DUAL OSCILLATOR, VARIABLE PULSE DURATION ELECTROTHERAPEUTIC DEVICE

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UNITED STATES PATENTS
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2,700,975 2/1955 Hepfinger et al. ......................... 128/421
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2,622,601 12/1952 Nemec .................. ........................ 128/422

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ABSTRACT

A first multi-vibrator produces square wave pulses of constant voltage for a 15 second period with a three second "off" interval in between each pulse. The 15 second pulses are converted into ramp pulses of the same period and interval. The ramp pulses are used to control a second multivibrator which produces a series of constant voltage square wave pulses during the 15 second period. Each succeeding square wave pulse during the 15 second period is of a slightly longer duration so that there is a constant increase in the time duration of the square wave pulses during each 15 second period. The cycle is repeated after the 3 second "off" interval between the 15 second pulse periods. The varying square wave pulses are used to trigger separate 4KHZ and 6KHZ voltage oscillators. Each oscillator produces output pulses at their respective frequencies of the same duration and interval as the square wave inputs. The frequency pulses are amplified by separate amplifiers and the amplified pulses are applied by a body probe to the patient. Zener diodes are provided at the output of each amplifiers to limit the maximum possible voltage that may be applied to the patient.

6 Claims, 1 Drawing Figure
DUAL OSCILLATOR, VARIABLE PULSE DURATION ELECTROTHERAPEUTIC DEVICE

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to electrotherapeutic devices, and more particularly to apparatus for applying two separate frequencies of electrotherapeutic currents to the body of the patient each of said frequency currents being applied as a repeating series of pulses of increasing duration during a predetermined period.

DESCRIPTION OF THE PRIOR ART

From the earliest times of electrical knowledge, the response of organic tissue to the stimulus of electric current has been known. The first detailed scientific investigation of these effects was performed in Italy by Luigi Galvani, professor of anatomy at the University of Bologna. Due to the primitive state of development of electro equipment in this era, his work was of necessity limited to application of steady-state DC and very low frequency (manually pulsed) AC. Galvani also observed and investigated the effects upon organic tissue of the induced energy resulting from the spark discharge of a nearby electrostatic generator, such discharges being largely oscillatory in nature and containing components of several frequencies.

Many studies were performed during the 19th century by many workers involving the application of electrical currents to the human body for medical purposes, with such studies being devoted to the effects of various intensities, frequencies, directions of current flow, and electrode arrangement. Various apparatus for applying electrotherapeutic currents to the body of a patient have been developed. For example, U. S. Pat. No. 1,425,743 — Baruch which issued in 1922 covered an apparatus which produced an alternating electrostatic field of a plurality of different frequencies so that a heterodyne effect was produced within the tissue of the patient. Similarly, French Patent No. 859,618 published Dec. 23, 1940 describes an electrotherapeutic method which comprises the application to the body of two high frequency currents which intersect within the tissue of the patient so that upon intersection, a beat frequency equal to the difference between the two high frequencies resulted and was experienced by the patient. Similar heterodyne effect electrotherapeutic devices have been developed. For example, U. S. Pat. No. 2,622,601 — Nemec and U. S. Pat. No. 3,096,768 — Griffith disclose electrotherapeutic devices for producing and applying two separate signals of different frequencies to the body of the patient to produce heterodyne "beat" frequency sensation.

As is well known in the art, the stimulating effect of therapeutic electrical current is dependent on the form of the individual impulses and the frequency and intensity of the pulses. Furthermore, it is a well-known phenomenon of human physiology that a constant application of a sensorial stimuli to the nervous system has the effect of desensitizing the nerves over a period of time. Consequently, if the purpose of the electrotherapeutic device is to produce an anesthesia of a particular portion of the body, a constant unvarying electrotherapeutic current should be applied to the area. However, where it is desired to limit the desensitization of the area to be treated, a constantly varying electrotherapeutic impulse should be applied to the area to be treated.

Further, to provide maximum therapeutic results, it is often desirable to apply various frequencies of electrotherapeutic current to the body of the patient. However, rather than utilizing the heterodyne effect between two frequencies to create a low frequency sensation to the patient, essentially the same sensation may be created by applying pulsed currents of a very low frequency.

SUMMARY OF THE INVENTION

An electrotherapeutic device for applying therapeutic electrical currents to the body of a patient comprises pulse producing means for producing a series of square wave voltage pulses during a repeating predetermined time period, each predetermined period being time separated by a predetermined time interval. Each succeeding square wave voltage pulse during each predetermined period being of a longer time duration than the preceding square wave voltage pulse. Thus a repeating series of time duration increasing pulses is produced during each predetermined period. Control means are included for controlling the magnitude of the square wave voltage pulses. A first oscillator means is provided for receiving the square wave voltage pulses and producing first output oscillating pulses in response to the input of the square wave voltage pulses. The first output oscillating pulses are of an oscillating frequency of a predetermined first oscillating frequency and have a time duration and repeating predetermined period corresponding to the time duration and repeating predetermined period of the square wave voltage pulses. Also provided is a second oscillator means for receiving the square wave voltage pulses and producing second output oscillating pulses in response to the receipt of the square voltage pulses. The second output oscillating pulses are of a second frequency different from the frequency of the first output oscillating pulses. The time duration and repeating predetermined period of the second output oscillating pulses corresponds to the time duration and repeating predetermined period of the square voltage pulses. Separate first and second amplifying means are provided for receiving and amplifying the first and second output oscillating pulses respectively. Probe means are provided for applying the amplified first and second output oscillating pulses the body of the patient.

Voltage sensitive means may also be connected to the first and second amplifier means for preventing the magnitude of the amplified first and second oscillating voltage pulses from exceeding a predetermined maximum voltage. Thus, patient safety is assured. In addition, audio monitor means may be connected to the first and second oscillator means to produce an audibly perceptible means of monitoring the output of the present invention. Further, visual indicating means may also be utilized to visually indicate the magnitude of the oscillating voltage pulses as applied to the patient.

Accordingly, it is an important object of this invention to provide an electrotherapeutic device which applies separate voltage currents of separate frequencies to the body of the patient by a series of pulses of varying duration during a predetermined period.

Another object of the present invention is to provide an electrotherapeutic apparatus having a voltage sensitive device connected to the output of the amplifying
means to prevent the output from exceeding a maximum predetermined magnitude to protect the patient from dangerous levels of electrical current.

Yet another object of the present invention is to provide an electrotherapeutic device having both visual and audible means for monitoring the output of electrical current applied to the patient.

These and other objects, advantages, and features of the subject invention will hereinafter appear, and for the purposes of illustration, exemplary embodiments of the present invention are illustrated in the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

The drawing is a schematic drawing of a preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

As shown in the drawing, an electrotherapeutic device for applying therapeutic electric current to the body of a patient comprises a first multi-vibrator 10 which produces a multiplicity of constant voltage signals of a predetermined time period. Each of the multiplicity of voltage signals is separated by a predetermined "off" interval. Immediately above multi-vibrator 10 is a visual representation of the output of multi-vibrator 10 with time being the horizontal axis and voltage being the vertical axis. The magnitude of the voltage being represented by the symbol V1, and the predetermined time period of the constant voltage signal being represented by the symbol T1. The predetermined interval between the constant voltage signals is represented by the symbol T2.

The constant voltage signals from multi-vibrator 10 are applied to an integrator circuit 12 which converts the constant voltage signal into "ramp" pulses of constantly increasing voltage from zero voltage to voltage V1 of the constant voltage signal provided by multi-vibrator 10. Immediately above integrator circuit 12 in the drawing is a visual representation of the ramp pulses produced by integrator 12.

The ramp pulses from integrator 12 are then applied to a second multi-vibrator 14. The ramp pulses from integrator circuit 12 are used to control multi-vibrator 14 so that multi-vibrator 14 produces a series of square wave pulses during the predetermined time period T1. Each succeeding square wave pulse during the predetermined time period T1 is of an increasing time duration. Thus, a repeating series of time duration increasing square wave pulses is produced by multi-vibrator 14 during each predetermined period T1. A visual representation of the square wave pulses produced by multi-vibrator 14 is illustrated in the diagram immediately above multi-vibrator 14 in the drawing.

The square wave voltage pulses are then applied to a variable voltage divider 16. Variable voltage divider 16 is utilized to provide a control means for controlling the magnitude of the square wave voltage pulses applied to first voltage oscillator 18 and second voltage oscillator 20. Provided at the output of variable voltage divider 16 is a meter 22 which visually indicates the magnitude of the output of the square wave voltage pulses from variable voltage divider 16.

First and second voltage oscillators 18 and 20 are either conventional variable frequency or set frequency voltage oscillators. Typically, first voltage oscillator 18 produces a 4KHZ frequency output and second voltage oscillator 20 produces a 6KHZ frequency output. The input of the square wave voltage pulses from variable voltage divider 16 triggers the operation of first voltage oscillator 18 and second voltage oscillator 20 respectively to produce oscillating pulses of the same time duration as the input square wave pulses. Thus, the output pulses of first and second voltage oscillators 18 and 20 comprise oscillating signals of for example 4 and 6 KHZ in the same pulse duration relationship during the predetermined time period T1 as the square wave voltage pulses produced by second multi-vibrator 14. The magnitude of the output oscillating signals of first and second voltage oscillators 18 and 20 is controlled by the magnitude of the pulses applied by variable voltage divider 16.

Also connected to first and second voltage oscillators 18 and 20 is a monitoring amplifier 22. Connected to monitoring amplifier 22 is a speaker 24. Monitoring amplifier 22 and speaker 24 provide an audible means of monitoring the output of first and second voltage oscillators 18 and 20.

The output of first and second voltage oscillators 18 and 20 are connected to first and second power amplifiers 26 and 28 respectively. First and second power amplifiers 26 and 28 amplify the respective oscillating voltage signals applied from the first and second voltage oscillators 18 and 20. The output of first and second power amplifier 26 and 28 are connected to electrodes 30 of body probe 32. Body probe 32 is applied to the portion of the body of the patient to which the electrotherapeutic current is to be applied.

Connected to the output of third and fourth power amplifier 26 and 28 are Zener diodes 34 and 36. Zener diodes 34 and 36 are connected to ground and are voltage sensitive devices which switch from a very high impedance to a very low impedance after a predetermined voltage level has been exceeded. Thus, when the output of first and second power amplifiers 26 and 28 exceeds the predetermined switching voltage of Zener diodes 34 and 36, the Zener diodes 34 and 36 switch to a low impedance thus preventing the output of first and second voltage amplifiers 26 and 28 from exceeding switching voltage of Zener diodes 34 and 36. In this manner the application of a dangerous level of voltage to the body of the patient is prevented.

Thus, it may be seen that a new and improved electrotherapeutic device for applying therapeutic electric currents to the body of a patient has been provided. This device provides additional advantages over the prior art electrotherapeutic devices since it applies two separate high frequency currents to the body of the patient by time duration increasing pulses during a predetermined interval of time. These time duration increasing pulses are repeated after a predetermined "off" interval (designated T2 in the drawing), and the series of pulses is continued. Thus, the therapeutic effectiveness of the device is maintained without desensitizing the patient's nervous system to the applied therapeutic electric currents.

It should be expressly understood that various changes, modifications may be made in the above described apparatus without departing from the spirit and scope of the present invention, the features of which are set forth in the accompanying claims.

We claim:
1. An electrotherapeutic device for applying therapeutic electrical currents to the body of a patient comprising:

- first multi-vibrator means for producing a multiplicity of constant voltage signals of a predetermined time period, each of said multiplicity of voltage signals being separated by a predetermined time interval;
- integrator means for receiving and converting each of said multiplicity of constant voltage signals into a corresponding ramp pulse having an increasing voltage magnitude during the predetermined period;
- second multi-vibrator means for receiving and converting each of said ramp pulses into a multiplicity of separate square wave voltage pulses, the time duration of each of said square wave voltage pulses increasing proportionately during said predetermined period;
- control means for controlling the magnitude of said square wave voltage pulses;
- first oscillator means for receiving said square wave voltage pulses and converting said square wave voltage pulses into first oscillating voltage pulses having a first frequency, said first oscillating voltage pulses having the same proportionally increasing time duration as said square wave voltage pulses;
- second oscillator means for receiving said square wave voltage pulses and converting said square wave voltage pulses into second oscillating voltage pulses having a second frequency, said second oscillating voltage pulses having the same proportionally increasing time duration as said square wave voltage pulses,
- first amplifier means for receiving and amplifying said first oscillating voltage pulses,
- second amplifier means for receiving and amplifying said second oscillating voltage pulses;

2. An electrotherapeutic device as claimed in claim 1 further comprising voltage sensitive means connected to said first and second amplifier means for preventing the magnitude of the amplified first and second oscillating voltage pulses from exceeding a predetermined maximum voltage.

3. An electrotherapeutic device as claimed in claim 1 further comprising visual indicating means to visually indicate the magnitude of the oscillating voltage pulses applied to the probe means.

4. An electrotherapeutic device as claimed in claim 1 further comprising audio monitor means connected to said first and second oscillator means, said audio monitor means for reproducing audible perceptible pulses of a frequency corresponding to the frequency of said first and second oscillating voltage pulses.

5. An electrotherapeutic device as claimed in claim 1 wherein said probe means comprises:

   a first pair of body contacts connected to said first amplifier means for receiving said first oscillating voltage pulses and applying said first oscillating voltage pulses to the body of the patient;
   a second pair of body contacts connected to said second amplifier means for receiving said second oscillating voltage pulses and applying said second oscillating voltage pulses to the body of the patient.

6. An electrotherapeutic device as claimed in claim 2 wherein said voltage sensitive means comprises a first Zener diode connected from said first amplifier means to a ground; and a second Zener diode connected from said second amplifier means to a ground.

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