United States Patent [19]

Monroe

[11] **3,884,218**

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[54] **METHOD OF INDUCING AND MAINTAINING VARIOUS STAGES OF SLEEP IN THE HUMAN BEING**

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[21] Appl. No.: **76,923**

[52] **U.S. Cl.** ..... **128/1 C**
[51] **Int. Cl.** **A61b 19/00**
[58] **Field of Search** ..... 128/1 C, 2.1 B, 422

[56] **References Cited**

UNITED STATES PATENTS

2,304,095	12/1942	Hull	128/1 C
3,032,029	5/1962	Cunningham	128/2.1 B
3,384,074	5/1968	Rautiola et al.	128/1 C
3,495,596	2/1970	Condict	128/422
3,576,185	4/1971	Schulz	128/1 C

FOREIGN PATENTS OR APPLICATIONS

211,752	4/1968	U.S.S.R.	128/1 C
1,165,541	10/1969	United Kingdom	128/1 C
1,183,607	12/1964	Germany	128/1 C

Primary Examiner—William E. Kamm
Attorney, Agent, or Firm—Sughrue, Rothwell, Mion, Zinn & Macpeak

[57] **ABSTRACT**

A method of inducing sleep in a human being wherein an audio signal is generated comprising a familiar pleasing repetitive sound modulated by an EEG sleep pattern. The volume of the audio signal is adjusted to overcome the ambient noise and a subject can select a familiar repetitive sound most pleasing to himself.

6 Claims, 8 Drawing Figures

FIG. 1

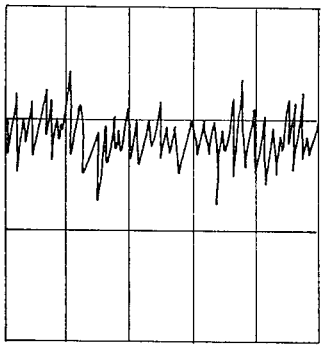


FIG. 2

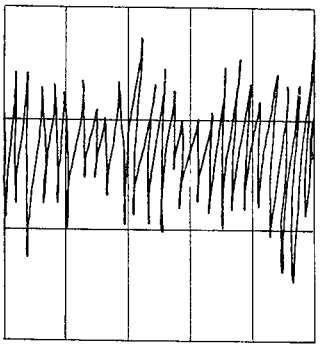


FIG. 3

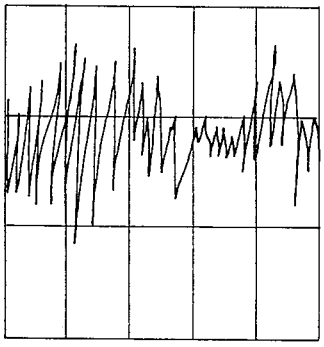


FIG. 4

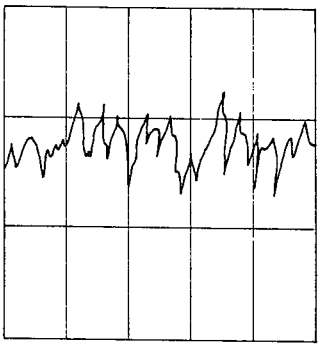


FIG. 5

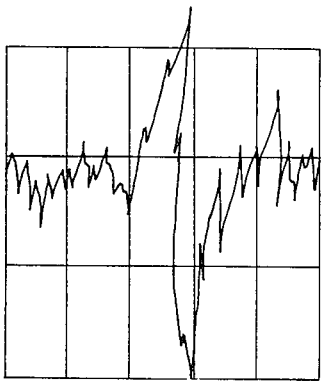


FIG. 6

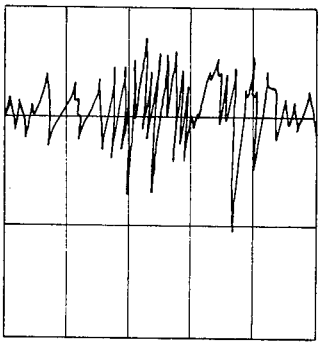


FIG. 7

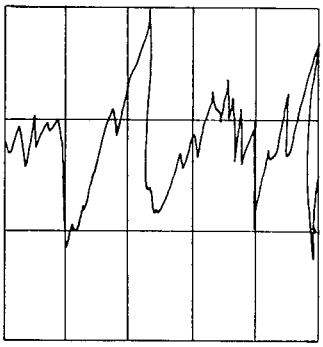
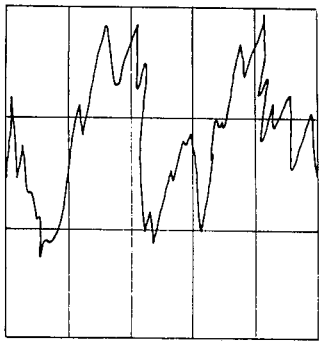


FIG. 8



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METHOD OF INDUCING AND MAINTAINING VARIOUS STAGES OF SLEEP IN THE HUMAN BEING

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a method of inducing sleep in a human being, and more particularly, to a method of inducing sleep by the generation of audio signals which are produced by the modulation of familiar repetitive noises with electroencephalographic (EEG) sleep patterns.

2. Description of the Prior Art

The use of audio generators to induce sleep is well known in the prior art, as exemplified by U.S. Pat. Nos. 2,711,165 and 3,384,074. The audio signals used include pleasing and harmonious steady sounds or vibrations, fixed frequency signals which are cyclicly varied as to amplitude, and repetitive sounds such as the falling of rain on a roof and the sighing wind through the trees.

The prior art also discloses, in U.S. Pat. No. 3,304,095, a method for inducing sleep by the generation of an audible or tactual signal which is related to the physiological processes of heartbeat and respiration. In this method, the pitch and amplitude of a pleasing audio signal are varied at a rate somewhat slower than either the rate of heartbeat or respiration. The heartbeat and respiration will tend to synchronize with the audio signal thereby lowering the heartbeat and respiration rate and inducing sleep.

SUMMARY OF THE INVENTION

The present invention comprises a method for inducing sleep wherein familiar, repetitive, pleasing sounds are modulated by predetermined EEG sleep signals to produce an audio signal which induces various stages of sleep.

It has been found through the use of an EEG that various patterns of electrical activity are associated with different states of consciousness. There are two primary states, waking and sleeping. Within the waking state, there are various degrees of alertness ranging from frantichyperalertness through relaxed attentiveness to drowsiness. There are also several stages of sleep ranging from a light to deep. All of the various states of alertness and sleep have EEG patterns which are characteristic of the state. These patterns tend to be basically similar for all normal human beings. It is well known in the prior art, as set forth above, that familiar, repetitive, pleasing sounds tend to produce drowsiness and sleep in an individual. In the method of this invention, however, the pleasing sounds are combined with the EEG sleep patterns by modulating the former with the latter. The audio signal thereby produced has been found to be a quick and efficient sleep inducing signal. In the method of this invention, the individual has the opportunity of selecting a signal most pleasing to himself for inducing sleep, and furthermore, he may determine the level of the sleep inducing signal in order to overcome ambient noise conditions.

In addition, the subject may time the sleep inducing signal such that upon completion of a predetermined time period the signal will stop and, he will drift back to wakefulness.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a typical human EEG pattern of awakeness with eyes open.

FIG. **2** is an EEG pattern of awakeness with eyes closed.

FIG. **3** is an EEG pattern of drowsiness.

FIG. **4** is an EEG pattern of descending stage 1 sleep.

FIG. **5** is an EEG pattern of stage 2 sleep.

FIG. **6** is an EEG pattern of stage 2 sleep with sleep spindles.

FIG. **7** is an EEG sleep pattern of stage 3 sleep.

FIG. **8** is an EEG sleep pattern of stage 4 sleep.

DESCRIPTION OF THE PREFERRED METHOD

An electroencephalogram (EEG) is a device for measuring the fluctuation of electrical potentials due to the electrical activity of the brain. It has been found, through the use of the EEG, that various patterns are generated during different states of consciousness of the human being. This is the subject of the book *Electroencephalography: A Symposium In Its Various Aspects*, by Hill and Park. There are two primary states of consciousness, waking and sleeping. Within the waking state, there are various degrees of alertness ranging from frantic hyperalertness to drowsiness. Extreme alertness is associated with a low voltage, generally fast and irregular, of 10 to 20 microvolts amplitude and frequencies ranging from 10 to 40 cycles per second. Relaxed alertness is accompanied by an alpha rhythm, which is a regular sinusoidal rhythm with a frequency between 8 to 13 cps. As the state of consciousness changes from relaxed alertness to drowsiness, the alpha rhythm breaks up and tends to become less and less frequent.

The first stage of sleep or state 1 has an EEG pattern, as shown in FIG. **4**, which consists of an irregular mixture of theta waves which are low in amplitude with a frequency of 4 to 8 cps, occasional alpha waves, and irregularly occurring alphoid waves which are similar to alpha waves but have a frequency of 1 to 2 cps lower than the alpha wave.

An individual progresses from stage 1 sleep to stage 2 sleep, the EEG pattern of which is shown in FIG. **5**. The stage 2 pattern is similar to stage 1 except that sleep spindles begin to appear. The spindles are short bursts of waves at a frequency of about 14 cps. They start at low amplitude and build up very rapidly to an amplitude of 30 or 40 microvolts and then quickly taper off.

The individual then passes into stage 3 sleep, the EEG pattern of which is shown in FIG. **7**. Stage 3 sleep is characterized by the appearance of delta waves which are waves of an amplitude of approximately 100 microvolts or more and a frequency of 1 cps. Stage 4 sleep which follows stage 3 sleep is characterized by a preponderance of delta waves as opposed to the occasional delta waves of stage 3 sleep. In sleep stages 3 and 4, the spindles and irregular theta waves appearing in stage 2 sleep still appear.

Stages 1 through 4 were initially conceived of as comprising a continuum from "light" to "deep" sleep, but many other measures of the depth of sleep contradict this ordering. Stage 1 sleep occurring later in the night seems to have very distinct characteristics which make it a distinct kind of sleep, while stages 2, 3 and

4 do seem to comprise a depth continuum in a second kind of sleep.

Stage 1 EEG sleep periods later in the night are accompanied by binocularly synchronous rapid eye movements (REMs), highly variable heart rate and breathing, and an inhibition of nerve transmission to the muscles.

If subjects are awakened from the two types of sleep and asked to report what they have been experiencing, the reports may be classified into two rather distinct types. One type – awakenings from stage 1 sleep or shortly (within, roughly 10–15 minutes) after stage 1 sleep has changed to nonstage 1 sleep – possesses the characteristics traditionally associated with the experience of dreaming. Reports from nonstage-1 sleep seem more like "thinking" and are generally called thinking by the subjects (these same subjects generally refer to their stage 1 experiences as dreams). The psychological differences reported so far are quantitative, rather than being completely dichotomous, but generally give the impression of distinct types of experiences.

Stage 1 sleep is almost always accompanied by REMs, and the evidence is very convincing that these are closely associated with the content of the dream, if not actual scanning movements of the dream imagery. Such REMs have not been reported in non-stage 1 sleep, although there are some slow, rolling movements of the eyes.

For a normal subject, stage 1 dreaming and non-stage 1 sleep alternate in a regular, cyclic fashion, the sleep-dream cycle. As a subject falls asleep, there is generally a brief period (a few seconds to a minute or two) of stage 1, without REMs, but subjects' reports indicate that this is a period of hypnagogic imagery rather than typical dreaming. At approximately 90 minute intervals throughout the night there are periods of stage 1 dreaming, each dream period generally being longer than the preceding one. The first stage 1 period may last for 10 minutes; the fourth or fifth may last as long as 50 minutes. Altogether, stage 1 dreaming occupies between 20 and 30% of the total sleep time of most young adults, spread over 3 to 6 stage 1 periods. While the exact percentage of dream time and the number of cycles vary from subject to subject, for a given subject the sleep-dream cycle is generally quite stable from night to night.

It is well known that the human body will respond to several sensory perceptions to induce sleep. However, the aural sense organ is the only one which continues to function not only during relaxation and drowsiness but also into the first three stages of sleep as well. Therefore, the induction of sleep by aural means is the most practical method of inducing controlled sleep.

It has been found that familiar repetitive sounds tend to produce drowsiness and sleep. Conversely, the lack of these sounds tends to produce alertness and wakefulness. The sounds which effect a particular individual, because they must be familiar sounds, are dependent upon the environment of that individual. In other words, a city dweller may sleep with the steady rumble of traffic but he might find the sound of crickets to be so noisy that he cannot sleep. Investigation has shown that each individual is receptive to a specific sound pattern and these patterns are the product of his environmental conditioning. Some of the more common familiar repetitive sounds which tend to induce sleep are rain on a roof, machinery hum, gentle wind, ocean surf, breathing, heartbeat, the human voice when noncommunicative or a steady 500 cycle hum. Wakefulness is produced by such warning signals as auto horns, alarms, baby cries, etc. Each individual, therefore, has a pattern of response to various sounds. This pattern has been labeled his sound condition index (SCI).

The cultural environment of humans has tended to standardize the SCI to some degree for the various environments which groups of people live in. For instance, the SCI for people living in a large city would tend to be approximately the same as would the SCI for people living out in the country.

In the preferred method of this invention, an audio generator is placed near the bedside of an individual desiring to have sleep induced. The generator has a capability of providing at least seven basic sound patterns. These patterns are in accordance with the SCI of the individual. Typically, the seven basic sounds for a person living in an urban environment would be sounds of rain on a roof, gentle wind, waves upon a beach, slow breathing, machinery hum, the sound of a noncommunicative human voice and a steady 500 cycle hum. An individual, by listening to each of the seven sounds picks the sound which would be most pleasing to him in order to induce the sleep.

The sound generated by the audio generator is the pleasing repetitive sound, as set forth above, amplitude modulated by the stage 3 and 4 EEG sleep pattern. The amplitude of the pleasing sound is confined to an envelope of the EEG sleep pattern. In other words, the familiar repetitive sound is modulated by a wave of theta sleep spindles and delta rhythms which are found in the EEG pattern during stage 3 and 4 sleep. It should be noted that EEG sleep pattern is not an EEG signal but a signal having the same wave shape as an EEG signal. This sound rapidly produces stage 1 sleep followed by stage 2, 3 and 4 sleep in most individuals. It has been found through experimentation that the results achieved by inducing sleep with a signal synthesized by modulating a pleasant signal with an EEG sleep pattern are several magnitudes higher than induction of sleep by use of a pleasant sound only.

The apparatus for generating the familiar repetitive signal and the EEG sleep pattern signal, as well as the apparatus for modulating the former with the latter, may be any standard signal generators and modulators which are well known in the signal generating art.

One of the primary requirements of this method is that the sound produced by the audio generator be sufficient to mask all of the ambient noise in the environment of the individual. This is effected by the individual raising the volume of the audio generator until it is at a level above the ambient noise level of the surroundings.

It has been found that sleep can be maintained by maintaining the presence of the audio signal and that awakeness may be induced by stopping the audio generator. Therefore, an individual may determine the time which he sleeps by setting a timer which will automatically turn off the sound generator and thereby return him to a state of consciousness.

While the invention has been particularly shown and described with reference to the preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and the scope of the invention.

What is claimed is:

1. A method of inducing sleep in a human being, comprising the steps of:

a. generating an audio signal representing a familiar, repetitive, pleasing sound;

b. generating a signal approximating a human EEG signal waveshape characteristic of a state of sleep;

c. amplitude modulating the audio signal with the EEG signal to produce an output signal; and

d. producing an audible sound signal from the output signal for listening by a human being.

2. The method of claim **1** further comprising the step of setting the level of the audible sound signal above the ambient noise level.

3. A method of inducing sleep comprising:

a. generating an EEG sleep pattern signal;

b. generating one of a plurality of signals;

c. modulating the one of a plurality of signals with the EEG sleep pattern signal;

d. generating an audio signal from the modulated signal;

e. raising the audible level of the signal above the ambient noise level of the environment; and

f. setting a timing device to automatically turn off the audio signal after a predetermined time.

4. The method of claim **3** wherein the plurality of signals is predetermined based upon the environment to which an individual is accustomed.

5. The method of claim **4** wherein the EEG sleep pattern signals are predetermined signals which have the same waveshape as the EEG patterns generated by sleeping individuals.

6. The method of claim **3** wherein the step of selecting one of the plurality of audio signals comprises an individual listening to seven signals and deciding which signal is the most pleasing to him.

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