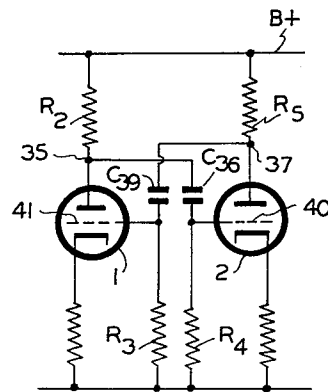
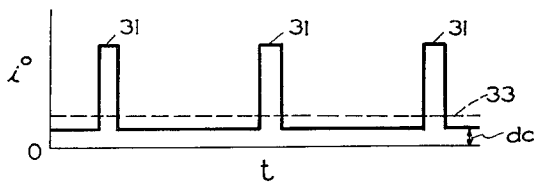
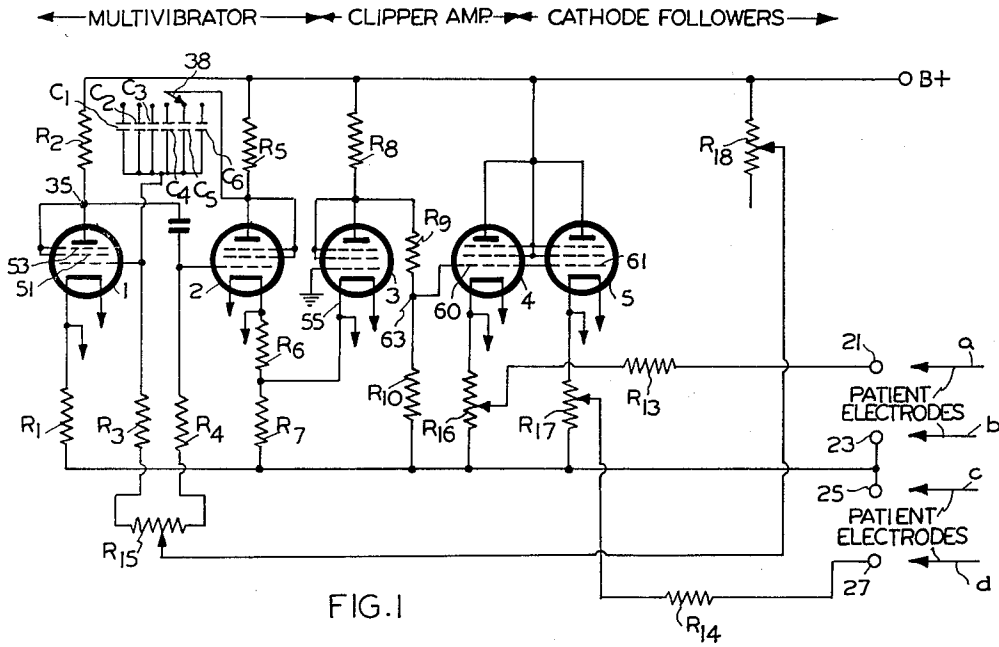


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 DEVICE FOR INDUCING SLEEP

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DEVICE FOR INDUCING SLEEP

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This invention relates to a method of treating various diseases by sleep and a device for the realization of the method.

The invention provides a device for treating various diseases by sleep induced by electric current pulses acting in the patient's brain and supplied to the patient through electrodes adapted to be secured on the patient's head, and has as an object the provision of a device for the realization of the method.

The described method is characterized in that in order to produce deeper sleep in the patient, a combined form of electric current is applied, consisting of square pulses in combination with a galvanic, i.e. direct-current, component in the 25 to 130 cycle per second and higher frequency range.

Electric devices of the stationary type intended for treating various diseases by artificially induced sleep are known. They include a pulse generator in the form of a self-excited multivibrator supplying the generated current pulses to a clipper for cutting the pulse peaks. The pulses are thereafter applied onto the grids of parallel connected tubes operating as cathode-follower stages. Output terminals are provided across the cathode resistors whereat the output voltage is available for application through electrodes to the patient.

One disadvantage of these stationary devices is the impossibility of using them in field conditions, for sleep therapy in the home, as well as during transportation of sleeping patients.

In the present device, this disadvantage is eliminated while reducing the overall dimensions of the device and enabling it to be fed either from A.C. mains or from a dry element battery. The unheated tube filament circuits for the electronic tubes are so designed that they can be fed from separate windings of a transformer, with a parallel connected resistance across each winding. Each resistance has a midtap which may be connected to the cathodes of the multivibrator, clipper and final amplifier.

The drawing shows, in FIG. 1, the circuit diagram of a portable electronic device for treating, by artificially induced sleep, two patients simultaneously. FIG. 2 depicts a composite waveform diagram, and FIG. 3 is a detail of the circuit of FIG. 1 to better explain the switching of the pulse generator.

The device is mounted in a portable case separately from the supply source (mains or battery) and consists of multivibrator tubes 1 and 2, clipping amplifier with grounded grid consisting of tube 3, and of two output stages 4 and 5, connected according to the conventional circuit diagram for cathode-follower stages.

The number of sleep channels may be increased by means of connecting parallel operating cathode-follower stages according to the required number of channels determined by the number of patients to be simultaneously treated.

Smooth alternation of the multivibrator frequency is effected through a potentiometer R_{18} ; coarse alteration of frequency is achieved by a capacitor switch (C_1 , C_2 , C_6).

Alteration of pulse duration (duty-ratio) is effected by potentiometer R_{15} . A milliamperemeter (not indicated in the diagram) is provided for permitting control of the duty of the device during operation, and is switched over,

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depending on necessity of controlling either channel, without interrupting the patient's circuit. Resistances R_{13} and R_{14} serve as shunts.

Output potentiometers R_{16} and R_{17} provide for smooth alteration of power. The output channels are indicated at 12 and 13.

The operation of the device may be better appreciated from a consideration of FIGS. 2 and 3, wherein a typical superimposed wave is illustrated in FIG. 2, and the switching circuitry of the electronic pulse generator is depicted in FIG. 3. It is important to note the absence of any coupling capacitors between the pulse generator, comprising tubes 1 and 2 and the remainder of the circuitry, including the output terminals 21-23 and 25-27, respectively provided for the patient electrodes a and b for the first patient and the patient electrodes c and d for a further patient. The absence of such coupling capacitors enables a galvanic or direct-current component to manifest itself at the output terminals for application to the patient via the patient electrodes. Such a direct-current component is illustrated by the ever present region, identified as the D.C. region in FIG. 2, wherein a train of repetitive square pulses is made up of the individual pulses 31, and the average value is depicted by the dotted line 33. Thus, FIG. 2 illustrates a composite pulse train superimposed upon a D.C. or galvanic component. The graph shows current along the ordinate, and time along the abscissa, each extending from a common zero or origin.

The switching of the multivibrator comprising tubes 1 and 2 will next be described, reference being had to FIGS. 1 and 3. The function of the multivibrator is to transfer current alternately from tube 1 to tube 2 to produce an output pulse across R_7 whenever tube 2 conducts, establishing a potential drop across this resistor. The cessation of current in tube 1 causes its plate voltage at point 35 to rise toward the B+ potential. Because of the flow of condenser current of C_{36} through resistor R_2 , the plate voltage of tube 1 does not immediately rise to the B+ value. The start of current in tube 2 naturally causes the plate voltage at point 37 to fall, because of the drop across resistor R_5 . Since the plate voltage of tube 1 is impressed across the series combination of condenser C_{36} and resistor R_4 , and the plate voltage of tube 2 is impressed across the series combination of resistor R_3 and condenser C_{39} , the sudden change in plate voltages causes a condenser discharging current to flow out of condenser C_{39} and a charging current to flow into condenser C_{36} . The flow of discharging current through resistor R_3 biases the grid of tube 1 negatively and prevents it from conducting; whereas, the flow of the charging current through resistor R_4 and the control grid 40 of tube 2 biases it positively and thus keeps it conducting. As condenser C_{39} discharges and condenser C_{36} charges, however, the condenser currents decrease exponentially and so the biasing voltages become smaller. The negative bias of tube 1 becomes so small that plate current starts flowing in tube 1 and the circuit triggers. The transfer of current from tube 2 to tube 1 is followed by a similar series of events, such that the control grid 41 of tube 1 is maintained positive and the grid 40 of tube 2, negative. Thus, as condenser C_{39} charges and condenser C_{36} discharges, the condenser currents and the biasing voltages gradually become smaller until the circuit again triggers. The cycle is automatically repeated, and its duration is under control of the selection of the condenser or capacitor switch 38 (FIG. 1), which may select any of capacitors C_1 through C_6 to serve as capacitor C_{39} in FIG. 3. Also, the relative value of the resistors R_3 and R_4 may be selected by an adjustment of potentiometer R_{15} , to change the biasing applied to tubes 1 and 2, respectively, thereby

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altering the pulse duration or duty-ratio for the generator.

In the foregoing analysis, it may be noted that the screen grid 51 and the suppressor grid 53 of tube 1 (FIG. 1) are not necessary, and they are accordingly tied together and to the anode of tube 1 at point 35. The screen and suppressor grids of the other tubes are similarly, respectively connected.

Thus, it may be appreciated that the output from the generator comprising tubes 1 and 2 appears across resistor R_7 and is applied directly to the cathode 55 of tube 3. The output of the clipper amplifier tube 3 determines the grid potential applied to the commonly-connected control grids 60 and 61 of tubes 4 and 5 at point 63 between resistors R_9 and R_{10} . Again, it should be noted that a direct path is provided without resort to coupling capacitors. It should also be noted that the effect of the clipper tube 3 is to eliminate any peaks or rounded regions from the tops of the pulses 31 of FIG. 2, so that the output pulses from clipper tube 3 are square, regardless of whether they were peaked or rounded when applied from the generator tube 2 to the clipper tube 3.

The superimposed square pulses on the D.C. level of FIG. 2 appear at potentiometers R_{16} and R_{17} , connected as the cathode-follower resistors for tubes 4 and 5. The output power is, of course, adjustable at the potentiometers R_{16} and R_{17} to control the energy applied respectively to the patients over patient electrodes $a-b$ and patient electrodes $c-d$, but in any event, it is apparent that energy is available at all times, because of the steady state D.C. component manifesting itself beneath and between the square pulses 31, as clearly seen in FIG. 2.

What is claimed is:

1. A portable apparatus for artificially inducing sleep by the action on the brain of electric current pulses, comprising electrodes adapted to be secured on the patient's head; an electronic pulse generator for producing square pulses; and means connected to receive the output of the generator for developing a direct-current component and superimposing said square pulses onto said direct-current component for application to said electrodes, said last-mentioned means including a cathode-follower connected electron tube having a cathode resistor across which the electrodes are connected for transmitting the pulses to the patient's head.

2. A portable apparatus for the treatment of various diseases by artificially inducing sleep through the action of electric current pulses applied to the brain, comprising electrodes adapted to be secured on the patient's head; a pulse generator operating as a self-excited multivibrator to produce a train of pulses; clipper means connected to the output of the generator for cutting off the multivibrator pulse peaks to provide substantially square

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pulses; means for deriving a direct-current component; and means for superimposing the pulses on the direct-current component, said last-claimed means comprising a cathode-follower connected electron tube with a cathode resistor, said cathode follower tube being connected to the clipper means for energization by the pulses from the clipper means, and output terminals connected to the cathode resistor whereat said electrodes are connected for transmitting the pulses to the patient's head.

3. A portable apparatus for artificially inducing sleep in one or more patients by the action of electric current pulses on the brain, comprising electrodes adapted to be secured on each patient's head; an electronic pulse generator of square pulses; means for developing a direct-current component; means for superimposing the square pulses on the direct-current component, comprising a plurality of cathode-follower connected electron tubes, the output of each such electron tube including a cathode resistor comprising output channels therefor, said means for superimposing further comprising output terminals across each cathode resistor whereat a pair of said electrodes is connected to the cathode resistor of each electron tube, each said pair of electrodes adapted to serve one patient; and means for independently controlling the output current from each of the electron tubes.

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