(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
29 December 2016 (29.12.2016)

(10) International Publication Number
WO 2016/209078 A2

(51) International Patent Classification:
A61N 1/04 (2006.01) *A61B 5/16* (2006.01) *A61N 1/36* (2006.01) *A61B 5/00* (2006.01) *A61B 5/048* (2006.01)

(21) International Application Number: PCT/NL2016/050448

(22) International Filing Date: 23 June 2016 (23.06.2016)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2015017 24 June 2015 (24.06.2015) NL

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

(54) **Title**: INDUCING LUCID DREAMING

(57) **Abstract**: The present invention is in the field of induction of lucid dreams by Transcranial Alternating Current Stimulation (TACS). Lucid dreaming refers to a well-documented and scientifically accepted phenomenon that may occur during natural sleep. Lucid dreaming is characterized by awareness of the fact that one is dreaming, an increased chance of control over the events that are occurring within the dream and increased logical or rational thought during the dream.

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Title Inducing lucid dreaming

FIELD OF THE INVENTION

The present invention is in the field of induction of lucid dreams by Transcranial Alternating Current Stimulation (TACS).

BACKGROUND OF THE INVENTION

The present invention is in the field of induction of lucid dreams by Transcranial Alternating Current Stimulation (TACS). Lucid dreaming refers to a well-documented and scientifically accepted phenomenon that may occur during natural sleep. Lucid dreaming can be characterized by awareness of the fact that one is dreaming, an increased chance of control over the events that are occurring within the dream, and increased logical or rational thought during the dream.

Research has shown that the likelihood of lucid dreaming to occur during natural sleep is relatively common for children, but declines with age. In adulthood, the likelihood of naturally occurring lucid dream is very small. Lucid dreaming and a deliberate induction of lucid dreams has been a topic of interest in Hinduism and Buddhism for many years. In western society the scientific and public interest in induction of lucid dreaming is increasing rapidly in recent years.

The induction of lucid dreams can be used in different contexts. A first application is recreational; the above characteristics of lucid dreaming: awareness, control and thought, are commonly experienced as entertaining, pleasurable and uplifting. Second, induction of lucid dreaming can be used in a therapeutic setting. The clinical application of lucid dreaming induction has mainly focused on treating recurrent nightmares (Abramovitch, 1995; Aurora et al., 2004; Brylowski, 1990; Spoormaker & van den Bout, 2006; Tanner, 2004; Zadra & Pihl, 1997), whereas possible clinical applications may include psychoses in schizophrenia, sleep walking, sleep paralyses and physical rehabilitation through motor imagery (Mota-Rolim & Araujo, 2013). Further lucid dream induction may be useful for practicing or rehearsing waking activities such as oral presentations, playing a musical instrument and sports.

There exist a number of methods that are aimed at increasing the likelihood of lucid dreams. These methods are detailed below and can roughly be categorized as cognitive techniques, external stimulation, drugs, and electrical neuromodulation.

Cognitive techniques.

Several forms of mental exercises have been studied that aim to increase the likelihood of lucid dreams. For example, the Mnemonic Induction of Lucid Dreams (MILD) technique requires subjects to practice remembering and rehearsing dreams, to focus on the intent to become lucid and to visualize becoming lucid during normal dreams. According to a recently published review paper (Stumbrys et al., 2012) there is some evidence that cognitive techniques may have a modest effect on the likelihood of lucid dreams.

External stimulation.

There have been numerous attempts to induce a lucid dream by applying some form of external stimulation during dreaming. One of the most common forms of external stimulation is light stimulation applied using a sleep-mask; more specifically, a sleep-mask containing small light bulbs starts to emit light flashes during dreaming. These light flashes will be experienced by a subject while dreaming and serves as a cue for realizing that the subject is dreaming, thus triggering a lucid dream state. Stumbrys et al. (2012) concluded that light stimulation may increase the likelihood of lucid dreams, but that the studies that report these effects have poor methodological designs and publication bias may have played a role. Therefore the results of these studies should be interpreted with caution.

Drugs.

There is a study that has been described in the U.S. Pat. No 0266659 (LaBerge, 2004) that showed that Donepezil, an acetylcholine esterase inhibitor, increases the likelihood of lucid dreams. However, this study has not been published in a scientific journal, which makes it not possible to judge its scientific validity.

Electrical neuromodulation

More recent attempts in inducing lucid dreams have used methods with which brain activity can be modulated directly using electrical stimulation applied to the scalp. One study by Stumbrys (2013) applied Transcranial Direct Current Stimulation (TDCS) during dreaming using electrodes attached to the subjects' forehead. TDCS refers to a technique in which a constant, weak electrical current flows from one electrode (the cathode) to another (the anode). Research has shown that brain activity increases at the anode site and decreases at the cathode site. The aim of Stumbrys et al. (2013) was to change brain activity in the frontal regions of the brain, since these are presumably involved in lucid dreaming. The TDCS stimulation increased the likelihood of lucid dreams only in experienced lucid dreamers and the effects were not very strong.

Transcranial Alternating Current Stimulation (TACS) refers to a technique in which a weak alternating current is applied to the brain using electrodes attached to the scalp. An important feature of TACS is that the alternating current can be applied in different frequencies. Kroll (U.S. Pat. No 8267851 B1, 2012) filed a patent directed to a method and device using a specific CES signal with a central frequency around 40Hz and a specific energy distribution which is applied during waking. The goal thereof is to increase the chance of lucid dreaming later on after the subject falls asleep. There have been no scientific studies showing that this indeed is an effective method to induce lucid dreams.

Voss et al. (2014) studied the effects of TACS with different frequencies applied to the frontal and temporal regions of the brain during normal dreaming. The results showed that in unexperienced, naïve subjects, lucid dreams were induced in about 58% and 77% of the cases when TACS was applied with 25Hz and 40Hz. TACS was only applied by a person detecting eye-movement associated with REM-sleep; such detection is considered to be quite random and not systematic. This percentage was significantly higher compared to TACS with 2Hz, 6Hz, 12Hz, 70Hz or 100Hz TACS or sham stimulation, which resulted in an average lucid dream induction percentage of 5%.

Dream detection

Most research on lucid dreaming relies on polysomnography in order to distinguish dreams from other sleep stages. The dream stage is often referred to as rapid eye movement

(REM) sleep in this context, since the occurrence of rapid eye movements is a common feature of dreams. Polysomnography is a technique in which several physiological measures are combined. These physiological measures include Electroencephalography (EEG, which measures brain activity), electrocardiogram (ECG, which measures hart rate), electro-oculogram (EOG, which measures eye movements), electromyogram (EMG, which measures muscle tension), and respiration measures (oral and nasal air-flow, thoraco-abdominal respiratory movements, and oxygen saturation).

Even though polysomnography is considered a 'golden standard' for distinguishing sleep stages, the technique is cumbersome, expensive and not suitable for home use without supervision. Therefore detection of eye movement is used in isolation for detecting REM sleep in the currently available lucid dreaming devices that either apply external auditory/visual stimulation or TACS. Eye movements are either detected with EOG or infrared light movement sensors in these devices. A standard way to record EOG is using electrodes placed at the outer canthus of the left and right eye. However, EOG can also be measured at other locations of the scalp, such as the forehead. Eye movements produce out-of-phase voltage deflections which can be used for automatic detection of eye movements. However, eye movements are only present in a fraction (about 27%) of the time in REM sleep and the scientific basis for reliably detecting REM sleep using eye movement is weak.

Some further documents may be considered.

US 2008/319505 A1 recites an integrated transcranial current stimulation and electroencephalography device, wherein data obtained by EEG electrodes is received, amplified, converted, and then processed by a microcontroller that extracts frequency information from the sampled data and produces signals in response to the extracted EEG data. These signals are converted to create a software-definable alternating voltage used to control a current-source that connects to stimulation electrodes. The device may further download recorded EEG data from the microcontroller to a computer for further analysis. Using the device, EEG signals are detected, then received, processed, and analyzed by a microcontroller to identify the patient state. Based on the patient state and the desired protocol, a type and amount of current stimulation to apply to the patient is determined and a control signal is sent from the microcontroller to the current source in order to trigger the transcranial current stimulation of the patient. Said device is first of all not intended for inducing lucid dreams but for treating schizophrenia and does not mention such at all. Further the used frequency of 1 Hz is typically too low, the device can not be fixed, no processor is provided, which makes it even more unsuited.

WO2015/069632 A1 recites methods, devices and systems for transcranial stimulation. Apparently certain characteristics of a detected EEG signal result in application of TACS. The EEG signal is used for detecting deviating neural oscillations and treatment thereof with TACS with the aim of reducing said deviations.

The above methods of inducing lucid dreaming are therefore considered unreliable.

The present invention therefore relates to an improved method and device for inducing lucid dreaming, which solves one or more of the above problems and drawbacks of the prior art, providing reliable results, without jeopardizing functionality and advantages.

SUMMARY OF THE INVENTION

The present invention relates to a device 100 according to claim 1, and a method according to claim 5, for inducing lucid dreaming.

The present method and device relate to lucid dream induction during dreaming such as by utilizing an Electroencephalogram (EEG) for detecting dreams. Lucid dreaming is then induced using electrical stimulation during normal dreams. The device monitors brain activity using at least one electrode attached to a subject’s head during sleep. The device detects when the subject starts to dream, upon which the device will start to stimulate the brain e.g. for several minutes using weak electrical pulses with an amplitude and frequency found to elicit lucid dreaming. It has been found that using a single channel EEG, REM-sleep can be detected with an accuracy of above 85%. After detecting REM-sleep lucid dreaming is almost always induced (> 77%).

In standard polysomnography, EEG is recorded using one or more electrodes positioned according to the international 10-20 system. Automatic detection of REM sleep on the basis of the EEG signal is fundamentally different from automatic detection of REM sleep on the basis of the EOG signal in that EEG analyses for automatic REM detection typically includes a form of spectral decomposition in order to assess the amplitude of the relevant different neural activity frequencies (or oscillations). Spectral decomposition analyses include, but are not limited to band-pass filtering, Fast Fourier Transformations and wavelet analyses.

None of the prior art methods describe a combination of detecting REM sleep using EEG and stimulating brain activity using TACS during the REM phase in order to induce lucid dreaming. With the present invention it has been found that in more than 77% of the detected REM sleep lucid dreaming is achieved.

Disclosed herein is a method and device for inducing lucid dreams by applying TACS during REM sleep; such is typically done in an automated manner, amongst others by detecting REM sleep, which is typically not possible with prior art devices. The device is preferably an integrated device, having substantially or all of its components, in so far as possible, in one housing 103 or the like. In addition the present device is wearable, typically on the head of a person. A preferred embodiment of the device contains electrodes 101a,b which are positioned on the forehead 101a and behind the ears 101b (on the mastoids) of a subject (or person). Using one or more of these electrodes, EEG can be measured and REM sleep can be detected e.g. by applying threshold criteria to specific spectral characteristics within the EEG signal. TACS may be applied using the same electrodes as those used for measuring EEG though it is preferred to apply TACS at least on the frontal brain areas (left and right) and only optionally in combination with the mastoids.

The present device comprises a fixing means 107 for fixing or attaching the device to a person’s head, such as an electrode with adhesive material, a strap, a belt, an elastic band, etc. The fixing means is preferably adjustable to a size of the persons head.

The device comprises an electrical pulse generator 326 for providing transcranial alternating current stimulation (TACS) pulses during REM sleep. The alternating current has a specific frequency and amplitude. It is also preferred to control electrode impedance within a specific range. Good results are obtained with alternating currents in a frequency range of 5-70 Hz, preferably 10-60 Hz, more preferably 35-45 Hz, such as 40 Hz, an electrode impedance of 1-100 kΩ, preferably 1-10 kΩ, such as 2-5 kΩ, and a current density of 1-10000 $\mu A/cm^2$, preferably 2-2500 $\mu A/cm^2$, more preferably 5-1000 $\mu A/cm^2$, even more preferably 10-100 $\mu A/cm^2$, such as 15-75 $\mu A/cm^2$, e.g. 18, 20, 40 or 60 $\mu A/cm^2$. The term impedance relates to the measure of the opposition that a circuit presents to a current when a voltage is applied. In this case the impedance relates to the output impedance of the electrodes.

The device comprises at least one pair of first electrodes 101a,b, the first electrodes of a pair spaced apart, for providing TACS pulses preferably to the frontal brain area, typically to a left and right section thereof. Typically the first electrodes are spaced apart e.g. such that at least one is located on a forehead of a person and at least one behind an ear (the mastoid). In such a case a connector is provided between the electrode and the device.

The device comprises at least one sensor 201 for electrically detecting REM sleep; such is typically not found in prior art devices. The sensor is typically provided as an electrode, though alternative options may be used as well, or combinations thereof. The sensing electrode is typically located on the forehead, it detects weak electrical changes and provides these as a signal to a processor. The sensor typically forms a part of the device, but may be located elsewhere on the body or the like.

The present (first, second, third, etc.) electrodes may have a shared functionality, i.e. be combined into one electrode, such as for both detecting REM sleep and providing (one pole) of the TACS.

The device comprises a processor 324 for processing the signal and determining presence or absence of REM sleep.

The device further comprises a controller 320, for controlling TACS parameters, which may be very sophisticated.

The first and optional further electrodes, electrical pulse generator, controller, and optional further elements, are functionally in electrical contact with one and another.

The present device can be applied in the present method.

Thereby the present invention provides a solution to one or more of the above mentioned problems and drawbacks, without jeopardizing beneficial effects.

Advantages of the present description are detailed throughout the description.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates in a first aspect to a device according to claim 1.

In an exemplary embodiment the device further comprises a REM signal spectral decomposer 325, which may implement a fast Fourier Transformation (FFT), a wavelet filter, and a band pass-filter. Therewith a reliability of detecting REM sleep is increased.

In an exemplary embodiment the device further comprises at least one second electrode 101a,b, preferably at least two second electrodes, wherein the at least one second electrode is placed at a distance arranged to be attached to a person's head behind the person's ear such as on the mastoids. These at least one second electrode may provide TACS pulses.

In an exemplary embodiment the device further comprises at least one third electrode 108a for measuring a reference signal, typically one or two electrodes. The reference signal may be deducted from the REM-sleep signal. It has been found that typically background noise, head movement, white noise, power supply noise of 50 or 60 Hz, and muscle tension, may distort a REM sleep signal. By detecting and using the reference signal the reliability of the REM sleep signal is hereby increased and thus the chance of induction of lucid dreams is further increased. The reference signal electrode may be one of the TACS electrodes. Moreover, the third electrode 108a may be used to measure impedance of the other electrodes 101a,b and 108b. TACS is only applied when the impedance is below a predefined threshold, for example 10kΩ.

In an exemplary embodiment the device further comprises at least one of an amplifier 325, a control unit 323, a storage unit 321, a connector 322, a power supply 310, a memory, a transceiver, an on-off switch (105), a status indicator (104), ventilation openings (106), and software stored on the memory. The amplifier may be used to amplify the REM sleep signal. The control unit may perform further functions as is e.g. detailed below. The storage unit may store data of a person, may comprise reference data, etc. A connector may be used to connect the present device to an outside world. Typically a power supply, such as a battery, an energy scavenger, a capacitor, and combinations thereof, is present for operating the present device. The present device is typically operated at a voltage of 1.5-12 V. The memory may perform comparable functions as the storage unit. Typically software for operating the device and for adapting functionality of the device is present.

In an exemplary embodiment the device further comprises at least one fourth electrode 108b or connector for grounding the device. As such noise and the like are reduced.

In an exemplary embodiment of the device at least one of the electrical pulse generator 326, the processor 324, the controller 320, the sensor 201, an amplifier 324, a control unit 323, a storage unit 321, a connector 322, a power supply 310, a memory, a transceiver, an on-off switch (105), a status indicator (104), ventilation openings (106), and software stored on the memory, are provided in a central part of the device for placement on a forehead of the person, preferably in one housing 103.

In an exemplary embodiment of the device the electrodes (first, and optionally second, third and fourth) have each independently an attachment surface area of 20-50 mm^2, preferably 30-40 mm^2, such as 35 mm^2. Good results are obtained with said electrodes.

In an exemplary embodiment of the device the at least one sensor for electrically detecting REM-sleep is an EEG sensor.

In a second aspect the present invention relates to a method, which is a non-medical method, of inducing lucid dream-

ing, comprising the steps of:
determining presence or absence of REM sleep, and if REM sleep is present, during a period of time providing transcranial alternating current stimulation (TACS) pulses with a frequency of 5-70 Hz, an impedance of 1-100 kΩ, and an amplitude of 1-10000 $\mu A/cm^2$. With the term "non-medical" a treatment of the human body, such as by surgery or therapy, as well as diagnostics methods practiced on the human body are excluded; however use of the present method for e.g. recreational purpose, for fun, for the benefit of a human, such as mental benefit, are included. In other words if REM sleep is detected a TACS stimulus is applied. The stimulus induces lucid dreaming. In most cases it has been found that if the TACS stimulus is completed (after the above period of time) the lucid dreaming remains as it is. In most cases it has been found sufficient to apply the TACS stimulus for a period of time being shorter than the length of a lucid dream. It has been found that in most cases no further TACS stimulus needs to be applied until an end of a lucid dream. In such cases TACS could be applied again after the lucid dream. In some cases, on the other hand, it has been found that TACS can be applied more than once during REM sleep, such as 2-10 times.

In an example of the present method REM sleep is determined using the present device. In an alternative, or in combination, REM sleep may be determined by a further device, being in (wireless) contact with a TACS device, the device being e.g. a heart rhythm monitor, a muscle tension monitor, and the like, which may be capable of detecting characteristics that can be attributed to REM sleep in a reliable fashion.

In an example of the present method TACS is applied for a predetermined duration of time of 1 sec-60 min, preferably 30 sec-30 min, more preferably 1 min-10 min, such as 2 min-5 min. It has been found that not too long periods of applying TACs are sufficient to induce lucid dreaming.

In an example of the present method TACS is applied directly after determining presence of REM sleep, i.e. within a few minutes time after detection, typically within 30 seconds. Therewith a more reliable manner of inducing lucid dreaming is given.

In an example of the present method TACS is applied after determining onset of REM sleep with a predetermined delay of 0.01 sec-30 min, such as 1 sec-5 min. For some persons a delay is found to provide better results.

In an example of the present method TACS is applied with a predetermined constant amplitude of 1-10000 μA/cm². The amplitude is preferably high enough to induce lucid dreaming, and low enough to prevent burning or unpleasant sensations on the skin.

In an example of the present method TACS is applied with a varying amplitude of between 1-10000 μA/cm², such as 10-100 μA/cm², e.g. 18, 20, 40 or 60 μA/cm². The amplitude may vary once, a few times, a number of times, or constantly. The amplitude may vary with a ratio relative to the applied amplitude, such as ±10-50% (e.g. 20±2 to 20±12 μA/cm²), or with an absolute amount, such as ±10-40 μA/cm². The varying amplitude is found to stimulate dreams even (slightly) better.

In an example of the present method TACS is applied with intermittent bursts of a predetermined duration of 2 msec-1 sec, preferably 10 msec - 0.5 sec, such as 100 msec-125 msec, and with a predetermined interval of 2 msec- 1 sec, preferably 10 msec - 0.5 sec, such as 100 msec- 125 msec. So at one hand a specific frequency for stimulation is chosen, e.g. 40 Hz. The stimulation is applied during a period of time, such as one minute. Within that one minute a burst of a certain duration of e.g. 125 mseconds is followed by a pause of also 125 mseconds, and such is continued for the period of time. It has been found that this intermittent mode of operation provides better results for some persons, and/or more intense lucid dreaming.

In an example of the present method the total number of TACS periods per sleeping period of approximately eight hours is limited to a predetermined number, preferably 1-30, more preferably 2-20, such as 3-10.

In an example of the present method through wireless contact settings are adapted, such as a frequency, impedance, amplitude, duration of time, moment of application of TACS, delay, constant amplitude, varying amplitude, duration of bursts, and number of TACS periods, and/or wherein statistical data is gathered. Wireless contact can be established using varies protocols, such as bluetooth. Contact may be established to a further device, such as a mobile phone. Adaptation can be performed on said further device.

The one or more of the above examples and embodiments may be combined, falling within the scope of the invention.

The invention is further detailed by the accompanying figures, which are exemplary and explanatory of nature and are not limiting the scope of the invention. To the person skilled in the art it may be clear that many variants, being obvious or not, may be conceivable falling within the scope of protection, defined by the present claims.

FIGURES

The invention although described in detailed explanatory context may be best understood in conjunction with the accompanying figures. In the figures:

Fig. 1a,b show a schematic example of the present device.

Fig. 2 shows a method of inducing lucid dreaming.

Fig. 3 shows a block diagram of an exemplary part of the present device.

DETAILED DESCRIPTION OF THE FIGURES

In the figures:

100	device
101a	first electrode (frontal or mastoid)
101b	second electrode (frontal or mastoid)
102	wiring
103	housing
104	status indicator
105	on-off switch
106	ventilation openings
107	adhesive material
108a	reference electrode
108b	ground electrode
201	monitor and record EEG
202,208	REM sleep detection
203	TACS period controller
204	impedance sensor
205,209	delay generator
206	TACS applicator

207	EEG monitor and recorder
310	power supply
320	control circuitry
321	Storage unit
322	connector
323	control unit
324	processor
325	EEG amplifier
326	TACS generator
331-336	electrodes
340	external hardware
341	user interface

The present invention involves a device which monitors EEG activity using one or more electrodes attached to the scalp of a subject. A headband or electrodes surrounded by adhesive material may be used to fixate the electrode(s) on a specific location for the duration of a sleeping period. Fig. 1a illustrates an example of a device 100 including first and second electrodes 101a,b surrounded with adhesive material 107 and hardware in a housing 103 for detecting REM sleep and applying TACS. It also includes wiring 102 outside of the device in order to connect the electrodes to the hardware. Figure 1b illustrates an example of a device including electrodes 101a,b, electrode wires 102, housing 103, status indicator 104, on-off switch 105 and openings 106 for ventilation. The electrodes consist of a gel core which surrounded by adhesive material 107. The gel core has the purpose of ensuring low impedance between the electrode and the skin. On the back of the device, there are two integrated electrodes 108a,b, one ground electrode and one reference electrode. These electrodes further has the purpose of keeping the device attached to the forehead.

FIG. 2 illustrates an example of a high level decision model in which the process of detecting REM sleep and subsequently applying TACS is depicted. During sleep, EEG activity is recorded and monitored 201. REM sleep detection 202 is implemented using some form of spectral decomposition such as, but not limited to: band-pass filtering, Fast Fourier Transformations or wavelet analyses. Algorithms are applied which extract features from the result of the spectral decomposition which are capable of differentiating REM sleep from non-REM sleep. These features are then compared with predetermined threshold criteria to determine whether the subject is currently in REM sleep or not. During REM sleep, when a total number of TACS periods is less than a predetermined number of TACS periods within a current period of sleep 203 and the electrode impedance is less than a predetermined threshold 204, the device will apply TACS immediately or with a predetermined delay 205. It is found that a low electrode impedance is important for the application of TACS, since high impedances may cause unpleasant tingling sensations on the skin and in extreme cases, skin burns. Skin burns are unlikely to occur with the current intensities used in the preferred embodiment. TACS is applied within the frequency range of 1-100 Hz, typically at 40 Hz. TACS may be applied with or without a ramp-up time, in which the current intensity is slowly increasing until it reaches a predetermined plateau. The current intensity may be held constant thereafter, but can also fluctuate, according to predetermined patterns. Alternatively, the TACS may be applied in intermittent bursts of a predetermined duration and with a predetermined interval. After the TACS stimulation has been terminated, EEG activity will again be monitored in order to determine whether the subject is still in REM sleep or REM sleep has ended 207,208. When REM sleep has ended, a delay with a predetermined duration 209 may be implemented before the onset of a new REM period can trigger a new TACS period. It is noted that humans may have about 7 REM sleep periods in an 8-hour sleeping period. Thus, TACS can also occur multiple times per sleeping period. However, a limit may be set as a default or set by the subject for the total amount of TACS periods per sleeping period.

FIG. 3 illustrates hardware components for an example of the embodiment of the present invention. The hardware components may include a power supply 310, for example an alkaline battery, electrodes 330 (331-336), and control circuitry 320. The control circuitry consists of a storage unit 321 for storing for example settings, EEG recordings and event logs, a control unit 323, an EEG amplifier 325, a (signal) processor 324, a TACS generator 326 and a connector, for example using Bluetooth or USB 322 for connecting to external hardware, such as a PC, tablet, smartphone, smart watch, or fitness tracker 340 to the device. Using user interface software 341 installed on one of these external devices, a subject can adjust settings such as TACS frequency, TACS intensity, REM detection thresholds, etcetera.

The figures have been further detailed throughout the description.

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CLAIMS

1. Wearable device (100) for inducing lucid dreaming comprising
a fixing means (107) for fixing the device to a person's head, an electrical pulse generator (326) for providing during REM sleep Transcranial Alternating Current Stimulation (TACS) pulses with a frequency of 5-70 Hz, an impedance of 1-100 kΩ, and an amplitude of 1-10000 $\mu A/cm^2$,
at least one pair of first electrodes (101a,b), the first electrodes of a pair spaced apart, for providing electrical TACS pulses preferably to the frontal brain area,
at least one sensor (201) for electrically detecting REM-sleep and providing a signal, such as an electrode,
a processor (324) for processing the signal and determining presence or absence of REM sleep,
and
a controller (320), for controlling TACS pulses,
the first electrodes, electrical pulse generator and controller being in electrical contact (102) with one and another.

2. Device according to claim 1, further comprising a REM signal spectral decomposer (325).

3. Device according to any of the preceding claims, further comprising at least one second electrode (101a,b), preferably at least two second electrodes, wherein the at least one second electrode is placed at a distance arranged to be attached to a person's head behind the person's ear such as on the mastoids.

4. Device according to any of the preceding claims, further comprising at least one of an amplifier (325), a control unit (323), a storage unit (321), a connector (322), a power supply (310), a memory, a transceiver, an on-off switch (105), a status indicator (104), ventilation openings (106), and software stored on the memory.

5. Device according to any of the preceding claims, further comprising at least one third electrode (108a) for detecting a reference signal.

6. Device according to any of the preceding claims,

further comprising at least one fourth electrode (108b) or connector for grounding the device.

7. Device according to any of the preceding claims, wherein at least one of the electrical pulse generator, the processor, the controller, the sensor, an amplifier (325), a control unit (323), a storage unit (321), a connector (322), a power supply (310), a memory, a transceiver, an on-off switch (105), a status indicator (104), ventilation openings (106), and software stored on the memory, are provided in a central part of the device for placement on a forehead of the person, preferably in one housing (103).

8. Device according to any of the preceding claims, wherein the fixing means is selected from one or more of an electrode with adhesive material (107), a strap, a belt, and an elastic band, and an adhesive material, wherein the fixing means is preferably size adjustable.

9. Device according to any of the preceding claims, wherein the electrodes have an attachment surface area of 20-50 mm^2, preferably 30-40 mm^2, such as 35 mm^2.

10. Device according to any of the preceding claims, wherein the at least one sensor for electrically detecting REM-sleep is an EEG sensor.

11. Non-medical method of inducing lucid dreaming, comprising the steps of:

determining presence or absence of REM sleep, and

if REM sleep is present, during a period of time providing at least once Transcranial Alternating Current Stimulation (TACS) pulses with a frequency of 5-70 Hz, an impedance of 1-100 kΩ, and an amplitude of 1-10000 $\mu A/cm^2$.

12. Method according to claim 11, wherein presence or absence of REM sleep is determined using the device (100) of any of claims 1-10.

13. Method according to any of claims 11-12, wherein TACS is applied for a predetermined duration of time of 1 sec - 2 hours.

14. Method according to any of claims 11-13, wherein TACS is applied directly after determining presence of REM sleep.

15. Method according to any of claims 11-14, wherein

TACS is applied after determining onset of REM sleep with a predetermined delay of 0.01 sec-30 min.

16. Method according to any of claims 11-15, wherein TACS is applied with a predetermined constant amplitude of 1-10000 μA/cm^2.

17. Method according to any of claims 11-16, wherein TACS is applied with a varying amplitude of between 1-10000 μA/cm^2.

18. Method according to any of claims 11-17, wherein TACS is applied with intermittent bursts of a predetermined duration of 2 msec-1 sec and with a predetermined interval of 2 msec- 1 sec.

19. Method according to any of claims 11-18, wherein a total number of TACS periods is limited to a predetermined number.

20. Method according to any of claims 11-19, wherein through wireless contact settings are adapted, such as a frequency, impedance, amplitude, duration of time, moment of application of TACS, delay, constant amplitude, varying amplitude, duration of bursts, and number of TACS periods, and/or wherein statistical data is gathered.

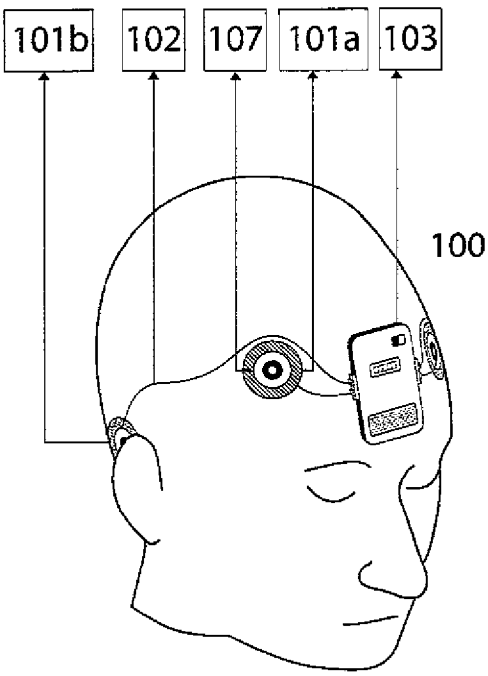
101b
102
107
101a
103
100

FIG. 1A

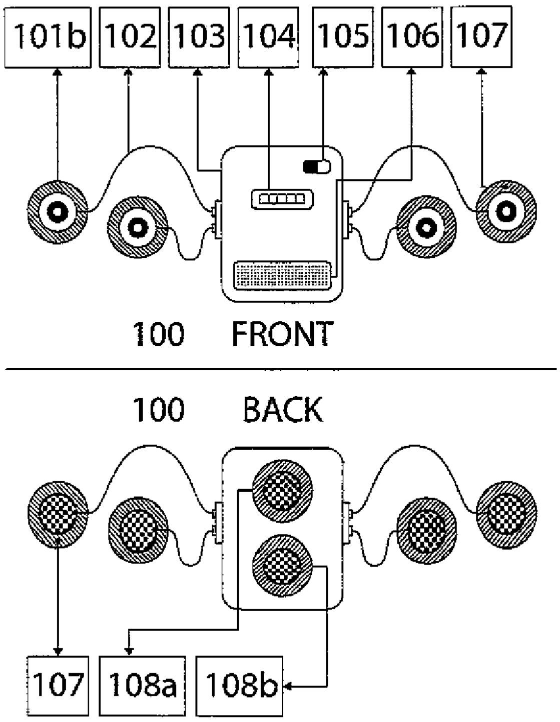
101b
102
103
104
105
106
107
100 FRONT
100 BACK
107
108a
108b

FIG. 1B

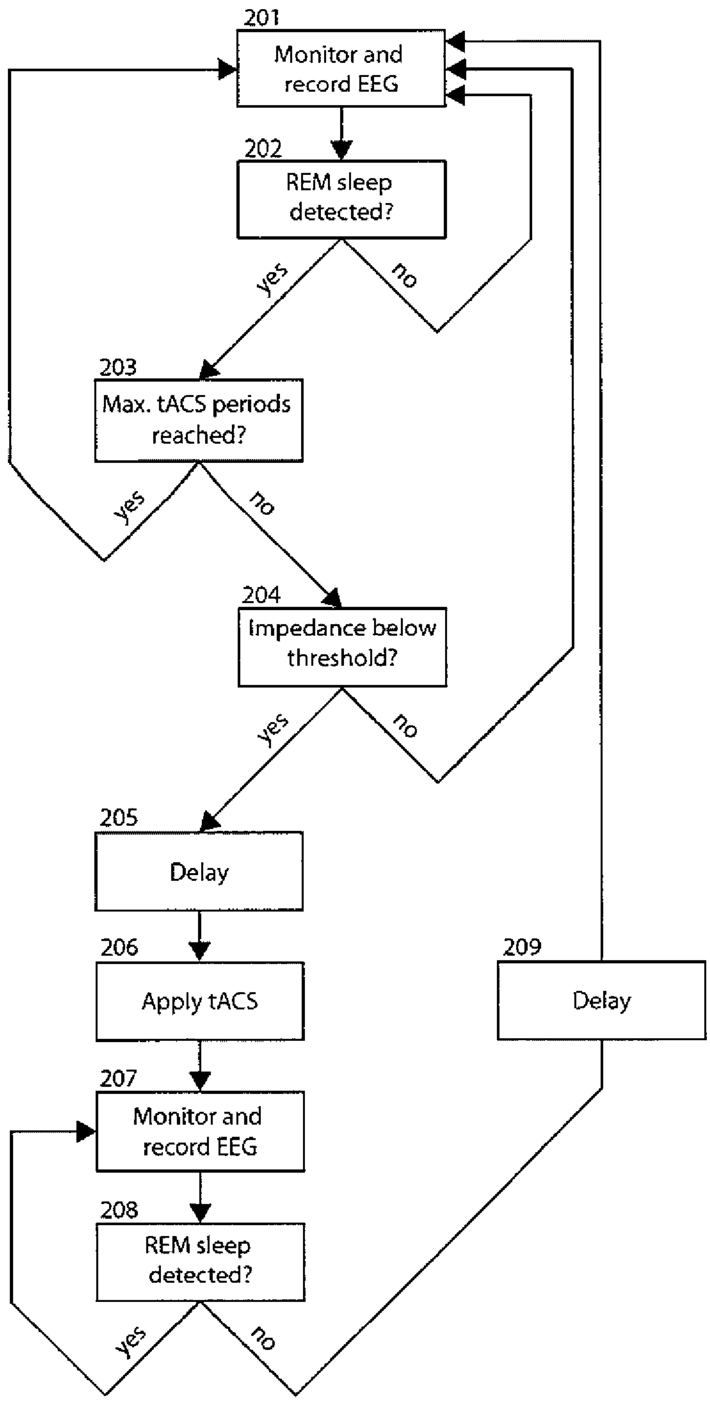
201
Monitor and record EEG
202
REM sleep detected?
yes
no
203
Max. tACS periods reached?
yes
no
204
Impedance below threshold?
yes
no
205
Delay
206
Apply tACS
207
Monitor and record EEG
208
REM sleep detected?
yes
no
209
Delay

FIG. 2

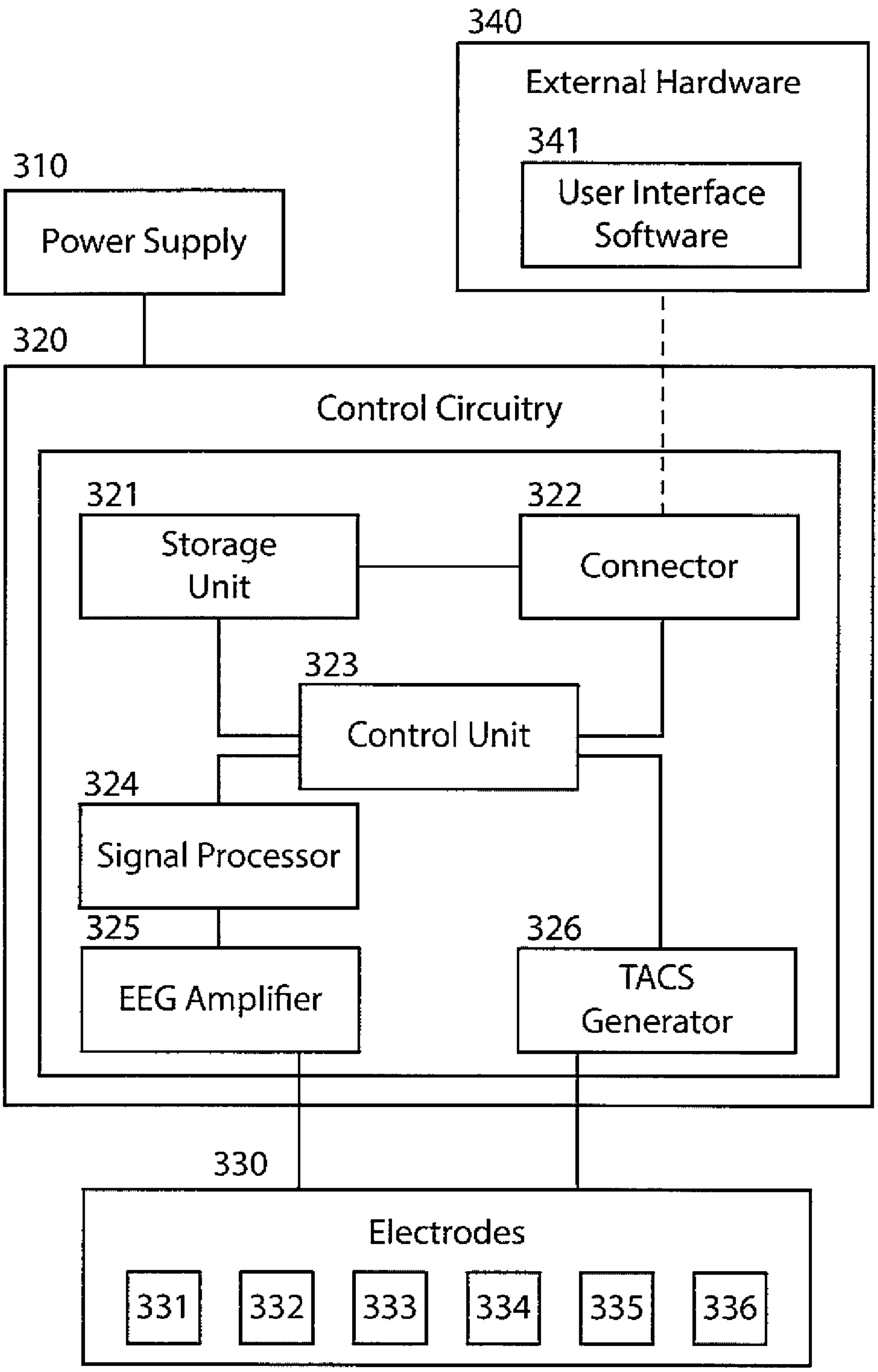
340
External Hardware
341
User Interface Software
310
Power Supply
320
Control Circuitry
321
Storage Unit
322
Connector
323
Control Unit
324
Signal Processor
325
EEG Amplifier
326
TACS Generator
330
Electrodes
331
332
333
334
335
336

FIG. 3