

March 19, 1968

R. TAPPER
ELECTRICAL MUSCLE STIMULATOR DEVICE
AND RAZOR ATTACHMENT THEREFOR
Filed April 28, 1967

3,373,747

FIG. 1.

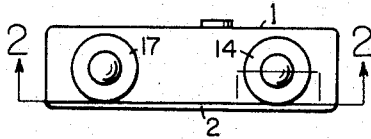


FIG. 2.

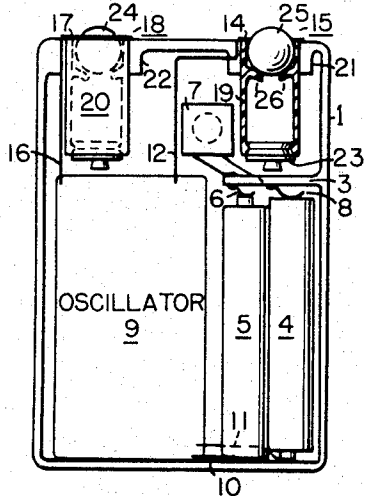


FIG. 3.

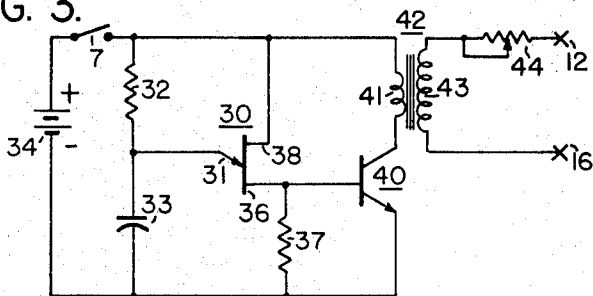


FIG. 7.

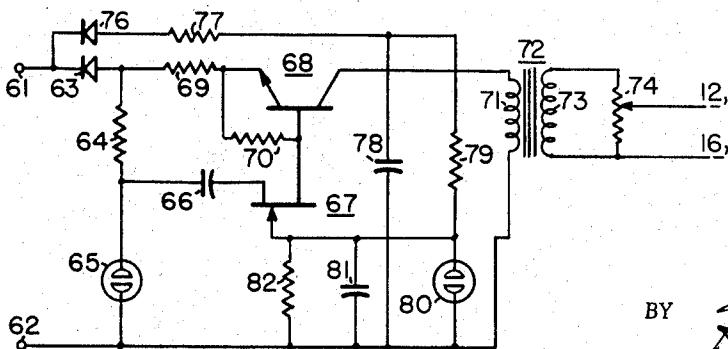


FIG. 4.

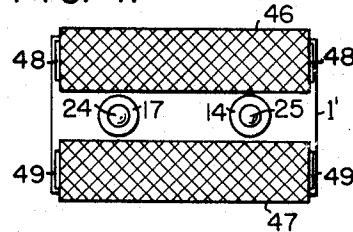


FIG. 5.

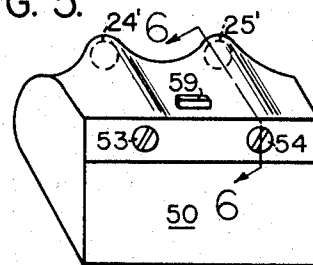
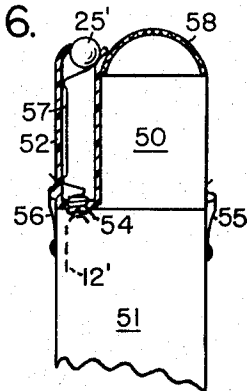


FIG. 6.



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ELECTRICAL MUSCLE STIMULATOR DEVICE AND RAZOR ATTACHMENT THEREFOR

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10 Claims. (Cl. 128-422)

ABSTRACT OF THE DISCLOSURE

An electrical muscle stimulator employs an electrically conductive substance to make contact superficially of a muscle to be stimulated. The conductive substance is dispensed from a pair of spaced dispensers having revolvable spheres. A semiconductor oscillator device provides a unidirectional peaked voltage waveform having relatively long dwell periods between the peaks. For a self-contained structure an amplifier and a step-up transformer in addition to the oscillator device provide a desired amplitude of electrical output, with a variable impedance element included for adjusting it. To accomplish shaving while accomplishing muscle stimulation and/or hair erection, one or more shaving heads are positioned adjacent to the pair of dispensers. Resilient mechanical contact and the electrical contact are provided by a spring within each dispenser. Gating, to periodically interrupt the series of peaked pulses to allow the muscles to relax, is achieved by motion of the device over the skin or by electrical interrupting means.

Cross-reference to related application

The subject matter of this application may be considered as further disclosed in certain aspects in my co-pending application, "Electrical Hair-Erector Shaver," Ser. No. 496,101, filed Oct. 14, 1965, now Patent No. 3,316,633, issued May 2, 1967.

Background of the invention

This invention pertains to pulse electrical means for stimulating muscles, typically those of the face or other exposed parts of the human anatomy, for the cosmetic or therapeutic benefit obtained by such treatment. Concomitantly, the electrical stimulation of the arrector pili muscle associated with each hair of the beard erects such hairs, thereby allowing a close shave to be accomplished when razor means are combined with the pulse electrical means. An electrically conductive substance (lotion) is dispensed in the use of the device.

The prior art for the last hundred years has disclosed various devices for "electric treatments." These have largely been based on the Ruhmkorff vibrator-activated induction coil as a supplier of "faradic currents." The electrical output of such a coil is a relatively high frequency damped alternating current oscillation that is repeated at every breaking of contact by the vibrator. It has long been established that such high frequency current travels largely along the surface of the body, for which reason theatrical performers may act as conductors for extremely high voltages to cause spectacular sparks to emanate from their body without harm.

Also known are "Galvanic currents"; i.e., low voltage direct current as produced by a (galvanic) battery. Electricity such as this has been applied to the body by means of an electrode held in the hand for application where desired, and usually with the required second or return electrode in contact with the hand. Also, pads of the nature of bandages have been used. With such pads, moistening with water at the beginning of a treatment has been disclosed in certain instances.

Summary of the invention

Applicant found that a particularly suitable waveform for the electrical energy consisted of a voltage electrical wave having a single peak of the order of one hundred volts of one polarity, which is repeated some eighty times per second with relatively long dwell periods between the pulses; perhaps fourteen times as long as the duration of the pulse. It is seen that this electrical energy is neither faradic nor galvanic. It is conveniently produced by a transistorized relaxation type oscillator or an equivalent pulse producer. These may be small and can be operated by batteries contained within a single hand-held device.

A pair of dispensers electrically connected to the oscillator output and positioned upon the device relatively continuously dispense small amounts of a conductive substance at the locations where electric current is to enter and leave the body. These locations may be changed simultaneously by movement of the device along the skin of the patient.

Such manipulation in combination with a razor, typically of the electrically operated clipper variety, allows a close shave in view of the stimulation of the arrector pili muscles, making each hair stand on end.

In any form the device allows manipulation of muscles according to a novel sequence of electric current by means of a single small handheld unit, with simultaneous dispensing of a substance which may also have a cosmetic influence upon the skin.

Related mechanical and electrical features combine to form a novel device that is particularly suited to accomplish localized muscle stimulation, with the option of close shaving.

Brief description of the drawings

FIG. 1 shows a plan view of the top of the electrical muscle stimulator according to this invention.

FIG. 2 shows a side elevation view of the same with the side cover removed and one dispenser shown in section along line 2-2 in FIG. 1.

FIG. 3 is the schematic diagram for an oscillator assembly, to provide required electrical energization of the device.

FIG. 4 shows a plan view of the device in combination with dual razor heads.

FIG. 5 shows a bottom perspective view of a modification of the device in combination with a single shaver head.

FIG. 6 shows an end elevation of the combination of FIG. 5, with one dispenser shown in section according to line 6-6 in FIG. 5.

FIG. 7 is the schematic diagram of an electrical pulse producer, an alternate for that of FIG. 3.

Description of preferred embodiments

In FIG. 1 and FIG. 2, numeral 1 indicates a housing of rectangular parallelepiped shape and of appropriate size to be held in one hand, for containing the various elements of a typical embodiment of the invention. Alternately, it may have a relatively oval shape in the horizontal and the vertical planes in order to more closely fit the hand. It is preferably molded of acrylonitrile butadiene styrene ("ABS"), by an injection molding process. This material has high impact strength and thus is suitable to house a device of this kind, which may be inadvertently dropped at times.

Preferably one side 2 is detachable, as a cover, which may be arranged with snap-in lips for fastening. Also, a partition 3 may be formed, between which and the bottom of the housing at least one battery 4 is positioned. In FIG. 2, two such batteries in series electrical connection are shown, the second one being 5. Whether the bat-

teries are series or shunt connected may vary according to circumstances. For the electric razor embodiment, the voltage employed is usually 2.5 volts, since that is a typical voltage for razors and would also be used for the stimulator.

In FIG. 2, batteries 4 and 5 are shown of the "pen-light" shape, although and shape and type of battery may be employed by suitably arranging the volume available for batteries. The batteries are preferably of the rechargeable type and so may be used over and over again upon being recharged by known rectifier charging means from household alternating electric current. As shown, one upper contact 6 contacts the upper external connection of battery 5 and connects to one terminal of on-off switch 7. Another upper contact 8 contacts the there present opposite external connection of battery 4 and connects to the second terminal of switch 7. Oscillator 9 is shown as a block in FIG. 2 and is detailed in FIG. 3. Bottom contact 10 contacting battery 5 is one of the leads from battery to oscillator as shown in FIG. 3, while bottom contact 11 contacting battery 4 is the other lead. Whether switch 7 is in the center of a series connection of batteries as shown in FIG. 2, or whether at one external lead, as shown in FIG. 3, is a matter of choice. The internal mechanical arrangement of oscillator 9 is also a matter of choice and so has not been detailed in FIG. 2.

The output of oscillator 9 appears at conductor 12, which is connected to the upper conductive cover 14 of dispensing means (dispenser) 15. This output also appears at conductor 16, which is connected to the upper conductive cover 17 of dispenser 18. By means of these spaced, yet adjacent dispensers the electric current is confined to the area to be treated. The art has previously often formed one electrode to contact the hand or arm. In such an arrangement the electrical resistance through the body is higher, which predisposes to irritating effects at the area to be treated because a greater voltage is required. Also, the current is required to pass through a path of considerable length within the body, frequently near the heart, where the treatment that was intended to be local may interfere with the health of the heart.

Conductive covers 14 and 17 are formed with overhanging lips of greater diameter than that of the dispenser as a whole; i.e., parts 19 and 20. The latter are convenient slide fits into case 1 by virtue of reentrant apertures 21 and 22 in housing 1. The overhanging lip allows a person to insert his fingernails thereunder and so withdraw the dispenser for refilling. In each instance the contact of connections 12 and 16 to conductive covers 14 and 17 is by the connection being embedded in the plastic housing under the cover, so that when the latter is pressed home after refilling electrical contact is established. Each dispenser body, as part 19, is provided with an open bottom with a circumferential internal ridge thereat, so that a partially resilient closure 23 having a circumferential groove fits into the ridge when pressed into place by the one refilling the dispenser. A knob of reduced diameter is provided to allow easy removal of each closure.

It is preferable to resiliently mount revolvable means 24, 25 within dispensers 20 and 19, respectively. These revolvable means may be metallic and thus electrically conductive, in which case circumferential contact with covers 14 and 17 provides a metallic type of conduction from the output of oscillator 9 to the skin of the patient. The essentially liquid conductive substance dispensed aids in establishing this contact, but does not provide the sole means of contact. In an alternate embodiment revolvable means 24, 25 are not electrically conductive, but are formed of a relatively hard plastic material, such as the "ABS" previously described. In this instance the electrical conductivity is from conductive covers 14 and 17 through the electrically conductive substance dispensed to the skin of the patient.

In any event, a partially or essentially wholly circumferential lip 26 is molded into each dispenser, as 19, to

resiliently support the corresponding revolvable means, as 25. By known fabrication of the dispenser according to the plastics molding art the lip can be relatively resilient while the dispenser as a whole, because of its cylindrical shape, can be relatively rigid. In both the lip and the conductive cover the inner aperture is preferably relieved at plural segments to a larger diameter around the circumference thereof to allow easy flow of the liquid conductive substance from the dispenser past the revolvable means and so to the skin of the patient.

The conductive substance may be in the form of a thin jelly or of a liquid having the viscosity of water, or any intermediate viscosity between these extremes. As a matter of composition the conductive substance may have known cosmetic ingredients, but must have an ionizable ingredient for conducting electric current, of which a dilute solution of the salt potassium chloride is an example.

A suitable circuit for oscillator 9 of FIG. 2 is detailed in FIG. 3. An electrical oscillator per se employs semiconductor device 30, which may be a unijunction transistor of the 2N1671 type. The emitter 31 thereof is connected to the common connection between resistor 32, having a resistance of the order of 15,000 ohms, and capacitor 33, having a capacitance of the order of 4 microfarads. The resistor and capacitor are connected across a primary power source, such as battery 34. This is the equivalent of battery units 4 and 5 of FIG. 2. Switch 7 is interposed in series with the battery for on-off operation.

Base one 36 of unijunction transistor 30 is connected to resistor 37, of 220 ohms resistance. The second terminal of that resistor is connected to the negative terminal of battery 34. Base two 38 of unijunction transistor 30 is connected directly to the positive terminal of battery 34 (through switch 7). This oscillator supplies a peaked pulse having a duration of one unit of time with a dwell (inactivity period) of approximately fourteen units of time between each pulse. The peaked pulse is essentially unidirectional, as regards electrical polarity. The repetition rate is within the range of from 60 to 80 cycles per second, preferably.

A peak voltage pulse of the order of 100 volts is desired for the purposes of the stimulator-shaver of this invention. There may be a following overthrow of opposite polarity of a fraction of this peak overt value. This is disregarded in considering the voltage values, but is not necessarily discharged as a matter of operation in view of the belief that it makes the electrical treatment more pleasurable because of the brief partial reversal of current following the major working pulse. With the self-contained battery operation device described an amplifier and a step-up transformer are desirable means of obtaining this amplitude from the oscillator output.

The amplifier is particularly characterized by transistor 40, which may be of the NPN type 2N1308. The base thereof is connected directly to base one 36 of the oscillator, the emitter of transistor 40 to the negative terminal of battery 34, and the collector thereof to primary 41 of output transformer 42 and therethrough to the positive terminal of battery 34.

Step-up transformer 42 has a step up voltage ratio of approximately 40 to 1. Secondary 43 therefore has more turns of wire by a considerable amount than does primary 41. A variable resistor 44 is connected to one terminal of secondary 43 in series with the output connection 12 (see also FIG. 2 with respect to connection 12). The resistor may have a maximum resistance of the order of 5,000 to 10,000 ohms. It allows adjustment of the voltage impressed upon the skin between the two electrodes; i.e., revolvable means 24 and 25. Since the effective resistance of the skin tends to reduce as treatment or shaving is carried out, resistor 74 may also be a constant current device, or a separate constant current device may be inserted in series with it. The second terminal of secondary 43 connects to connection 16 to complete the circuit.

FIG. 4 shows the device of FIG. 2 combined with a two cutting head electric razor to form a unified device for both muscle stimulation and close shaving at the same time. Cutting heads 46 and 47 are attached at 48, 49 to housing 1' with a space between the heads. Housing 1' is thicker than housing 1 of FIG. 1, and in addition to what is contained in housing 1 also contains mechanical driving means for the two cutting heads of known type. Between the two heads the dispensers are spaced apart as before, having conductive covers 14 and 17 and revolvable means 24 and 25. The muscle stimulation provided by these electrodes in combination with the dispensed conductive material erects the several hairs of the beard or hair elsewhere on the human body by stimulating the arrector pili muscles within an oval area of which the electrode positions are approximately the foci of the ellipse involved as the mathematical equivalent of the oval area. The conductive covers do not touch the (conductive) heads.

An alternate structure for dispensers and a single shaving head is shown in FIGS. 5 and 6. Revolvable means 24' and 25' are the equivalent of prior means 24 and 25. However, the dispensers are an integral part of the head structure as shown in FIG. 5, with details in FIG. 6.

The two dispensers are at one side of the shaving head per se 50, which contains the motor or vibratory apparatus to accomplish shaving. The lower part 51 of the whole device houses oscillator 9, the batteries and other circuit elements as has been described. The reservoir part of the new dispensers 52 are molded in a single plastic structure the ABS material previously mentioned, which structure may or may not also house shaving head 50. In any event, parts 50 and 52 are integral in use, made so by epoxy cement or known fastenings, such as rivets, bolts threaded into threaded inserts in the molded part, or snap-in elements.

Threaded electrically conductive plugs 53 and 54 are located at the bottom of the head 50 structure. These are removable to allow filling the dispensers with the conductive substance and also as intermediate contacts in the scheme of electrical connections. In FIG. 6 connection 12' connects to oscillator 9 (not shown) in the same manner as in FIG. 2, but terminates at the top in a rounded-over spring having an upward thrust when the device is fully assembled. Head 50 is removably attached to housing 51 by spring catches 55 and 56 engaging projections 59 on each side of the head. Connection 12' thus bears securely against plug 54 and connection 16' (not shown) similarly bears against plug 53.

Within each dispenser there is positioned a leaf spring 57 of electrically conductive material, normally a non-corrosive metal. This spring is specially shaped in an expanded W shape as is shown in edge elevation in FIG. 6. At the top the spring has an upward portion which bears against revolvable means 25' and a bight which presses against the opposite side of dispenser 57. The spring extends downward therefrom to another bight near the bottom of the dispenser and then makes a lower return loop against which the top of plug 54 bears when that plug is screwed into place. The shape of the spring is such that it can be pushed into the dispenser after revolvable means 25' has been inserted in the manufacturing process while head 50 is held upside down. Assuming the modification in which revolvable means 25' is electrically conductive it is seen that an electrically conductive path is provided from the output of oscillator 9 to the skin of the person shaving.

In FIG. 6 curved comb 58 indicates the type of electric razor in which a cutter blade sweeps back and forth from left to right and vice versa. This is typical for this type of single head embodiment. However a single or multiple cutter type longitudinally reciprocating head may be substituted, in which event the reciprocation would be in and out of the paper of the drawing. Such heads are illustrated in the copending application.

The construction of FIG. 4 is typical for a two head shaver. However, that general construction can be used for a single head, preferably by moving the dispensers, identified by conductive covers 14 and 17 in FIG. 4, to one side of housing 1' and giving the single remaining head 46 a relatively central lateral position.

Revolvable means 24, 25, 24' and/or 25' may have cylindrical rather than spherical shapes, and may have a length of the cylinder exceeding its diameter.

It will be understood that in addition to the "cordless" type of device previously described an embodiment of the "cord" type can also be fabricated. In this instance the space occupied by batteries 4, 5 in FIG. 2 houses an AC to DC rectifier and other elements of oscillator 9 are preferably altered. Since the typical input power to a cord type device is 115 volt 60 cycle alternating current, the voltage is more than sufficient to energize an oscillator or equivalent pulse producer, thus an amplifier of the type shown at 40 in FIG. 3 is not required. At least one transformer with adequate electrical insulation is required between the cord which connects to the 115 volt supply and revolvable means 24 and 25. This may be either an output transformer, as 42, or a step-down transformer between the 115 volt supply and the rectifier mentioned.

A cord type device is shown in FIG. 7, in which terminals 61 and 62 represent an alternating current source, such as 115 volt 60 cycle house current. A diode 63, which may be a 1N2070 type, is connected to terminal 61 to pass the negative half-cycles of the alternating voltage. This is applied to a series circuit of resistor 64 and gaseous discharge means 65, which also connects to terminal 62. The alternating waveform at the junction between elements 64 and 65 is modified by an abrupt positive-going excursion when discharge means 65 fires. Resistor 64 may have a value of the order of 22,000 ohms and the discharge means may be a neon-filled lamp of small size which may break down at 57 volts.

Capacitor 66 has a capacitance of the order of 0.005 microfarad and is connected to the junction between elements 64 and 65. This capacitor has a very high impedance to any part of the alternation of the 60 cycle sine waveshape of the source mentioned but has a relatively low impedance to the abrupt positive-going excursion. This capacitor is also connected to the source of field effect transistor (FET) 67. The drain of the same is connected directly to the base of transistor 68 to accomplish a modulation process that will be later described.

Transistor 68 may be of the NPN 2N3440 type. The emitter thereof is connected to diode 63 through resistor 69, of 1,000 ohms resistance, while the emitter and base thereof are connected by resistor 70, of 20,000 ohms resistance. Transistor 68 is considered a first semiconductor means, whereas FET 67 is considered a second semiconductor means. The output from this pulse producer device is taken from the collector of transistor 68 and passed through primary 71 of output transformer 72. This may have a step-up ratio of 1 to 1.4. Secondary 73 connects in shunt to potentiometer 74 and from there to output leads, as 12 and 16 in FIG. 2. At these leads a short pulse of a maximum voltage of the order of 100 volts is obtained. The impedance of primary winding 71 may be 5,000 ohms and that of secondary winding 10,000 ohms. Similarly, the resistance of potentiometer 74 may be a maximum of 10,000 ohms.

A second diode rectifier 76 also connects to AC terminal 61 and through resistor 77 of 1,000 ohms resistance and capacitor 78 of 2 microfarads capacitance to AC terminal 62. Elements 77 and 78 comprise a low pass filter to provide essentially direct current for energizing the oscillator means.

A resistor 79 and second gaseous discharge means 80 are connected in series across capacitor 78. The common connection between elements 79 and 80 connects to still another capacitor 81, another resistor 82 and the gate of

FET 67. The second terminals of elements 81 and 82 connect to AC terminal 62.

Elements 79, 80, 81 and 82 comprise a gaseous discharge relaxation oscillator and produce a ramp (saw-tooth) voltage, which is applied to the gate of FET 67. The time constant of elements 79, 81, and 82 is chosen to provide a period of from one to four seconds and to provide bias for the FET. These elements, including 80, are non-linear means.

The ramp voltage modulates the amplitude of the short output pulse from essentially zero amplitude to full 100 volts amplitude in a more or less increasing linear manner during a period of from 1 to 4 seconds according to the time constant selected for elements 79, 81 and 82. This gives the muscle relaxation time normally desired in muscle stimulation. This relaxation need not be provided for the shaving embodiments of FIG. 4 through FIG. 6, since motion over the face takes place.

It will be understood that a number of modifications both mechanical and electrical can be made under the teaching of this specification. While the device of FIG. 2 is normally constructed all in one piece, it will be seen that the same can be separated at partition 3 and only that portion of the structure above the partition applied to the patient.

Various mechanical dimensions and proportions may be altered from the examples given and values of circuit elements may be similarly varied while still obtaining the effect and functioning according to the invention.

A knob for variable control of resistor 44 or potentiometer 74 is positioned with respect to case or housing 1 so that external control of the resistance is possible by turning the knob, or an equivalent adjusting means.

The preferred forms described herein have been given by way of example.

Having thus fully described the invention and the manner in which it is to be practiced, I claim:

1. An electrical muscle stimulator device comprising:

- (a) a hand-sized housing (1), having a narrow end,
- (b) an electrically conductive substance,
- (c) a pair of spaced dispensing means (15, 18), holding said substance, electrically insulated one from the other and attached to said housing upon said end, for dispensing said substance to form electrical contacts superficially of a selected muscle to be stimulated,

- (d) single electrical oscillator means (9) with said housing employing a semiconductor to form an essentially unidirectional spaced peak electrical output waveform, and

- (e) means (12, 16) to connect the electrical output of said oscillator means to said substance dispensed from each of said dispensing means, by an electrically conductive element of each said dispensing means.

2. The stimulator of claim 1 in which each dispensing means comprises:

- (a) a container (20) to hold said electrically conductive substance, and
- (b) revolvable means (24) resiliently attached to said container and in direct contact with said substance to dispense said substance.

3. The stimulator of claim 2 in which:

- (a) said revolvable means (25 or 25') is electrically conductive and essentially spherical in shape, and
- (b) mechanically resilient means (26 or 57) yieldingly retain said revolvable means within said dispensing means (19 or 52), whereby increased pressure upon said revolvable means dispenses an increased amount of said substance upon said superficial area by depressing said revolvable means farther into said dispensing means.

4. The stimulator of claim 1 in which said oscillator means is comprised of:

- (a) a single oscillation-producing semiconductor device (30), and

- (b) only resistive (32, 37) and capacitive (33) electrical circuit elements connected to said semiconductor device to form an oscillator of relaxation type, to impose a relatively long inactivity period upon said semiconductor device, wherein said unidirectional peaked electrical output occurs periodically with relatively long dwell periods between said peaks.

5. The stimulator of claim 1 which additionally includes:

- (a) an electrical energy source (4, 5) within said housing,
- (b) a semiconductor voltage amplifier (40) connected to said oscillator means (9), and
- (c) a voltage step-up transformer (42) connected to said amplifier and to said means to connect (12, 16) to the dispensed substance.

6. The stimulator of claim 1 in which said oscillator means is comprised of:

- (a) an alternating current source (61, 62),
- (b) first non-linear means (64, 65, 66) connected to said source to produce pulses of short duration with respect to the duration of an alternation of voltage of said source,
- (c) first semiconductor means (68) connected to said first non-linear means to amplify said produced pulses,
- (d) second semiconductor means (67) connected to said first non-linear means and to said first semiconductor means, and
- (e) second non-linear means (79, 80, 81, 82) connected to said second semiconductor means to modulate the amplitude of said produced pulses amplified by said first semiconductor means.

7. The stimulator of claim 1 in which said oscillator means is comprised of:

- (a) an alternating current source (61, 62),
- (b) rectifier (63) and first gaseous discharge means (65) connected to said source to produce a pulse upon alternate alternations of short duration with respect to the duration of an alternation of said source,
- (c) a first transistor (68) connected to said rectifier and to said first gaseous discharge means to amplify said produced pulses,
- (d) a second transistor (67) connected to said rectifier and to said first gaseous discharge means through a capacitor (66),
- (e) a second gaseous discharge means (80) and a time-constant circuit (79, 81, 82) connected to said second transistor, the time constant of said time-constant circuit being long with respect to the time interval between said produced pulses,
- (f) a connection from said second transistor to said first transistor to modulate the amplitude of said produced pulses in accordance with the amplitude of the electrical energy flowing in said second gaseous discharge means and said time constant circuit, and
- (g) output transformer means (72) connected to said first transistor and to said means to connect (12, 16) the electrical output to said substance dispensed from each of said dispensing means.

8. The stimulator of claim 7 in which said oscillator means additionally includes:

- (a) a second rectifier (76) connected to said alternating current source (61, 62), and
- (b) a low-pass filter (77, 78) connected to said second rectifier and to said second gaseous discharge means (80), to provide essentially direct current to operate said oscillator means.

9. The stimulator of claim 1 which additionally includes:

- (a) means for cutting hair (46, 47; or 53), and
- (b) means to attach (48, 49; or 55, 56 and 59) said means for cutting hair to said housing (1'; or 51) adjacent to said pair of spaced dispensing means,

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whereby both said means for cutting hair and said dispensing means simultaneously contact an area of skin to be shaved.

10. The stimulator of claim 1 which additionally includes:

(a) means for cutting hair comprising a pair of shaving heads (46, 47), and

(b) a pair of means to attach (48, 49) said shaving heads to said housing (1') on opposite sides of, but out of electrical contact with said dispensing means (14, 17).

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