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A PORTABLE DIATHERMY APPARATUS

The present invention is directed to a portable battery powered high frequency electromagnetic therapy applicator adapted in use to be attached to the skin of a patient e.g. for promoting hematogenous effects to the living tissue, and a charger unit therefor.

According to the present invention there is provided a portable diathermy apparatus as set out in claim 1. Preferred and optional features are set out in the remaining claims.

In a preferred embodiment the electrodes are provided on the bottom of the applicator casing and the terminals are provided on the bottom of the recess in the charger unit. The electrodes comprise a center electrode concentric with the center of the applicator casing and an outside electrode extending circumferentially about the center electrode. The applicator is round-shaped to have no particular orientation. For assuring constant contact of the respective electrodes with the terminals without paying undue attention to the orientation of the applicator when setting the applicator in the recess of the charger unit, unique arrangements are made to the terminals in the recess and the electrodes of the applicator. The terminals comprise a center terminal on the center of the recess bottom and a pair of

outside terminals which are spaced at the same distance from the center terminal and are aligned therewith. The outside electrode extends circumferentially at an angular range of more than 5 180° about the center electrode so that at least one of the outside terminals can always come into contact with the outside electrode irrespective of the angular orientation at which the applicator is set into the recess.

10 Accordingly, in this embodiment the therapy applicator can be set into the charger unit for the recharging purpose without requiring a special attention as to the angular orientation of the applicator.

15 The outside electrode is preferably in the form of an open loop so that the electromagnetic field will not induce an eddy current loss in the outside electrode although the outside electrode is in closely adjacent relation to the antenna.

20 Preferably the charger unit has at the periphery of the recess a latch member which is movable between a position of projecting into the recess and a position of retracting therefrom. The latch member is spring biased to the projected position at which the 25 applicator has its peripheral edge engaged into a

groove formed in the latch member so as to retain the applicator within the recess. Upwardly of the groove the latch member is formed with a downwardly inclined taper edge for abutment against the peripheral edge of the applicator being inserted in the recess. By this abutment, the latch member is pushed back to the retracted position of allowing the peripheral edge to ride over the taper edge for engagement into the groove. Thus, the applicator can be easily guided into the recess and retained therein for prevention of accidental removal of the applicator. An eject button is also provided at the periphery of the recess and is made vertically movable. The edge of the eject button extends arcuately and fits in a notched portion of the peripheral wall of the recess to be in direct engageable relation to the peripheral edge of the applicator such that when the eject button is depressed the arcuate edge of the eject button passes over the peripheral edge of the applicator into engagement with the bottom surface thereof. Upon being released, the eject button returns upwardly by a bias force to lift the applicator on the upwardly returning edge thereof, making it ready to remove the applicator from the recess by the fingers of the user.

In the preferred embodiment a control circuit of

the applicator is operative to cease producing the electromagnetic field upon detection of the presence of an external voltage supplied from the charger unit or detection of the voltage level of the rechargeable battery dropping to a predetermined level. Also the control circuit is operative to stop recharging either when a full charged condition is reached or when the recharging is made for over a predetermined time.

Battery powered high frequency electromagnetic therapy applicators are known as disclosed in U.S. Patent No. 4,471,787. The applicator of this patent comprises a substrate mounting thereon a battery, a circuit for producing a high frequency electromagnetic field, and an antenna directing the electromagnetic field. The substrate is made resilient so that it is capable of conforming to the shape of the skin of a patient. However, the resiliency of the substrate brings about a drawback that the antenna mounted on the substrate is subject to a considerable stress as it is resiliently deformed during the repeated operations of attaching and detaching the applicator. Thus, the applicator of this patent is not expected to have an extended operating life.

In view of the above drawback, the applicator is preferably formed so that the battery as well as electronic components forming the oscillator are

mounted on a substrate which is rigid enough free from substantial warping which would otherwise occur each time the applicator is detached from the skin of the user. This prevents the antenna on the substrate from suffering from repeated stress and therefore prevent it from breaking.

In this way the antenna is more likely to be kept intact during the repeated operations of detaching the applicator to thereby enhance reliability and extend an operating life.

The antenna is preferably disposed on the undersurface of the substrate, while the battery is located centrally on the uppersurface of the substrate. The electronic components forming the oscillator are arranged on the uppersurface of the substrate around the battery for effective utilization of the space within the applicator. The antenna is preferably provided in the form of a spirally wound coil to have an elongated overall length within a limited space for obtaining an increased output energy at a minimum power consumption, which is most suitable for the battery powered applicator.

The applicator casing is composed of a bottom plate and a cover which are bonded at their peripheries with the periphery of the substrate clamped therebetween. The clamped portion is

hermetically sealed to prevent the entry of fluid or vapor for keeping the applicator sanitary, which is therefore a further object of the present invention.

5 Formed in the outer surface of the bottom plate are a plurality of ventilation channels which face the skin of the user and permit the perspiration induced at the skin to escape outwardly therethrough from the undersurface of the applicator, ensuring a continued use of the applicator on the skin without accumulating
10 the droplets of the perspiration.

This tends to make the presence of the applicator on the skin of a patient more comfortable.

Features of the applicator are claimed in application 9104258.0 (2240720), which has been
15 divided from the present application

FIG. 1 is a perspective view of a high frequency therapy applicator of an embodiment of the present invention;

20 FIG. 2 is a vertical section of the therapy applicator;

FIG. 3 is a bottom view of the therapy applicator;

FIG. 4 is a top view of the therapy applicator with its cover removed;

25 FIG. 5 is a bottom view of the therapy applicator with its bottom sealing sheet removed;

FIG. 6 is a bottom view of the sealing sheet;

FIG. 7 is a cross section taken along line 7-7 of
FIG. 6;

FIG. 8 is a waveform chart of high frequency
5 pulses produced at the applicator;

FIG. 9 is a perspective view of a charger unit
for recharging the therapy applicator;

FIG. 10 is a top view of the charger unit;

FIG. 11 is a cross section taken along line 11-11
10 of FIG. 10;

FIG. 12 is a cross section taken along line 12-12
of FIG. 10;

FIG. 13 is a sectional view similar to FIG. 12
but with the applicator shown in the set position in
15 the charger unit;

FIGS. 14 and 15 are sectional views illustrating
the removal of the applicator from the charger unit;

FIG. 16 is a block circuit diagram of the
applicator and the charger unit;

20 FIG. 17 is a flow chart illustrating the
operation of the applicator and the charger unit.

Referring to FIGS. 1 and 2, there is shown a portable battery powered electromagnetic therapy applicator 1 in accordance with a first preferred embodiment of the present invention, which operates to apply a high frequency electromagnetic field to living tissue for promoting hematogenous effects. The applicator 1, which is configured into a generally flat disk with a rounded top having a diameter of approximately 30 mm, is adapted in use to be attached by means of a disposable adhesive pad 60 to a desired area of the patient. As shown in FIG. 2, the applicator comprises a bottom plate 10 and a top cover 20 fitted thereon to encapsulate therebetween a rechargeable battery 5 and a substrate 30 carrying thereon an antenna 40 for transmitting the high frequency electromagnetic field. The substrate 30 is provided as a printed board with a print pattern on either side. One printed pattern 31 on the upper surface of the substrate 30 provides the interconnections for electronic components such as an IC chip 32 which are mounted to form an oscillating circuit for producing the high frequency magnetic field to be transmitted through the antenna 40. The other printed pattern on the undersurface of the substrate 30 constitutes the antenna 40 of a dense coiled configuration on the peripheral area thereof, as seen in FIG. 5. The substrate 30 or the printed board is made from a glassfibre reinforced

plastic material to be rigid enough to resist deformation, whereby protecting the antenna 40 mounted thereon from suffering from such deformation or stress which might lead to the breakage of the antenna 40. The antenna 40 is connected at respective terminals 41 and 42 to the oscillator circuit on the upper surface of the substrate 30. Also printed on the undersurface of the substrate 30 are a center electrode 34 and an arcuately shaped outside electrode 35 extending over an angular range of 180° about the center terminal 34, or at approximately 270° angular range. These electrodes 34 and 35 are connected through corresponding lugs 36 and 37 on the substrate 30 to the opposite poles of the rechargeable battery 5 for effecting the recharging by an external charger unit 70, the detail of which will be explained hereinafter.

The bottom plate 10 receiving thereon the substrate 30 is provided with a center opening 11 in which the electrodes 34 and 35 on the substrate 30 are exposed. Interposed between the bottom plate 10 and the substrate 30 is an electrically insulative sealing sheet 50 which is made of a thin plastic material. The sheet 50 has on its both faces adhesive layers 51 and 52 by which the sheet 50 is secured to the complementary surfaces of the bottom plate 10 and the substrate 30 for effecting water-tight sealing therebetween. As shown in FIGS. 6 and 7, the sheet 50 is formed with a center hole 54 and an arcuate slot 55 which correspond respectively to the center electrode 34 and the outside

electrode 35 on the substrate 30 but has a less diameter and a less width than those, as seen in dotted line of FIG. 5. With this arrangement, enlarged contact faces can be provided between the edge portions the center hole 54 and the center electrode 34 and between the edge portions of the slot 55 and the arcuate electrode 35, assuring firm adhesion therebetween and preventing spurious peeling of the sheet 50 from these edge portions. The adhesive layer 51 is formed on the entire upper surface of the sheet 50 for completely clog the throughholes in the substrate 30 as well as for covering the antenna 40, maintaining the substrate 30 in sealed condition to prevent the entry of perspiration and other fluids and thus prevent the proliferation of germs in the applicator 1. As seen in FIG. 4, the battery 5 is centrally mounted on the substrate 30 to leave therearound sufficient space for mounting the electronic components forming the oscillator circuit by effectively utilizing available space.

The bottom plate 10 is formed on its upper surface with a peripheral groove 12 into which the peripheral edge of the top cover 20 engaged, as seen in FIG. 2, and is hermetically sealed to the bottom plate 10 by the known supersonic sealing technique. In addition, an O-ring 21 is received in a furrow 22 formed inward of the peripheral edge of the top cover 20 to be in sealing contact with the marginal portion of the substrate 30 for completely sealing the electronic circuits on the substrate 30. The circuit formed on the substrate

includes a light emitting diode (LED) 38 operative to produce visible light repetitively until the battery 5 drops to a predetermined voltage level, which light is visible through a window 23 formed in the top cover 20. The top cover 20 is
5 made of a transparent material and has an opaque coating on its inside surface except for a portion which defines the window 23.

The therapy applicator 1 is in use to be attached to a portion of the body to be treated by means of the removable
10 adhesive pad 60. As shown in FIGS. 1 and 2, the adhesive pad 60 is provided in the form of a ring 61 with an adhesive layer on either face thereof, one adhesive layer 62 for adhesion to the under surface of the bottom plate 10 and the opposite adhesive layer 63 for adhesion to the skin S of the patient.
15 The ring 61 or the core material of the adhesive pad 60 is made from a flexible and air permeable material such as foamed polyurethane and is shaped to coincide its center aperture 64 with the center opening 11 of the bottom plate 10. Each of the adhesive layers 62 and 63 is formed to have a plurality of
20 uniformly disposed tiny air vents 65 which allow the ventilation of perspiration induced on the treated surface of the skin. In this connection, the bottom plate 10 is formed in its outer surface with a plurality of radial channels 13 each of which, as best shown in FIG. 3, runs the full radial
25 distance from the circumference of the center opening 11 to the outer peripheral edge of the bottom plate 10. Thus, the

perspiration or vapor on the skin surface can be allowed to be directed into radial channels 13 either through the adhesive pad 60 or through the center opening 11 and is successfully ventilated outwardly through the channels 13. Further the perspiration or vapor can be routed through the adhesive pad 60 itself into the air. These escape flows are indicated by arrows in FIG. 2. The above ventilation arrangement enables the continued use of the applicator without accumulating the droplets of perspiration and therefore without causing rashes on skin. Further with the provision of the radial channels 13, the adhesive pad 60 can be easily peeled off from the bottom plate 10 by piercing the nail of the user into the outer end of the channel 13, enhancing the convenience of replacing the adhesive pad 60.

Referring to FIGS. 9 and 10, the charger unit 70 for recharging the therapy applicator 1 is shown to comprise a flat rectangular casing 71 with a circular recess 72 for detachably receiving the applicator 1. The charger casing 71 is held on a foldable covering 80 with its one end inserted in a holder loop 82 on one flap 81 of the covering 80 and with the other end secured on the same flap 81 by means of a snap closure (not seen). The other flap 83 includes a pocket 84 for a retainer sheet 85 carrying thereon a number of fresh adhesive pads 60 to be attached to the applicator 1.

The charger casing 71 accommodates dry batteries 73 as a power source for recharging the battery 5 in the applicator 1.

Projected on the bottom of the recess 72 are a series of three terminal pins 74 and 75 for electrical contact with the center electrode 34 and the outside electrode 35 on the bottom of the applicator 1 received in the recess 72. These terminal pins
5 74 and 75 are equally spaced and aligned horizontally with one terminal pin 74 located at the center of the recess 72. The center terminal pin 74 is connected within the casing 71 to one end of the power source while the other two terminal pins 75 are together connected to the other end of the power
10 source. It should be noted at this time that since the arcuate electrode 35 extends over a angular range of 180° about the center electrode 34, as described with reference to FIG. 5, at least one of the terminal pins 75 can be kept in electrical contact with the arcuate electrode 35 irrespective
15 of the angular orientation of the applicator 1 received in the recess 72, ensuring the constant electrical connection between the applicator 1 and the charger unit 70. In this connection, the arcuate electrode 35 is advantageous in preventing eddy current loss which would be otherwise developed under the
20 effect of the high frequency field from the antenna 40 if the terminal 35 were formed in the form of a closed loop conductive elements. The terminal pins 74 and 75 are spring biased upwardly into the projected position on the bottom of the recess 72 where they are in positive contact engagement
25 with the corresponding electrodes on the bottom of the applicator 1 for the recharging purpose.

The recess 72 is formed in its circular peripheral wall 76 with diametrically opposed first and second arcuate notches 77 and 78, the second notches 78 having a greater circumferential length than the first notch 77. The first notch 77 receives
5 an arcuate latch 91 formed at the center of a resilient strip 90 which is supported at its longitudinal ends 92 and 93 within the casing 71. The latch 91 is biased by the resiliency of the strip 90 to project slightly into the recess 72, as shown in FIGS. 10 and 12, and is formed with a first
10 groove 94 which is open to the recess 72 and receives therein the peripheral edge of the applicator 1, as shown in FIG. 13. The second notch 78 is open to an indent 79 which is formed in the upper wall of the casing 71 and receives therein an eject button 100. The eject button 100 is shaped to have an arcuate
15 inner wall which is positioned in the second arcuate notch 78 to complete the peripheral wall of the recess 72 in cooperation with the latch 91. Projecting inwardly from the upper end of the arcuate wall is a jaw 102 which defines therebelow a second groove 104 for retaining therein the
20 peripheral edge of the applicator 1 at the portion diametrically opposed to the latch 91, as shown in FIG. 13. The eject button 100 is mounted with its downwardly extending stem 105 into a hollow stud 108 in the casing 71 to be vertically movable therealong and is biased upwardly by a
25 spring 106 to an upward position of retaining the peripheral edge of the applicator 1 in the second groove 104.

When the applicator 1 needs to be recharged, it can be easily set into the recess 72 of the charger 70 as the latch 91 is pushed in by the peripheral edge of the applicator 1 to permit the opposed peripheral edge to ride over the jaw 102 of the eject button 100 into engagement with the second groove 104, after which the latch 91 is resiliently urged inwardly to engage the peripheral edge of the applicator 1 into engagement with the first groove 94. Provided on the upper ends of the latch 91 and the jaw 102 is an inwardly inclined taper brims 95 and 103 which serve to facilitate the insertion of the applicator 1 into the recess 72. When the applicator 1 is put with its peripheral edge firstly engaged only at one portion into the first groove 94 of the latch 91 but with the opposed portion left resting on the jaw 102, further pressing in of the applicator 1 will cause the opposite portion of the peripheral edge to easily slip over the inclined brim 103 of the jaw 102 into engagement with the second groove 104 as pushing the latch 91 radially outwardly. In the opposite case when the applicator 1 is put with its peripheral edge firstly engaged only into the second groove 104 behind the jaw 102 while left resting on the latch 91, the peripheral edge of the applicator 1 on the latch 91 can easily ride over the taper brim 95 into engagement with the first groove 94 as resiliently pushing back the latch 91 by the like pressing in of the applicator 1.

The applicator 1 thus placed in the recess 72 is kept in

the recharge condition until the eject button 100 is pressed. After the applicator 1 is recharged to an enough level, it is popped out by simply pressing down the eject button 100. As the eject button 100 is pressed down from the position of FIG. 14 to the position of FIG. 15, the applicator 1 is moved under the effect of the return bias of the latch 91 to the left of the FIG. 14 at which the one portion of the peripheral edge thereof rides on the taper brim 103 of the jaw 102 of the lowered eject button 100 while the opposite portion of the peripheral edge is disengaged from the first groove 94. During this movement, the applicator 1 also receives the upward bias from each of the terminal pins 74 and 75 to be thereby lifted slightly, assisting the peripheral edge to ride on the taper brim 103 and at the same time to be disengaged from the first groove 94. Upon subsequent release of the eject button 100, the button 100 returns upwardly by the bias of the spring 106 to thereby lift up the one peripheral edge of the applicator 1 on the upwardly moving jaw 102, thus popping the applicator 1 substantially outwardly of the recess 72, as shown in FIG. 15, and permitting the easy access to the applicator 1 by the fingers of the user. Thus, the applicator 1 can be readily picked out from the charger unit 70 by the fingers to be ready for use on the portion of the body to be treated.

The circuits and the operations of the applicator 1 and the charger 70 are explained with reference to FIGS. 16 and 17.

As shown in the block diagram of FIG. 16, the circuit of the applicator 1 includes an oscillator 2 which is powered by the rechargeable battery 5 to produce a high frequency electromagnetic field at a frequency range of 9 MHz which is transmitted through the antenna 40. The oscillation is controlled by a control section 3 to occur repetitively at a time interval of 1200 microseconds and last a short time period of 400 microseconds, as shown in FIG. 8. The LED 38 of the circuit is also controlled by the control section 3 to repeat turning on and off during the energization of the antenna 40 at a suitable cycle for indicating that the oscillation of the high frequency electromagnetic field is being produced. Further, the control section 3 is operative to monitor through a voltage sensor 6 the external voltage supply from the charger unit 70 as well as the voltage level of the battery 5 so as to cause the oscillator 2 to operate only when the external voltage is not supplied and the voltage level of the battery 5 is above a predetermined value, as seen from the operation sequence of FIG. 17. When the voltage is supplied from the charger unit 70, or the applicator 1 is set into the recess 72 of the charger unit 70, the control section 3 responds to cease the operation of the oscillator 2 and permits the applicator 1 to be recharged. During the charging process, the control section 3 sends to the charger unit 70 a signal which keeps an on-charge lamp 8 turned on until the battery 5 is charged up to a predetermined level (full charged

level) or it has been charged over a predetermined period of time. When either of the above is detected, the control section 3 acts to terminate the recharging process for prevention of over-charging and at the same time to turn off
5 the on-charge lamp 8 for notifying the completion of the recharging.



CLAIMS:

1. A portable diathermy apparatus comprising in combination a battery powered applicator for applying
5 a high frequency electromagnetic field to a living tissue and

a charger unit for recharging said applicator;

said applicator adapted in use to be attached to the skin of a patient and comprising:

10 an oscillator for producing the high frequency electromagnetic field;

an antenna which is energized by said oscillator to transmit the electromagnetic field to the tissue;

15 a rechargeable battery for driving the oscillator;

a casing encapsulating therein electronic components forming said oscillator together with said antenna and said rechargeable battery; and

20 electrodes connected to said rechargeable battery and exposed on the exterior of said casing;

said charger unit comprising a source of electric power and a recess for receiving therein said applicator, said recess provided with charging terminals for electrical connection respectively with
25 the electrodes of said applicator fitted in said



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recess for recharging the battery of said applicator from said source of electric power.

5 2. A portable diathermy apparatus as set forth in claim 1, wherein said electrodes lie flat on the bottom of said casing while said charging terminals project on the bottom of said recess.

10 3. A portable diathermy apparatus as set forth in claim 2, wherein said charging terminals are made movable between a projected position on the bottom of said recess and a retracted position into the bottom of said recess, and said charging terminals are spring biased to said projected position.

15 4. A portable diathermy apparatus as set forth in claim 2 or claim 3, wherein said casing of the applicator is generally disk-shaped to have no particular angular orientation and wherein said
20 electrodes comprise a centre electrode concentric with said casing and an outer electrode extending circumferentially about said centre electrode, and said center and outer electrodes arranged for
25 electrical contact respectively with said charging terminals provided on the corresponding portions on the bottom of said recess in said charger unit.



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5. A portable diathermy apparatus as set forth in claim 4, wherein said outer electrode is arcuately shaped to be interrupted at its end, said charging terminals of said charger unit comprising a center terminal for contact with said centre electrode and a pair of outer terminals spaced at the same distance from said centre electrode for electrical contact with said outer electrode.

6. A portable diathermy apparatus as set forth in claim 5, wherein said outer electrode extends circumferentially at an angular range of more than 180° about said center electrode, said center and outer terminals are aligned on the bottom of said recess such that at least one of said outside terminals is in constant electrical contact with said outside electrode of the applicator held within said recess.

7. A portable diathermy apparatus as set forth in any one of the preceding claims, wherein said recess is provided at its periphery with retainer means for detachably retaining said applicator within said recess.



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8. A portable diathermy apparatus as set forth in claim 7, wherein said recess is provided at its periphery with an eject button movable in the depth direction of said recess and with a latch member
5 movable in a direction perpendicular to the movement of said eject button between a projected position into said recess and a retracted position away from said recess, at least one of said reject button and said latch member defining said retainer means for
10 detachably retaining said applicator within said recess.

9. A portable diathermy apparatus as set forth in claim 7, said retainer means is provided to have a
15 groove which is open to the periphery of said recess and into which the peripheral edge of said applicator engages, and said retainer means being formed upwardly of the groove with a downwardly inclined tapering edge directed toward the center of said recess such that as
20 the applicator is being inserted in said recess the peripheral edge of the applicator is guided over the tapering edge in such a manner as to move the retainer means into a position allowing the peripheral edge to be engaged with said groove past said tapering edge.

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10. A portable diathermy apparatus as set forth in



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any one of the preceding claims, wherein said applicator is arranged to cease the operation of said oscillator when it is set into the recess of said charger unit.

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11. A portable diathermy apparatus as set forth in claim 10, wherein the cessation of said oscillator is effected upon detection of an external voltage supplied from said power supply of said charger unit.

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12. A portable diathermy apparatus as set forth in any one of the preceding claims, wherein said oscillator is controlled to cease producing the high frequency electromagnetic field when the voltage level of the rechargeable battery drops to a prescribed level.

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13. A portable diathermy apparatus as set forth in any one of the preceding claims, wherein said applicator includes control means which control the recharging of the battery in such a manner as to prevent the rechargeable battery from being over-charged.

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14. A portable diathermy apparatus as set forth in



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claim 13, wherein said control means including means
for monitoring the voltage level of said rechargeable
battery and the time lapse for which the recharging
continues so that it will stop recharging either when
5 the voltage level is detected to exceed a
predetermined level or when the recharging has been
performed over a prescribed time period.

15. A portable diathermy apparatus as set forth in
10 claim 13 or claim 14, wherein said charger unit is
provided with an on-charge lamp which is electrically
connected to said control means of said applicator
being set in the charger unit and controlled thereby
to turn on during the recharging of the battery and
15 turn off once the recharging is stopped.

16. A portable diathermy apparatus as set forth in
any one of the preceding claims, wherein said casing
of the applicator accommodates a substrate which
20 carries on one surface thereof said antenna together
with said electrodes and carries on the other surface
said rechargeable battery together with an electronic
circuit formed by said electronic components.



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17. A portable diathermy apparatus as set forth in claim 16, wherein said electrodes are formed inwardly of said antenna.

5 18. A portable diathermy apparatus as set forth in claim 16 or claim 17, wherein said casing has a bottom and said electrodes are located within an opening formed in said bottom.

10 19. A portable diathermy apparatus as set forth in claim 18, wherein a sealing sheet is interposed between the substrate and the bottom of said casing to effect the sealing therebetween while exposing only said electrodes in said opening.

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20. A portable diathermy apparatus as described in the description with reference to Figures 9 to 17 of the drawings.
