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[Continued on next page]

(54) Title: TRANSCRANIAL DIRECT CURRENT STIMULATION APPARATUS AND METHODS

(57) Abstract: A transcranial direct current stimulation (tDCS) apparatus including a cap sized to fit over a portion of a patient's head and two or more electrodes associated with an inner service of a cap. Also included is a power supply in electrical communication with the electrodes. The power supply is sized to be worn by or otherwise transported by a patient in use. A portable control interface may be provided. Various types of releasable attachment mechanism may be associated with one or more electrodes. Thus, the placement position of the electrodes with respect to the inner surface of the cap is selectively variable.

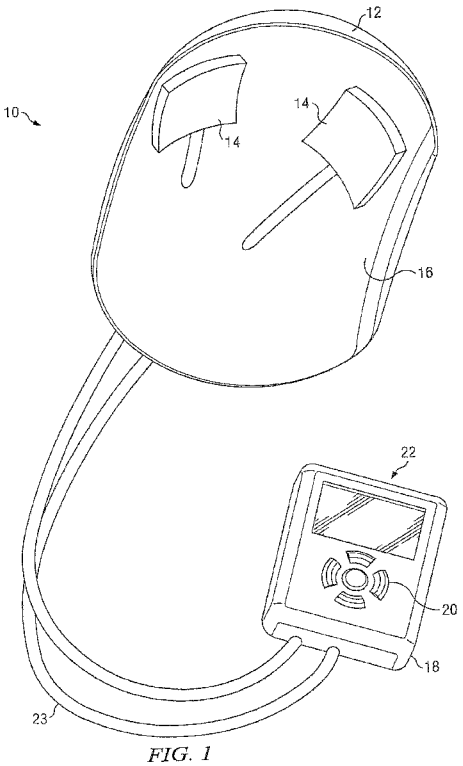


FIG. 1

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TRANSCRANIAL DIRECT CURRENT STIMULATION APPARATUS AND METHODS

TECHNICAL FIELD

[0001] The present invention is a transcranial direct current stimulation (tDCS) apparatus and method. In particular, embodiments of a portable tDCS which is suitable for home or clinical tDCS treatment and research are disclosed.

BACKGROUND

[0002] Transcranial direct current stimulation (tDCS) involves the application of electrical currents to modulate the activity of neurons in the brain. Typically, the electrical currents applied are relatively weak, from 1 to several mA. TDCS has been known for about 40 years as a technique to generate prolonged modifications of cortical excitability and activity. TDCS has been used to treat pain, depression, migraine and other conditions.

[0003] Conventional tDCS therapy typically involves placing at least one anode and one cathode in contact with a subject's scalp. The location of electrode placement can be critical to successful tDCS treatment. In addition, conventional tDCS apparatus may limit the opportunity of the subject to engage in normal activities while treatment occurs. The present invention is directed toward overcoming one or more of the problems discussed above.

SUMMARY OF THE EMBODIMENTS

[0004] One embodiment is a transcranial direct current stimulation (tDCS) apparatus including a cap sized to fit over a portion of a patient's head, and two or more electrodes operatively associated with an inner surface of the cap. This embodiment also includes a power supply in electrical communication with the electrodes. The power supply is sized to be worn by or otherwise transported by a patient in use. This embodiment also includes a portable control interface in electrical communication with the power supply and electrodes.

[0005] The cap may optionally be associated with a chin strap to facilitate close engagement between the electrodes and a patient's scalp. The cap may have a substantially rigid outer shell or a flexible outer portion. The cap may include a mesh portion or openings. Various types of releasable attachment mechanisms may be associated with the electrodes. Thus, the placement position of the electrodes with respect to the inner surface of the cap is designed to be selectively variable.

[0006] Suitable attachment mechanisms for the electrodes include, but are not limited to, hooks, barbs, arrows, snaps, buttons or other structures which may be removably engaged with a corresponding surface or structure associated with the inner surface of the cap.

[0007] The electrodes may be implemented with sponges which may be soaked in saline or other ionic solution. In one embodiment, the contact surface area of at least one sponge electrode is between 25 and 35 cm^2. The contact surface area of an electrode may be structured or have separate structures to provide for enhanced contact with a patient's scalp. The structure may include but is not limited to protuberances, corrugations, bristles or teeth.

[0008] In an alternative implementation, the tDCS apparatus may include a cap having one or more sliding adjustment bands associated with the inner surface of the cap with a sliding

adjustment band having at least one electrode attached thereto. The sliding adjustment band or bands may be selectively positioned with respect to the inner surface of the cap and thereby selectively position and support an electrode.

[0009] The power supply of the various embodiments may be implemented with batteries. The control interface and a microprocessor which may be associated therewith may be configured to provide direct current stimulation having various current parameters. For example, the output current level may be set and selected to achieve specific therapeutic or research goals. The output level may be constant or varied. If the output level is variable it may be varied according to specific patterns or wave forms. The duration of current application and the time interval between the successive applications of current may be selected and varied.

[0010] Another embodiment is a method of providing tDCS which includes providing a patient with a tDCS apparatus as is described above. A clinic technician, health care provider, or other person may adjust the position of one or more electrodes with respect to the inner surface of the cap which will be worn by the patient, at the time the apparatus is provided to a patient. The technician may program selected treatment protocols. The method further includes the patient receiving tDCS treatment through the tDCS apparatus. Treatment may be administered at home, work or another remote site away from the main clinic location. Since the apparatus is portable and wearable, the patient may in many instances engage in normal routine activities while treatment is being administered.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Fig. 1 is an inside perspective view of a tDCS apparatus as described herein.

[0012] Fig. 2 is a side perspective view of a cap associated with a tDCS apparatus.

[0013] Fig. 3 is a rear perspective view of the cap of Fig. 2.

[0014] Fig. 4 is a perspective view of a sponge electrode showing attachment apparatus.

[0015] Fig. 5 is a perspective view of a sponge electrode showing alternative attachment apparatus.

[0016] Fig. 6 is a perspective view of a sponge electrode showing button attachment apparatus.

[0017] Fig. 7 is a perspective view of the scalp interface side of a sponge electrode featuring protuberances.

[0018] Fig. 8 is a perspective view of the scalp interface side of a sponge electrode featuring pyramid-shaped protuberances.

[0019] Fig. 9 is a side perspective view of an alternative embodiment of a tDCS cap.

[0020] Fig. 10 is a side perspective view of an alternative embodiment of a tDCS cap.

[0021] Fig. 11 is a rear perspective view of the tDCS cap of Fig. 9.

[0022] Fig. 12 is a top perspective view of the cap of Fig. 9.

[0023] Fig. 13 is a side plan view of a tDCS apparatus.

[0024] Fig. 14 is a functional block diagram of the electronic subsystems of a tDCS apparatus.

[0025] Figs. 15a-c are illustrations of an alternative tDCS cap with separate frame and cap elements.

DETAILED DESCRIPTION

[0026] One embodiment is a transcranial direct current stimulation (tDCS) apparatus 10 which apparatus as shown on Fig. 1 includes a cap 12. As shown on Fig. 2 the cap 12 is sized to

fit over a portion of a patient's head. Returning to Fig. 1, the tDCS apparatus 10 also includes two or more electrodes 14 associated with an inner surface 16 of the cap 12.

[0027] Although the embodiment depicted in Fig. 1 includes only two electrodes 14, it is important to note that embodiments with any number of electrodes are within the scope of the present disclosure. As is customary with tDCS, at least one electrode 14 will be configured as a cathode and at least one other electrode 14 will be configured as an anode. The tDCS apparatus 10 may, however, be implemented with any number of anode and cathode pairs, or a dissimilar number of anodes and cathodes as may be desired to achieve specific therapeutic goals.

[0028] The tDCS apparatus 10 will also include a power supply 18 and a control interface 20. Each of the power supply 18 and control interface 20 will be in electrical communication with the two or more electrodes 14. Both the power supply 18 and the control interface 20 will be of a size and weight which renders these elements readily transportable, for example these elements may be attached to the cap 12 or worn attached to an article of clothing. As shown in Fig. 1 the power supply 18 and control interface 20 may be integrated into a single power and control module 22 which is connected by interconnect wires or cables 23 to the electrodes 14. Alternatively as shown in Fig. 2 and Fig. 3, the power supply 18 may be housed separately from the control interface 20 for example in a housing attached to or molded into the cap 12. The electronics associated with the power supply 18 and control interface 20 are described in detail below.

[0029] The cap 12 may include a substantially hard or rigid outer shell 24 as is depicted in Figs. 2 and 3. Alternatively, the cap 12 may include a substantially flexible outer portion. In embodiments having a flexible outer portion, the cap 12 may be fabricated from fabric, a natural or synthetic mesh or weave, leather, or other suitable flexible material. Typically, but not

necessarily, the inner surface 16 of the cap 12 will be fabricated from a flexible material which is somewhat softer and more comfortable for a wearer than a rigid shell 24 or mesh or other type of outer cap material. A relatively soft and flexible inner surface 16 both enhances the comfort of the wearer and, as is described below, may facilitate the selective placement of electrodes 14 with respect to the patient's scalp.

[0030] In particular, it is desirable in any embodiment of the tDCS apparatus 10 that the position of one or more of the electrodes with respect to a patient's head and scalp be selectively variable. Variable placement is desirable for a number of reasons. For example, certain tDCS treatment regimens will require or be facilitated by stimulation of specific areas of a patient's brain including, but not limited to, the PFC, motor areas (with greater or lesser emphasis on extremities or speech areas) SMA, occipital or other cerebellar regions. In each case electrode placement depends upon the selected treatment plan or disorder to be treated. Relatively easy variation of the placement of the electrodes with respect to the inner surface of the cap 12 is thus desirable to assure that the tDCS apparatus 10 is suitable for treatment of or investigation of a wide variety of conditions. It is also important to note that the head and scalp physiology of patients of various sizes, genders and ages can be quite variable. Accordingly, an apparatus which facilities the selectively variable placement of electrodes with respect to the inner surface of the cap 12 will assure that the greatest number of patients may be effectively treated with a tDCS apparatus 10.

[0031] Various attachment mechanisms 26 may be associated with the inner surface 16 of the cap 12 and one or more electrodes 14 to provide for the selective attachment of an electrode at more than one possible position on the inner surface of the cap. For example, an attachment mechanism 26 may be associated with an electrode 14 which may then be removably

engaged with a fabric, mesh or other surface associated with the inner surface 16 of the cap 12. The cap or mesh may include a map, template or diagram indicating the position of desired electrode placement. Representative attachment mechanisms include, but are not limited to, hooks, barbs, arrows, hook and loop (Velcro™) structures, snaps, buttons, or other well known removable attachment structures. As is illustrated in Figs. 4-6, representative attachment mechanisms 26 may include, but are not limited to, one or more arrows 28 associated with one or more pads 30 which are in turn attached to an electrode 14. In use, an attachment mechanism 26 such as an arrow 28, barb, hook or similar device may be made to selectively and removably engage with a loop, fabric, mesh, socket or other structure associated with the inner surface 16 of cap 12. An alternative snap button 32 attachment mechanism 26 is illustrated on Fig. 6. Returning to Fig. 5, it may be noted that a separate structure such as ball and slot 34 may be provided for the attachment mechanism 26 to allow for the easy removal of the attachment mechanism 26 from an electrode 14. Removal may be desirable in instances where the electrode must be soaked in saline solution as described below, cleaned or otherwise separated from the attachment mechanism 26.

[0032] In one embodiment of the tDCS apparatus 10, the one or more electrodes 14 may be implemented with a sponge which prior to use will be associated with a saline or other ionic solution. The effectiveness of tDCS can be impacted by impedance at the contact area between an electrode 14 and a patient's scalp. This impedance may be reduced or minimized in several ways. The use of a highly conductive saline or ionic solution in conjunction with a sponge electrode will help to ensure a proper low impedance pathway between the electrode and a patient's scalp. In addition, the electrodes may be configured to have a relatively large surface area. For example, an electrode surface area may be between 25 and 35 cm^2. In addition, as is

shown in Figs. 7 and 8, the scalp interface surface of a sponge electrode 14 may have a structured surface designed to assure good contact with the patient's scalp depending upon the patient's hair type. For example, as is shown in Figs. 7 and 8 the scalp interface side of the electrode 14 may have corrugations, rounded cobblestone-type protuberances, knobs, bristles, teeth, pyramid-shaped protuberances or other structures which provide for good scalp contact notwithstanding the patient's hair type.

[0033] An alternative embodiment of a cap 12 which may be used to implement the tDCS apparatus 10 is illustrated in Figs. 9-12. This alternative embodiment includes a cap 12 which features a flexible lightweight frame 38, a stretch fabric or mesh flexible portion 40 between the elements of the lightweight frame 38, various adjustment mechanisms such as a size adjuster 42 and at least one sliding adjustment band 44. As shown in Fig. 9, an electrode 14 may be attached to the sliding adjustment band 44 at any point along the length of the sliding adjustment band. The sliding adjustment band 44 may be attached to the flexible frame 38 at one end and attached in sliding engagement with a separate portion of the frame at the opposite end. Accordingly, the sliding adjustment band 44 may pivot on pivot point 46 and slide to various positions with respect to a patient's scalp as is best shown in Figs. 9 and 10.

[0034] As described above, one or more electrodes may be positioned anywhere along the length of the sliding adjust band 44. When combined with the positional mobility of the sliding adjustment band itself, the combination provides an alternative method for the convenient and easily varied placement of an electrode with respect to a patient's scalp.

[0035] This embodiment of the tDCS apparatus 10 also includes, as is shown on Fig. 11, size adjusters such as a center size adjuster 42 and width size adjusters 48 associated with the flexible frame 38. This configuration provides for a cap 12 which may be adjusted to fit any

number of patient head sizes and shapes. The embodiment shown in Figs. 9-12 also features electrode connectors 50 embedded in the mesh 40 of the cap 12 which provide for the convenient connection of a power supply 18 and control interface 20. Although the embodiment shown in Figs. 9-12 is illustrated with only two sponge electrodes 14 this configuration is not intended to be limiting upon the scope of the invention. Multiple anodes, cathodes, anode and cathode pairs, or a dissimilar number of anodes and cathodes may be implemented and operatively disposed on the mesh or attached to the sliding adjustment band 44 as is necessary to achieve specific therapeutic goals. Similarly, as is shown in Fig. 12, this embodiment of the tDCS apparatus 10 may include two or more separate sliding adjustment bands 44 which may be disposed on the left and right sides of the cap 12 or any combination thereof.

[0036] The power supply 18 associated with the tDCS apparatus 10 may be implemented with any suitable DC power supply. One or more batteries are particularly well suited for implementation of the various embodiments described herein. Batteries enhance portability, are available in an appropriately small size, and are well suited to installation within a small and portable housing such as shown on Figs. 1-3. The batteries may be operatively positioned within the same housing as the control interface 20, for example in an integrated power and control module 22 as shown on Fig. 1. Alternatively, batteries may be operatively placed within a separate power supply housing as shown on Figs. 2 and 3. In all embodiments, it may be desirable to provide outboard housings or structures such as the power and control module 22 as shown on Fig. 13 with hooks or other apparatus for attachment to a patient's clothing thus facilitating convenient transportation. For example, the power and control apparatus 22 may include a belt clip 52, strap, belt, hook and loop fastener, button snap or other suitable attachment structure. Fig. 13 illustrates a power and control module 22 attached to electrodes 14 (not shown

on Fig. 13) with wires 23. In other embodiments, particularly where the power supply 18 is mounted on or in the cap 12 the control interface may communicate with the other electronic components through a wireless connection such as a Bluetooth, radio, or other wireless link.

[0037] The tDCS apparatus 10 is useful for both the application of tDCS for therapeutic purposes and for research into the effects of tDCS. In either case, the enhanced mobility provided by a fully portable unit significantly increases the ease of implementing long-term treatment plans and protocols. A tDCS apparatus 10 which is specifically designed for research purposes may be structurally very similar to an apparatus designed for therapeutic implementation. However, certain variations which may enhance the suitability of a tDCS apparatus for research use may be included in a research embodiment. For example, an apparatus designed for therapeutic treatment may have a control system which limits the output current of the power supply to a range from 0.5mA to 3mA. Such a limited range would enhance patient safety which is particularly important since the tDCS apparatus 10 is designed for the delivery of therapeutic treatment in the clinic or at a remote location away from the main clinic. On the contrary, a research model may allow current to be delivered over a broader range, for example, 0.5mA to 5mA. Safety in a research setting would be assured by the close monitoring of patient comfort and safety as is typical in a research setting. Furthermore, a research model may have a control interface 20 which provides for protocol selection among anonymous choices, for example, "protocol A and protocol B" to allow for double-blind experimentation. On the other hand, a therapeutic treatment apparatus will typically have a control interface designed to be as straightforward and easy to use as can be conveniently implemented. Both research and therapeutic versions of the tDCS apparatus 10 will have an attachment mechanism between the electrodes 14 and an inner surface 16 of the cap 12 which facilitates the accurate,

easy and relatively unrestricted positioning of electrodes to achieve specific therapeutic or research goals.

[0038] A functional block diagram of the electronics associated with a representative tDCS apparatus 10 is included on Fig. 14. The primary electronic subsystems are a battery power supply 54 which is switchably connected to the other electronic components through a main power switch 56. It is advantageous to implement the control interface and control electronics with a microprocessor 58. Non-microprocessor based embodiments are within the scope of the present disclosure, however embodiments without a microprocessor will lack some of the sophisticated functionality described herein. As shown on Fig. 14, the microprocessor 58 may be in digital communication with various subsystems such as the current level adjustment and start/stop buttons 60, or the LCD display 62 associated with the control interface 20. The microprocessor 58 may also directly control an analog to digital converter 64 in electronic communication with the electrodes 14 configured to obtain and record impedance measurements between the electrode 14 and the patient's scalp. The microprocessor may also control and receive feedback from the current generator 66.

[0039] Direct current may be applied to the electrodes at a constant current at or near the ranges described above. Preferably, the current level is adjustable using the control interface 20. For example, current may be adjustable in 0.1mA or other suitable increments. Other attributes of the current provided to the electrodes may be adjusted to achieve specific therapeutic or research goals. For example, the duration for which current or stimulus is applied to the patient may be controlled by a timer associated with microprocessor 58. The stimulus duration may be set to any desired range. For example, the stimulus duration may be set to a relatively short time period, for example 0.5 seconds or set to over 30 minutes if necessary to achieve specific

therapeutic goals. Similarly, the time interval between stimulations may be set through the timer associated with microprocessor 58 to any selected interval, for example, 0.5 seconds up to 30 minutes. The microprocessor 58 may be utilized to control the polarity of a given electrode 14. For example, one electrode may be configured as a cathode at one phase of a treatment program and configured as an anode at a subsequent phase of treatment. The microprocessor 58 may be programmed to apply current according to a suitable ramp up from 0mA when turning on and a similar ramp down to 0mA when turning off. The ramp duration may be set at any time; one suitable ramp duration is 10 seconds. Ramp functionality as described above may be employed to achieve specific therapeutic goals and to enhance patient comfort and safety which may be compromised by the sudden application of full current.

[0040] The microprocessor 58 and current generator 66 may, as described above, be configured to apply constant current to selected electrodes. Alternatively, the control electronics may be configured to apply time varying current levels. For example, current may be set to vary between 0.5mA and 1mA at 1 second (1 HZ) intervals. Other current settings and other periods of variation are within the scope of the present disclosure and may be utilized to achieve specific therapeutic goals.

[0041] The control electronics may be configured to vary current according to certain pre-selected wave forms. For example, current may be varied as described above according to a sinusoidal wave form where the variation between the selected current levels is sinusoidally modulated. Alternatively, linear transitions could be employed between selected current levels resulting in current which varies according to a triangular or square wave. A combination of current modulation wave forms or multiple modulation wave forms may be implemented in an overall treatment program to achieve specific therapeutic goals.

[0042] As will be apparent from the block diagram of Fig. 14, the microprocessor 58 may be used to receive user input such as button pushes and sensor feedback. The microprocessor 58 may also be used to display user interface information on an LCD display or other output device. Based upon the input settings, the microprocessor may control output power as described above. Output current may be measured using an analog to digital converter which converts measurement of the applied voltage and current delivered to the patient into digital data which is provided back to the microcontroller. An over-current sensing circuit may be used as a safeguard to assure that the delivered current is within the range of the selected current parameter. Other system levels or measurements may be monitored by the microprocessor to assure that the system is fully functional. For example, battery voltage may be monitored and a warning displayed when battery power is low. The sponge electrodes may be fitted with at least 4 spaced apart impedance sensors. When impedance rises beyond a specified limit, the sensor will alert, and the control display will inform the patient regarding the specific region (quadrant or other region) of the electrode which is in poor contact. The device may then be programmed to not function until this contact error is corrected. This will assure equal current distribution throughout the conducting electrode, providing improved safety and efficacy. The microprocessor may be associated with onboard memory suitable for logging data. In addition, a digital interface, for example a USB port, RS-232 port, wired or wireless interface of any type may be provided to enable the microprocessor to communicate with a PC or other outboard storage device to transfer and store information logged about the operation of the device. Data logging may be particularly useful during clinical testing or other research implementations.

[0043] The LCD display 62 or an alternative type of display which is associated with the control interface 20 may be configured to provide feedback information to a user, patient or

clinical technician. For example, the LCD display 62 may have several lines of characters which show the time remaining in a selected treatment protocol or the battery charge level. The display may also be configured to show current intensity either numerically or graphically. Similarly, applied voltage or other current dependent parameters such as scalp/electrode impedance may be displayed numerically or graphically as a histogram.

[0044] The LCD display 62 may be utilized to display a menu structure to allow the easy selection of treatment parameters and the convenient modification of same. If the microprocessor 58 is provided with a digital interface as described above parameters may alternatively be set via the menu system on the unit itself or through a digital connection to a PC or similar device. The display may be used to provide feedback such as any type of alert message which may include, but is not limited to: "low battery," "poor impedance detected," or "treatment stopped."

[0045] Another embodiment disclosed herein is a method of providing tDCS treatment using an apparatus such as described above. The method includes providing a patient or research test subject with a tDCS apparatus 10. Typically the apparatus will be delivered to the patient at a clinic or research facility location. At the clinic, a technician may position the electrodes for specific therapeutic purposes and program one or more treatment protocols utilizing the control interface 20. The electrodes may be placed by the technician according to a template, map, chart or diagram associated with the tDCS apparatus. At this point, particularly if the patient is receiving direct therapeutic treatment, the patient may leave the clinic or facility, go home or otherwise carry on with routine daily activities.

[0046] The patient may then at the appropriate time initiate treatment by selecting a treatment protocol or merely pressing a "start" switch on the control interface 20. The patient

will, of course, be wearing the cap 12 and proper electrode placement will be reasonably well assured because the electrodes were pre-positioned by a technician. Alternatively, the patient may have positioned the electrodes according to a template, chart, map or diagram associated with the inner surface 16 of the cap 12 as described above. Once a select treatment protocol is initiated, the patient may carry on normal activities. The ability of the patient to engage in normal activities is facilitated by the portable and wearable technologies described above.

[0047] While the invention has been particularly shown and described with reference to a number of embodiments, it would be understood by those skilled in the art that changes in the form and details may be made to the various embodiments disclosed herein without departing from the spirit and scope of the invention and that the various embodiments disclosed herein are not intended to act as limitations on the scope of the claims. All references cited herein are incorporated in their entirety by reference. The disclosure also encompasses all possible permutations of the claim set, as if they were multiple dependent claims.

[0048] The description of the present invention has been presented for purposes of illustration and description, but is not intended to be exhaustive or limiting of the invention to the form disclosed. The scope of the present invention is limited only by the scope of the following claims. Many modifications and variations will be apparent to those of ordinary skill in the art. The embodiment described and shown in the figures was chosen and described in order to best explain the principles of the invention, the practical application, and to enable others of ordinary skill in the art to understand the invention for various embodiments with various modifications as are suited to the particular use contemplated.

CLAIMS

What is claimed is:

1. A transcranial direct current stimulation (tDCS) apparatus comprising:

a cap sized to fit over a portion of a patient's head;

two or more electrodes operatively associated with an inner surface of the cap;

a power supply in electrical communication with the electrodes wherein the power supply is sized to be worn by and transported by a patient in use; and

a portable control interface in electrical communication with the power supply.

2. The tDCS apparatus of claim 1 wherein the cap further comprises a chin strap.

3. The tDCS apparatus of claim 1 wherein the cap further comprises a substantially rigid outer shell.

4. The tDCS apparatus of claim 1 wherein the cap further comprises a substantially flexible outer portion.

5. The tDCS apparatus of claim 1 wherein the cap further comprises a mesh portion.

6. The tDCS apparatus of claim 1 wherein the placement of the electrodes with respect to the inner surface of the cap is selectively variable.

7. The tDCS apparatus of claim 6 further comprising an attachment mechanism associated with a cap side of one or more electrodes which provides for the selective attachment of the electrode at more than one possible position on the inner surface of the cap.

8. The tDCS apparatus of claim 7 wherein the attachment mechanism is a hook, barb, arrow, snap, button or other structure which may be removably engaged with a fabric or mesh surface associated with the inner surface of the cap.

9. The tDCS apparatus of claim 1 wherein at least one electrode is a sponge.

10. The tDCS apparatus of claim 9 wherein a contact surface area of at least one sponge electrode is between 25 and 35 cm^2.

11. The tDCS apparatus of claim 10 wherein the contact surface area is structured to provide for contact with a patient's scalp.

12. The tDCS apparatus of claim 11 wherein the structured surface area comprises one or more protuberances, a corrugation, one or more bristles or one or more teeth.

13. The tDCS apparatus of claim 1 further comprising at least one sliding adjustment band operatively associated with the inner surface of the cap and having at least one electrode attached thereto wherein the sliding adjustment band may be selectively positioned with respect to the inner surface of the cap and thereby selectively position an electrode.

14. The tDCS apparatus of claim 13 further comprising a second sliding adjustment band wherein the first sliding adjustment band is operable to position an electrode on the right side of a patient's scalp and the second sliding adjustment band is operable to position and electrode on the left side of a patient's scalp.

15. The tDCS apparatus of claim 1 wherein the power supply is one or more batteries.

16. The tDCS apparatus of claim 1 wherein the power supply provides a DC current level between 0 mA and5 mA.

17. The tDCS apparatus of claim 16 wherein the current level provided by the power supply is adjustable in 0.1 mA increments.

18. The tDCS apparatus of claim 17 wherein the duration of current application is adjustable between 0.5 seconds and 30 minutes.

19. The tDCS apparatus of claim 18 wherein the selected current level is initially provided according to an up current ramp having a selected duration and current application is terminated according to a down current ramp having a selected duration.

20. The tDCS apparatus of claim 19 wherein the selected duration of the up current ramp or the down current ramp is about 10 second.

21. The tDCS apparatus of claim 18 wherein an inter-stimulus interval between the application of current is between 0.5 seconds and 30 minutes.

22. The tDCS apparatus of claim 1 wherein the polarity of at least one electrode is controllable.

23. The tDCS apparatus of claim 1 wherein the DC current level is variable between a select maximum and a select minimum with a select period of variation.

24. The tDCS apparatus of claim 23 wherein the select period of variation is 1Hz.

25. The tDCS apparatus of claim 23 wherein the current level is varied according to a selected pattern.

26. The tDCS apparatus of claim 25 wherein the pattern is a sine wave, a triangle wave or a square wave.

27. The tDCS apparatus of claim 1 wherein the power supply is attached to the cap.

28. The tDCS apparatus of claim 27 wherein the control interface comprises a fastener providing for attachment of the control interface to an article of clothing.

29. The tDCS apparatus of claim 1 wherein the control interface is in electrical communication with at least one electrode and provides for the display of an impedance measurement taken at a point of contact between the electros and a patient's scalp.

30. The tDCS apparatus of claim 1 wherein the control interface provides for data logging to onboard memory or an external data storage device.

31. A method of providing tDCS treatment comprising:

providing a patient with a tDCS apparatus at a clinic location which tDCS apparatus comprises;

a cap sized to fit over a portion of a patient's head;

two or more electrodes operatively associated with an inner surface of the cap;

a power supply in electrical communication with the electrodes wherein the power supply is sized to be worn by and transported by a patient in use; and

a portable control interface in electrical communication with the power supply; and

initiating tDCS treatment at a remote location away from the clinic location.

32. The method of providing tDCS treatment of claim 31 further comprising adjusting the position of one or more electrodes with respect to the inner surface of the cap at the clinic location.

33. The method of providing tDCS treatment of claim 31 further comprising adjusting a DC stimulation current parameter at the clinic location.

34. The method of providing tDCS treatment of claim 31 wherein the tDCS apparatus is as claimed in any one of claims 1-30.

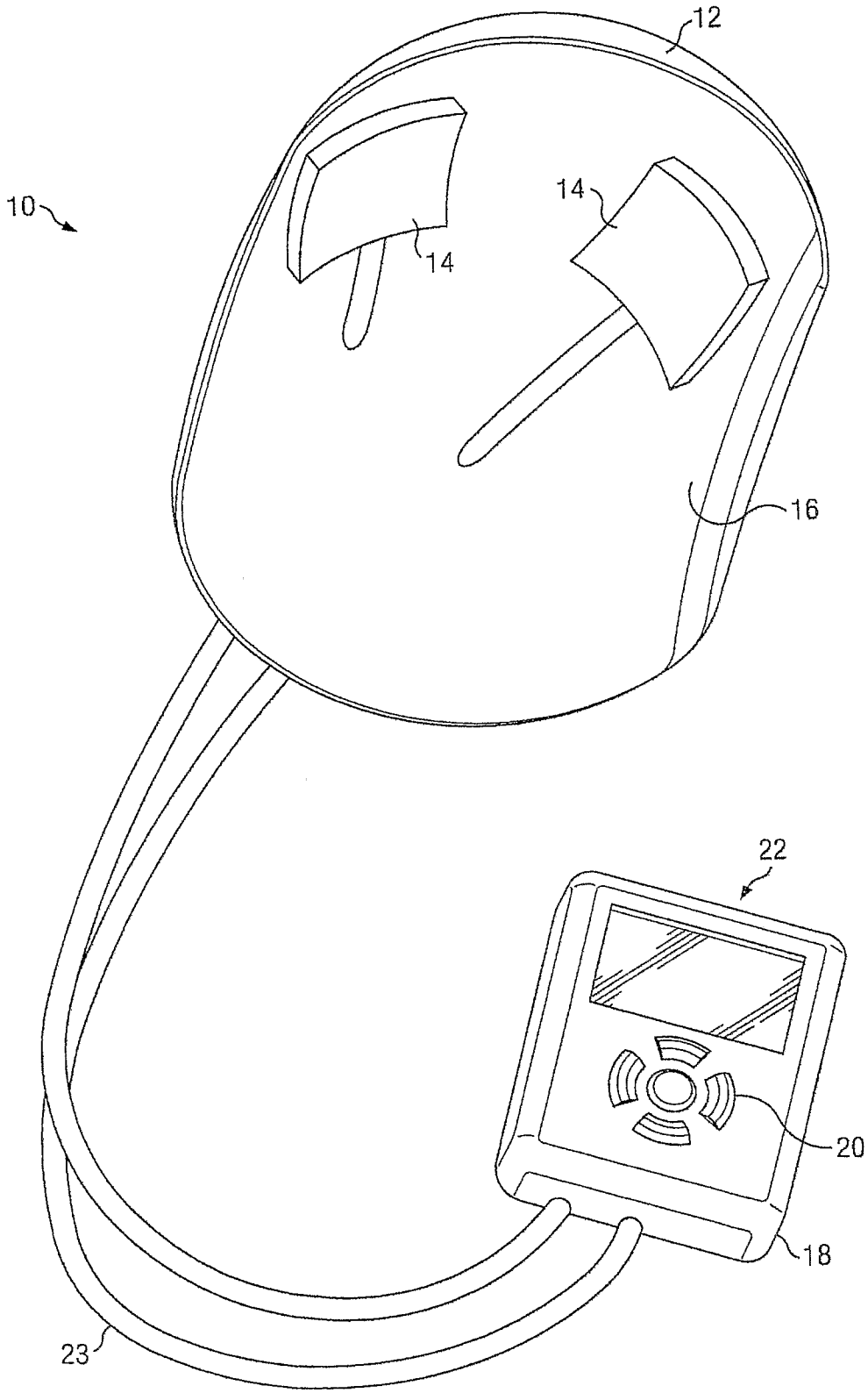


FIG. 1

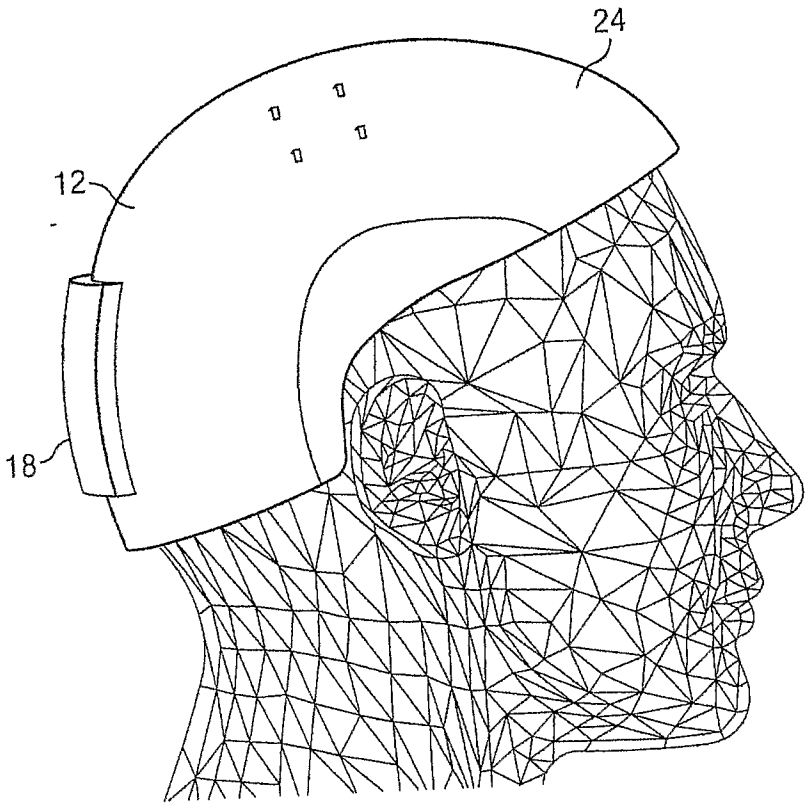


FIG. 2

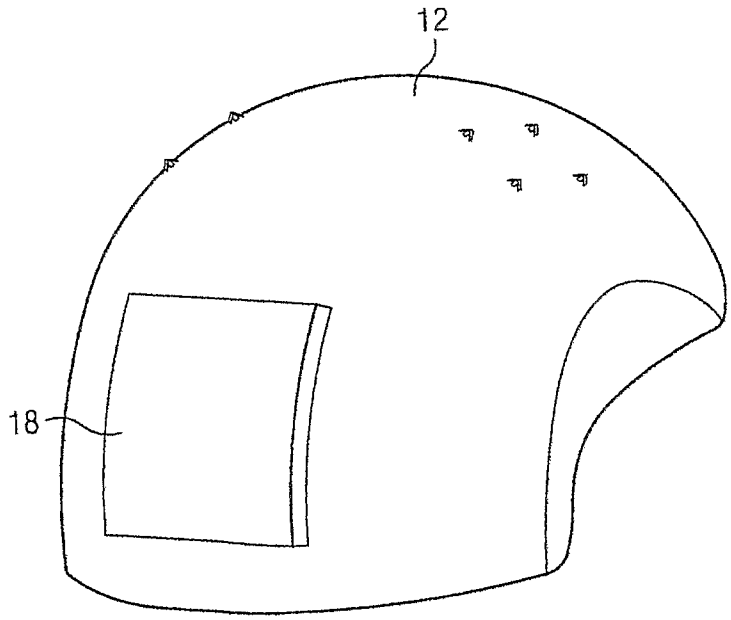


FIG. 3

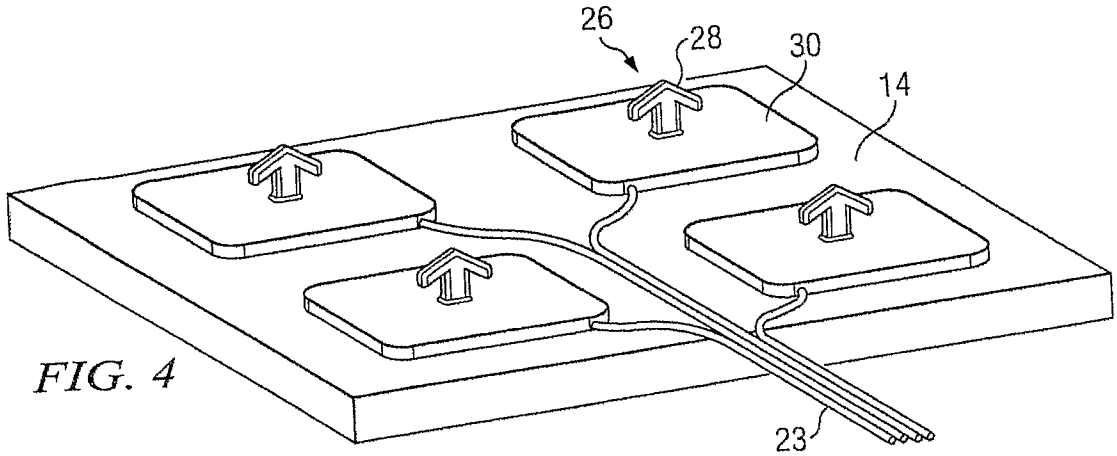


FIG. 4

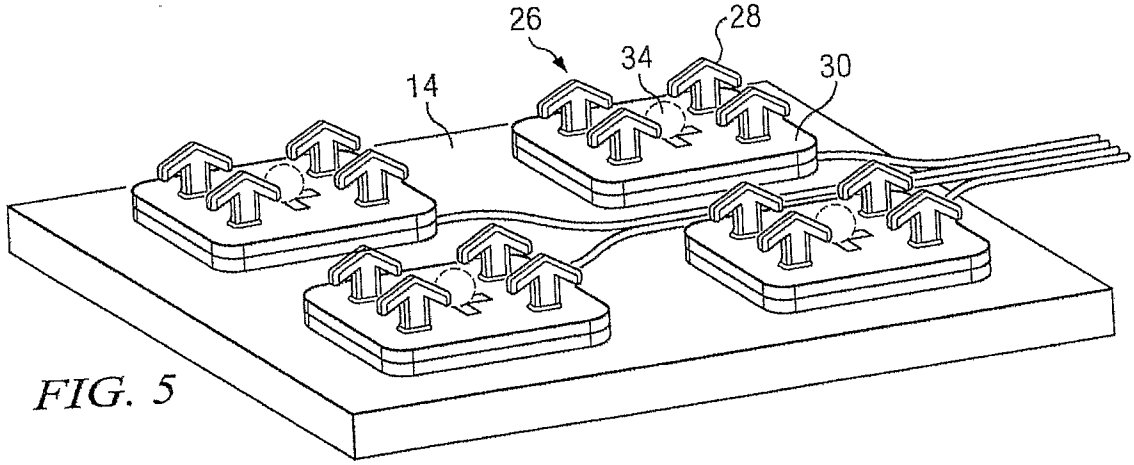


FIG. 5

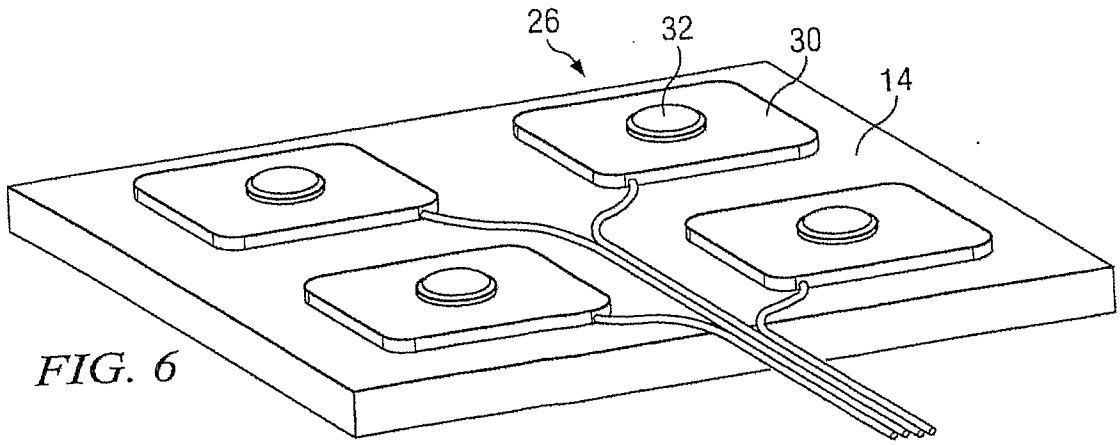


FIG. 6

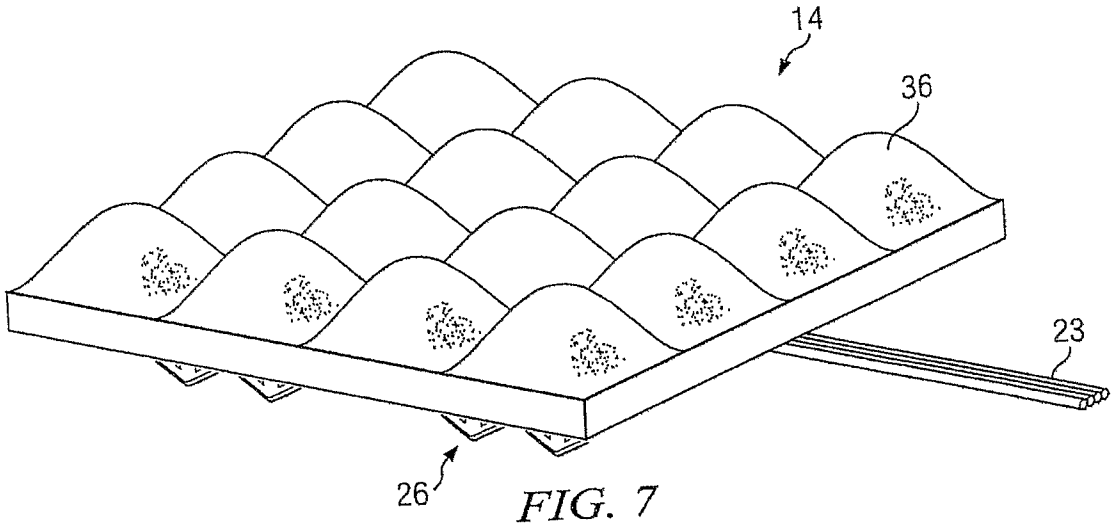


FIG. 7

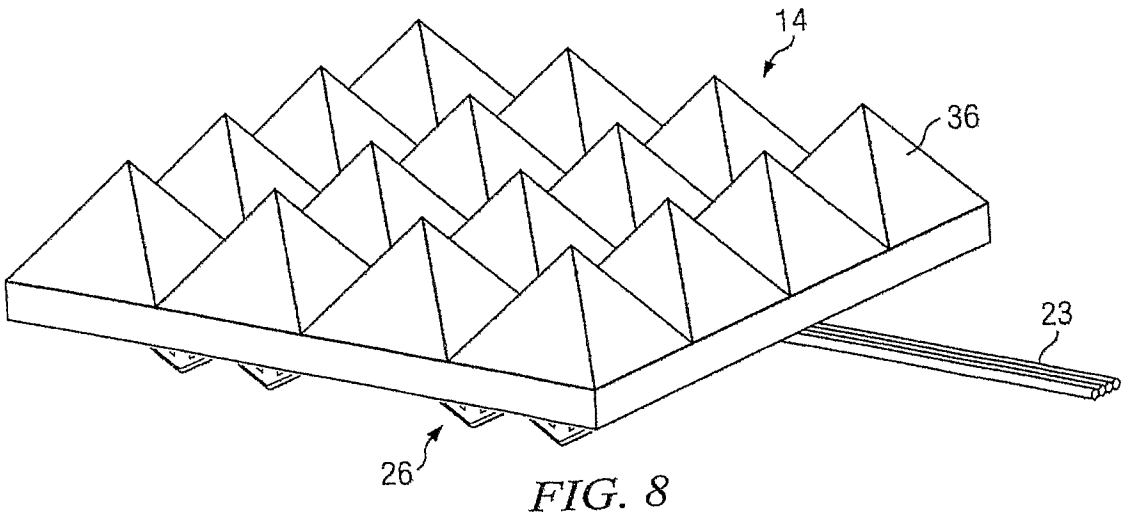


FIG. 8

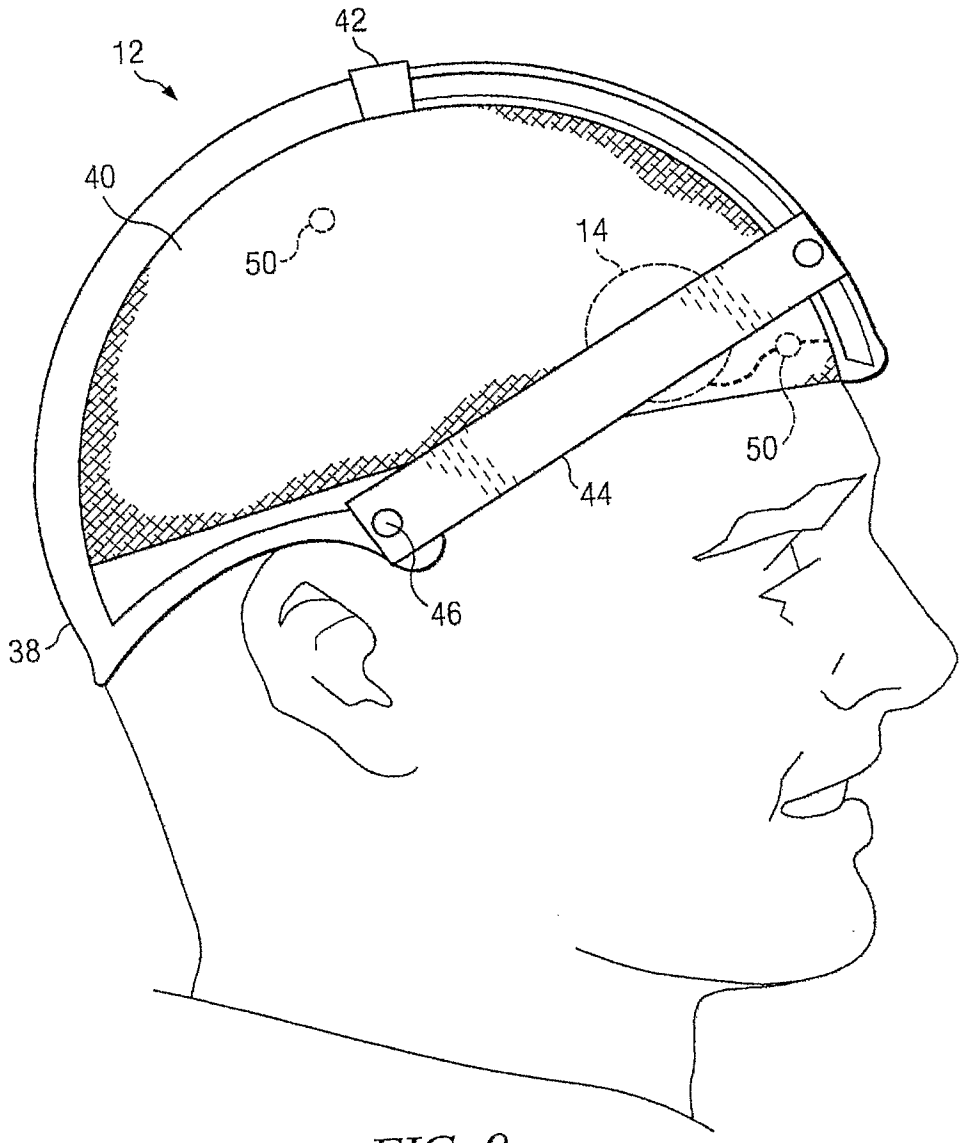


FIG. 9

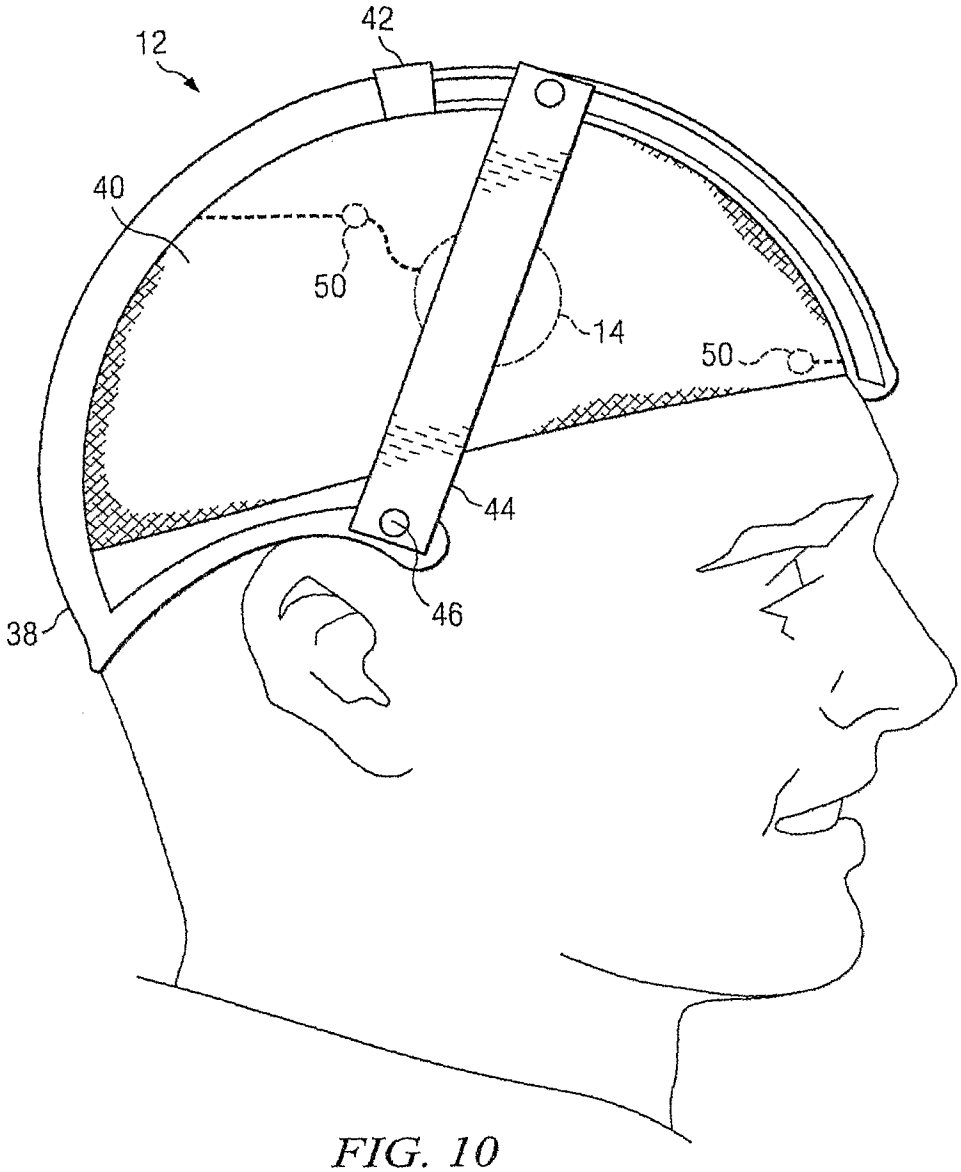


FIG. 10

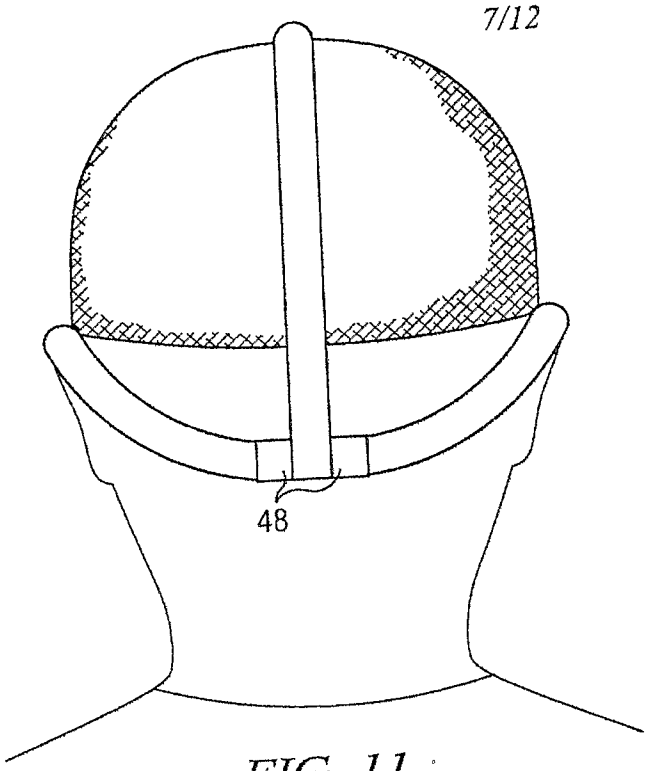


FIG. 11

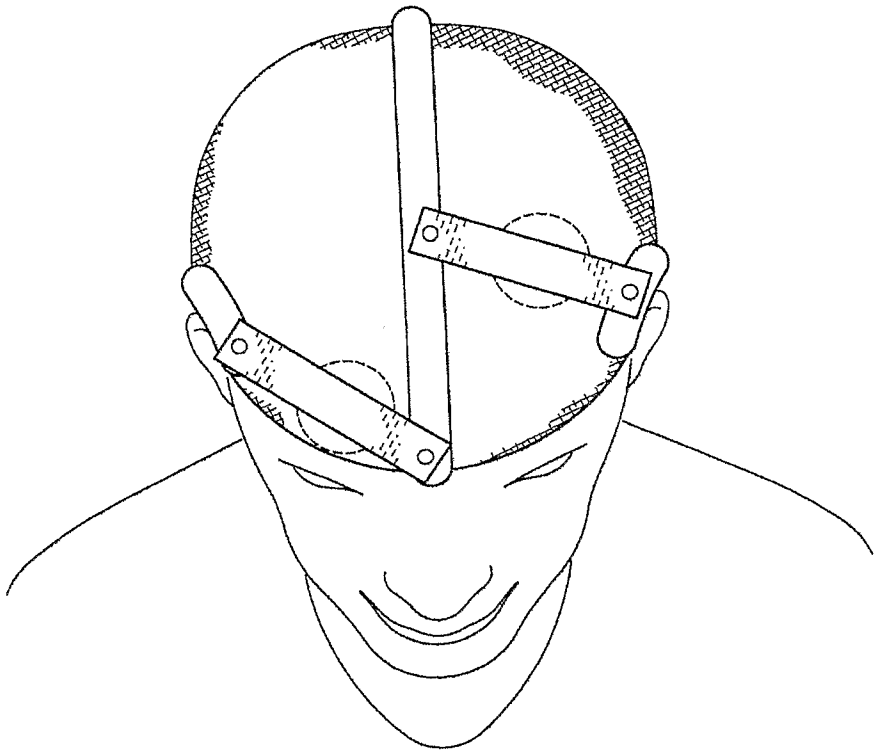


FIG. 12

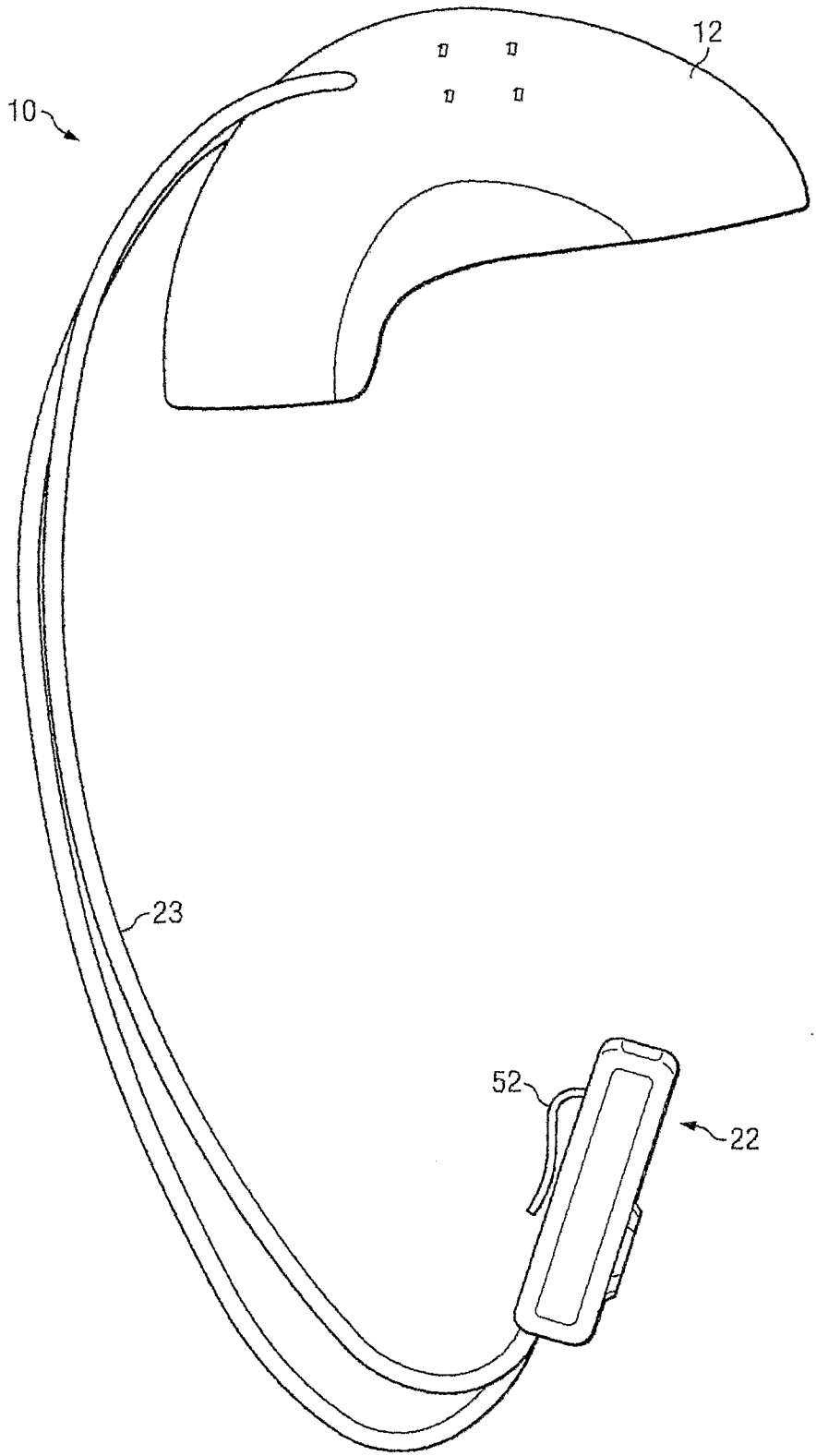


FIG. 13

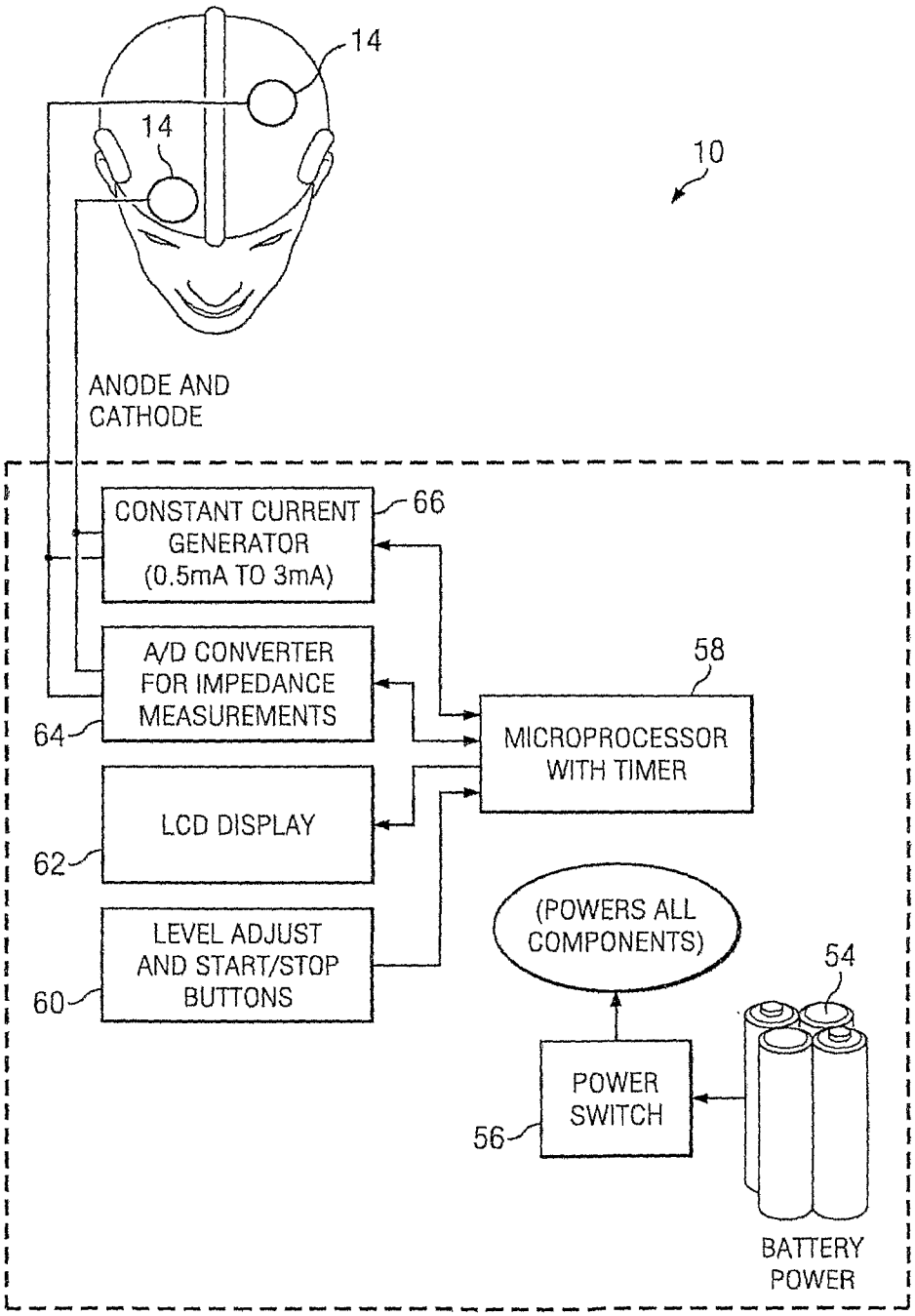

14
14
10
ANODE AND
CATHODE
CONSTANT CURRENT
GENERATOR
(0.5mA TO 3mA)
66
A/D CONVERTER
FOR IMPEDANCE
MEASUREMENTS
64
58
MICROPROCESSOR
WITH TIMER
LCD DISPLAY
62
LEVEL ADJUST
AND START/STOP
BUTTONS
60
(POWERS ALL
COMPONENTS)
54
POWER
SWITCH
56
BATTERY
POWER

FIG. 14

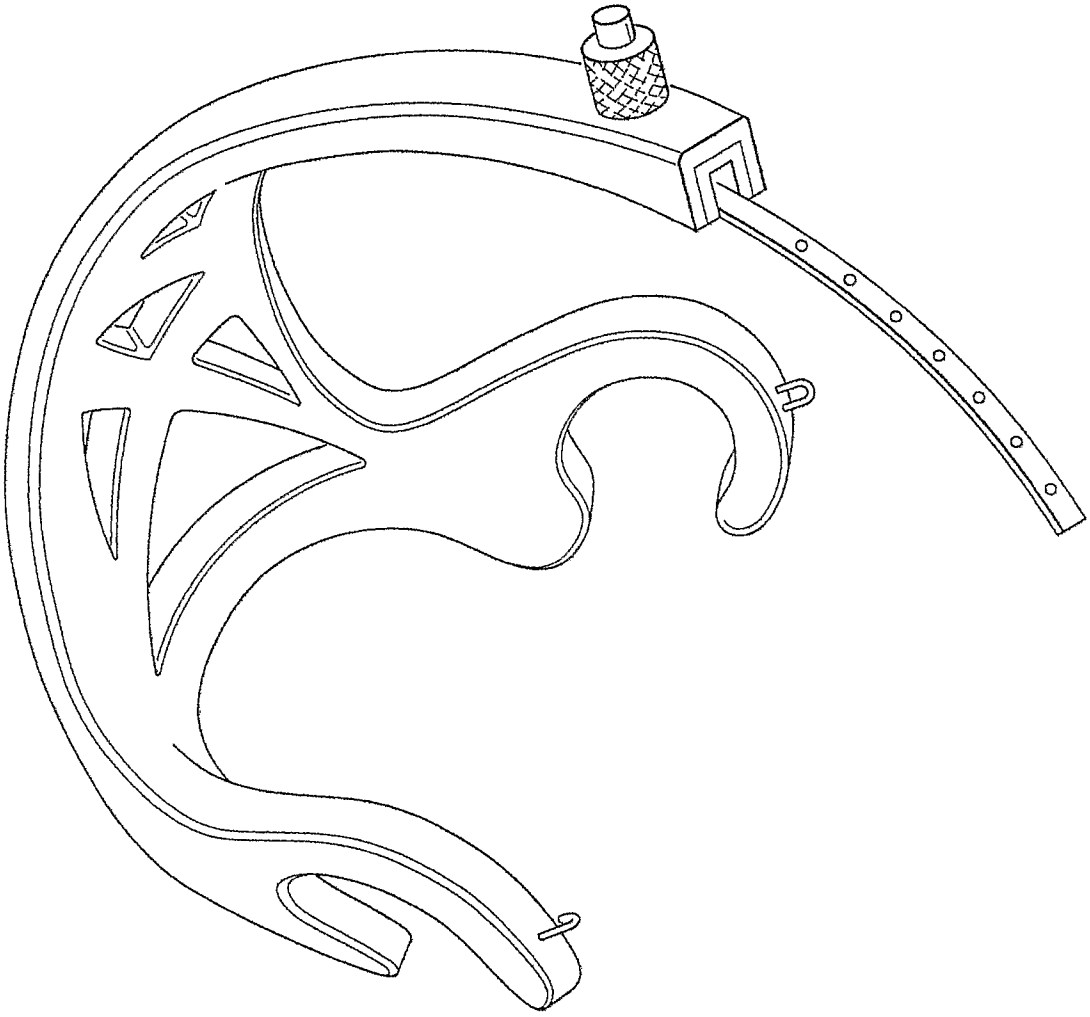


FIG. 15a

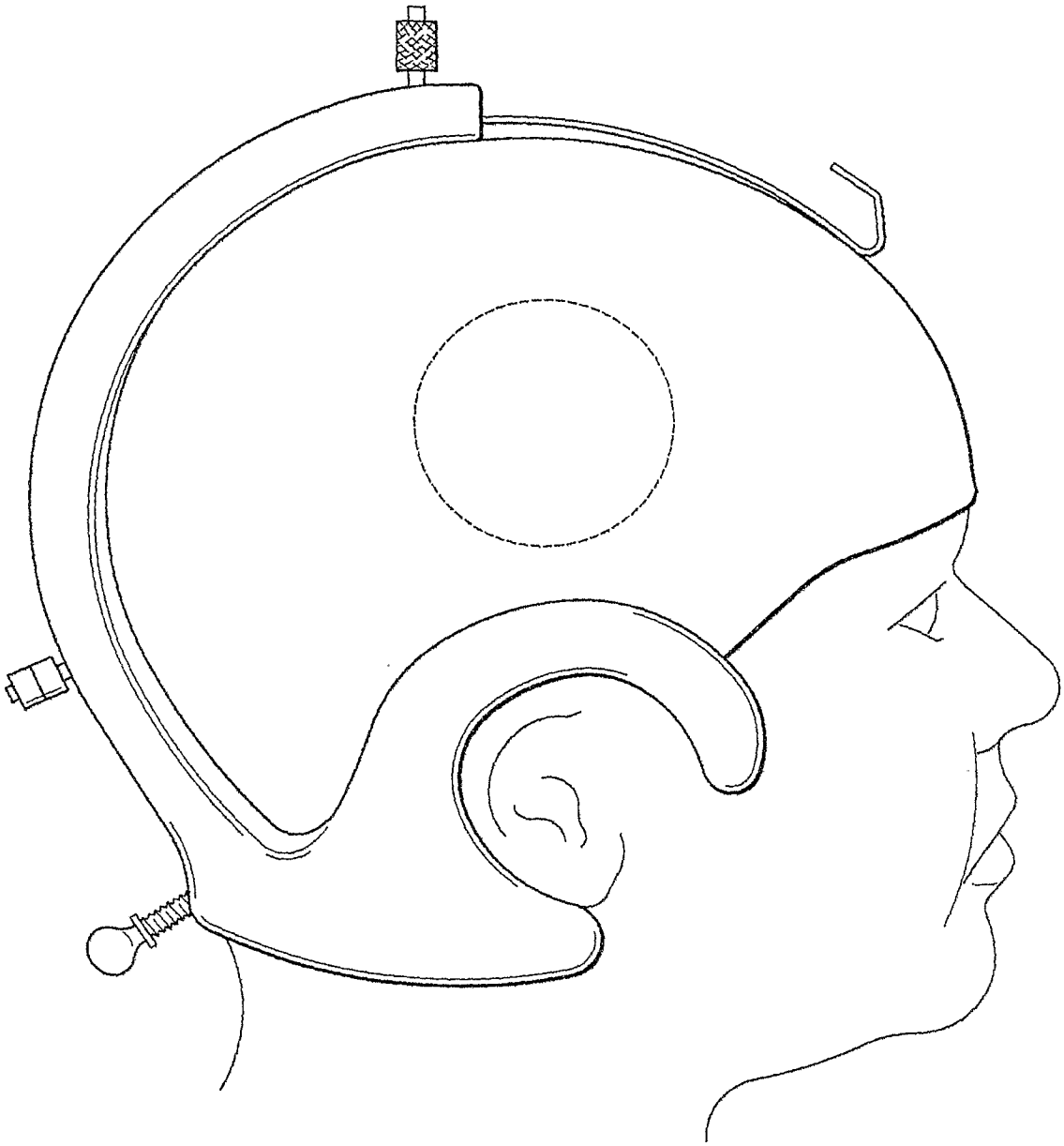


FIG. 15b

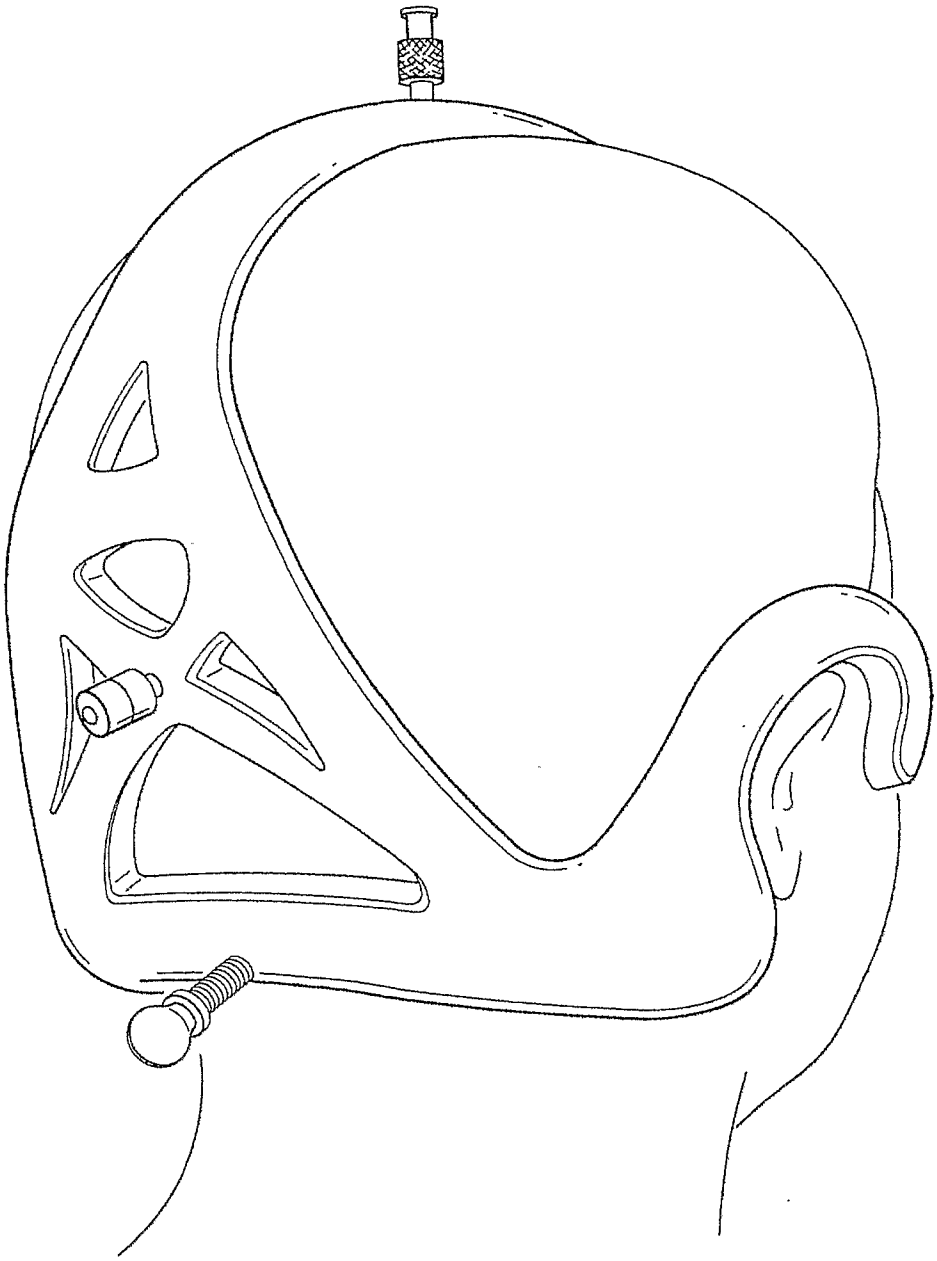


FIG. 15c