 which engages one surface thereof and upon whose threaded end the usual form of terminal post 28 is screwed to rigidly hold the bolt in operative position. The terminal post 28 is provided with the usual hole 29 for the reception of the end of the lead wire and a firm connection is made by means of the thumb screw 30. The bolt 25 is provided with a spring socket 32 for the reception of a ball 34 formed integrally upon the rear face of the electrode to thereby permit the electrode to be readily removed or installed in operative position. The ball and socket connection between the electrode and its supporting member enables the electrode to adapt itself to different positions during the use of the apparatus as will be described.

In order to avoid objectionable sparking, each plate electrode 20, 21 is preferably formed in the shape illustrated in Fig. 4 and with a contacting surface of such composition as to reduce the insulating effect of oxidation to a minimum. In practice I prefer to form the electrode of brass with the contacting surface silver plated. As herein shown, the contacting plate electrode is cup shaped and the marginal portion 36 thereof is rolled back in a direction away from the contacting face, so that when such an electrode is applied to the tissue and firmly pressed against the same a partial vacuum is formed, the effect of which operates to draw the tissue into close and firm contact with the surface of the electrode forming an ideal contact. The fact that the edge of the electrode is rolled back out of contact with the tissue serves to prevent any concentration of current at the edge and consequently enables a uniform distribution of current density to be had over the contacting surface of the electrode with the result that a minimum tendency toward sparking exists.

In the use of the apparatus, the ball and socket connection between the electrode and the supporting member enables the electrodes to adapt themselves to different and irregular angles of the body and facilitates obtaining proper contact between the electrode and the tissue. The fact that the electrodes may be readily removed not only facilitates the cleaning and sterilization of the electrodes but also enables electrodes of different sizes to be utilized, depending upon the portion of the body to be treated. In this connection it is possible by utilizing electrodes of different sizes, as illustrated in Fig. 3, to secure varying intensities of localized diathermic effect. By using an electrode of relatively large area on one side and an electrode of relatively small area on the other side, it is possible to produce a concentrated effect near the smaller electrode.

By the use of the present apparatus, the current produced from many machines now in use and considered impractical due to the uncomfortable sparking may be used, and in the use of the apparatus bandages and other instrumentalties which have heretofore been used for obtaining effective contact will be found to be unnecessary.

It is well-known that some metals when they become oxidized have the property of insulating or interfering with an electric circuit, while there are some oxides while not being exactly an insulator interfere with the passage of the current in one direction, having a rectifying effect, such as the oxide of copper. Inasmuch as the device herein described is used primarily with currents of high frequency, it is quite important that the contacting surface of the electrodes be of such substance that the oxide will not rectify or insulate the current. If rectification is produced, it interferes with the true heating effects in the body that the high frequency current is intended to give, and if the electrodes partially insulate, some of the lower potential oscillations of the high frequency current will not pass through directly as they are generated from the machine, and an accumulated charge will be built up in the plate electrodes, acting as condensers, and occasionally a discharge of this current will take place giving a very erratic and uncomfortable effect from the high frequency current, even though the generator of the same is working satisfactorily.

While it is preferred to embody the different features of the present invention in apparatus of the form illustrated herein, nevertheless it is to be understood that they may be embodied in other forms within the scope of the following claims.

Having thus described the invention, what is claimed is—

1. An apparatus for the application of diathermy current comprising two electrodes supporting members, and an electrode mounted upon each supporting member and consisting of a metallic plate provided with a concave contacting face and a surrounding rim portion curved back from said face to form a convex rim extending entirely around said concave contacting face.
2. In an apparatus for the application of diathermy current, an electrode supporting member and an electrode mounted thereon comprising a metallic member having its contacting face concave and its entire edge rolled back to form an annular convex edge portion and provided with a metallic surface of a character such that upon oxidation no insulating effect is produced whereby substantially uniform current density over the contacting surface is insured.

3. In an apparatus for the application of diathermy current, an electrode supporting member, and an electrode mounted therein comprising a conducting plate provided with a shallow spherically concave face and with the edge portions thereof surrounding said concavity, rolled back to form an annular convex edge portion to thereby prevent sparking at the edge.

4. As a new article of manufacture, a plate electrode for use in the application of diathermy current comprising a circular disk of contacting material having its contacting face slightly concave and having its entire edge portion rolled back to form a convex annular edge portion whereby substantially uniform distribution of current density is obtained over the entire contacting surface.

5. As a new article of manufacture, a plate electrode for use in the application of diathermy current comprising a circular metal disk provided with a shallow concave contacting face and with an annular convex edge portion surrounding said concave contacting face, and having the contacting face silver plated.

6. The combination with an electrode supporting arm, of a plate electrode, and means for removably supporting the plate electrode upon said arm including a bolt extended through the arm, a thermal post screwed upon the end of the bolt, a socket member upon one end of the bolt, and a ball attached to the electrode and received within the socket member.

7. The combination with an electrode supporting arm, of a plate electrode, and means for supporting the electrode upon the arm including a bolt extended through the arm, a terminal post screwed upon the end of the bolt, and a ball and socket connection between the second end of the bolt and the electrode.

8. As a new article of manufacture, a plate electrode for use in the application of diathermy current comprising a plate of contacting material having its contacting face slightly concave and having its entire edge portion convex and rolled back whereby substantially uniform distribution of current density is obtained over the entire contacting surface.

In testimony whereof I have signed my name to this specification.

CHARLES E. CAMPBELL.