June 26, 1951 R. REITER 2,558,270

THERAPEUTIC ELECTROSTIMULATOR

Filed Nov. 17, 1947

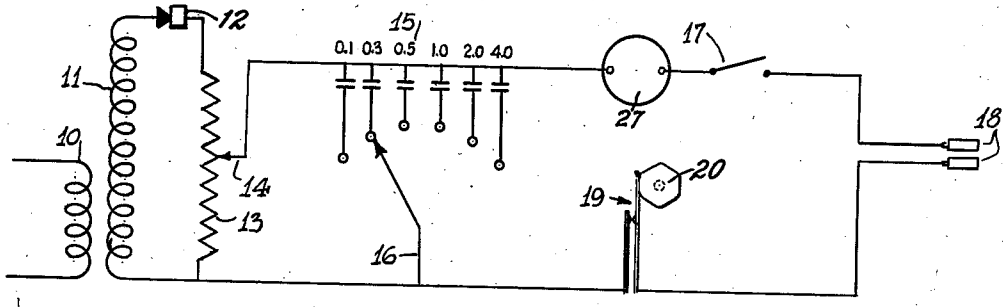
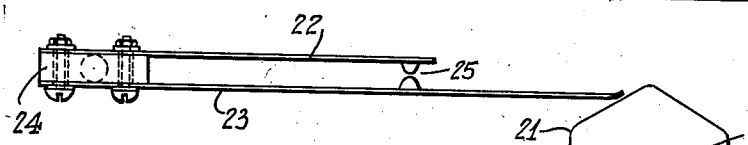


Fig. 1.



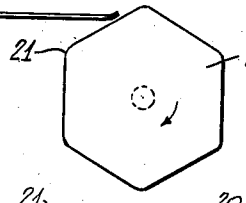


Fig. 2.

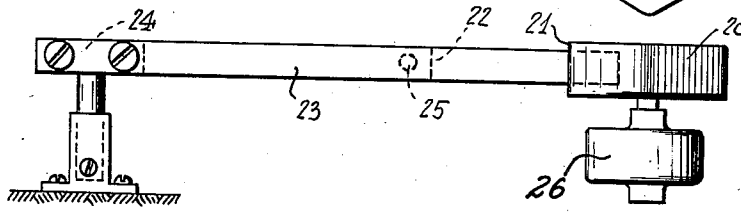


Fig. 3.



Fig. 4.

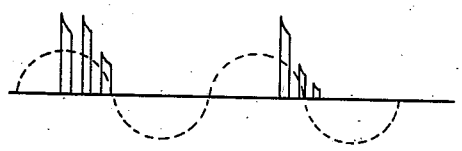


Fig. 5.

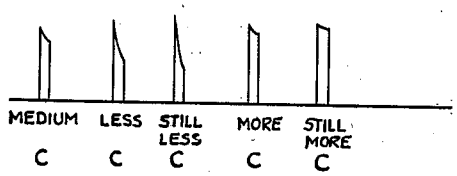


Fig. 6.

INVENTOR.
REUBEN REITER.
BY Carey Freeman
ATTORNEY.

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THERAPEUTIC ELECTROSTIMULATOR

Reuben Reiter, New York, N. Y.

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13 Claims. (Cl. 128—423)

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This invention relates to a new and useful method and apparatus for use in shock therapy.

An object of the invention is to change the customary procedure in giving patients shock treatments so that with minimum dosage least brain destruction is caused; minimum confusion ensues; minimum apnea or none at all may be resultant; similarly minimum or zero anoxia is caused; and controlled after effects may be achieved.

A further object is to provide simple, efficient, economical, easily operated means for the treatment of manic depressives, schizophrenics, melancholics, paranoiacs, etc., and for the effective relief of ailments such as hyper-tension, to produce narcosis with small dosage, to produce hypnotic states, and slumber, and to produce minimum physical reactions without the use of drugs.

Still further objects concern the provision of an easily portable unit which can be plugged into an ordinary light socket and is reasonably free of maintenance troubles or can be used with converters from standard sources of power.

Further and more specific objects, features, and advantages will more clearly appear from the detailed specification hereinafter set forth especially when taken in connection with the accompanying drawings which illustrate a present preferred form which the invention may assume and which forms part of the specification.

In general and brief terms the invention concerns the provision of a small, portable, compact, easily operated, economically manufactured unit in which power of small current and high voltage pulsating quality can be impressed upon a pair of electrodes to be applied to a patient's anatomy for shock treatment.

In the art of shock therapy, I have found that a particular type of voltage pulse train, composed of periodic bursts of pulses of a continually varying nature as to amplitude and shape, will produce the desired improved results.

More particularly the invention comprises a source of sine waves, preferably rectified, in parallel with a condenser, and both in series with electrodes to apply to the patient, and a circuit closer operated at determined intervals with auxiliary means to make and break the circuit rapidly between said regular closures, these auxiliary means preferably in the form of vibrating springs with circuit contacts thereon.

Another way of looking at the invention is to consider that it involves the application to electrodes, at regular instants, of a sinusoidal wave

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and the discharge from the condenser and at the same time opening and closing said circuit at stated periodicity between said instants to create a series of pulses or bursts.

A present preferred form which the apparatus, operated in accordance with the novel method, may assume, is shown in the drawings, of which,

Fig. 1 is a schematic diagram of the apparatus employed;

Fig. 2 is a detail of the rotating contact making cam and the "bouncing contacts";

Fig. 3 is a side view of the detail shown in Fig. 2.

Fig. 4 is a diagram of the pulses or bursts produced and impressed upon a sine wave and slightly out of synchronism with it;

Fig. 5 is a similar view of pulses applied at a different phase of the sine wave; and,

Fig. 6 shows various types and shapes of bursts or pulses produced to achieve different desired effects.

Referring now merely to the specific apparatus shown in the drawings, there is provided (Fig. 1) a connection from an ordinary 110 v. light socket to the primary 10 of a transformer, the secondary of which 11 forms with a rectifier 12 an alternating current wave rectifier. This rectifier therefore produces pulsating current unidirectional in character. For the purposes intended, rectified current is desired although under certain conditions and for other purposes regular alternating waves may be employed.

Across the rectifier is disposed a 5000 ohm potentiometer 13 with an adjustable arm 14, in series with which arm is one side of a variable condenser 15 the other side of which is connected to an adjustable arm 16 connected to one end of the potentiometer 13. A series circuit is formed and contains the condenser and the included portion of the potentiometer; in parallel, a hand switch 17, a D. C. milliammeter 27, electrodes 18, and a rotary contact maker 19, the details of which are important and are to be explained.

In Figs. 2 and 3 is shown an enlarged view of the rotary contact making device 19. It consists of a rotary disk or cam 20 having a plurality of corners or lobes 21 and in this detail is in the form of a hexagon. It is rotated by any suitable means as for instance by motor 26 and at a predetermined speed which of course can be varied as desired. The corners or projections 21 are adapted and intended to make contact with one element of a pair of spring blades 22 and 23 separated and fixed at one end by an insulating

spacer block **24**. At the other ends of the blades they are provided on adjacent faces with contact elements **25**. The rotation of the disk **20** causes the points or corners to elevate the lower blade **23** and close the contacts **25**. The blades "bounce" or vibrate between the time successive points close them, and, in so doing, close the circuit rapidly between each definite closing thereof by the cam corners. The rate at which this intermediate or auxiliary make and break of the circuit occurs depends upon the nature of the blades and therefore their natural frequency of vibration. Blade **23** particularly will vibrate in its natural periodicity until it is again contacted by cam corner **21**.

In this manner, the current supplied to the electrodes and therefore to the patient is caused to consist of a burst of brief, more or less sharp, unidirectional pulses, as indicated in Figs. 4 and 5. Preferably 60 cycle A. C. current is transformed to a voltage of about 370 volts and is then rectified so that only unidirectional half-sine waves are provided to charge the condenser at the rate of 60 per second. This unidirectional current is applied to the patient through the electrodes **18**, the contact maker serving to make and break the circuit, the "bouncing" means thereof serving to form the series of current pulses as shown in Fig. 4. These pulses may vary in number but generally are in number from 20 to 10 for each individual sine wave depending upon the adjustment of the contacts of the contact maker. These contacts are normally open so that not until they are definitely closed by the rotating disk or cam, and then begin to "bounce," is there any discharge through the electrodes into the patient. The contacts **25** are generally disposed in normal position about 1/64 inch apart so that the spring blades **22—23** have only a small distance to make and break relative to the length of the blades, whereby spring fatique is minimized. The small currents needed for treatment cause little wear of the contacts after many equivalent treatments, there being substantially no sparking between the contacts due to the energy dissipation in the resistance of the patient at electrodes **18**. The position of the moving spring blades is so adjusted that the maximum average current as read on milliammeter **27** is approximately 20 to 30 milliamperes and this adjustment is accomplished by moving the set of blades relative to the rotating disk or cam **20** in any suitable manner (not shown). This also adjusts the duration of the pulses, or of bursts.

The rotating disk **20** is designed to close the contacts approximately 32 times a second. Thus the contacts close at slightly different portions of the sine wave, shown in dotted lines in Fig. 4. When the contacts are closed current flows to the patient both from the charged condenser and from the rectified half waves. The combined current is affected by the "bounce" of the contact maker **19**. When the contacts **25** close, and bounce, the individual steep-walled pulses are formed. They consist primarily of current derived from the charged condenser and, therefore, attain an instantaneous peak followed by a typical condenser decay characteristic as current flows until the contact "bounce" causes an interruption. Each pulse is similarly effected. The condenser current is combined with the rectified half wave. The train of pulses thus created starts with a high pulse current because of the initial condenser charge and varies thereafter

for each pulse in accordance with the point of the rectified half wave at which the contacts were closed. Thus each train of pulses starts with a high current pulse received from the condenser and varies thereafter in a regular manner as the contacts close on different portions of the rectified half wave. This character of the pulses and their variation in the manner and for the reasons above stated are shown in Figs. 4 and 5. In these figures the sine wave is shown in dotted lines. In the first series of "bounce" pulses shown at the left in Fig. 4 the regular sine wave is increasing and that is why the second, third, and fourth pulses increase after the initial high pulse. The fifth pulse starts to decrease in amplitude since the sine wave is starting then to decrease. Similar reasoning shows why the pulses shown in the remainder of Figures 4 and 5 are shown as they are.

In Fig. 6 the first pulse is shown as fairly sharp in the peak slope. The next is shown with a sharper peak and the next with a very sharp peak. The next two pulses are shown with much flatter peaks. The nomenclature below each of these peaks indicates that the variation in condenser values is the cause of these variations.

In Fig. 1 the switch or arm **16** may be connected to a circuit with condenser values running from 0.1 to 4.0 microfarads in gradual steps as shown. The lowest value provides a pulse with a pointed peak and sharp decay before the pulse is interrupted. As the condenser value increases, the top of the pulse becomes less pointed because the decay curve is more gradual so that the pulse tops become nearly flat.

With high condenser values and consequent flatter pulse tops, it appears that sleep is induced in the patient most readily. In general, a condenser value of 0.3 microfarads is most suitable for an average treatment in which specific effects are not looked for. In general, a value of 0.3 or 0.5 does not produce apnea i. e. respiratory embarrassment, when larger currents are used for treatment.

From the above, it will be obvious that with the operation of the "bouncing" contacts being instituted at the rate of 30 times per second, the wave trains would be exactly alike in general form from train to train. However, with a few more or less operations than 30, the wave trains produced are progressively initiated at adjacent and varying points in the half waves. It is therefore very clear that here is offered an infinite variety of resultant wave forms which can be simply produced by altering the disk or cam speed, by varying the contact position with respect to the disk, or by changing the natural periodicity of the springs. This all is effected by an apparatus and combination of elements which are exceedingly durable, and easy to operate.

Furthermore, it can be observed that in the treatments the apparent effect on the brain of the patient can be varied by selecting any one condenser out of six available and shown in Fig. 1. The smaller condensers allow a sharper peak and sharper decay curve for each pulse; conversely, the larger value of condenser creates a much smaller peak as well as a more gradual decay curve for each pulse. Moreover, the smaller condenser discharges practically completely during the first closure of the "bouncing" contacts so that the pulses have a magnitude corresponding to the rectified sine wave in general, following the initial pulse of large magnitude

due mainly to the fully charged condenser. In similar manner, the large condenser discharges only partially during any one closure of said contacts and, therefore, has enough charge to supply each of the pulses in the pulse train and the train is only slightly affected by the shape of the rectified sine wave, so that the pulses were nearly of the same magnitude for the entire wave train.

In the practical application of the device in use for treatments, if large currents, from ten to twenty milliamperes, are used, it was found necessary to use a condenser of 0.3 or 0.5 or 1.0 microfarad to avoid marked apnea. With smaller currents, from 2 to 7 milliamperes, it is found possible to use all of the six condensers at will without marked apnea.

Of course it is clear that the specific combination of elements herein set forth and illustrated are only one form of combination which may be used to produce the same beneficial and desirable results. In any form however there must be produced a rectified wave which is impressed upon a condenser or similar device. There must be means to make and break the circuit of discharge at controlled intervals, and means between said intervals for an auxiliary make and break of the circuit to create a series of pulses of separate identity but of shape and number depending upon the periodicity of the auxiliary make and break means and the value of the condenser.

While the invention has been described in detail and with respect to a present preferred form which it may assume, it is not to be limited to such details and form since many changes and modifications may be made in the invention without departing from the spirit and scope of the invention in its broadest aspects. Hence it is desired to cover any and all forms and modifications of the invention which may come within the language or scope of any one or more of the appended claims.

What I claim as my invention, is:

1. A method of producing a therapeutic unidirectional current in a circuit of which a patient is a part which comprises applying rectified sine waves to said circuit, storing part of the energy of said waves in a storage device, momentarily periodically discharging said storage device and simultaneously utilizing the rectified source of sine wave current to produce a type of current different from said original rectified source, and making and breaking said circuit a series of times between said momentary discharge instants.

2. A method of producing therapeutic unidirectional currents in a circuit of which a patient is a part, which comprises the simultaneous application of rectified alternating current sine wave-voltage and the voltage of a storage device to the circuit, closing said circuit momentarily periodically, and then making and breaking said circuit at a determined rapid rate between said momentary periodic closures to produce bursts of current pulses.

3. In a therapeutic device, means for impressing sine waves on a circuit, a condenser connected thereto to receive part of the energy of said waves, a pair of normally spaced contacts mounted on spring elements in said circuit, at least one of said spring contacts being free to vibrate in its natural periodicity, and a rotary means engaging one of said elements to close the contacts momentarily at stated intervals, said spring elements being vibratory to open and close said circuit in a series of vibrations between said stated moments of closure by said rotary means.

4. In a therapeutic device, means for impressing rectified sine waves on a circuit, a condenser connected thereto to receive part of the energy of said waves, a pair of spring blades having normally spaced contacts and disposed in said circuit, a rotary disk engaging said blades to close them a number of times a second, said blades being capable of vibration when released after closure by said disk to vibrate in their natural periodicity to open and close said circuit at a determined rate between said closure moments, and adjustable power means to rotate said disk at various selectable substantially constant speeds.

5. In a therapeutic device, a rectifier for alternating current, a condenser in parallel therewith, therapeutic electrodes and a circuit maker and breaker in series with said rectifier and said condenser, power means coupled thereto for momentarily actuating the circuit maker and breaker in timed sequence and auxiliary means to open and close said circuit a number of times between the actuations of said circuit maker and breaker.

6. A method of producing a unidirectional therapeutic current in a patient which comprises producing a rectified alternating current wave, storing some of the wave energy in a storage device, combining said wave and stored energy in parallel so that the resultant wave can be applied to therapeutic terminals which are in series with the patient, initiating such application at periodic intervals, each periodic application comprising a plurality of momentary applications of said resultant current to said terminals.

7. An apparatus for producing therapeutic unidirectional currents which includes a pair of normally spaced spring contact members, and power-driven means coupled with said spring members for positively making said members contact at periodic intervals, said driven means permitting at least one of said spring members to vibrate between said contact-making instants whereby the circuit in which the members are located will open and close in stated series for a determined portion of the time between said stated contact-making instants.

8. In a therapeutic device, a pair of switch members having cooperating contacts, at least one of said members being a freely vibratory spring mounted for free vibration in its natural periodicity to make repeated contacts during excursions of full amplitude and means on said device periodically to replenish the stored energy in said freely vibrating spring to maintain said full amplitude during a determined portion of the time between said periods.

9. In a therapeutic device, means connected to a circuit for impressing half sine waves thereon, a storage device in said circuit to receive some of the wave energy, a pair of electrodes in said circuit for attachment to a patient, power driven means coupled to said storage device and to at least one of said electrodes for making and breaking said circuit at stated moments, and means in said circuit for opening and closing said circuit a number of times between said stated moments whereby to supply half sine wave energy and stored energy simultaneously to a patient attached to the electrodes.

10. In a therapeutic device, means for impressing rectified alternating current waves on a circuit, a storage device connected thereto to receive

some of the energy of said waves, a pair of electrodes in said circuit for attachment to a patient, a pair of normally open spring switch elements in said circuit, power driven means coupled thereto to positively close said switch elements briefly at stated moments, at least one of said elements vibrating freely when released after said closure to make an auxiliary series of rapid closures and openings of the circuit in tune with its natural periodicity between said positive closure moments whereby intermittently to apply the rectified alternating current waves and stored energy simultaneously to a patient attached to said electrodes.

11. In a therapeutic device, a rectifier for alternating currents, a potentiometer across said rectifier output, a condenser in parallel with a portion of said potentiometer, therapeutic electrodes and a circuit maker and breaker in series with said portion of said potentiometer and said condenser, said maker and breaker comprising a make and break device, power means to drive said make and break device, and a pair of spring vibratory elements engaged by said make and break device to cause said elements positively to contact at stated moments and to release them, whereby they are free to vibrate at their natural frequency between said closure instants and to open and close the circuit a number of times between each pair of closures.

12. A method of producing a unidirectional therapeutic current in a patient which comprises producing a rectified alternating current wave, storing some of the wave energy in a storage device, combining said wave and stored energy in parallel so that the resultant wave can be applied to therapeutic terminals which are in series with the patient, initiating such application at periodic intervals, each periodic application comprising a plurality of momentary applications of said resultant current to said terminals, the utilization of the current from said storage device being at a different rate than that of the rate of energy storage therein, whereby spaced bursts of varying amplitude unidirectional current pulses are produced in the patient.

13. A method of producing therapeutic unidirectional currents in a circuit of which a patient is a part, which comprises the simultaneous application of rectified alternating current wave-voltage and the voltage of a storage device to the circuit, periodically, closing said circuit momentarily, and then making and breaking said circuit at a determined rapid rate between said momentary periodic closures for a period less than the interval therebetween to produce spaced bursts of current pulses.

REUBEN REITER.

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